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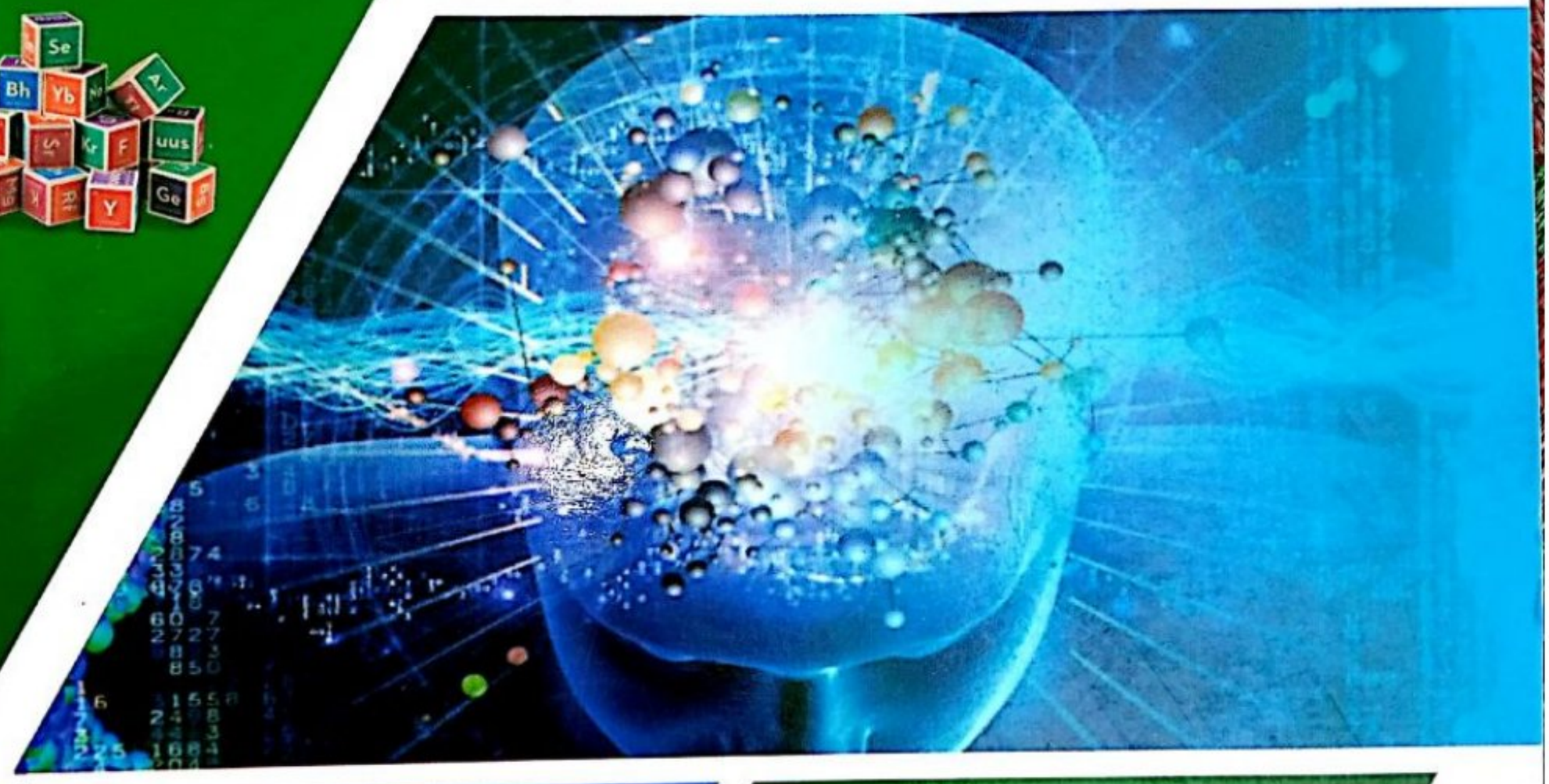

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FUNDAMENTAL CONCEPTS AND MCQs IN CHEMISTRY

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FUNDAMENTAL CONCEPTS AND MCQs IN CHEMISTRY

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This book is intended to provide fundamental concepts in basic and advanvced chemistry and also to comprise sufficent relevant multiple choice questions. This book is intended for maximizing chemistry students' learning experience and skills. The sequence of chapters in this book is designed to make it understandable for all students. We welcome any suggestions for improvements in the organization, scope, and content of this book, as well as notification of any errors. We also want to thank Dr. Muhammad Idrees Jilani for the excellent service provided with both the edit and the proofread.

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PART I: ANALYTICAL/INORGANIC CHEMISTRY

1. PRINCIPLES OF ANALYTICAL CHEMISTRY

The whole universe and everything there in it is composed of matter. In simple, every living or non-living part of universe is made of chemicals. Knowledge of chemicals is important in our daily life. For example determination of nitrogen in fertilizer, pesticide residues in food, pollutants in drinking water etc. Analytical chemistry provides information about any aspect of the chemical characterization of a sample material.Analytical chemistry deals with qualitative and quantitative analysis of all types of physical and chemical analysis of any form of matter including gas, liquid, solid, plasma or supercritical fluid. The acceptability of results of any analytical measurements depends upon accuracy and precision. Accuracy is the degree of agreement between a measured value and a true value.For example, if in lab a weight measurement of 90 g is obtained for a given substance, but the actual or known weight is 100 g, then the accuracy of measurement is 90%. Precision is the degree of agreement between replicates measurements of the same quantity. For example if given given substance in substance previous example weigh 90 g on weighing thrice, its precision will be 100 % although accuracy was 90%. One thing can be very easily concluded from these examples that accuracy and precision are quite different things from each other. Good precision does not guarantee accuracy.The precision may be presented as standard deviation, coefficient of variation or confidence interval (e.g. 95%).An analysis involves several steps and operations which depend on (i) the particular problem (ii) expertise of analyst (iii) Avilable apparatus/equipment. Every analysis should be properely planned before carrying out in the laboratory. Following steps defines how analysis can be carried out in the laboratory. (i) Define problem (ii) Select a method (iii) Obtain a representative sample (iv) prepare the sample for analysis (v) Perform any necessary chemical seaparations (vi) Perform the measurement (vii) Calculate the results and report. A chemical analysis is usually performed on only a small portion of the material to be characterized. For example if soil of a field needs to be tested, it is not possible to transport or analyze whole soil of field. The sample may be solid, liquid or gas. It may be homogenous or heterogenous in composition. Whatever is the situation it is always required to collect every sample in a statistical way. The gross sample consists of several portions of the material to be tested and the laboratory sample is a small portion of gross sample made homogenous. Analysis sample is only a small portion of the material to be characterized. A special care must be taken to avoid alteration or contamination of the collected sample. Analytical methods are arbitrarily classified on the basis of sample size to meso, semimicro, micro, or ultramicro (Table 1).

Table 1. Arbitrary classification of analytical methods

Analytical Method	Sample Quantity
Meso	> 100 mg or µL
Semimicro	10-100 mg or 50-100 µL
Micro	1-10 mg or < 50 µL
Ultra Micro	< 1 mg

Once measurements have been performed, the results obtained should be presented by keeping the data handling rules of statistic as well as significant figures in the mind. Significant figures include all of

the digits that are known plus the first uncertain or doubtful one.The last significant figure is only the best possible estimate.For example, if volume in between 100.3 and 100.5, it must be written as 100.4 not as 100.40. Once you decide how many digits to retain, the rules for rounding off numbers are straightforward. There are three possibilities of rounding off number as follows (i) last digit is less than 5 (ii) last digit is more than 5 (iii) the last digit is 5.If last digit retained followed by a digit less than 5, the last retained digit must be left as it is. If the last retained digit is more than 5, it must be increased by one. And third possibility is that the last digit retained is 5. If the first discarded digit is 5 and followed by zeros only or no other digit is there, leave it as it is if last digit retained is even (this is called rounding down) and round up if last digit retained is odd.For example in rejecting the last figure of 8.946, the new value will be 8.95 and in rejecting the last figure of 8.944, the new value will be 8.94. The former is known as rounding up and later is known as rounding down.For example, the number 3.7650 is rounded down to 3.76 and 3.8750 round up to 3.88. In this case, the digit retained after rounding up or down will always be an even number. In the result of addition or subtraction, the number of digits after decimal should be same to that of the term with the least number. For example, the answer of sum of following terms (0.413 + 7.0124 + 6.2315 = 13.66) will not be more than three places after decimal as the quanity 0.413 has least number of digits after decimal. In multiplication or division, round the answer to the shortest number of significant digits in the numbers you are multiplying or dividing. e.g. 3.0/ 1.15 = 2.6. Rounding off never changes the power of 10.An error is a discrepancy between a computed, observed, or measured value or condition and the true, specified, or theoretically correct value or condition.Two types of errors effect experimental result (1) determinate or systematic errors (2) indeterminate errors. Determinate errors are non-random and can be controlled and eliminated by careful experimentation. Changes in solution volume or solubility with temperature are examples of determinate errors.Indeterminate errors are random and and cannot be avoided. These can be only reduced by the use of better instrument and experience. Nuclear counting or changing condition errors are examples of indeterminate errors.Determinate errors are of three types such as (i) Method errors: That arise due to problems in methodology e.g. such co-precipitation of impurities with analyte (ii) Instrumental errors: are produced due to uncelebrated glassware, instrument. e.g. use of uncalibrated pH meter or analytical balances produce such errors. (iii) Operative or personal errors: are produced due to unskilled operators. These can be reduced by experience and care of the analyst in the physical manipulations involved.e.g. wrong volume measurements.Absolute or relative errors are used to define or present accuracy of any measurement by expressing the difference between true value and the measured value, with sign of error. If measured value is greater than true value a positive sign is used or vice versa. Suppose if an object of8.67g is weighed to be 8.40g, the absolute error is -0.27g. Mean error is calculated by making multiple measurements and averaging the individual errors in the measurements. Relative error is determined by expressing absolute/mean errors as percentage (%), part per thousand (ppt) or part per million (ppm) of true value e.g. for above measurement the relative error will be (-0.27/6.47) × 100 = - 4.17 %.

Chemometrics (Statistics in analytical chemistry)

Chemometrics is the chemical discipline that uses mathematical and statistical methods to design or select optimal procedures and experiments, and to provide maximum chemical information by analysing chemical data. In simple words, chemometrics means performing calculations on measurements of chemical data.Confidence interval is a given range in which a true value might fall within a given probability e.g. 95% or 99% confidence interval. Confidence interval is represented by experimental mean and standard deviation values. The limits of confidence interval are called confidence limit. There are various tests including commonly used F test, T test and Q test available to

test the significance and validity of experiment data and results. The F test is used to determine significant or non-significant difference between two different methods based on their standard deviations. Suppose a new method has developed for sodium determination in drinking water. F test can be used to compare newly developed method with previously accepted valid methods. The T test is used to determine the possibility of significant difference between two sets of measurements. It is preferable to perform analysis in replicates. The Q test is used to take decision whether to reject the outlier result or to retain it, if one value differs widely from other replicates.The t-test is used to find out if the means between two populations is significantly different. F-test is used to find out if the variances between the two populations are significantly different. While T-test is used to compare two related samples, F-test is used to test the equality of two populations.Correlation coefficient (R^2) is used to determine statistical relationships between two or more values in fundamental statistics.R^2maximum value is 1. R^2 value between 0.90-0.95, 0.95-0.99 and 0.99-1.00 indicates fair curve, good curve and excellent linearity curves, respectively.The unwanted response or noise of instrument in the absence of blank or sample is called as background signal. The background signal may arise due to due to fluctuation in electric current, ion current, flicker in flame etc. Detection limit is a concentration that gives a signal equals to three times to the standard deviation of the blank.

MULTIPLE CHOICE QUESTIONS

1. Which of following is key number?
   (a) 958765 (b) 0.09000 (c) 460.578 (d) 0.053020
2. Following command is used to calculate standard deviation in a excel sheet cell:
   (a) STD (b) STDV (c) STDVE (d) STDEV
3. Give answer to maximum number of significant figures: 50.00 × 27.8 × 0.1167?
   (a) 162.213 (b) 162.0 (c) 162.20 (d) None
4. Following symbol represents
   
   (a) Miscellaneous danger (b) Oxidant
   (c) General danger (d) Inhalation hazard
5. Following symbol represents
   
   (a) Miscellaneous danger (b) Oxidant
   (c) General danger (d) Inhalation hazard
6. Following symbol represents
   
   (a) Miscellaneous danger (b) Oxidant
   (c) General danger (d) Inhalation hazard
7. What is most important in analytical laboratory?
   (a) Cleanness (b) Temperature control
   (c) Environment (d) Safety
8. What is right way to take square root in excel?
   (a) SQRT (b) =SQRT (c) =Squareroot (d) Squareroot
9. What is answer according to rules of significant figures: 76.98765 + 24?
   (a) 100.9(b) 100.98 (c) 100.9876 (d) 100
10. Find median from following numbers, 1, 2, 3, 4, 8, 6, 5, 3?
    (a) 3 (b) 4 (c) 8 (d) 3.5
11. Which of volumetric and gravimetric analysis is more sensitive?
    (a) Volumetric analysis (b) Gravimetric
    (c) Precipitation (d) Weight measurements
12. Gravimetric analysis requires iron to be present in which of following forms?

(a) Fe (b Fe^{2+} (c) Fe^{3+} (d)Fe^{2+} and Fe^{3+}

13. _____ (soluble protein) is converted to _____ on clotting (insoluble protein)?
(a) Fibrinogen, Fibrin (b) Fibrin, Fibrinogen
(c) Plasma, Red blood cells (d) Red blood cells, Plasma

14. Sulphur dioxide is present in auto exhaust smoke and show following property?
(a) Corrosive gas (b) Lost in water vapors
(c)Safe for nature (d) a and b

15. The number of significant digits in 4900 is?
(a) at least 2 (b) at least 4 (c) exactly 4 (d) at most 2

16. An analysis is based on following step/s or operation/s:
(a) The particular problem (b) Apparatus and instrument
(c)Your expertise (d) all

17. Volumetric pipettes can be?
(a) TC or TD (b) Only TC (c) Only TD (d) TC and Multi-volumetric

18. Which of following are weighed in weighing bottle?
(a) Hygroscopic (b) Liquids (c) Non-metals (d) All

19. Hygroscopic chemicals can be used as?
(a) Primary standards (b) Secondary standards
(c) Primary and secondary standards (d) Liquids

20. Which of following laboratory material has highest working temperature?
(a) Borosilicate (b) Quartz glass (c) Fused silica (d) Platinum

21. An object of approximately 0.001mg can be best measure with which of following analytical balance?
(a) Electric (b) Macro (c) Semi-micro (d) Micro

22. 5.5234 mL of mercury is transferred to a graduated cylinder with scale marks 0.1 mL apart. Which of the following will be the correct reading taken from the graduated cylinder?
(a) 5.5 mL (b) 5.52 mL (c) 5.523 mL (d) 5 mL

23. Round the 0.90985 cm2 to three significant figures
(a) 0.909 cm^2 (b) 0.910 cm^2 (c)0.9099 cm^2 (d)0.91 cm^2

24. The volume of liquid being measured in the graduated cylinder is

(a) 8.000 cm^3 (b) 8.50 cm^3 (c)8.00 cm^3 (d)8.0 cm^3

25. Find answer in significant figure: 999.0-0.007896?
(a) 998.0 (b) 998.9 (c)998.992104 (d) 999.0

26. Find key number among following: 999.0-0.007896(102.3+127.9)?
(a) All are same (b) 127.9 (c) 102.3 (d)999.0

27. Spectrophotometry is a?
(a) Technique (b) Protocol (c) Method (d) Procedure

28. Distribution ratio can be calculated from following formula:
(a) $D = \frac{K_D}{1+\frac{K_a}{[H^+]a}}$ (b) $D = \frac{K_D}{1-\frac{K_a}{[H^+]a}}$
(c) $D = \frac{K_a}{1+\frac{K_D}{[H^+]a}}$ (d) $D = \frac{K_D}{1+\frac{K_D}{[H^+]a}}$

29. Which of following is not a desiccant?
(a) Calcium chloride (b) Silica gel (c) NaOH (d)CaO

30. Temperatures up to about _____°C can be reached with muffle furnaces? (a) 300 (b) 800 (c) 1000 (d) 1200

31. Ashless filter paper is generally used for _____ work in which the paper is ignited away and leaves a precipitate suitable for weighing?
(a) Qualitative (b) Quantitative (c) bio-lab (d) Semi-macro

32. Which of following method can be used to process sample for organic matter analysis?
(a) Wet digestion (b) Ashing (c) Solvent extraction (d) c,d

33. Which of following is/are suitable for extraction of inorganic samples?
(a) Ashing (b) Digestion (c) Solvent extraction (d) All

34. Parallax errors are due to incorrect alignment of?
(a) Observer's eye (b) Meniscus (c) Scale (d) All

35. How many significant figures in 0789.0984$_7$?
(a) 8 (b) 9 (c) 7 (d) 5

36. What is answer according to rules of significant figures: 25.5555 + 34?
(a) 59.5 (b) 59.55 (c) 59.555 (d) 59

37. Find median from following numbers, 1, 2, 3, 7, 0, 6, 5, 3?
(a) 3 (b) 4 (c) 8 (d) 3.5

38. Urine samples are unstable and _____ precipitate out:
(a) Calcium chloride (b) Uric acid (c) Acetic acid (d) Calcium phosphate

39. In semimicro analysis the liquid sample (microliters) varies from:
(a) 1-100 (b) 10-100 (c)1-50 (d) 50-100

40. How many significant figures in 01189.0984$_{7680}$?
(a) 8 (b) 9 (c) 7 (d) 5

41. Round off 589000 to 2 significant figures?
(a) 580000 (b) 590000 (c) 59000 (d) 59

42. If on a 15ml TD pipette 10/100 divisions is mentioned. What will be single division equal to?
(a) 0.01 (b) 0.1 (c) 0.5 (d) 0.2

43. Ascarite is _____on asbestos?
(a) Magnesium perchlorate (b) Sodium hydroxide
(c) Magnesium hydroxide (d) Chromic acid

44. Which of the following gases is unsuitable for use as a GC carrier gas?
(a) Nitrogen (b) Helium (c) Hydrogen (d) a & b

45. NaOH solution is a _____ standard?
(a) Primary (b) Secondary (c) Tertiary (d) Strong

46. The mass of a watch glass was measured three times. The masses were 15.012 g, 15.10 g and 15.1 g. What is the number of significant figures in the average mass of the watch glass?
(a) 3 (b) 4 (c) 5 (d) 2

47. How many significant figures in 0799.0675$_7$?
(a) 8 (b) 9 (c) 7 (d) 5

48. Round up to 5 significant figures 99.12437?
(a) 99.123 (b) 99.125 (c) 9900 (d) 99.124

49. Which of following glass has lowest working temperature?
(a) Fused quartz (b) Borosilicate (c) High silica (d) a,b

50. Which of following is/are suitable for extraction of organic samples?
(a) Ashing (b) Solvent extraction (c) Digestion (d) a & b

51. The chances of random error in 2 replicates is _____ times to 1 replicate or observation?
(a) 4 (b) 2 (c) 1/4 (d) 1/2

52. How many significant figures in answer of 67.987 – 67. 213.
(a) 1 (b) 2 (c) 5 (d) 3

53. How many significant figures in 0.000608070.
(a) 1 (b) 2 (c) 5 (d) 6

54. How many significant figures in following: 620234000 and 0.050610
(a) 8, 6 (b) 8, 7 (c) 5, 6 (d) 6, 5

55. The number 8.5563 after rounding to two digits is:
(a) 8.8 (b) 8.7 (c) 8.6 (d) All

56. Which of following is easiest to calibrate?
(a) 10mL pipette with 0.1mL graduation (b) 100 mL Cylinder
(c) 50 mL Burette (d) 100 mL Volumetric flask

57. What type of compounds can be determined by using paper chromatography?
(a) Colored (b) Colorless (c) Dyes (d) All

58. Which of following is most useful for purification and contrating sugar cane juice?
(a) Vacuum distillation (b) Distillation
(c)fractional crystallization (d) crystallization

59. Which test could be helpful if results of same set of samples using different methods needed to be compared on the basis of obtained standard deviation values?
(a) Q test (b) F test (c) T test (d) All

60. Determinate errors are also known as:
(a) Random (b) Non-random (c) Systematic (d) b & c

61. Detection limitis a concentration that gives a signal equals to ————times to the standard deviation of the blank.
(a)5 (b)2 (c) 3 (d) 4

62. If on a 2ml TD pipette 1/100 is mentioned. What will be single division equal to?
(a) 0.01 (b) 0.1 (c) 0.5 (d) 0.02

63. When mixing acid and water
(a) Pour water into acid (b) Let the group leader pour them (c) Pour them at the same time (d) Pour acid into water

64. Chlorides must be generally limited to _____ in drinking water and _____ in water used for domestic purposes.
(a) 250 mg/L, 2000 mg/L (b) 2000 mg/L, 250 mg/L
(c) 250 mg/L, 250 mg/L (d) 2000 mg/L, 2000 mg/L

65. Following symbol represents
(a) Miscellaneous danger (b) Oxidant
General danger (d) Inhalation hazard

66. Analytical method classified as meso when concentration of analyte is:
(a) 15-100 mg (b) 1-10 mg (c)>100 mg (d)> 1000 mg

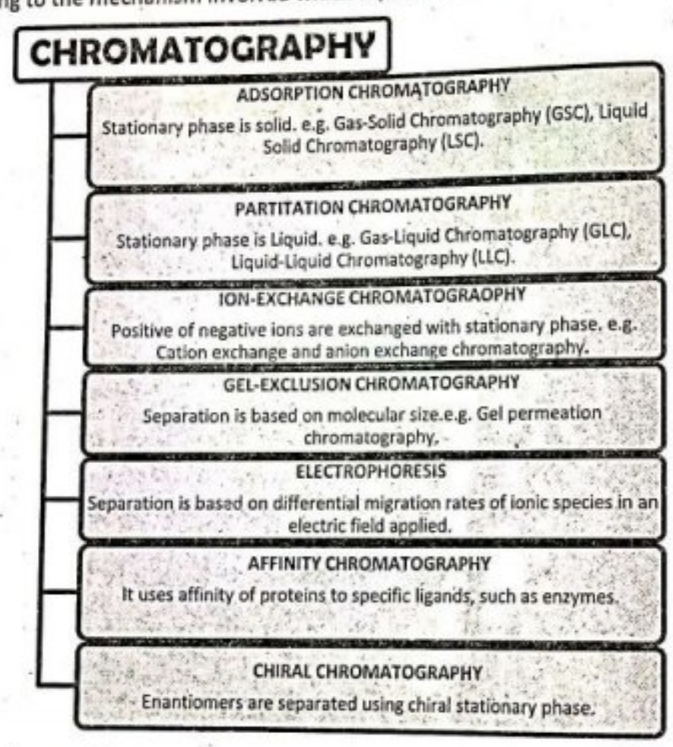
67. How many significant figures in the sum of 15.4 + 24.82 + 0.655
(a) 1 (b) 2 (c) 5 (d) 3

ANSWERS

1	b	21	d	41	b	61	c
2	d	22	b	42	b	62	d
3	d	23	b	43	b	63	d
4	a	24	d	44	c	64	a
5	b	25	d	45	b	65	c
6	d	26	d	46	a	66	c
7	d	27	a	47	c	67	d
8	b	28	a	48	d		
9	d	29	c	49	b		
10	d	30	d	50	b		
11	a	31	b	51	d		
12	c	32	d	52	d		
13	a	33	d	53	d		
14	d	34	d	54	d		
15	a	35	c	55	c		
16	d	36	d	56	d		
17	c	37	d	57	d		
18	d	38	d	58	a		
19	b	39	d	59	b		
20	d	40	a	60	d		

2. CHROMATOGRAPHY

Chromatography is a separation technique which involve two phases one of which is a stationary phase and other is mobile phase and separation is based on any one of 7 different mechanisms involved including adsorption, partitation, ion-exchange, gel exclusion, electrophoresis, affinity or chirality. IUPAC definition of chromatography is as follows:"Chromatography is basically an essential procedure used generally for separation during which the distribution of the components to be separated occurs between two phases, one of which is referred as a stationary phase, whereas the other referred as mobile phase which moves in a distinct direction".A solute that interacts more with stationary phase than mobile phase will move slower along a column. There are several classifications available for chromatographic methods. However, the most fundamental and popular classification method is according to the mechanism involved which is presented in following diagram.



The stationary phase in case of partition chromatography is always liquid whereas in case of adsorption chromatography the stationary phase is always solid. Liquid – liquid chromatography can be run in two experimental setups, i.e. normal phase and reverse phase setup. When the polarity of stationary phase (e.g. aqueous phase) is more than the mobile phase, it is called as normal phase chromatography. Polar compounds are better separated using normal phase chromatographyNormal phase chromatography is useful for separation of polar compounds. In reversed phase chromatography a polar mobile phase (such as water) is used with a nonpolar stationary phase. In reversed phase chromatography nonpolar compounds are separated.Band broadening affects the results of chromatographic techniques. Efficiency of column can be evaluated using theoretical plates. The more theoretical plates, the greater the efficiency or the resolving power of a column. A theoretical plate is a hypothetical portion of

chromatographic column in which a single equilibrium step occurs. Narrow the peak, the greater the number of theoretical plates.

Paper Chromatography (PC): Paper chromatography is based on partition phenomena. Paper is composed of cellulose polyerms chains which always contain mostiure or water to support partitation process on its surface. Cellulose is a sugar and glucose polymer. Advancements in coating technologies made it possible to use other processes such ion exchange, size exclusion, adsorption etc on the surface of coated paper. The retention factor or relative to front (R_f) may be defined as "the ratio of the distance travelled by the substance to the distance travelled by the solvent". A zero R_f value shows that the solute stays in the stationary phase and is totally immobile. If R_f value = 1 then the solute has no attraction for the stationary phase and moves with the mobile phase and travels to the solvent front. The paper chromatography can be carried out in ascending, descending, radial or two dimensional setups. The compound on the chromatogram can be positioned / located by physical methods, such as fluorescence, radioactivity, etc. or by chemical methods using chemical reagents to produce a distinctive coloured product. Chemicals methods are usually preffered for the identification of colorless substances by converting these into color derivatives using chemical reactions. Although, paper chromatography is cheapest form of chromatography but there exists some disadvantages of using paper chromatography. It is not a preparative technique; it can't be used in quantitative analysis and doesn't permit the partition of complex mixtures. Corrosive reagent such sulphuric acids cannot be applied on paper.

Thin Layer Chromatography (TLC): It is a chromatographic technique in which a solid stationary phase supported on a thin plate is used to separate non-volatile mixtures using a liquid mobile phase.TLC involves the use of a sheet of glass, plastic, or aluminium foil coated with silica gel $(SiO_2.xH_2O)_n$, alumina $(Al_2O_3.xH_2O)n$ or cellulose powder which are commonly used stationery phases in TLC. A binding agent usually plaster of Paris. TLC is an inexpensive and quick technique used for identification, purification and montioring of mixture components. Silica gel is most commonly used stationary phase. However, different adsorbents are used for different compounds e.g. bases and steroids have been separated on alumina and for polar compounds, including amino acids and nucleotides, cellulose powder is preferred as adsorbent. Modified cellulose powders such as diethylaminoethyl (DEE), triethylaminoethyl (TEAE) and carboxymethyl (CM) are useful for nucleotides, phospholipids, glycolipids and pigments. Polyamide powder, magnesium silicate, calcium sulphate are also available commercially. For separation of non-polar compounds, less polar stationary phases like methyl/phenylsiloxane, cyanopropylsiloxane, polydimethyl siloxane, and carbowax are preffered. To initially observe separation of a unknown mixture, it is preffered to start with a non-polar solvent such as ligroin (non-polar petroleum fraction, consists of C7 through to C11 in the form of about paraffins (55 %), monocycloparaffins (30 %), alkylbenzenes (12 %), and dicycloparaffins (2 %)). If separation is not successful polar solvents or combination of various solvents can be tried. The thickness of the absorbent layer is typically around 0.1–0.25 mm for analytical purposes and is about 0.5–2.0 mm for preparative TLC. For silica gel based TLC, the particle size should be between 5–17 µm. The use of refined silica gel having a particle size of 5 µm and particle size range is of 2–10 µm has led to develop high performance TLC (HPTLC) which use thinner layer and small sample. The removal of water or other solvents from chromatographic plates and adsorbent known as activation which is done by drying and heating plates in an oven for 30 minutes at 110 °C. After drying, cellulose or silica gel coated plates are exposed to the atmosphere for some time. Because certain amount of moisture is essential for better resolution and this process is known as deactivation.The colored substances are visualized directly, whereas colorless substances are detected by spraying the plate with an appropriate reagent which produce colored spots and are being visualized. Many aromatic and non-aromatic compounds appear as dark spots against light background

and can be detected under UV light of suitable wavelength in a dark box. For organic compounds generally, iodine is used as a locating agent which is also a non-destructive locating reagent. It gives a dark brown color to the spots. For this purpose, 10% methanolic solution of iodine is sprayed on a chromatogram or crystals of iodine can be placed in tank during development.By measuring the area and photodensity of a spot, quantitative analysis can be performed or alternatively the separated components can be removed from the plates by scrapping off the relevant portion of the adsorbent. The component is eluted from the adsorbent with a suitable solvent and determined by an appropriate technique, e.g.; by fluorescence or UV/visible spectrophotometry. The disadvanagte of TLC is that it operates as an open system, so factors such as humidity and temperature can be alter the results of developed chromatogram.

Ion-exchange chromatography (IEC): Ion exchange chromatography separate compounds on the basis of net charge on them. Cross-linked polymer resins are the common stationary phases in IEC. One of commonly used polymers in IEC is divinylbenzene cross-linked polystyrene, with covalently attached ionic functional groups. Ion-exchange resins are of four types: strong acid cation exchangers (e.g. sulfonic acid functional group); weak acid cation exchangers (e.g. carboxylic acid functional group), strong base anion exchangers (e.g. quaternary amine); and weak base anion (e.g. ammonia) exchangers.Buffers are commonly used to maintain pH in IEC as ionization of species is pH dependent.

Gel Permeation Chromatography (GPC): Gel filtration chromatograpy and size exclusion chromatography are other names of Gel Permeation Chromatography (GPC). In GPC inert particles that contain small microscopic pores of controlled size are used as stationary phase. If observed under high resolution microscope, these small pores in the gel particles are more likely resemble to pores of a sponge. Under the influence of mobile phase any mixture of different molecular mass components are pass through the gel filtration columnin a continuous manner. Mixture components having higher molecular mass or larger size than pores of the gel cannot pass though the interior volume of gel. Such molecules adopt different path and pass through the space between the gel beads in a matrix. Resultantly, very large molecules are not slowed significantly by the presence of gel beads elute very quickly as compared to the other molecules in a single unseparated zone. On the other hand small and smaller molecules diffuse intoinner parts of the beads and move through much larger paths. This results in slowing down of these molecules and appearance their bands later. While the molecules possessing the intermediate molecular size pass through this gel column at a rate somewhere fall between the higher and low molecular size. It is inferred the order of elusion of different analyte molecules in the gel filtration chromatography is directly related to the molecular masses/size.

Gas chromatography: The credit of invention of partitiation chromatography is goes to Archer J.P Martin and L.M Synge. Volatile organic compounds which are thermally stable can be separated with the help of gas chromatography. It is estimated that nearly 20 % of all the compounds can be analyzed through gas chromatography. The gases used as mobile phase in gas chromatography, generally aninertgas such as; nitrogen, helium or argon. A low density gas gives faster speed but lower efficiency since diffusivity is higher, but a high density gas gives best efficiency due to lower diffusivity. In gas chromatography, the sample/analyte should be in the vapor state and the components that are not in gaseous phase are vaporized prior to passing through the column. The temperature of the column is kept high to keep analytes in vapor form. The sample injection port, column and detector are heated about 50°C above the boiling point of highest boiling solute to attain the vapor pressure of at least 50 torr. The stationary phase could be liquid or solid and depending upon stationary phase GC is termed as gas liquid chromatography and gas solid chromatography, respectively. Two types of column used in gas chromatography are packed columns (conventional) and capillary columns (modern). For large sample size and convenient use packed columns are preferred. The most common stationary phases

for capillary GC are polysiloxanes. Detectors used in GC are either general or specific for a particular substance. Over 40 detectors are in use in GC analysis and most common are mass spectrometry (MS), flame ionization detector (FID), electron capture detector (ECD), flame photometric detector (FPD), thermal conductivity detector (TCD), flame thermoionic detector (FTD) and β-rays detector.

High performance liquid chromatography (HPLC): HPLC uses liquid mobile and is used to analyze non-volatile samples (e.g. pesticides and peptides) directly. Two columns are used in any typical HPLC system includeing: a guard column (to protect analytical column from clogging and degradation) and an analytical column (responsible for the separation). HPLC separation can be carried out in normal and reverse phase setup under either isocratic or gradient elution. In isocratic elution the composition of mobile phase remains constant throughout the separation. In gradient elution, the composition of mobile phase is made less polar as the separation progresses. Efficiency factor (N) is used to measures how sharp the component peaks are on the chromatogram. Generally a tall, sharp and quite narrower peak indicates that separation method competently removed a component from a mixture with high efficiency. Efficiency factor is synonymous with plate number, and the number of theoretical plates.Retention factor (kappa prime) describes for how long a component of the mixture trapped to the column, measured by the area under the curve of its peak in a chromatogram. Since HPLC chromatograms are a function of time, each peak in a chromatogram will have its individual retention factor as it may be corrected for the void volume of the column. Selectivity or separation factor (α) is the capability of a chromatographic system to chemically distinguish between two sample components. It is a relative comparison on how well two neighboring components of the mixture were separated (i.e. resolution of two neighboring bands on a chromatogram). This factor is defined in terms of a ratio of the retention factors of a pair of neighboring peaks and may also be corrected for the void volume of the column. The greater the value of separation factor (i.e. over 1.0) the better the separation, until it is about 2.0 or more which means that an HPLC method may not be required for that separation. Selectivity of a separation depends upon several factors such as polarity of solvent, pH of mobile phase, solvent strength and additives, types of the stationary phase and temperature. Therefore, selectivity of an HPLC separation can be optimized by altering these factors. Resolution equations for HPLC relate these three factors in such a way that efficiency and separation factors are improved for the resolution of component peaks in an HPLC separation.

Supercritical fluid chromatography (SFC): Critical point (also termed a critical state) is a point at which the difference between the liquid and gas (or vapor) phases vanishes. A supercritical fluid is any substance above its critical temperature and critical pressure, where discrete gas and liquid phases do not occur. Supercritical fluid can dissolve materials like a liquid and effuse through solids like a gas. Furthermore, near to the critical point, small changes in temperature or pressure may result in huge changes in density, permitting several properties of a supercritical fluid to be "perfectly adjusted or fine-tuned".Compressed fluid is a fluid that has only pressure above the critical pressure point and temperature below the critical temperature. Pseudocritical line is a line, which consists of pseudocritical points. Pseudocritical point is a point at a pressure above the critical pressure and at a temperature below critical temperature. Supercritical "steam" term is used widely for supercritical water above critical temperature and critical pressure since water exists as a single-phase substance above critical points. Superheated steam is another term being used in literature. Superheated steam is steam at temperatures above the critical temperature but at pressures below the critical pressure. SFC is a recent technique to overcome several draw backs of gas chromatography and liquid chromatography. Detectors used in GC and HPLC can be coupled with SFC. SFC has applications in the analysis of waxes, polymers, drugs, fossil fuels and food products.

MULTIPLE CHOICE QUESTIONS

1. If the peak asymmetry factor value is <1, it indicates?
(a) Tailing peak (b) Fronting peak (c) Symmetrical peak (d) Ideal Peak
2. In the first chromatography experiment by Tswett separated?
(a) Xyanothophyll (b) Beta carotene (c)Colors(d) Chlorophyll
3. Fluid entering a column is known as?
(a) Eluate (b) Elution (c) Eluent (d) Chromatography
4. _____lamp is useful for variable UV wavelengths in HPLC.
(a) Hydrogen (b) Sodium (c) Helium (d) Deuterium
5. Retention factor, *k'*, describe
(a) Mobile phase velocity
(b) Distribution ration of analyte between two phases
(c) Stationery phase stability
(d) Migration rate of analyte through a chromatographic column
6. _____is also called as "Soap Chromatography".
(a) Ion Pair Chromatography (IPC) (b) HPLC
(c) LLC (d) TLC
7. Xanthophylls and carotenoids can be separated using _____ intermediate adsorbent?
(a) Silica gel (b) Alumina (c) Starch (d) Calcium carbonate
8. A blue green band appears during separation of plant pigment. This band is due to presence of?
(a) Carotene (b) Xanthophyll (c) Chlorophyll a (d) All
9. BET method for measuring surface area of stationary phase was discovered by?
(a) Bruner (b) Emmett (c) Michael Faraday (d) All
10. Which of the gases below is most suitable as a carrier gas in supercritical fluid chromatography?
(a) Helium (b) Nitrogen (c) Oxygen (d) Carbon dioxide
11. Which of following is the silanol group?
(a) $Si(OH)H_3$ (b) $Si(OH)_2H_3$ (c) $Si(OH)H_5$ (d) $Si(OH)H_{13}$
12. Activation of alumina is done at?
(a) 50-100°C (b) 100-150°C (c) 50-70°C (d) None
13. Brockmann scale where alumina with 15% is classified as grade.
(a) I (b) II (c) III (d) V
14. In case of counter ions with _____ charge anion exchangers are used. (a) Positive (b) Negative (c) Neutral (d) a,b
15. Which of following type of chromatography involves electric current?
(a) Electrophoresis (b) Ion exchange (c) Column (d) Paper
16. The relationship between linear Rf values and circular is?
(a) RR_fR (b) RR_fR_f (c) R_fR^2 (d) $(RR_f)^2$
17. Dinitrophenylhydrazine is used as a specific reagent for detection of _____ in TLC.
(a) Aldehydes (b) Ketones (c) Ethers (d) Carbonyl compounds
18. TLC Plates commercially available use following fluorescent indicator.
(a) Mn activated Mn silicate (b) Zn activated Mn silicate
(c) Mn activated Mn silicate (d) Mn activated Zn silicate.
19. Best measurements can be obtained in _____ mode.

(a) Absorption (b) Transmission (c) Transmittance (d) Reflection
20. Which of following is not commonly used for staining of RNA?
(a) Ethidium bromide (b) silver stains(c) SyBr gold (d) SyBr green
21. A _____ solvent front indicates that the atmosphere in tank is not saturated.
(a) Polar (b) Non-polar (c) Hydro (d) Concave
22. Tswett used _____ as a stationery phase to separate chlorophyll?
(a) $CaCl_2$ (b) $CaCO_3$ (c) $Ca(OH)_2$ (d) CaO
23. Improved detection due to _____ separated zones.
(a) Solute (b) Solvent (c) Smaller (d) Color
24. Gradient elution is used to separate compounds of _____?
(a)Wide polarities (b) Close polarities
(c)Specific polarities (d)Surface polarities
25. If proteins are stable below PI, what type of resin/s can be used?
(a) Anion exchanger (b)Cation exchanger
(c)Both a & b (d) cannot be separated this way
26. Retention of solute in GC is dependent upon?
(a) Polarity of solute (b) Type of column used
(c) Vapor pressure of solute (d) a and c
27. Back flow during pumping in chromatography is prevented using?
(a) Check valve (b) Pressure
(c) Diffusion (d) Gas flow
28. _____is main advantage of the mass spectrometer detection in GC over the FID?
(a) Sensitivity (b) Linear range
(c) Identification through compound library (d) Dynamic range
29. Two analytes present in the sample are of similar chemical type still can be separted using?
(a) Partition chromatography (b) Chiral chromatography
(c) Adsorption chromatography (d) Ion exchange chromatography
30. Non-polar compound will come out of column first if we use following stationery phase?
(a) Xerogel (b) Kamrosil (c) Benyl (d) Poly olefins
31. Which of the detectors is most common for analysis of liquids in HPLC?
a. UV detector b. Mass Spectrometer
c. Flame Ionization detector d. TCD
32. Which of the gases below is not explosive and is suitable as a carrier gas in gas chromatography?
a. Helium b. Nitrogen c. Oxygen d. All except c
33. Which of following method of measurement is most sensitive.
a. Absorption b. Transmission c. Transmittance d. Reflection
34. In case of counter ions with _____ charge cation exchangers are used.
a. Positive b. Negative c. Neutral d. a,b
35. Paper chromatography is a type of?
(a) Partition Chromatography (b) Adsorption Chromatography
(c) Ion-exchange Chromatography (d) Liquid-Solid Chromatography
36. Which technique is most suitable for analysis of nuçleic acid?
(a) Capillary electrophoresis (b) Agarose Electrophoresis
(c) PAGE (d) SDS-PAGE

37. Cation exchange chromatography retains cations using _____functional group
(a) Positively charged (b) Negatively charged (c) Both (d) neutral

38. Silica gel is loaded with following group?
(a) H_2SiOH (b) H_2OSiOH (c) H_3SiOH (d) H_2OSiH

39. Lower the Rf the ____ the activity and ____ Brockmann number.
(a) lower, higher (b) lower, lower (c) higher, higher (d) higher, lower

40. Which of following can be analyzed using Gas Chromatography?
(a) Solids (b) Liquids (c) Gases (d) Solids, liquids and gases

41. Paper is a random pile of cellulose fibres, each fibre comprises a number of chains of approximately?
(a) 2000 anhydroglucose units (b) 2000 hydroglucose units
(c) 200 anhydroglucose units (d) 200 hydroglucose units

42. Which of the gases below is not suitable as a carrier gas in gas chromatography?
(a) Helium (b)Nitrogen (c) Oxygen (d) Helium

43. Which of the detectors is not used for gas chromatography?
(a) UV detector (b) Mass Spectrometer (c)FID d. TCD

44. Which of the statements is correct? Gas Chromatography is used to analyse_____.
(a) Solids (b) Liquids (c) Gases (d) Solids, liquids and gases

45. The deactivation of silica gel at 400-500°C is _____ and _____.
(a) permanent, irreversible (b) temporary, irreversible
(c) permanent, reversible (d) temporary, irreversible

46. Plates commercially available use following fluorescent indicator.
(a) Mn activated Mn silicate (b) Zn activated Mn silicate
(c) Mn activated Mn silicate (d) Mn activated Zn silicate

47. Best measurements can be obtained in _____ mode.
(a) Absorption (b) Transmission (c) Transmittance (d) Reflection

48. Which of following is not commonly used for staining of RNA?
(a) Ethidium bromide (b)Silver stains (c) SyBr gold (d)SyBr green

49. Electrophoresis is used to
(a) Separate DNA fragments (b) Identify DNA fragments
(c) Purify DNA fragments (d) a & c

50. DNA and dye molecule used in DNA analysis possesses
(a) Supercharge (b) No charge (c)+ charge (d) neg charge

51. Silanol group is
(a) H_2SiOH (b) H_2OSiOH (c) H_3SiOH (d) H_2OSiH

52. Higher the Rf the ____ the activity and ____ Brockmann number.
(a) lower, higher (b) lower, lower
(c) higher, higher (d) higher, lower

53. Which of following is a weak cation exchanger?
(a) Sulphopropyl (b) Carboxymethyl celloulose
(c) Aminoethyl (d) Diethylaminoethyl

54. If proteins are stable below PI, what type of resin/s can be used?
(a) Anion exchanger (b) Cation exchanger
(c) both a & b (d) cannot be separated this way

55. Electrophoretic separations are based upon
(a) Electric charge (b) Electric force
(c) Fractional coefficient (d) All

56. At pH 8.6 all plasma proteins have
(a) Same negative charge (b) Positive charge
(c) Negative charge up to different extent (d) Isoelectric point

57. FID responds to all organic compounds except for?
(a) Oxalic acid (b) Butyric acid (c) Benzoic acid (d) Formic acid

58. Which of following is a universal as well as a specific detector.
(a) ECD (b) TCD (c) FID (d) MS

59. Standard addition has limited applications in chromatography because of?
(a) Difficulty of injecting accurate amounts of standards/samples
(b) Unavailability of standards
(c) The velocity of the mobile phase
(d) Nature of stationary phase

60. The plate theory ignores the concept related to?
(a) Diffusion of sample components (b) Paths of flow
(c) Succession of equilibrium steps (d) A and B

61. Separation number can be calculated from following equation?
(a) $SN = \frac{(W_{h\,(Z+1)} - t_{RZ})}{(t_{R\,(Z+1)} + W_{hZ})} - 1$ (b) $SN \simeq \frac{(t_{R\,(Z+1)} - t_{RZ})}{(W_{h\,(Z+1)} - W_{hZ})} - 1$
(c) $SN = \frac{(t_{R\,(Z+1)} - t_{RZ})}{(W_{h\,(Z-1)} + W_{hZ})} - 1$ (d) $SN = \frac{(t_{R\,(Z+1)} - t_{RZ})}{(W_{h\,(Z+1)} + W_{hZ})} - 1$

62. In the first chromatography experiment by Tswett, he had used _____ as a mobile phase and _____ as a stationery phase to separate chlorophyll?
(a) Ether/calcium carbonate (b) Calcium carbonate/ether
(c) Ether/Charcoal (d) Charcoal/Ether

63. In a chromatogram, there is _____ on x-axis?
(a) Retention time (b) Peak splitting
(c) Column efficiency (d) Detector Response

64. Cellulose used in _____ chromatography is more uniform and regular?
(a) Paper (b) TLC (c) Both (d) None

65. Back diffusion and back flushing is associated with?
(a) HPTLC and GC (b) GC and HPLC
(c)TLC and GC (d) GC and SCF

66. Van Deemter plot provides information regarding
(a)The capacity factor (b) Optimum column temperature
(c)The selectivity factor (d)Optimum mobile phase flow rate

67. "Brock Mann Activity Scale" is used for the characterization of _____ in chromatograpgy?
(a) Mobile phase (b) Stationery phase
(c)Gradient elution (d) Isocratic elution

68. After separation using silica gel cated TLC _____ compound will appear towards top of the plate?
(a)Polar (b) High boiling point
(c)Low boiling point (d) Non-polar

69. On a SEC plot molecular weight increases _____.
(a) Left to right (b) Linearly, with increasing y-values.
(c) Remains constant (d) Right to left

70. Molecular weight obtained by GPC is _____?
(a) Correct (b) Approximation
(c) Not correct (d) Cannot be determined

71. Which of the following is correct statement?
(a) Resolution is proportional to the square root of the number of theoretical plates in a column
(b) Resolution is inverse proportional to the square root of the number of theoretical plates in a column
(c) Resolution is proportional to the square of the number of theoretical plates in a column
(d) Resolution is proportional to the number of theoretical plates in a column

72. For quantification in chromatography which of following factor/s is important?
(a) b,c (b) Area for reference (c) DR_F (d) dead time

73. High noise in a chromatographic instrument will result in?
(a) Poor resolution (b) Better signal
(c) Speedy analysis (d) Higher concentration

74. Which of the following is true regarding Chemisorptions?
(a) An adsorption process, results in an irreversible chemical reaction of the analyte with sorbent surface
(b) An absorption process, results in an irreversible chemical reaction of the analyte with sorbent surface
(c) An adsorption process, results in an reversible chemical reaction of the analyte with sorbent surface
(d) An absorption process, results in an reversible chemical reaction of the analyte with sorbent surface

75. Frontal analysis method is particularly useful for components eluting _____ of chromatographic process
(a) At start (b) At end (c) At all times (d) at mid

76. "Triple point" is present in?
(a) GC (b) GLC (c) SCFE d. HPLC

77. Perfusion chromatography is type of liquid chromatography used for separation of ——?
(a) Polar compounds (b) Macromolecules
(c) Nano particles (d) Non-polar compounds

78. HPLC use silica gel after polymerization _____ form?
(a) Hydrogel (b) Xerogel
(c) Aquagel (d) Biogel

79. ——— Is a compound that is added to sample before preparation step in HPLC and it is not a part of sample matrix.
(a) Tar (b) Diffuser
(c) Surrogate (d) Isolater

80. Radio activity detector is most easy to combine with?
(a) TLC (b) SEC
(c) GC (d) HPLC

81. In first chromatographic experiment Tswett used _____ stationary phase to separate chlorophyll
(a) $CaCO_3$ (b) Calcium chloride
(c) Calcium hydroxide (d) Calcium fluoride

82. Fluid entering a column (solvent used in elution)?
(a) Eluent (b) Eluate (c) Elution (d) Solute

83. According to mobile phase chromatography can be divided into _____ types?
(a) 1 (b) 2 (c) 3 (d) 4

84. A low noise in a chromatogram will indicate in?
(a) Poor resolution (b) Higher concentration
(c) Speedy analysis (d) Better signal

85. The plate theory ignores the concept related to?
(a) Diffusion of sample components (b) Paths of flow
(c) Succession of equilibrium steps (d) A and B

86. Highest purity compound can be isolated using _____ chromatography?
(a) Size exclusion (b) Ion-exchange (c) Chiral (d) Affinity

87. The adsorption sites on the silica gel contains following active groups?
(a) Si (b) OH (c) Silanol (d)None

88. Plant extracts contains many components however the slower-moving band contains _____and fastest-moving band contains the _____.
(a) Chlorophylls, Carotenes (b) Carotenes, Chlorophylls
(c) Xanthophylls, Chlorophylls (d) b, c

89. Resolution is proportional to?
(a) Square root of the number of theoretical plates in a column
(b) Inverse of square root of the number of theoretical plates in a column
(c) The number of theoretical plates in a column
(d) Square of the number of theoretical plates in a column

90. _____ is the release of soluble components of stationery phase during operation.
(a) Creeping (b)Flushing (c) Bleeding (d) roadening

91. _____ column has the greater efficiency and resolution?
(a) Packed (b) Non-packed (c) Capillary (d)Steel

92. _____ occurs if large sample volume slowly injected in GC column.
(a) Linear detector response (b) Non-linear detector response
(c)Decreased resolution (d) Increased resolution

93. GPC is used to measure _____ polymer.
(a) The length of the chain (b) Retention time of polymer
(c) Molecular weight (d) Hydrodynamic volume

94. Molecular sieving process occurs in
(a) GPC (b) SEC
(c) SFC (d) a & b

95. Most retained compound in reverse phase HPLC will be more ——?
(a)Ionic (b) Non-polar
(c)Neutral (d) Polar

ANSWERS

1	b	21	d	41	a	61	d	81	a
2	d	22	b	42	c	62	a	82	a
3	c	23	c	43	a	63	a	83	c
4	d	24	a	44	d	64	b	84	d
5	d	25	b	45	a	65	b	85	d
6	a	26	d	46	d	66	d	86	d
7	d	27	a	47	d	67	b	87	c
8	d	28	a	48	a	68	d	88	a
9	d	29	a	49	d	69	d	89	a
10	d	30	a	50	d	70	b	90	c
11	a	31	a	51	c	71	a	91	c
12	d	32	d	52	b	72	a	92	b
13	d	33	a	53	b	73	a	93	c
14	b	34	a	54	b	74	a	94	d
15	a	35	a	55	d	75	a	95	b
16	d	36	a	56	c	76	c	96	
17	d	37	b	57	d	77	b	97	
18	d	38	c	58	d	78	b	98	
19	d	39	c	59	a	79	c	99	
20	a	40	d	60	d	80	d	100	

3. INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS

Spectroscopy is the study of interaction between matter and radiated energy. Radiation is energy in the form of (i) electro-magnetic waves or (ii) particulate matter, traveling in the air. Types of spectroscopy are differentiated by the type of radiative energy participating in the interaction. The spectrum is usually produced by measuring changes in the intensity or frequency of energy. Electromagnetic radiation was the first source of energy used for spectroscopic studies. Techniques that employ electromagnetic radiations are typically classified by the wavelength region of the spectrum and include gamma, x-ray, ultraviolet and visible, infrared, microwave and radiowave spectroscopy. Faraday, Maxwell elucidated that a moving electric charge produces magnetic fields and changing magnetic fields move electric charges. Einstein saw electricity and magnetism as frame-dependent facets of *unified* electromagnetic force. Electricity and magnetism are different facets of *electromagnetism*. All electromagnetic radiation travels at $c = 3\times10^8$ m/s (real number is 299792458.0 m/s *exactly*) in vacuum that is the cosmic speed limit. Particles, due to their de Broglie wavelength, can also be a source of radiative energy and both electrons and neutrons are commonly used in spectroscopic studies. For a particle, its kinetic energy determines its wavelength.Acoustic spectroscopy involves radiated pressure waves. Acoustics is the interdisciplinary science that deals with the study of all mechanical waves in solids, liquids and gases including vibration, sound, ultrasound and infrasound.Mechanical methods can be used to impart radiating energy, similar to acoustic waves, to solid materials. Spectroscopy can also be divided on the basis of the nature of the interaction between the energy and the material. These interactions include (i) Absorption (ii) Emission (iii) Elastic scattering and reflection (iv) Inelastic scattering. Absorption occurs when energy from the radiative source is absorbed by the material. Absorption is usually determined by measuring the fraction of energy transmitted through the material; absorption will decrease the transmitted portion.Emission shows that radiative energy is released by the material under study. A material's blackbody spectrum is a spontaneous emission spectrum determined by its temperature. Emission can also be induced by other sources of energy such as flames or sparks or electromagnetic radiation in the case of fluorescence.Elastic scattering and reflection spectroscopy determine how incident radiation is reflected or scattered by a material. Crystallography determines the scattering of high energy radiation, such as x-rays and electrons, to examine the arrangement of atoms in proteins and solid crystals.Impedance spectroscopy studies the ability of a medium to slow or impedethetransmittance of energy. For optical applications, this is characterized by the index of refraction.Inelastic scattering phenomena involve an exchange of energy between the radiation and the matter that shifts the wavelength of the scattered radiation. These include Compton and Raman scattering.

Atoms have only translational energy levels. Atomic spectra can be obtained due to electronic states. The creation of molecules from atoms leads to the formation of unique types of energetic states and therefore unique spectra of the transitions between these states. Molecular spectra can be obtained due to electronic states, molecular vibration, molecular rotations and electron spin states (electron paramagnetic resonance). Electronic excitations are studied using visible and ultraviolet spectroscopy as well as fluorescence spectroscopy. Vibrations are relative motions of the atomic nuclei and are studied by both infrared and Raman spectroscopy. Rotations are collective motions of the atomic nuclei and typically lead to spectra in the microwave and millimeter-wave spectral regions; rotational spectroscopy and microwave spectroscopy are synonymous. The combination of atoms or molecules leads into crystals or other extended forms results in the creation of additional energetic states. These states are numerous and therefore have a high density of states exists in crystals or other extended materials. This high density of energetic states in crystals often makes the spectra weaker, less distinct and broader. Blackbody radiation is generated due to the thermal motions of atoms and

molecules within a material. Acoustic and mechanical responses are due to collective motions as well.Pure crystals, though, can have distinct spectral transitions and the crystal arrangement also has an effect on the observed molecular spectra. The regular lattice structure of crystals also scatters neutrons, electrons or x-rays allowing for crystallographic studies.Gamma ray spectra arise due to distinct energy states of nuclei. Magnetic field separates the energy of distinct nuclear spin states, and this allows for NMR spectroscopy.Wavelength (λ) is distance between two adjacent crests or troughs of the wave in a beam of electromagnetic radiation.The common unit for wavelength measurement is meter, micrometer, nanometer and angstrom.Frequency (ν) is the number of waves passing a fixed point on the path of a beam of radiation per unit time. The commonly used unit for expressing frequency is hertz or cycle per second (1Hz = 1cps). Wavenumber ($\bar{\nu}$) is the number of waves per unit distance and is expressed in reciprocal centimeter (cm^{-1}). It is interesting to note that gamma, x-ray, ultraviolet and visible, infrared, microwave and radiowave radiations are usually appear on electromagnetic spectrum but not alpha and beta radiation. It is so because alpha and beta are particles, are not electromagnetic radiation. However, when alpha rays traverse matter their kinetic energy is converted to light and electromagnetic radiation emitted. Alpha particles ionize molecules by knocking off electrons and as these electrons slow down they emit x-rays. Positron and electron are also called as beta rays. These also knock off electrons as they slow down after hitting matter. Once an alpha slows down enough it picks up two electrons and becomes a normal helium atom. When a positron slows down enough is forms positronium with an electron and then they annihilate releasing gamma rays. Flame spectroscopy determines theconcentration of an element in a solution by measuring the absorption, emission or fluorescence of electromagnetic by its monatomic particles in gaseous state in the flame.Atomization is the conversion of molecules to their component atoms in gaseous state. Molecules in the solution are introduced in the form of very fine droplet in flame. Atoms in gaseous state in the flame absorb thermal energyfrom the flame itself,some of the atoms get excited &on their return to ground state radiation is emitted having energy equal to that absorbed.The radiation emission is proportional to the number of excited atoms, which is proportional to the total number of atoms in the flame i.e. the sample concentration. The spectra of gaseous, atomic particles consist of well defined narrow discrete lines arising from electronic transition of outermost electrons. Since there are no bonds, atoms undergo electronic transition only, no vibrational or rotational transitions. The energy to which the atoms are subjected for excitation must be less than the ionization potential. The resonance wavelength is that at which the most intense absorption and emission occur for any element. The resonance wavelength is 671 nm for Li, 589 nm for Na and 767 nm for K. Atomic absorption spectroscopy is the study of the absorption of light by free gaseous atoms produced by discharge, flame or plasma. In all, AAS can be used to analyze a total of 68 metals.Sample preparation for AAS is straight forwardand often involving only dissolution in an acid. High-temperature plasmas are of three types: (i) inductively coupled plasma (ICP) (ii) direct current plasma (DCP) (iii) microwave induced plasma (MIP). ICP is the most important of these plasmas.

There are several electroanalytical methods do exists in analysis of compounds. Conductivity is siemens per meter (S/m) and is a measure of ability of an electrolytye solution to conduct electricity. Potentiometry involves the measurement of potential difference between two electrodes to determine concentration of analyte. Glass electrode used in Ph meter is an example of potentiometric electrode.Coulometry involves the application of applied potential or current to completely convert an analyte from one oxidation state to another by the transfer of electrons to determine its concentration. Voltammetry uses three electrode system to measure the resulting current due to applied constant and/or varying potential at an electrode's surface.

Polarography is a subclass of voltammetry that involve the use of a dropping mercury electrode as the working electrode.

Amperometry measures current as a function of an independent variable that is, typically, electrode potential or time. Oxidation is the *loss* of electrons or an *increase* in oxidation state by an atom, ion or molecule. Reduction is the *gain* of electrons or a *decrease* in oxidation state by an atom, ion or molecule.

The tendency of a metal to get 25ollowin or reduced when it is placed in a solution of its own salt is called electrode potential.

An electrochemical cell consists of two half-cells. The potential of a single electrode in a half-cell is called the Single electrodepotential. The single electrode potential of a half-cell depends on: (i) concentration of ions in solution; (ii) tendency to form ions; and (iii) temperature. The overall electrode potential is sum of two half cell reactions.

$$E_{cell} = E_{anode} + E_{cathode}$$

Standard electrode potential (E°) is the measure of the electrical potential of an electrochemical cell at 1M ionic concentrations of reactants, 1 atm pressure and 25°C.

Nérst equation is used to calculate electrode potentials

$$E = E^\circ - \frac{RT}{nF} \ln a_{ion}$$

Where E is Electrode potential,$E^\circ$is standard electrode potential, R is gas constant,T isabsolute temperature, n isnumber of electrons transferred, F is Faraday anda_{ion} is activity of the ion. Feasibility of occurring of any chemical reaction can be calculated from its redox potential. A positive value of redox potential indicates the reaction is feasible. For example, in Daniel cell reaction feasibility can be calculated as follows:

The reaction occurs in two steps.

$Zn_{(s)} \rightleftharpoons Zn^{2+} + 2e^-$ $\quad E_{oxi} = 0.76$ V

$Cu^{2+} + 2e^- \rightleftharpoons Cu_{(s)}$ $\quad E_{red} = 0.34$ V

Overall reaction: $Zn_{(s)} + Cu^{2+} \rightleftharpoons Zn^{2+} + Cu_{(s)}$ $\quad E_{cell} = 1.10$ V

Overall reaction positive voltage is positive suggest that reaction is feasible and will proceed in forward direction. An electrode gets positive sign if it is oxidized after connecting to standard hydrogen electrode (SHE). In case of reduction a negative sign is assigned to electrode. In electrochemical or e.m.f or activity seriesis a series of chemical elements arranged in order of their standard electrode potentials. The hydrogen electrode [$H^+(aq) + e^- \rightarrow\leftarrow \frac{1}{2}H_{2(g)}$] is taken as having zero electrode potential.

MULTIPLE CHOICE QUESTIONS

1. Which radiations are due to vibrational changes?
   (a) UV (b) Visible (c) Infrared (d) Microwave
2. A moving electric charge _____ produces magnetic fields?
   (a) Does not (b) Rarely (c) Always (d) Sometimes
3. Electromagnetic radiations move in which plane:
   (a) Horizontal (b) Vertical (c) Both (d) Outward
4. Which of following spectroscopic region is just above (stronger) the region in which we can see?
   (a) UV (b) Visible (c) Infrared (d) Laser
5. Electronic excitations are studied using

(a) UV (b) Visible (c) Fluorescence (d) All

6. Which of following have maximum number of energetic states?
(a) Crystals (b) Atoms (c) Molecules (d) C

7. Which of following is strongest?
(a) x-rays (b) Gamma rays (c) Microwaves (d) IR radiation

8. If transmission is 100% absorption will be?
(a) 0% (b) 10% (c) 50% (d) 80%

9. Solvent effect is more pronounced in _____ compounds.
(a) Aldehyde (b) Ketone (c) Ester (d) Carbonyl

10. The light source in visible spectrophotometer is:
(a) Tungsten lamp (b) Mercury
© Hydrogen gas lamp (d) Deuterium discharge lamp

11. Hypochromic effect cause?
(a) Shift to longer λ (b) Shift to shorter λ
© An increase in intensity (d) A decrease in intensity

12. Single band near 3000cm^{-1} is a specific band for identification of?
(a) Alcohols (b) Alkanes (c) Alkenes (d) Amine

13. The atoms of the molecules do not move during electronic transitions.
(a) Beer-Lamberts Law (b) Maxwell Principle
© Faraday Principle (d) Frank-Condon Principle

14. If calomel electrode acts as cathode, the reaction on electrode is,
(a) $2Hg(s) + 2Cl \rightarrow Hg_2Cl_2 + 2e^-$ (b) $Hg_2Cl_2 + 2e^- \rightarrow 2Hg(s) + 2Cl^-$
© $2Cl^- \rightarrow Cl_2 + 2e^-$ (d) $Cl_2 + 2e^- \rightarrow 2Cl^-$

15. The relation between emf of the cell using glass electrode and Ph is __
(a) $E = E_o + 0.0591Ph$ (b) $E = E_o - (2.303RT/Nf)Ph$
© $E = (2.303RT/Nf)Ph$ (d) None of these

16. Water is universal solvent because of its
(a) High dielectric constant (b) Strong intermolecular forces
©It is liquid in nature (d) Large quantity in nature

17. For a reaction, there are ions involved, which of the following method is suitable to determine the rate of reaction
(a) Spectrometry (b) Conductometry
© Potentiometry (d)Dilatometry

18. What is Nernstian response in Mv is expected for every factor of 10 difference in activity of Cr^{+6}?
(a) 59.16(b) 19.58 (c) 10.58 (d) 9.86

19. Calomel reference electrode Contains solution of,
(a) NaCl (b) KCl (c) Hg_2Cl_2 (d) All of these

20. Which of the following is disadvantage of calomel electrode
(a) It is delicate to handle (b) It cannot be used above 50°C
© Emf of electrode depends upon [KCl] in it.
(d) It does not have stable and reproducible potential

21. _____ solution is filled in a glass electrode.
(a) 1N HCl (b) Saturated KCl (c) 0.1 N HCl (d)1M NaCl

22. Ion selective membranes work on the principle of,
(a) Migration of ions from high to low concentration
(b) Migration of ions fromlow to high concentration
©Exchange of ions in membrane with solution
(d)Adsorption of ions in solution on membrane

23. The electrode used to measure Ph is,_____
(a) Solid Pt electrode (b) Liquid-liquid membrane electrode
© Glass membrane electrode (d) Au electrode

24. _____ electrode in solid-state ion selective electrode for F –
(a) BF_3 (b) LaF_3 (c) PF_5 (d) NaF

25. _____ does not conduct electricity
(a) NaCl crystal (b) NaCl solution in water
© NaCl solution in alcohol (d) Molten NaCl

26. Aqueous solution _____ does not conduct
(a) $AgNO_3$ (b) CH_3COOH (c)Ethyl alcohol (d)NaOH

27. Equivalent conductance of strong electrolyte solution on dilution
(a) Increase (b) Decrease (c) Remains same (d) Zero

28. There is increase in equivalent conductance of solution of weak
(a) Increase the mobility of ions
(b) Decrease in the number of ions per ml in the solution
© Increase in the number of ions per ml in the solution
(d) Increase in the dissociation

29. Equivalent conductance of an electrolyte at infinite dilution is,
(a) Zero (b) Minimum (c) Maximum (d)Equal to molar conductance .

30. The Ph of 0.01M HCl solution is _____
(a) 1 (b) 2 (c) 3 (d) 4

31. The Ph value of buffer _____ on addition of small amount of acid or base.
(a) Decreases (b) Increases (c) Remains same (d)None

32. n $\rightarrow \pi^*$ Transition are possible in molecules having electrons?
(a) Bonding electron only (b) Non-bonding
© σ bond (d) π bond

33. _____ disperses the polychromatic radiation into bands of monochromatic radiation?
(a) Prism(b) Grating (c) Chopper (d) a,b

34. The polar solvents shift the ____ bands to longer wavelength and the ____ band to a shorter wavelength.
(a) $\pi \rightarrow \pi^*$, $n \rightarrow \pi^*$ (b) $n \rightarrow \pi^*$, $\pi \rightarrow \pi^*$
© $\pi \rightarrow \pi^*$, $n \rightarrow n^*$ (d) $\pi \rightarrow \pi^*$, $n \rightarrow \sigma^*$

35. Which radiations are also known as inner shell radiations?

(a) UV (b) Visible (c) Infrared (d) X-rays

36. _____ is/are allowed transitions?
(a) $\pi \rightarrow \sigma^*$ (b) $\sigma \rightarrow \sigma^*$ (c) $\pi \rightarrow \pi^*$ (d) b,c

37. Mid IR region ranges from?
(a) 14000-400cm^{-1} (b) 400-10cm^{-1} (c) 6000-400cm^{-1} (d) 4000-400cm^{-1}

38. Nuclear quantum transition is involved in emission of?
(a) x-rays (b) Gamma rays
© Microwaves (d) IR radiation

39. If a molecule moves from a ground state of $E_1V_2R_0$ to $E_1V_3R_1$, it absorbs_____ radiations?
(a) Microwave (b) IR (c) UV (d) Visible

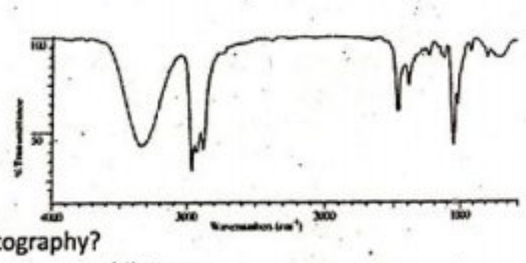
40. Which of following is/are ionizing radiation/s?
(a) Microwave (b) UV (c) Radiowaves (d) b & c

41. Which of following molecule do not absorb in the IR region?
(a) HCl (b) Icl (c) CO_2 (d) N_2

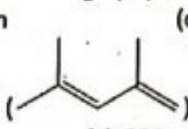
42. Which of following molecule do appear in Raman spectroscopy?
(a) HCl (b) Icl (c) CO_2 (d) N_2

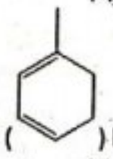
43. The impinging electrons strike with enough energy to eject --------- secondary electrons in PMT?
(a) 3-6 (b) 2-5 (c) 1-5 (d) 1-4

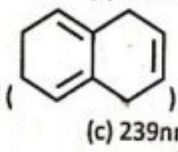
44. Following spectra cannot be of?
(a) Butyl alcohol
(b) Ethyl alcohol
© Carbonyl compound
(d) All

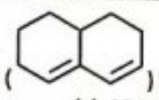


45. Which of following is a type of plane chromatography?
(a) HPLC (b) Ion exchange (c) Column (d) Paper

46. Predict the λ_{max} of following compound () by providing details of calculations?
(a) 230nm (b) 298nm (c) 239nm (d) 221nm

47. Predict the λ_{max} of following compound () by providing details of calculations?
(a) 240nm (b) 268nm (c) 249nm (d) 242nm

48. Predict the λ_{max} of following compound () by providing details of calculations?
(a) 283nm (b) 258nm (c) 239nm (d) 243nm

49. Predict the λ_{max} of following compound () by providing details of calculations?
(a) 240nm (b) 278nm (c) 234nm (d) 231nm

50. Which of following is example of coherence spectroscopy?
(a) UV (b) Visible (c) X-rays (d) NMR

51. Which of following types of bonds normal absorbs more than 3000 in IR region?
(a) O-H (b) N-H (c) C=O (d) a,b

52. Which of following radiation are weakest in energy?
(a) Microwave (b) X-Rays (c) UV (d) Gamma

53. Which of following color has highest energy?
(a) Pink (b) Yellow (c) Violet (d) Red

54. Infrared spectroscopy provides exact valuable information about?
(a) Alkylation (b) Molecular weight (c) Functional group (d) All

55. The half-reaction is always written as_____ according to Gibbs-Stockholm convention?
(a) Electron exchange (b) Redox reaction
© Oxidation (d) Reduction

56. For a sharp end point the potential difference between the titrant and the analyte half-reaction should be _____ V.
(a) 0.4-0.2 (b) 0.3-0.5 (c)0.2-0.3 (d) 0.5-0.6

57. To use Ph electrode at a Ph above 9, it is necessary to soak it in a buffer of
(a) Low Ph (b) High Ph
©Neutral buffer (d) Distilled water/KCl

58. Photomultipliers are very sensitive and rapid in their response to radiations in the spectral range
(a) 1000–12000 A° (b) 1000–5000 A°
© 5000–20000 A° (d) 10–1000 A°

59. In 20th century, x-ray work shows the diameter of atom of the order (m) (a) 2×10^{-10}
(b) 2×10^{-18} (c) 2×10^{-2} (d) 2×10^{-6}

60. Sublimation is _____?
(a) Formation of a solution (b) Volatile liquid
© Conversion of solid directly into vapors (d) Non-compressed gas

61. The maximum value of R_f can be _____
(a) 0 (b) 0.100 (c)1 (d) 0.99

62. Total energy of molecules is due to
(a) Translational (b) Rotational motion (c) Vibrational motion (d) a,b,c, Nuclear spin

63. Which reaction occurs in a voltaic cell _____
(a) A non-spontaneous reaction is forced to occur
(b) A spontaneous reaction occurs
© No electrochemical reaction occurs
(d) Photoelectric energy is produced

64. The most commonly used indicator electrode is
(a) Au electrode (b) Pt electrode (c) Cu electrode (d) Ag electrode

65. The process of distribution of a solute between a stationary and mobile phases is called
(a) Solvent extraction (b) Solid phase extraction
© Chromatography (d) Spectroscopy

66. Nano meter is equal to how many meters?
(a) 10^{-18}m (b) 10^{-9} m (c) 10^{-12} m (d)10^{-6} m

67. Ph of pure deionized distilled water is
(a) 6-8 (b) 7 (c) 14 (d) 0

68. Oxidation number of Mn in $KmnO_4$, is
(a) +7 (b) +2 (c) +5 (d) +3

69. Which statement is correct about standard hydrogen electrode?
(a) 1.0M HCl solution is used (b) H_2 gas at 1 atm pressure is present
© Platinum electrode is used (d) All of the above

70. Oxidation state of O in OF_2 is
(a) 0 (b) +1 (c) -2 (d) +2

71. In case of superoxides, the oxidation number of oxygen is
(a) 0 (b) +1 (c) -1/2 (d) -1

72. _____ produces electrical current by a redox reaction.
(a) Voltaic cell (b) Standard cell (c) Reversible cell (d) Electrolytic cell

73. A non-sponatenous redox reaction takes place as a result of electricity in
(a) Voltaic cell (b) Denial cell (c) Dry cell (d) Electrolytic cell

74. Oxidation state of 30ollowi in $SO^{2-}{}_3$?
(a) -4 (b) -2 (c) +2 (d) +3

75. Cathode in lead storage battery is made of
(a) $PbCl_2$ (b) Pb coated with PbO_2(c) $PbSO_4$(d) Mixture of $PbNO_3$ and PbO_2

76. During electrolysis at cathode _____ reaction takes place
(a) Oxidation (b) Reduction (c) Both (d) Chlorination

77. During electrolysis of aqueous NaCl which of following ions gets discharged at anode
(a) Cl^- (b) OH^- (c) Na^+ (d) H^+

78. An arbitrarily fixed potential of standard hydrogen electrode (SHE) is
(a) 0.00 volt (b) 1.00 volt (c) 10.0 volt (d) 2.00 volts

79. Electrolysis is a produces _____
(a) Chemical energy (b) Electricalenergy
© Heat energy (d) Biochemical energy

80. The oxidation number of Cr in $K_2Cr_2O_7$ is
(a) 3 (b)5 (c) 6 (d) 7

81. Which statement is correct about electrolysis of molten NaCl
(a) Oxidation takes place at cathode (b) Cl_2 gas is produced at anode
© Reduction occurs at anode (d) H_2 gas is produced at cathode

82. _____ can be determined using mass spectrometry
(a) Number of electrons (b) The molecular mass of a substance
© The reactivity of a substance (d) Chemical properties

83. The magnet functions as _____ in a mass spectrometer.
(a) Current reducer (b) Accelerator for the ions
© Deflector for the ions (d) Deaccelerator for the ions

84. Metal will displace another metal from the aqueous solution of its salt if it lies _____ the electrochemical series
(a)Below (b) Above (c)Between (d) Anywhere in

85. The cathode of a fully charged Pb accumulator is
(a) Cu (b)PbO_2 (c)$PbCl_2$ (d) CuO

86. The single cell of Pb accumulator provides around
(a) 2 VOH (b) 3.5 VOH (c) 5 VOH (d)6 VOH

87. The voltage of alkaline batteries cell is _____
(a) 1 volt (b) 1.5 volt (c) 2 volt (d) 6 volt

88. What is correct statement for 31ollowing reaction?
$CrO_7^{2-} + 14H^+ + 6Cl^- \rightarrow 2Cr^{3+} + 3Cl_2 + 7H_2O$
(a) Chromium is oxidized (b) Cl^- is reduced to Cl_2
© Cl^- is oxidized to Cl_2 (d) H^+ is reduced to H_2

89. Phenolphthalein is used in _____ titration
(a) NaOH against oxalic acid (b) Ferrous sulphate against $KmnO_4$
© Iodine titration (d) Back titration of any material

90. A solution containing maximum amount of solute dissolved at a given temperature is called?
(a) Saturated solution (b) Unsaturated solution
© Supersaturated solution (d) Impure solution

91. The solid electrolyte used in calomel electrode is,
(a) KCl (b) Hg_2Cl_2 (c) HCl (d) NaCl

92. Which of the following statement is/are correct:
i. Calomel electrode emf is stable
ii. Glass membrane electrode of specific composition can be used to measure K^+
iii, Emf of calomel electrode is independent of [KCl]
iv. Potentiometric titration uses Pt as reference electrode
v. Ph meter uses calomel reference electrode
(a) ©, ii, iii (b) ii, iii, v (c) ©, ii, iv (d) ©, ii, v

93. Electrode potential of a reference electrode,
(a) Remains constant during use
(b) Decreases if connected to an anodic half cell
© Increases if connected to an anodic half cell
(d) Increases if connected to cathodic half cell

94. The concentration of dissolved impurities is usually expressed in terms of
(a) Calcium carbonate equivalent (b) Magnesium carbonate equivalent
© Calcium bicarbonate equivalent (d) None of these

95. Calomel electrode is,
(a) $Hg,Hg_2Cl_2\,|Cl^-$ (b) $Hg,HgCl_2\,|Cl^-$ (c) $Pt,AgCl|Cl^-$ (d) Pt|1 m HCl

96. The conductance of the electrolyte solution _____ with the temperature.
(a) Decreases (b) Increases (c) Remains same (d) None

97. Specific resistance is directly proportional to _____
(a) Area of cross-section of conductor (b) Current passing
© Potential (d) Distance between electrodes

98. The purpose of the high-energy flame is to
(a) Desolvate the sample (b) Atomize the sample
© Excite the analyte atoms (d) All

99. The background correction for UV region is accomplished with
(a) Hydrogen/D_2 source (b) Tungsten source
© a& b (d) none

100. Light scatter or absorption by solid particles or unvapourized solvent in flame will cause interference
(a) Spectral (b) Chemical (c) Physical (d) a & b

101. Refractory compound formation is avoided by chemical competition or
(a) High temperature, lean flame
(b) High temperature, high velocity flame
© High temperature, low velocity flame
(d) High temperature, reducing flame

102. Specific conductance of solution on dilution _____
(a) Increase (b) Decrease (c) Remains same (d) Zero

103. Unit of specific conductance is,
(a) Ohm. Cm^{-1} (b) Ohm $^{-1}$.Cm (c) Ohm $^{-1}$ .cm^{-1} (d) Ohm.cm

104. Specific conductance represents conductivity of _____ electrolyte
(a) 1mole/litre (b) 1gm-equi/litre (c) 1 ml (d) 1mg/litre

105. One mole of H_3PO_4 can successfully neutralize almost____ moles of KOH
(a) ½ (b) 2 (c) 1/3 (d) 3

106._____ moles NaOH are completely neutralized by one mole of H_3PO_4.
(a) 1 (b) 2 (c) 3 (d) 4

107. Charactistics line spectra of elements which appear in absorption and emission is
(a) Same (b) Different (c) Very different (d) Far apart

108. Background in atomic absorption spectrum is
(a) Bright (b) Dark (c) Brown (d) Purple

109. Atomic spectra is an example of
(a) Line spectra (b) Continuous spectra (c) Band spectra (d) Both a and b

110. Isotopes can be separated using
(a) Laser separation (b) Chromatography (c) Ionization (d) a, b

111. High quality monochromator used in UV spectroscopy _____
(a) Grating (b) Glass prism (c) Laser (d) Glass print

112. The light source used in UV spectroscopy _____
(a) Halogen lamp (b) Helium lamp
© Hydrogen lamp (d) Na-vapour lamp

113. Absorbed wavelengths in atomic absorption spectrum appear as
(a) Dark background (b) Dark lines

© Light background (d) Light lines

114. Instrument use to collect ions is called _____.
(a)Electrometer (b) Ionizer (c) Spectrometer (d) None

115. Near ultraviolet region of the electromagnetic spectrum generally lies between
(a) 100–200 nm (b) 200–400 nm (c) 400–750 nm (d) 200–500 nm

116. Far ultraviolet or vacuum ultraviolet region generally lies between
(a) 10–200 nm (b) 100–400 nm (c) 400–700 nm (d) 200–500 nm

117. Far infrared region of the electromagnetic radiation generally lies between
(a) 50–200 μm (b) 100–500 μm (c) 500–1000 μm (d) 1–20 μm

118. In spectrometers each ion hits finally a _____ for concentration determination.
(a) Detector (b) Ionizer (c) Reflector (d) Chopper

119._____mass spectrometer use to determine isotopes in solid state.
(a) Bohr's (b) Aston's (c) Dempester's (d) Alison's

120._____ is the potential difference in accelerating chamber of mass spectrometer
(a) 500-2000 (b) 800-7000 (c) 500-8000 (d) 400-9000

121. Microwave region of electromagnetic spectrum generally lies between
(a) 0.1–100 cm (b) 5–100 cm (c) 50–1000 cm (d) 50–150 cm

122. Radio waves region of the spectrum generally lies between
(a) 1–100 m (b) 50–1000 m (c) 10–1000 m (d) 10–500 m

123. For a particular molecular species _____ is used to determine its concentration
(a) Absorbance (b) % transmission (c) Transmission (d) All

124. Which of the following are classified as heat detectors?
(a) Thermocouple (b) Thermister (c) Bolometer (d) All

125. Photomultipliers are very sensitive and rapid in their response and are used as
(a) Detector (b) Monochromator (c)Amplifier (d)All

126. Which of the following involve a change in bond angle with reference to a set of co-ordinates arbitrarily set up within the molecule?
(a) Rocking (b) Twisting (c) Sciorring (d) All

127. Which of the following statements is/are correct?
(a) Molecule of N atoms has 3N degrees of freedom
(b) In a non-linear molecule, 3 degrees of freedom describe rotation and there describe transition.
(c) In non-linear molecule 3N – 6 degrees of freedom are vibrational degrees of freedom
(d) All are correct

128. In order to excite the spectra of many metals in flame photometry which of the following is /are good oxidants
(a) Oxygen (b) Nitrogen (c) Nitrous oxide (d) All

129. The best flame temperature for an analysis is determined empirically and depends upon.
(a) Excitation energy of the element
(b) How it is combined in the sample
(c) The sensitivity required
(d) The presence of other elements

130. The most widely used flame in atomic absorption is
(a) Air-methane gas (b) Air-propane gas
© Air-acetylene gas (d) Oxyacetylene gas

131. Which of following is IR inactive?
(a) H_2O (b) NO_2 (c) N_2 (d) CO_2

132. Which of following is Raman active?
(a) HCl (b) CO (c) CH_3Cl (d) N_2

133. Which of the following devices is most commonly used for the formation of an atomic vapour in atomic absorption?
(a) Flame atomization (b) Electric atomization
(c) Sputtering devices (d) Ovens

134. Which of the following molecules show rotational spectra?
(a) HCl (b) CO (c) CH_3Cl (d) All

135. Which of the following statements are correct?
(a) HCl and $CHCl_3$ are infrared active
(b) CO_2, H_2O, CH_4 and C_2H_4 are infrared active
(c) NO, and CO are infrared active (d) All

136. In vibrational rotational bands, the frequency or wavelength of absorption depends on.
(a) Relative masses of the atoms (b) The force constant of the bonds
(c) Geometry of the atoms (d) All

137. Which of the following process may occur in flames?
(a) Excitation (b) Ionization (c) Dissociation (d) All

138. To check accuracy and precision in results following chart is used?
(a) Control chart (b) Bar chart (c) Linear chart (d) Scatter plot

139. Which of following method can be used to process sample for organic matter analysis?
(a) Wet digestion (b) Solvent extraction
(c) Solid Phase Extraction (d) b, c

140. Which of volumetric and gravimetric analysis is more sensitive?
(a) Volumetric analysis (b) Gravimetric
(c) Precipitation (d) Weight measurements

141. Gravimetric analysis requires iron to be present in which of following forms?
(a) Fe (b) Fe^{2+} (c) Fe^{3+} (d) Fe^{2+} and Fe^{3+}

142. Which of following are weighed in weighing bottle?
(a) Hygroscopic (b) Liquids (c) Non-metals (d) All

143. Plasma gas flows through the:
(a) Outer tube (b) Inner tube (c) Central tube (d)None

144. Protective isolation of plasma from the quartz wall is accomplished by
(a) Ar-gas (b) Coolant gas (c) Outer tube (d) a, b & c

145. Support gas flow at the rate of:
(a) 1 – 2L/min (b) 1 – 5 L/min (c) 1 – 7L/min (d) 1 – 12 L/min

146. Spectroscopic measurements are made at
plume (b) Normal analytical zone
(c) Initial radiation zone (d) Lower in plasma

147. Hygroscopic chemicals can be used as?
(a) Primary standards (b) Secondary standards
(c) Primary and secondary standards (d) Gases

148. Which of following laboratory material has highest working temperature?
(a) Borosilicate (b) Quartz glass
(c) Fused silica (d)Platinum

149. Which of the following gases is unsuitable for use as a GC carrier gas?
(a) Nitrogen (b) Helium
(c) Hydrogen (d) a & b

150. NaOH solution is a _____ standard?
(a) Primary (b) Secondary
(c) Tertiary (d) Strong

151. Line spectra is produced by excited _____.
(a) Lines (b) Molecules
(c) Atoms (d) None

152. A small diameter central tube is used to introduce
(a) Ar stream gas (b) Support gas
(c) Sample aerosol (d) Coolant gas

153. Multielement analysis can be performed with
(a) AAS (b) AES
(c) Both a & b (d) None

154. What is most important in analytical laboratory?
(a) Cleanness (b) Temperature control
(c) Environment (d) Human Safety

(a) Tail

ANSWERS

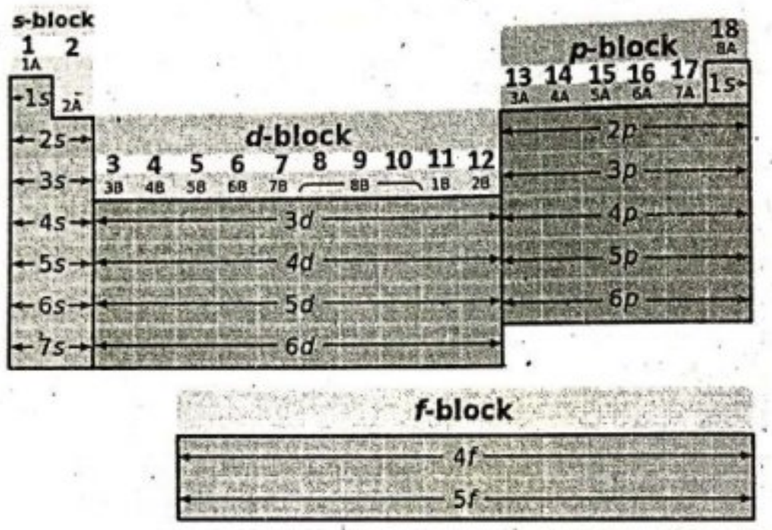
1	c	28	d	55	d	82	b	109	a	136	d
2	c	29	c	56	c	83	c	110	d	137	d
3	c	30	c	57	b	84	b	111	a	138	a
4	a	31	c	58	a	85	b	112	c	139	d
5	d	32	b	59	a	86	a	113	b	140	a
6	a	33	d	60	c	87	b	114	a	141	c
7	b	34	a	61	c	88	c	115	b	142	d
8	a	35	d	62	d	89	a	116	a	143	b
9	d	36	d	63	b	90	a	117	a	144	d
10	a	37	d	64	b	91	b	118	a	145	b
11	d	38	b	65	c	92	d	119	c	146	b
12	b	39	b	66	b	93	a	120	a	147	b
13	d	40	b	67	b	94	a	121	a	148	d
14	b	41	d	68	a	95	a	122	a	149	c
15	a	42	d	69	d	96	b	123	d	150	b
16	a	43	b	70	d	97	d	124	d	151	c
17	b	44	c	71	c	98	d	125	c	152	c
18	d	45	d	72	a	99	a	126	d	153	c
19	b	46	a	73	d	100	a	127	d	154	d
20	b	47	b	74	a	101	d	128	d		
21	c	48	a	75	b	102	b	129	c		
22	c	49	c	76	b	103	c	130	c		
23	c	50	d	77	a	104	c	131	c		
24	b	51	d	78	a	105	c	132	d		
25	a	52	a	79	b	106	c	133	c		
26	c	53	c	80	c	107	a	134	d		
27	a	54	c	81	b	108	a	135	d		

4. ELEMENTS AND PEROIDIC TABLE

The region of space around the nucleus of an atom where an electron is likely to be found is known as Atomic orbitals. Electrons are in continuous motion around the nucleus in atomic orbital. Atomic orbitals allow atoms to make covalent bonds. The most commonly filled orbitals are s (spherical), p (polar, dumbbell shaped), d (diffused) and f (fundamental). A maximum of 2, 6, 10 and 14 electrons can be reside in s, p, d and f orbitals, respectively. There is one s, three p (p_x, p_y and p_z), five d (d_{xy}, d_{yz}, d_{zx}, $d_{x^2-y^2}$ and d_{z^2}) and seven f (z^3, xz^2, xyz, $x(x^2-3y^2)$,yz^2,$z(x^2-y^2)$, $y(3x^3-y^2)$ orbitals.*S* orbitals have no angular nodes and are spherical. *p* orbitals have a single angular node across the nucleus and are shaped like dumbbells. *d* and *f* have two and three angular nodes, respectively. According to Pauli Exclusion Principle a maximum of two electrons can be accommodated in any orbital space.Pauli's exclusion principle states that no two electrons in an atom can have the same values of all the four quantum numbers. An electron can exist in various energy levels in an atom. These energy levels are defined by four quantum numbers including Principal quantum number (n), Azimuthal quantum number (l), Magnetic quantum number (m) and Spin quantum number (m_s). The energy level of a shell is defined by Principle quantum number n and it can attain n = 1, 2, 3, 4, ... values. A shell can have maximum of $2n^2$ electrons. The sub shell of electron associated to n can be calculated fromAzimuthal quantum number which defines the angular momentum of the electron. The values of l can be 0, 1, 2, 3,... (n - 1) and represents s, p, d and f sub-shells. Energy levels present within a subshell are shown by Magnetic quantum number (m). Subshells s, p, d and f can have 1, 3, 5 and 7 orientations in a magnetic field. An electron spin can be either in clockwise (+½,↑) oranticlockwise(- ½, ↓) directions.Aufbau Principle states that electrons fill orbitals starting at the lowest available (possible) energy states before filling higher states (e.g. $1s < 2s < 2p < 3s < 3p < 4s < 3d < 4p < 5s < 4d < 5p < 6s < 4f < 5d$ etc.)

Peroidic table grouped elements into different classes on the basis of similarity in electronic structure. Dobereiner's (1829) classified elements in the form of Triads (a group contains three elements) considering similarities in chemical and physical properties. In each triad, the central member has an atomic weight that was roughly the average of other two elements. For example, Li (A.W= 7), Na (A.W= 23) and K (A. W = 39). Newlands (1864) arranged elements in the group of eight elements (Octaves) in order of atomic mass. He had noted that in an octave every eighth element had similar properties. Mendeleev (1869) perodic table contained 63 elements arranged in order of their increasing atomic weights. Mendeleev called in vertical columns as groups (I to VIII) and horizontal rows as periods(1 to 7). Group number defined the valance state of elements except for group VIII. In Mendeleev periodic table there was diagonal relationship among the elements of the second row of group I, II and III to the next elements of group II, III and IV, respectively. Spaces for those elements were left in Mendelev's periodic table which were not known at that time on the basis of the properties of the missing elements. Mendeleev's periodic table had following drawbacks: position of hydrogen was not clear, some similar atoms placed in different groups, e.g. Cu and Hg or Au and Pt, some dissimilar elements placed together such as alkali metals, copper, silver and gold, proper position was not allotted to lanthanides and actinides, Arranegment of some elements in periodic table was not proper such as Argon (A.W. 40) proceeded potassium (A.W. 39) and cobalt (A.W. 59) proceeded nickel (A.W. 58.6), Isotopes and isobars position was not clear, explanation for inert pair and anomalous behavior of the first member of a group was not provided, group VIII did not indicated true valance state.Moseley (1913) made a better periodic table and stated that *"The properties of the elements are periodic functions of their atomic numbers".*

The amount of energy required to remove the most loosely bound electron from an atom in gaseous state is called ionization energy (IE) or ionization potential. Electron affinity (EA) is the amount of energy released on addition of an electron in an isolated atom gaseous state.Generally,Ionization energy, electronegativity and electron affinity increase from left to right in a period decrease down a group. Following table shows a general overview of modern periodic table.



MULTIPLE CHOICE QUESTIONS

1. Oxidation state of an atom represents
   (a) Apparent charge in compound (b) Number of electrons gained
   (c)Number of electrons lost (d) Its vacancies
2. _____ possesses maximum hydration energy?
   (a) Mg^{+2} (b) Na^{+} (c) K^{+} (d) Ca^{+2}
3. ____ always increases on going from top to bottom in a group?
   (a) Electronegativity (b) Oxidizing power
   (c) Metallic character (d) Tendency to get reduced
4. _____ the p-block elements are not representative elements?.
   (a) Group-18 elements (VIII-A) (b) Alkali metals (I-A)
   (c) Halogens (VII-A) (d) Group-14 elements (IV-A)
5. ____the highest boiling point among halogens
   (a) Bromine (b) Fluorine (c) Chlorine (d)Iodine
6. _____ will not form crystalline structure with oppositely charged ions
   (a) Mg^{2+} (b) H^{+} (c) Ca^{2+} (d) H^{-}
7. Which following is incorrect?
   (a) All the metals form acidic oxides
   (b) All the metals form positive ions
   (c) All the metals are good conductor of electricity.
   (d) All the metals are good conductor of heat
8. Periodic table provides a basic framework to study elements with respect to their
   (a) Physical properties
   (b) Properties of their compounds
   (c) Chemical properties

   (d) All
9. _____ was not known when Mendeleev proposed his classification?
   (a) Germanium (b) Copper (c) Hydrogen (d) Sodium
10. Elements with similar chemical properties appear in the _____
    (a) p block elements (b) Same period
    (c) Same family (d) Right upper corner
11. What is oxidation number of carbon in chloroform?
    (a) -4 (b) -3 (c) -2 (d) +4
12. _____ shows maximum oxidation sates?
    (a) Mn (b)Fe (c) Cr (d) Ar
13. _____ is a non-metal?
    (a) Ga (b) B
    (c) In (d) St
14. Element with 31 atomic number is placed_____ of modern periodic table?
    (a) S-block (b) p- block
    (c) d-block (d) f- block
15. What will be ionic radius of Cl^- ion, if ionic radius of $Na^+$is 0.95 Å and the internuclear distance of NaCl is 2.76 Å. Calculate the radius of Cl^- ion (Hint: $d(Na^+—Cl^-) = r_{Na+} + r_{Cl-}$) ∴ $2.76 = 0.95 + r_{Cl-}$
    (a) 1.84 (b) 1.82 (c) 1.77 (d)1.87
16. In conjugate pair of oxidant and reductant, the reductant oxidant number is?
    (a) Higher (b) Same (c) Lower (d) All
17. On increasing oxidation state, the ionic character of any metal————.
    (a) Increases (b) Decreases (c) Remain same (d) Any of above
18. _____ act as both oxidizing as well as reducing agent?
    (a) H_2O_2 (b) $KMnO_4$ (c) $FeCl_3$ (d) $K_2Cr_2O_7$
19. _____ has following configuration $1s^2 2s^2 2p^6 3s^2$.
    (a) Alkali metal (b) Alkaline earth metal
    (c) Metalloid (d) Non-metal e. Inert gas
20. The atomic radii decreases by increasing atomic number in
    (a) Alkali metal (b) Elements from Li to Ne
    (c) Alkaline earth metal (d) Halogens
21. Which discovery caused a revision in the periodic law as stated by Mendeleev?
    (a) Atomic number by Moseley
    (b) Location of nucleus by Rutherford
    (c) Natural radioactivity by Henry Bacquerel.
    (d) X-rays by Roentgen
22. Ionization energy depends upon
    (a) Atomic size
    (b) Nuclear charge
    (c) Shielding effect
    (d) All of the above and nature of orbital
23. Shielding effect across the period
    (a) Remains constant (b) Can not be predicted
    (c) Increases (d) Decreases
24. Addition of 2nd electron to a uninegative ion is always
    (a) Endothermic (b) Exothermic

(c) Unpredictable (d) Data is insufficient

25. Higher value of electron affinity means
(a) Atom will gain electron easily
(b) Atom will lose electron easily
(c) Atom may form di-positive ion
(d) The reason is unknown

26. Metallic characters of alkali metals
(a) No regular trend
(b) Decrease down the group
(c) Remain same
(d) Increase down the group

27. Mendeleev's failed to predict exact position for ___ in perodic table?
(a) Isotopes (b) Lanthanides
(c) Isotopes of oxygen (d) All

28. ————arranged elements by putting atomic weights against their atomic volumes
(a) Bohr (b) Lother Meyer
(c) Dobereiner (d) Bohr

29. _____ contains non-metals.
(a) s-block (b) p- block
(c) d-block (d) f- block

30. In a period all elements have same?
(a) Color (b) Valency
(c) Shells (d) Chemical properties

31. ————element derives its symbol from Latin word aurum (shining dawn)
(a) Al (b) Au (c)Ag (d)Hg

32. Elements at the extreme right of the periodic table are
(a) Noble gases (b) Tranisition metals
(c)Alkali metals (d) Halogens

33. The law of Octaves was presented by
(a) Dobereiner (b) Mendeleev
(c) Bohr (d) John Newlands

34. Elements in the same vertical group of the periodic table have same
(a) Atomic mass
(b) Number of valence electrons
(c) Atomic number
(d) Atomic volume

35. _____ atomic number element show +3 oxidation states?
(a) 13 (b) 15 (c) 17 (d)16

36. The bleaching action of sulfur dioxide is due to?
(a) Acidic nature (b) Amphoteric nature
(c) Oxidation (d) Reduction

37. Which of following element is expected to exhibit more than one oxidation states?
(a) Al (b) Mg (c) Fe (d) K

38. An element having low value of ionization energy and low value of electron affinity is likely to belong to
(a) Group IB (b) Group VIII (c)Group VIIA (d)Group IA

39. _____ cannot exist in solution
(a) O^{-2} (b) Na^{+} (c) Cl^{-} (d) H^{+}

40. Concept of Triads was introduced by _____
(a) Mendeleev (b) Newland (c) Al-Razi (d) Dobereiner

41. The property which increases upto group IV-A then decreases onwards
(a) Melting & boiling points (b) Ionization energy
(c) Atomic radii (d) Atomic volume

42. _____ is stable in aqueous solution?
(a) Cl^{-} (b) H^{+} (c) H^{-} (d)All

43. The atoms of same element having same atomic number but different mass number are called
(a) Isotopes (b) Isobars
(c) Isotropes (d) Isomers

44. Deuterium reacts with oxygen to form
(a) Heavy water (b) Hard water
(c) Soft water (c) Water gas

45. _____ order of ionization energy is correct
(a) Mg > Al (b) Mg < Al
(c) Si > P (d) Both b & c

46. Non-metals usually form _____ oxides
(a) Amphoteric (b) Acidic
(c) Neutral (d) All

47. Amphoteric oxides are those which possess _____ properties
(a) Basic (b) Acidic
(c) Acidic and basic (d) Neutral and acidic

48. Best position of hydrogen in the periodic table is above I.A Group because
(a) Both are electropositive
(b) Similar outer most shell electronic configuration
(c) Both form ionic compounds
(d) All

49. Hydrogen resembles with carbon because of having
(a) Remarkable reducing properties
(b)Same number of electrons in the valence shell
(c) Similar physical state
(d)Homovalent (show same valency)

50. _____ sets consists of all coinage metals?
(a) Cu Ag Au (b) Cu Hg Au (c) Ag Au Hg (d) Cu Fe Au

51. _____ belonging to the same group?
(a) Nitrogen & Phosphorous
(b) Boron & Beryllium
(c) Magnesium & Aluminium
(d) Gallium & Helium

52. _____ is correct order of increasing ionization energy?
(a) Sb < As < Cl < S < P (b) Sb < As < S < P < Cl
(c) As < Cl < P < S < Sb (d) Cl < As < P < S < Sb

53. _____ did not contribute in the construction of periodic table?
(a) Democritus (b) Al-Razi
(c) Moseley (d) Dobereiner

54. In _____ halides halogen atoms act as a bridge between two atoms of the other element.
(a) Electronegative halides (b) Covalent halides

(c) Polymeric halides (d) Polymeric hydrides

55. Less electronegative elements such as Be and Ga form _____.
(a) Ionic halide (b) Polymeric halide
(c) Covalent halide (d) All

56. Iodine is solid due to _____
(a) High polarizability (b) Strong covalent bond
(c) Large value of dipole moment (d) Strong hydrogen bonding

57. _____increasing order of acidity of the oxides of Mn
(a) $MnO_2 > MnO > Mn_2O_7$ (b) $MnO_2 > Mn_2O_7 > MnO$
(c) $Mn_2O_7 > MnO_2 > MnO$ (d) $MnO < MnO_2 < Mn_2O_7$

58. Keeping in view the size of atom which order is correct one?
(a) Mg > Sr (b) Lu > Ce (c) Ba > Mg (d) Cl > I

59. ____made first attempt to classify metals?
(a) Democritus (b) Al-Razi (d) Moseley (d) Dobereiner

60. Melting points of VII-A group elements _____down the group
(a) Decrease (b) No regular trend
(c) Remain constant (d) Increase

61. Noble gases are named so because they are
(a) less reactive
(b) Having completely filled valence shell
(c) Zero group elements
(d) All

62. In modern periodic table all the leements are arranged in ascending order of
(a) Atomic number (b) Valency
(c) Valence electrons (d) Atomic mass

63. The longest period in the modern periodic table is
(a) 2nd and 3rd both (b) 6th (c) 7th (d) 5th

64. Inner transition elements are called
(a) Actinides (b) Lanthanides
(c) Rare earth metals (d) All

65. Seventh period contains _____ normal elements
(a) 4 (b) 2 (c) 6 (d) 7

66. Modern periodic table has been divided in _____ blocks
(a) 4 (b) 2 (c) 5 (d) 6

67. An element has electronic conviguration $1s^2\ 2s^2\ 2p^2$. It belongs to
(a) Group II-A (b) Group VII-A
(c) Group IV-A (d) Group VI-A

68. What property could not be predicted due toposition of the element in the periodic table?
(a) Its number of isotopes (b) The nature of its oxides
(c) The charge on its ions (d) The formula of its oxide

69. _____ is not a periodic property?
(a) Melting point of elements
(b) Boiling point of elements
(c) Coordination number of ions
(d) Ionization energy of elements

ANSWERS													
1	a	11	c	21	a	31	b	41	a	51	a	61	d
2	a	12	a	22	d	32	a	42	a	52	b	62	a
3	c	13	b	23	a	33	d	43	c	53	a	63	b
4	a	14	b	24	a	34	b	44	a	54	c	64	d
5	d	15	d	25	a	35	c	45	a	55	b	65	b
6	b	16	a	26	d	36	d	46	b	56	a	66	a
7	a	17	d	27	d	37	c	47	c	57	d	67	c
8	d	18	a	28	b	38	a	48	d	58	c	68	a
9	a	19	b	29	b	39	a	49	a	59	b	69	c
10	c	20	b	30	c	40	d	50	a	60	d		

5. CHEMICAL BONDING& MO' ECULAR STRUCTURE

Why do atoms bond together? Let us answer this. Some atoms are very reluctant to combine with other atoms and exist in the air around us as single atoms. These are the Noble Gases and have very stable electron arrangements. All other atoms therefore, bond together to become electronically more stable, that is to become like Noble Gases in electron arrangement. Bonding produces new substances and usually involves only the 'outer shell' or 'valency' electrons and atoms can bond. Chemical bonds may be (i) electrovalent or ionic bond (ii) covalent bond (iii) coordinate covalent bond (vi) metallic bond. Two other types of interaction that exists between atoms are (i) hydrogen bonding (ii) Vander Waals interactions.Ionic bonding is the complete transfer of valence electron(s) one atom to another and is a type of chemical bond that generates two oppositely charged ions. An ionic bond and is most likely formed when a metal (electron loser) combines with a non-metal (electron acceptors) e.g. NaCl, CuF_2. Ionic compounds are crystalline solids at room temperature having high brittleness, density, melting and boiling points, high heats of fusion and vaporization. Ionic compounds preferably dissolve in polar solvents and tend to conduct electricity in melted as well as in solution form. Ionic bonds are non-directional in character. A covalent bond is formed by two atoms sharing electrons so that the atoms combine to form molecules. Metallic bonding is quite different from ionic or covalent bonding. Between all particles, but with particular reference to covalently bonded molecules, there always exist some very weak electrical attractive forces known as intermolecular forces or intermolecular bonding. These constantly acting attractive forces or intermolecular bonds are very much weaker than full covalent or ionic chemical bonds.These have approximately $^1/_{30}$ to $^1/_{20}$th in comparative attractive force).In metallic bonding the immobile positive metal ions/atoms in the lattice are attracted together by the free moving negative electrons between them. So, like ionic bonding, no attraction between positive and negative particles.Valence bond theory (VBT), Valence Shell Electron Pair Repulsion (VSEPR) Theory and Molecular orbital theory (MOT) are most common theories put forward to explain chemical bonding.Valence Bond Theory (VBT) assumes that all bonds are localized bonds formed between two atoms by the donation of an electron from each atom. VBT explains covalent bond formation as well as the electronic structure of molecules. Hybridization is the concept that says mixing atomic orbital results into new *hybrid orbitals* with different energies, shapes, etc., than the component atomic orbitals. Hybrid oribitals are suitable for the pairing of electrons to form chemical bonds in VBT. Hybrid orbitals are very useful in the explanation of atomic bonding properties and molecular geometry. Valence Shell Electron Pair Repulsion (VSEPR) Theory assumes that each atom in a molecule will achieve a geometry that minimizes the repulsion between electrons in the valence shell of that atom. Molecular Orbital Theory (MOT) is a method for determining molecular structure in which electrons are not assigned to individual bonds between atoms, but are treated as moving under the influence of the nuclei in the whole molecule.Each electron in a molecule can be described by a wave function, known as the molecular orbital. Molecular orbital are formed by combination of atomic orbitals are bonding (lower energy than atomic orbitals) and antibonding molecular orbitals (have higher energy than atomic orbitals). A hydrogen bond is a weak type of force that forms a special type of dipole-dipole attraction which occurs when a hydrogen atom bonded to a strongly electronegative atom exists in the vicinity of another electronegative atom with a lone pair of electrons.

MULTIPLE CHOICE QUESTIONS

1. The atomic radii _____ in a peroid
   (a) Decreases (b) Increases
   (c) Remain same (d) First decreases then increases
2. An atom loses or gains electrons to become _____
   (a) Gain stability (b) Complete its outermost shell
   (c) Form a bond (d) All
3. Ionic radii _____ in a group.
   (a) No change (b) Increases
   (c) Variable trend (d) Decreases
4. _____ is the energy required to remove electron from an atom
   (a) Electron affinity (b) Activation energy
   (c) Ionization potential (d) Electronegativity
5. _____does not contain covalent bond
   (a) Diamond (b) Copper (c) Ice (d) Graphite
6. _____Molecular orbital have higher energy than atomic orbitals.
   (a) Super atomic (b) Bonding (c) Hybrid (d) Antibonding
7. Unpaired electron in a molecule gives _____ character.
   (a) Ferromagnetic (b) Paramagnetic (c) Both a & b (d) Diamagnetism
8. Bond order for N_2 molecule is ____
   (a) 3 (b) 1 (c) 2 (d) 4
9. Product of charge and distance is called
   (a) Dipole moment (b) Bond length (c) Work (d) Pressure
10. The relative attraction of the nucleus for the electrons in a chemical bond is called
    (a) Electro negativity (b) Ionization energy
    (c) Electron affinity (d) Dipole moment
11. The octet rule does not always hold for _____
    (a) P (b) O (c) F (d) N
12. Energy of atom in compound is _____ than individual atom.
    (a) No change (b) Lesser (c) Higher (d) Unpredictable
13. CO_2 is non polar molecule and its _____.
    (a) Dipole moment is zero (b) Linear geometry
    (c) Sp hybridization (d) Gas nature
14. Shielding effect across the period _____.
    (a) Constant (b) Increases
    (c) Decreases (d) Unpredictable
15. _____ the absolute term of the element?
    (a) Ionization energy (b) Atomic size
    (c) Electro negativity (d) Electron affinity
16. In O_2 each oxygen atom is _____hybridized
    (a) sp^2 (b) sp^3 (c) sp (d) dsp^3
17. The ionization energy _____ in periodic table
    (a) Does not change in a period
    (b) Generally increases from left to right in a period
    (c) Generally decreases from left to right in a period

(d) Unpredictable

18. ____ have highest value of electron affinity
(a) Cl (b) F (c) Na (d) I

19. Bond will beionic when E.N difference of bonded atom is
(a) >1.7 (b) =1.7 (c) <1.7 (d)1

20. Sharing of 1 electron pair by one specie forms
(a) Coordinate covalent bond (b) Hydrogen bond
(c) Single covalent bond (d) Double covalent bond

21. Angle in water molecule is
(a) 104.5° (b) 105.9° (c) 100.5° (d)120°

22. The geometry of ammonia is
(a) Trigonal Pyramidal (b) Tetrahedral
(c) Square planner (d) Trigonal bipyramidal

23. Orbitals of same energy produced after mixing of orbitals of different energy are called
(a) Hybrid orbitals (b) Zeeman orbitals
(c) Degenerate orbitals (d) Generate orbitals

24. _____ bond is formed by overlap of p orbitals
(a) Sigma (b) Pi (c) Both (d) None

25. Molecular orbitals are filled according to
(a) Hunds rule (b) Auf bau principle (c) Pauli's Exclusion principle (d)All

26. Measurement of the degree of polarity is called _____.
(a) Dipole moment (b) Ionization energy
(c) Electron affinity (d) Ionic character

27. Electronegativity _____ in peroid from left to right.
(a) Decreases (b) Remain constant
(c) Variable trend (d) Increases

28. The Lewis acids are
(a) Octet is complete (b) Electron rich
(c) No such acids exist (d) Electron deficient

29. Geometry of sp^3 hybrid orbital is _____
(a) Tetrahedral (b) Triangular
(c) Square planner (c) Linear

30. Unit of dipole moment is
(a) Debye (b) Poise (c) Newton (d) Pascal

31. Geometry of molecule will be pyramidal if the outer most shell of the central atom has
(a) 1 bond pair 3 lone pair (b) 2 bond pair 2 lone pair
(c) 3 lone pair 1 bond pair (d) 3 bond pair one lone pair

32. Pi bonds are produced by overlapping of
(a) Hybrid orbitals
(b) Hybrid and un hybrid orbitals
(c) Un-hybrid orbitals
(d) Atomic orbital and hybrid orbital

33. According to VESPR Model the geometry of molecule having 5 bond pair in outer most shell will be _____
(a) Square planner (b) Trigonal bipyramidal
(c) Octahedral (d) Triangular

34. _____ shows high %age of the ionic character?
(a) HF (b) HNO_3 (c) HBr (d) H_2O

35. _____ have their outer most shell complete in atomic form?
(a) Coinage metals (b) Alkaline earth metals
(c) Gun metals (d) Noble gases

36. Force responsible to hold atoms together in a compound is called
(a) Attractive force (b) Interaction
(c) Bond (d) Ionization energy

37. Ionization energy generally _____ in a peroid
(a) No change (b) Increases (c) Variable trend (d) Decreases

38. Ionic bond is produced after complete transfer of
(a) Electrons (b) Beta particles (c) Neutrons (d) Protons

39. By combining n atmic orbitals no. of hybrid orbitals will be
(a) n (b) 2n (c) 3n (d) All

40. _____ make sp^3 hybridization
(a) One s and 3 p-orbitals (b) Four p-orbitals
(c) One p-orbital (d) All

41. Mostly ionic compound are produced in between elements of
(a) IA and IB (b) IB and VIIB
(c) IA IIA and VIIA (d) IA and VIA

42. Greater shielding effect corresponds to a _____ ionization energy value
(a) Lesser (b) Greater (c) Constant (d) No effect on

43. Elements having high ionization potential values are
(a) Liquids (b) Metals (c) Solids (d) Non metals

44. _____ is the energy released or absorbed when electrons are added in an atom.
(a) Electron affinity (b) Ionization potential
(c) Activation energy (d) Electronegativity

ANSWERS

1	a	11	a	21	a	31	d	41	c
2	d	12	b	22	a	32	c	42	a
3	b	13	a	23	c	33	b	43	d
4	c	14	a	24	c	34	a	44	a
5	b	15	c	25	d	35	d		
6	d	16	a	26	a	36	c		
7	b	17	b	27	d	37	b		
8	a	18	a	28	d	38	a		
9	a	19	a	29	a	39	a		
10	a	20	a	30	a	40	a		

6. ACIDS, BASES AND SALTS

According to Arrhenius acid-base concept states an acid is a species that produces hydrogen ions (H^+) or hydronium ions in water and base is species that hydroxide ions (OH^-) in water. e.g. Acid (CH_3COOH) and base (KOH). This concept defines acid and bases only in water as a solvent.The Bronsted-Lowry theory classifies a substance as an acid if it acts as a proton donor and as a base if it acts as a proton acceptor. This concept failed to explain aprotic solvents like SO_2, BF_3 etc.The Lewis theory classifies a substance as an acid (e.g. BF_3, $AlCl_3$) if it acts as an electron-pair acceptor and as a base (OH^-, H_2O, Cl^-, Br^-, NH_3) if it acts as an electron-pair donor.According to Lux-Flood theory, acid is an oxide acceptor and base is an oxide donor. For example, CaO donates oxygen, therefore, it is a basic oxide. SiO_2 is an oxide acceptor, hence, it is a acidic oxide.The most comprehensive of all previous acid and base theories is Usanovich concept according to which acid is a cation,cation donor or electron pair acceptor and base is any specie capable of giving up anions or electrons combining with cationsor neutralizing an acid to give a salt. For example, acids(HCl, SO_3)and bases (Na_2O, Na, NH_3).Pearson's Soft and Hard Acids and Bases (SHAB) theory states hard acids prefer binding to the hard bases to give ionic complexes, whereas the soft acids prefer binding to soft bases to give covalent complexes. Hard acids are characterized by high positive charge, strongly solvated, small ionic radii, empty orbitals in the valence shell and with high energy LUMOse.g. CO_2, RCO^+, NC^+.Soft acids are characterized by low positive charge, completely filled atomic orbitals, large ionic radii, and with low energy LUMOs. e.g HO^+, RO^+.Hard bases are characterized by weakly polarizable, small ionic radii, strongly solvated, highly electronegative, and with high energy HOMOse.g. NH_3, RNH_2, N_2H_4.Soft Lewis bases are characterized by intermediate electronegativity, highly polarizable, large ionic radii, and with low energy HOMOs, e.g. RS^-, SO_3^-. pH stands for "power of hydrogen". It has also been suggested that the "p" stands for the German *Potenz* (meaning "power").pH is a measure of the hydorgen ion concentration of a solutionin water and vaies from 0-14. This pH range (0-14) is observed in aqueous medium, however, a pH greater than 14 is observed in liquid ammonia as a solvent.A solution that resists change in pH on addition of small amount of acid or base in it is called as buffer. pH of human blood is 7.40. pH of buffer solution can be calculated using *Henderson—Hasselbalch equation.*

$$pH = pKa + \log \frac{[\text{conjugate base}]}{[\text{Acid}]}$$

Law of mass action states that the principle that the rate of a chemical reaction is proportional to the concentrations of the reacting substances. The ability of a lonic substance to dissolve in any solvent is called solubility.The solubility product principle states that the product of the lonic concentrations in a saturated solution of a sparingly soluble salt is constant at a given temperature.

MULTIPLES CHOICE QUESTIONS

1. $K_2O + H_2O \rightarrow$ _____?
   (a) $K(OH)_3$ (b) KOH (c) $KOH.H_2O$ (d) $KO + H_2 + O_2$
2. Mineral acids are _____
   (a) Naturally occurring (b) Man made
   (c) Carbonic acids (d) Weak acids
3. Excess acidity caused by acid rain can be neutralized by adding
   (a) Fertilizers (b) Nitrogen (c) P_2O_5 (d) Lime
4. What is the pH of buffer solution containing 1 mole·dm^{-3} each of acetic acid (pKa 4.74) and sodium acetate.
   (a) 4.91 (b) 4.98 (c) 4.61 (d) 4.74

5. Which is not correct order of strength?
   (a) $H_2SO_4 > H_2SO_3$ (b) $HClO_4 > HClO_3$
   (c) $HNO_3 > HNO_2$ (d) $H_2SeO_3 > H_2SO_3$
6. An acid is a proton donor.
   (a) Arrhenius theory (b) Bronsted-Lowry theory
   (c) Lewis theory (d) SHAB concept
7. _____ react with both acids and bases are called
   (a) Neutral (b) Conjugate bases
   (c) Amphoteric substances (d) Conjugate acids
8. PO_4^{3-} is conjugate base of:
   (a) H_3PO_4 (b) $H_2PO_4^-$ (c) HPO_4^{2-} (d) OH
9. The conjugate acid of H_2O is:
   (a) H_3O^+ (b) H_2O (c) OH^- (d) None
10. Following is conjugate base of ammonia is:
    (a) NH_3 (b) OH (c) NH_2^- (d) NH_4^+
11. _____is amphoteric.
    (a) $Ca(OH)_2$ (b) HCN (c) CsBr (d) $Al(OH)_3$
12. Bronsted-Lowery acid in reaction $H_2O + NH_3 \rightarrow NH^+_4 + OH^-$ is
    (a) H_2O (b) NH_3 (c) OH^- (d) NH^+_4
13. _____ donates a pair of electrons to form coordinate covalent bond.
    (a) Lewis acid (b) Lewis base
    (c) Bronsted-Lowry acid (d) Bronsted-Lowry base
14. $H_3PO_4 + HCO_3^- <=> H_2PO_4^- + H_2CO_3$ K>>1
    The acids in order of decreasing strength are:
    (a) $H_3PO_4 > H_2CO_3$ (b) $H_2CO_3 > H_3PO_4$
    (c) $HCO_3^- > H_2CO_3$ (d) $HCO_3^- > H_2PO_4^-$
15. Calculate $[H_3O^+]$ for a 0.50 M solution of formic acid.
    $K_a = 1.8 \times 10^{-4}$ for formic acid.
    (a) 9.5×10^{-3} (b) 5.4×10^{-5} (c) 9.0×10^{-5} (d) 0.30
16. $H_3PO_4 + HCO_3^- <=> H_2PO_4^- + H_2CO_3$ K>>1
    The strongest base is:
    (a) H_3PO_4 (b) H_2CO_3 (c) $H_2PO_4^-$ (d) HCO_3^-
17. _____more corrosive acid is
    (a) H_2CO_3 (b) H_2SO_3 (c) HNO_3 (d) $C_6H_8O_7$
18. When an acid (H^+) is added to alkali (OH^-), product is _____
    (a) Hydroxides (b) Water (c) Salts (d) Hydrogen gas
19. _____ is able to accept a proton is called
    (a) Acid (b) Base (c) Neutral compound (d) Cation
20. The pH of a carbonated drink is _____.
    (a) > 7 (b) < 7 (c) 7 (d) 7.6 approximately
21. _____ is a weak base?
    (a) NaOH (b) KOH (c) NH_4OH (d) $Ca(OH)_2$

22. What is pH of 0.0032 *M* H_2SO_4?
(a) 3.02 (b) 11.0 (c) 1.45 (d) 2.19

23. What is pH of 1.0×10^{-3} *N* NaOH
(a) 3.2 (b) 11 (c) 10 (d) 13

24. Which is not a strong, soluble base?
(a) RbOH (b) NaOH (c) $Ba(OH)_2$ (d) $Cu(OH)_2$

25. _____is the most acidic substance in aqueous solution?
(a) NH_2^- (b) H_2O (c) NH_4^+ (d)Na^+

26. _____ is the most basic substance in aqueous solution?
(a) I^- (b) NO_3^- (c) Cl^- d. F^-

27. What is pH of 1.3×10^{-4} *N* HCl?
(a) 4.08 (b) 6.87 (c) 3.88 (d) 4.02

28. Select correct order of increasing strength:
(a) HI > HBr > HCl > HF (b) HF > HI > HBr > HCl
(c) HF > HCl > HBr > HI (d) HCl> HBr > HI > HF

29. Calculate pH of 1.5% dissociated. 0.25 *N* formic acid solution
(a) 1.58 (b) 2.42 (c) 3.59 (d) 4.16

30. _____ exist in a neutralization reaction?
(a) H_3O^+ (b) H_2O (c) HCl^- (d) H^+

ANSWERS

1	b	6	b	11	d	16	d	21	c	26	d
2	a	7	c	12	a	17	c	22	d	27	c
3	d	8	c	13	b	18	c	23	b	28	a
4	d	9	a	14	a	19	b	24	d	29	b
5	d	10	d	15	a	20	b	25	c	30	a

7. s- BLOCK ELEMENTS

All of the s-block elements outermost electrons in a s orbital. The s orbital is spherical and can be occupied by a maximum of two electrons. The s-block elements are the 14 elements. The s-block elements include H (hydrogen), He (helium), Li (lithium), Be (beryllium), Na (sodium), Mg (magnesium), K (potassium), Ca (calcium), Rb (rubidium), Sr (strontium), Cs (cesium), Ba (barium), Fr (francium) and Ra (radium). The atomic number of metals in IUPAC group 1 (Group IA) are Li (Z = 3), Na (Z = 11), K (Z = 19), Rb (Z = 37), Cs (Z = 55), and Fr (Z = 87).All of the s-block elements are metals and are silvery, shiny, good conductors of heat and electricity and lose their valence electrons of s orbital easily. The elements in column 1 except hydrogen are collectively known as the alkali metals. The word alkali comes from Arabic. It can be translated into 'dissolved ashes.' Alkali metals always lose their one valence electron to make a +1 ion. These metals are characterized by being silvery, very soft, not very dense and having low melting points. These metals react extremely vigorously with water and even oxygen to produce energy and flammable hydrogen gas. Alkali metals are kept in mineral oil to reduce the chance of an unwanted reaction or worse, an unwanted explosion. The metallic character in alkali metals increases from Li to Cs and Cs is the most electropositive metal in periodic table. Alkali metals have a single valance electron so they form weak metallic bonds. The strength of metallic bond decreases in a group from top to bottom and the softness of metal increases. Alkali metals form a varied range of amalgams. Alkali metals are strong reducing agents with Li the strongest. Alkali metal oxides are strong oxidizing agents. The density of alkali metals increase from Li to Cs. However, K (0.86 g/cc) is lighter than Na (0.97 g/cc) due to unusual increase in size. Li is lightest known metal (0.54 g/cc). Alkali metals have very low melting point, boiling points. Electronegativities, hydrated radii, hydration energy, melting point and boiling point decrease down a group from Li to Cs. Alkali metals are paramagnetic and their mono-positive ions are diamagnetic. Down a group, electropositive character of alkali metals increase. Alkali metals are used in photoelectric cells particularly K and Cs (best) because of their better electropositive character. All alkali metal salts except Li salts are soluble in water. K^+ is poor electric conductor in water and Cs^+ has best electric conductivity in aqueous form. Alkali metals have pecific heat in following order: Li > Na > K > Rb > Cs. For flame tests, alkali metals are usually converted to chlorides by action of HCl. Li, Na, K, Rb and Cs gives crimson red, golden yellow, purple, violet or reddish violet color, respectively in flame. Alkali metals get rapidly oxidized in the air and become tarnished. Amon alkali metals, Li has maximum covalent and least ionic character whereas Cs has maximum ionic and least covalent character. It is not possible to extract alkali metals using reducing agents, metal displacement or electrolysis because of their highly positive metallic character. The preffered method of extraction of alkali metals is to form amalgams using mercury electrodes or as metal halides in presence of some impurity. Sodium is extracted from NaCl (common salt), $Na_2SO_4.10H_2O$ (Glauber's salt), $NaNO_3$ (chile salt petre) and borax (sodium tetraborate or sodium borate), ($Na_2B_4O_7.10H_2O$). The common potassium ores are langbeinite ($K_2SO_4.2MgSO_4$), sylvite (KCl), carnalite ($KCl.MgCl_2.6H_2O$), and polyhalite ($K_2SO_4.MgSO_4.2CaSO_4.2H_2O$).

Alkaline earth metals (except helium) are present in column 2 of period table. Beryllium (Z = 4), Magnesium (Z = 12), Calcium (Z = 20), Strontium (Z = 38), Barium (Z = 56) and Radium (Z = 88) are IUPAC group 2 (IIA elements) or alkaline earth metals. Alkaline earth metals always lose their two valence electrons from s-oribtal to make a +2 ion. Alkaline earth metals are shiny, silvery and relatively soft. Some of the alkaline earth elements react vigorously with water and must be stored carefully. S-block elements are famous for being ingredients in fireworks. The ionic forms of potassium, strontium and barium make appearances in firework displays as the brilliant purples, reds and greens. Hydrogen is the simplest and lightest element known. It is the most abundant element in the universe and the tenth most abundant by mass on Earth. Hydrogen is only element without neutron and has only one

proton and one electron. Hydrogen exists in three isotopic forms. Three isotopes of hydrogen are known. The most abundant is protium (a single proton species with a relative abundance of 99.98%) followed by deuterium (has a proton and a neutron with a relative abundance of 0.0156%) and the least abundant (4×10^{-15} %) tritium, the third isotope. Hydrogen exists in following allotropic forms such as atomic hydrogen, molecular hydrogen, nascent hydrogen, triatomic hydrogen, ortho and para hydrogen, adsorbed hydrogen. Francium is an alkali metal and most rare element of all naturally occuring elements of periodic table. Scientists estimate that there is no more than thirty gram of francium in the earth's crust at one time as it has half life about 22 min. Beryllium (Z = 4), Magnesium (Z = 12), Calcium (Z = 20), Strontium (Z = 38), Barium (Z = 56) and Radium (Z = 88) are IUPAC group 2 (IIA elements). All alkaline earth elements have an oxidation number of +2, making them very reactive. Because of their reactivity, the alkaline metals are not found free in nature. The alkaline-earth elements are good conductors of electricity and are highly metallic. They have a gray-white lustre when freshly cut but tarnish readily in air, particularly the heavier members of the group. Beryllium is sufficiently hard to scratch glass, but barium is only slightly harder than lead. Alkaline earth metals have higher melting points (mp) and boiling points (bp) than those of the corresponding alkali metals. MIting and boiling points vary in an irregular fashion, Mg having the lowest (mp 650 °C) and bp 1,090 °C and beryllium the highest (mp 1287 °C) and bp about 2471 °C. All alkaline earth metals are strong reducing agents. The free metals are soluble in liquid ammonia. The atoms of the alkaline-earth elements all have similar electronic structures, consisting of a pair of electrons (designated *s* electrons) in an outermost orbital, within which is a stable electronic configuration corresponding to that of a noble gas. The radii of the ions of the alkaline earth elements increase steadily from Be^{2+} (0.27 Å) for a coordination number of 4, to Ra^{2+}, with a radius of 1.48 Å and a coordination number of 8. Radium is radioactive metal in this group. General electronic configuration of alkali earth metals is ns^2 and common oxidation state is 2+. Oxides of alkaline earth metals are basic and thermally very stable. Reactivity of alkaline earth metals is less than alkali metals. Relative abundance of alkaline earth metals by weight is as follows: Be < Sr < Ba < Mg < Ca. Atomic volume of group IIA elements increases from Be to Ra due to addition of an extra shell of electrons to each element down a group.

MULTIPLE CHOICE QUESTIONS

1. Electrolysis of dilute solution of NaCl Produces ____ at the anode
   (a) Na (b) Oxygen (c) Cl_2 (d) H_2
2. Which ion will have maximum value of heat of hydration?
   (a) Mg^{+2} (b) Ba^{+} (c) Al^{+3} (d) Cs^{+}
3. Which one can form complex?
   (a) Li (b) Na (c) K (d) Cr
4. _____ is called as natron?
   (a) $Na_2CO_3.H_2O$ (b) Na_2CO_3 (c) $NaHCO_3$ (d) $Na_2CO_3.10H_2O$
5. Addition of 2% gypsum in cement
   (a) Prevents rapid hardening (b) Activates hydration
   (c) To induce hydrolysis (d) All
6. _____ least ionic in nature and decompose on heating.
   (a) NaOH (b) CsOH (c) KOH (d) LIOH
7. _____ element hydride contains maximum number of hydrogen atoms?
   (a) Na (b) O (c) Si (d) B
8. Which following is strongest reducing agent?
   (a) LIH (b) NH_3 (c) C_2H_6 (d) $LiAlH_4$

9. _____ form of hydrogen exists at absolute zero.
   (a) Only ortho H (b) Only Para H (c) Only Gemma H (d) None
10. In rocket fuel H_2O_2 used in which percentage?
    (a) 100 % (b) 70 % (c) 60 % (d) 30 %
11. _____ will not be displaced by hydrogen?
    (a) Hg (b) Ba (c) Pb (d) Mg
12. Occlusion is hydrogen adsorption and is shown by following metal
    (a) Zn (b) Pd (c) K (d) Al
13. _____ is not present in hard water?
    (a) $MgCO_3$ (b) $MgSO_4$ (c) $CaCl_2$ (d) All
14. Alkali metals are strong reducing properties due to their _____?
    (a) Large ionic radii (b) High enthalpy of hydration
    (c) Low ionization energies (d) Electron affinity
15. _____ can be reduced using hydrogen
    (a) Cu^{2+} (b) Ag^{+} (c) Hg^{2+} (d) All
16. _____ diatomic molecules possible for three isotopes of hydrogen?
    (a) 3 (b) 6 (c) 9 (d) 4
17. _____ will liberates hydrogen on treatment with HCl?
    (a) Cu (b) Ag (c) Au (d) Mg
18. _____ has following formula Na_2O_2
    (a) Ozone (b) Mezon
    (c) Oxone (d) Sodamide
19. _____ is correct increasing order of atomic radius?
    (a) Ne> O> S> Al (b) Ne< O> S> Al
    (c) Ne< O< S< Al (d) Ne> O> S< Al
20. _____principally forms covalent compound?
    (a) Ba (b) Be
    (c) Ca (d) Ra
21. _____ has maximum hydration energy?
    (a) Ba^{2+} (b) Ra^{2+}
    (c) Ca^{2+} (d) Mg^{2+}
22. _____ amphoteric in nature?
    (a) MgO (b) BeO
    (c) Ag_2O (d) SnO_2
23. Salts of alkaline earth metals are _____ in nature?
    (a) Paramagnetic (b) Ferromagnetic
    (c) Diamagnetic (d) All
24. _____is extracted from sea water
    (a) Ca (b) Fe
    (c) Cu (d) Mg
25. _____ is sparingly soluble?
    (a) CaF_2 (b) MgF_2
    (c) BaF_2 (d) SrF_2
26. Addition of hydrogen to unsaturation points in vegetable oils is called?
    (a) Hydration (b) Hydrolysis

(c) Hydrogenation (d) Reduction

27. _____ has highest affinity towards hydrogen?
(a) F_2 (b) Cl_2 (c) Br_2 (d) I_2

28. Freezing point of heavy water is
(a) 0°C (b) 3.8 °C (c) -3.8 °C (d) 4.2 °C

29. Alkali metals has _____ electronegativty in periodic table
(a) Minimum (b) Maximum
(c) Constant (d) Unpredicatable

30. _____ is the correct order of alkali metals reaction with water
(a) Li >Na>K>Rb>Cs (b) Cs> Rb > K > Na > Li
(c) Cs> Rb < K > Na > Li (d) Cs<Rb > K > Na > Li

31. _____ is the strongest reducing agent in water?
(a) Li (b) Cs
(c) K (d) Rb

32. _____alkali metal has maximum hydration energy
(a) Li (b) Cs
(c) K (d) Rb

33. _____ elements give different products on thermal decomposition
(a) Na K (b) Li Na (c) Li Ca (d) Mg Ca

34. _____ is not an alkali metal.
(a) Caesium (b) Radium (c) Francium (d) Rubidium

35. _____ is not soluble in water
(a) Potassium sulphate (b) Barium sulphate
(c) Zinc sulphate (d) Sodium sulphate

36. $CaSO_4.H_2O$ is called as
(a) Dolomite (b) Calcite (c) Gypsum (d) Plaster of Paris

37. Downs cell is used to prepare
(a) Na (b) NaOH (c) Na_2CO_3 (d) $NaHCO_3$

38. ___ is produced at the cathode during the electrolysis of brine in Nelsons cell?
(a) Mg (b) H_2 (c) Cl_2 (d) N_2

39. Ammonia is prepared by heating NH_4Cl with
(a) H_2SO_4 (b) Water (c) Aq. NaOH (d) NaCl

40. CaC is prepared by heating lime with coke at
(a) 2200°C (b) 2400°C (c) 2800°C (d)3000°C

41. When exposed to air crystals of $Na_2CO_3.10H_2O$ becomes
(a) Hygroscopic (b) Dehydrated
(c) Deliquscent (d)Remains unchanged

42. The Arbic word Alkali means _____
(a) Ashes (b) Spirit (c) Base (d) Basic salt

43. _____ is the formula of Chile saltpeter
(a) $CaCO_3$ (b) $NaNO_3$ (c) NaCl (d) $Ba(NO_3)_2$

44. _____ very abundant in earth crust are
(a) Si & Al (b) B & Al (c) Ca & Mg (d) All

45. BeO is _____
(a) Amphoteric (b) Acidic (c) Basic (d) Neutral

46. Which element is necessary for normal leaf development?

(a) Ca (b) Na (c) Mg (d) Si

47. Li is differs from other alkali metals due to
(a) Small size (b) High charge density
(c) Less electropositivity (d) All

48. Lithium carbonates are not stable due to _____
(a) Low electropositivity (b) Low charge density
(c) Not known yet (d) Low electronegativity

49. _____ conducts electricity by the movement of ions?
(a) Graphite (b) Molten sodium chloride
(c) Copper (d) Iron

50. _____ is water insoluble?
(a) $(NH_4)_2CO_3$ (b) $CaCO_3$ (c) Na_2CO_3 (d) K_2CO_3

51. A deliquescence substance _____
(a) absorbs moisture and remains solid
(b) absorbs moisture changes in to liquid form
(c) becomes dehydrated
(d) loses water of crystallization

52. In diaphragm cell hydrogen is discharged by the reduction of _____
(a) HCl (b) KCl (c) Water (d) K^+

53. Caustic soda (NaOH) got its name because
(a) It is part of soda water
(b) It is used in soap
(c) it used to produce chlorine gas
(d) It corrodes the organic tissues

54. Chemical formula of carnalite is _____
(a) $KCl.MgCl_2.6H_2O$ (b) $Na_2B_4O_7$
(c) $CaCO_3.MgCO_3$ (d) $Na_2B_4O_7.10H_2O$

55. Magnesium metal does not burn in the vessel containing
(a) N_2/O_2 (b) Ne (c) N_2 (d) O_2

ANSWERS

1	b	11	a	21	d	31	a	41	b	51	b
2	c	12	b	22	b	32	a	42	a	52	c
3	a	13	a	23	c	33	b	43	b	53	d
4	a	14	c	24	d	34	b	44	a	54	a
5	a	15	d	25	b	35	b	45	a	55	b
6	d	16	b	26	c	36	c	46	a		
7	c	17	d	27	a	37	a	47	d		
8	d	18	c	28	b	38	b	48	a		
9	b	19	c	29	a	39	c	49	b		
10	d	20	b	30	b	40	c	50	b		

8. p - BLOCK ELEMENTS

Elements in which the last electron enters in the any one of the three p-orbital of their outer most shells (ns^2np^{1-6}) are called p-block elements. The block of elements in the periodic table consists of the following main groups: Group 13 (B to Tl), Group 14 (C to Pb), Group 15 (N to Bi), Group 16 (O to Po), Group 17 (F to At) and Group 18 (He to Rn). Members such as C,N,P,O,F,S,Cl,Br,I,At at the top and on the right of the *p* block are non metals. Elements such as Al, Ga, In, Tl, Sn, Pb, Sb, Bi, Po, on the left and at the bottom are metals. The elements present between the two, from the top left to bottom right, B,Si,Ge,As, Te are metalloid elements. The group 13 containing elements like B (Z = 5), Al (Z = 13), Ga (Z = 31), In (Z = 49) and Tl (Z = 81) is called the boron group with outer electronic configuration (ns^2np^1). The elements of this group have smaller size than the corresponding elements of second group. On moving down the group both atomic and ionic radii are expected to increase due to the addition of new shells. The ionization energies of group 13 elements are less than the corresponding members of the alkaline earths. All are metals except boron. Boron show diagonal relationship with Silicon; both are semiconductors metalloids & forms covalent compounds. From B to Al, a sharp decrease in ionization energy and increase in metallic characteris is due to increase in size. The order of melting point and boiling point is as follows: B > Al > Tl > In > Ga and B > Al > In > Ga > Tl. The co mmon oxidation states of group 13 elements are +3 and +1 are due to inert pair effect, the stability of the +1 oxidation state increases in the sequence Al<Ga<In<Tl. None of the group 13 elements reacts directly with hydrogen. However, by using indirect method a number of hydrides of these elements were prepared.The boron hydrides are called boranes and classified as nidoboranes (B_nH_{n+4}) and arachnoboranes (B_nH_{n+6}). The other elements of group 13 form only a few stable hydrides.The thermal stability decreases down the group.^{11}B (80.1%) and ^{10}B (19.9%) are two naturally occurring boron isotopes. The most common metal borate is borax ($Na_2B_4O_7.10H_2O$ or $Na_2[B_4O_5(OH)_4].8H_2O$). B_2O_3 gives following boric acids in water Ortho boric acid ($B_2O_3.3H_2O$ or H_3BO_3), Meta boric acid ($B_2O_3.H_2O$ or HBO_2), Tetra boric acid ($2B_2O_3$.H O or $H_4B_2O_7$) and Pyro boric acid ($2B_2O_3.3H_2O$ or $H_6B_4O_7$). Al is usually obtained by the Hall-Heroult process. Aluminium is used extensively in everyday life and industry.It forms many useful alloys with Cu, Mn, Mg, and Zn.Hence, aluminium and its alloys find use in utensil making, packaging, construction aerospace and other transportation industries.

C (Z=6), Si (Z=14), Ge (Z=32), Sn (Z=50) and Pb (Z=82) are group 14 elements with generatic configuration of ns^2np^2. Covalent radius increases from C to Si. The ionization enthalpies a electronegativity of group 14 elements are higher than those of the corresponding group 13 element Carbon and siliconmostly show +4 oxidation state. Germanium forms stable compounds in +4 state a only few compounds in +2 state. Tin forms compounds in both oxidation states.Lead compounds in state are stable and in +4 state are strong oxidizing agents. Carbon has three allotropic forms includi diamond (sp^3 hybridization), graphite (sp^2 hybridization) and fullerence (sp^3 hybridisation). Densi increases down a group IVA (Si < C < Ge < Sn < Pb). Due to increase in the inter atomic attraction melti points (C > Si >Ge > Sn < Pb) and boiling points (C > Si < Ge > Sn > Pb) decrease down a group. Silica abundant in the nature mainly in the form of aluminium silicate. Silica exhibits allotropy in crystalli (Quartz, Crystobalite, Trydimite) and amorphous forms (Onyx, Agate, Jaspar, kiesulguhr silica Kiesulguhr silica is made of minute sea organisms. There are six types of silicates (i) Nesosilicates Orthosilicates ($M_2^n(SiO_4)$ e.g. Willemite $Zn_2(SiO_4)$, (ii) PyroSilicates or SoroSilicates or DiSilicat (contain SiO_7^{-6}units e.g. thortveitite $Ln_2[Si_2O_7]$, (iii) sheet silicates $(Si_2O_5)^{2n-}{}_n$ e.g. kaolin $Al_2(OH)_4Si_2O_5$, chain silicates (contain units of $SiO_3)^{2n-}{}_n$ e.g. spodumene $LiAl(SiO_3)_2$ (v) Cyclic Silicates $(SiO_3)^{2n-}{}_n$ e.g. be

$Be_3Al_2[Si_6O_{18}]$ (vi) Frame work silicates or three dimensional silicates (contain three dimensional lattice of SiO_4 e.g. quartz; feldspar and zeolites etc. Aluminium silicates are known as zeolites e.g. $Na_2Al_2Si_2O_8.xH_2O$.Zeolites are used as catalysts for cracking and isomerization of hydrocarbons in in petrochemical industries.

Group 15or nitrogen group elements N (Z = 7), P (Z = 15), As (Z = 33), Sb (Z = 51), Bi (Z = 83) are called as pnicogens and their compound are called pnictides. N is a gas, P, As, Sb and Bi are solids. N and P are non – metals, As and Sb are metalloids and Bi is a metal. Outer shell electronic configuration of group 15 elements is ns^2np^3. Except Bi the common oxidation states of group VA elements are 3+, 5+ and 3-. Most abundant gas in atmosphere is nitrogen that exists as triple bonded diatomic gaseous molecule. In contrast, Earth's crust is relatively poor in nitrogen. Nitrogen has the unusual ability to form compounds in nine different oxidation states, including –3, +3, and +5. Bi exists as monatomic metal. P is most abundant element of this group in earth's crust. As, P, and Sb exist as tetratomic and tetrahedral molecules. Important P sources are phosphate rocks, phosphorite $[Ca_3(PO_4)_2]$ and fluorapatite $[3Ca_3(PO_4)_2, CaF_2]$ etc. Co-ordination number of P is 3 in layered structures. Electronegativity decrease, atomic size and boiling points increases down a group. Melting points increase from N to Bi and then decreases.Oxyacids of phosphorous include: Hypophosphorous acid (H_3PO_2), Ortho Phosphorous acid (H_3PO_3), Orthophosphoric acid (H_3PO_4), Hypophosphoric acid ($H_4P_2O_6$), Peroxy phosphoric acid(H_3PO_5),Pyrophosphoric acid ($H_4P_2O_7$), Metaphosphoric acid (HPO_3). Metal-rich phosphides are hard, high-melting, electrically conductive solids with metallic luster, whereas phosphorus-rich phosphides, which contain catenated phosphorus units, are lower melting and less thermally stable.Group 16 or oxygen group elements contains oxygen (Z = 8), sulphur (Z = 16), selenium (Z = 34), tellurium (Z = 52) and polonium (Z = 84) and are collectively called as chalcogens. Chalcogen means ore formingelements. The metallic properties increase down the group. Polonium is essentially a metal. It was discovered by M. Curie, who named it after her native country Poland.Oxygen is most abundant element in earth's crust (46.5%). Atomic radius and density increases down a group from oxygen to polonium. Electronegativity, ionization energy or ionization potential IP, and electron affinity decrease for the group as atomic weight increases. The atomic radii and melting point increase. Polonium has less m.p. and b.p. than tellurium. O and S are non-metals, Se and Te are metalloids, Po is a pure metal. Oxygen is diatomic while sulphur (S_8), selenium (Se_8) and tellurium (Te_8) are octa atomic.All group VI elements exhibit - 2, +2, +4 and + 6 oxidation states except oxygen. O is second most electronegative element in periodic table after F. Oxygen exhibits positive oxidation in its compounds with fluorine (e.g. 1+ and 2+ in $O_2F_2$and OF_2, respectively). Oxygen has -2, -1 and -1/2 oxidation state in oxides, peroxide and superoxides. Metals form basic oxides (e.g. Na_2O, CaO. PbO, etc.), non-metals form acidic oxides (e.g. CO, SO_2, SO_3 etc), and metalloids form amphoteric oxide (e.g. SeO_2, ZnO, SnO_2, etc). Neutral oxides are formed by non-metals e.g. CO, NO, H_2O etc).Allotropy or polymorphism is shown by many elemenets of this group. O, Te and Po have two allotropes where as Se has six allotropic forms. O_2 is paramagnetic and O_3 is diamagnetic. Rhombic sulphur changes into monoclinic sulphur at 96.5°C.

Group 17 elements includes F (Z = 9), Cl (Z = 17), Br (Z = 35), I (Z = 53) and At (Z = 85) are called as Halogens. Astatine is only radioactive element in this group. Halogens are highly electronegative element and found in combined state only. Density, bond length, vander Waal's forces of attractions, melting point, boiling point, and color intensity of halogens increase down the group. Electronegativity, solubility in water, volatility, non-metallic character, first ionization potential, and standard reduction potential value decreases down the group. F is most electro negative element and its electronegativity is 4 at Paulig's scale. Electron affinity (EA) of halogens is in following order: I < Br < F < Cl. Cl, Br, and I exhibit – 1, + 1, + 3 + 5 + 7 oxidation states but F exhibits

only –1 oxidation state in its compounds. F do not show more valency states due to the absence of vacant d-orbitals in valence shell. Some important minerals of Cl are rock salt (NaCl), carnallite ($KCl.MgCl_2.6H_2O$), sylvine (KCl), and horn silver (AgCl). Fluorspar (CaF_2) and Fluorapatite $3Ca_3(PO_4)_2.CaF_2$ are important sources of F. Down's (electrolysis of fused NaCl electrolyte) or Nelson cell process (electrolysis of brine solution) is used for commercial production of Cl. Hypochlorous acid ($HClO_2$), chlorous acid (HClO), chloric acid (HClO) and Percloric acid (HClO) are oxy acids of Cl.Group 18 consists of helium (Z=2), neon (Z=10), argon (Z=18), krypton (Z=36), xenon (Z=54) and radon (Z=86) collectively called as noble gases due to chemical inertness and existence in free state.Except He ($1s^2$), all other noble gases has ns^2p^6 electronic configuration. Ionization energies of noble gases are higher than any other elements. Noble gases have very low melting and boiling points due to absence of bonding. Helium has lowest melting and boiling points in periodic table. Atomic mass, boiling point, and atomic radii increase down a group in the periodic table. The first ionization energy decreases down a group in the periodic table. Halides are formed by sparking helium at low pressure in presence of mercury, tungsten etc; e.g., $HgHe_2$, WHe_2, FeHe. Hydrates are formed by Ar, Kr and Xe form compounds at low temperature and high pressure e.g. $Ar.6H_2O$, $Kr.6H_2O$ and $Xe.6H_2O$. Ar, Kr and Xe enter crystal lattices of phenol, hydroquinone under pressure to form Clathrates or cage compounds. On reaction with BF_3, argon forms a number of unstable e.g., $Ar.BF_3$, $Ar.2BF_3$, $Ar.3BF_3$, $Ar.6BF_3$, $Ar.8BF_3$ and $Ar.16BF_3$. Xenon combines with F to form XeF_2, XeF_4 and XeF_6.Helium is used as a component of breathing gases due to its low solubility in fluids or lipids. This is important because other gases are absorbed by the blood and body tissues when under pressure during scuba diving.Helium is used as coolant in atomic reactors, food preservation, signal lights, in the treatment of asthma with oxygen, and creating in artificial radioactivity. Neon is used in neon lights, voltage detectors, luminous warnings, fog lights, TV cine scopes, lasers, and advertising signs. Argon is used in welding, electric bulbs, fluorescent tubes, and metallurgy. Krypton is used in high efficiency miner's cap lamps and in cosmic rays detectors. Xenon is used in gamma photon discharge tubes and neutral mesons detection. Radon is used in detecting defects in steel castings and in the treatment of cancer and other diseases.

MULTIPLE CHOICE QUESTIONS

1. B_2O_3 is _____ oxide?
   a. Acidic b. Amphoteric
   c. Basic d. Neutral
2. _____ Lewis acid has triangular geometry and zero diploe moment?
   (a) AlF_3 (b) BF_3
   (c) GaF_3 (d) TlF_3
3. Which chlorine oxide is produced from following reaction?
   $2KClO_3 + H_2C_2O_4 + H_2SO_4 \rightarrow K_2SO_4 + 2H_2O + 2CO_2 +$ Chlorine ___Oxide
   (a) ClO_2 (b) Cl_2O_7 (c) Cl_2O_6 (d) Cl_2O
4. Which iodine oxide is used for quantitative analysis of CO?
   (a) I_2O_5 (b) I_2O_4 (c) I_4O_2 (d) All
5. Consider the following reaction is _____ reaction
   $3Cl_2 + 6NaOH \rightarrow NaClO_3 + 5NaCl + 3H_2O$ This reaction is
   (a) Disproportionation (b) Displacement
   (c) Reduction (d) Double displacement
6. _____ can displace other three elements?
   (a) Chlorine (b) Flourine (c) Iodine (d) Bromine

7. The chemical formula of sodium hypochlorite is
   (a) $NaClO_3$ (b) $NaClO_2$ (c) $NaClO_4$ (d) NaClO
8. In which Xenon compound the oxidation state of Xenon is + 6.
   (a) Na_4XeO_6 (b) XeF_4 (c) $XeOF_4$ (d) $XeOF_2$
9. Thin coating of _____ is made on photographic plates
   (a) AgBr (b) AgCl (c) $AgNO_3$ (d)AgI
10. The anhydride of $HClO_4$ is
    (a) Cl_2O (b) Cl_2O_7 (c) ClO_2 (d) Cl_2O_6
11. _____ is present in Teflon:
    (a) F_2 (b) Br_2 (c) Cl_2 (d) I_2
12. _____ paramagnetic oxide of chlorine:
    (a) ClO_2 (b) Cl_2O_6 (c) Cl_2O_7 (d) All
13. Physical appearance of _____ element is different from other?
    (a) Phosphorus (b) Antimony (c) Arsenic (d) Bismuth
14. _____ is protected by layer of its own oxide?
    (a) Ni (b) Fe
    (c) Pb (d) Al
15. Borax bead test can not be used to test _____?
    (a) Ni (b) Cr
    (c) Pb (d) Mn
16. Which of group IIIA elements form wide variety of hydrides?
    (a) Al (b) B
    (c) Cu (d) Ni
17. Hydrides of boron are called as _____?
    (a) Borate (b) Coranes
    (c) Dorano (d) Boranes
18. Ga, In and Tl exhibited oxidation state/s ———— due to inert pair effect
    (a) +1 (b) +3, +2
    (c) +1 and +3 (d) +2 and +5
19. Due to inert pair effect ———— oxidation state is more stable than ———— for Sn and Pb.
    (a) +2, + 4 (b) +1, +3
    (c) +4, +1 (d) +2, +3
20. Metallic character ———— down the group
    (a) Decreases (b) Increases
    (c) Constant (d) Unpredictable
21. _____ has highest electron affinity
    (a) Chlorine (b) Fluorine (c) Bromine (d) Iodine
22. Select strongest acid?
    (a) $HClO_4$ (b) $HClO_3$ (c) $HClO_2$ (d) HClO
23. __ can liberate brominefrom KBr solution
    (a) Iodine solution (b) Chlorine (c) KI (d) NaCl
24. Bleaching powder is a _____ salt
    (a) Complex (b) Double (c) Normal (d) Mixed
25. Compounds of phosphorus and nitrogen are mostly
    (a) Ionic (b) Polar (c) Covalent (d) All

26. Select most electronegative element _____
(a) Sb (b) P (c) As (d) N

27. SO_3 is not absorbed in water directly because
(a) It is insoluble in water (b) Dilute acid is produced
(c) Reaction is exothermic (d) All

28. In diamond each C is _____hybridized.
(a) sp^2 (b) dsp
(c) sp^3 (d) dsp^3

29. Graphite is also known as
(a) Black lead (b) Plumbago
(c) Lead sulfate (d) a and b

30. In graphite each C atom is ____ hybridized?
(a) sp^2 (b) dsp
(c) dsp^2 (d) dsp^3

31. Lead pencil contains _____percent lead?
(a) 0 (b) 50
(c) 100 (d) 80

32. PbO_2 is _____.
(a) Amphoteric oxide (b) Acidic oxide
(c) Basic oxide (d) Neutral oxide

33. Iodine vapors has _____ color?
(a) Grey (b) Pink
(c) Violet (d) Black

34. $HClO_2$has _____ structure.
(a) Linear (b) Tetra hedral
(c) Trigonal pyramidal (d) Angular

35. _____ does not react to water?
(a) PCl_5 (b) SF_5
(c) BCl_3 (d) $SiCl_4$

36. _____ is the strongest reducing agent?
(a) HF (b) HCl
(c) HI (d) HBr

37. _____ boils at higher temperature among following is?
(a) HI (b) HF
(c) HCl (d) HBr

38. _____ maximum ionic character?
(a) HF (b) HCl
(c) HBr (d) HI

39. Isotopes discovery began with experiments on?
(a) Kr (b) Xe
(c) Ar (d) Ne

40. Which one is called lazy gas?
(a) Kr (b) Xe
(c) Ar (d) He

41. _____ has least tendency to form compound?
(a) Kr (b) Xe
(c) Ar (d) Ne

42. Hydrolysis of XeF_6 yields ___?
(a) XeO_2 (b) Xe
(c) XeO_3 (d) XeO_5

43. _____ does not form clathrates?
(a) Kr (b) Xe
(c) Ar (d) Ne

44. Radon gas is used to treat _____?
(a) Cancer (b) Cold
(c) Flu (d) Lungs

45. _____ are present in characteristic spectrum of He.
(a) Red lines (b) Yellow lines
(c) Green lines (d) Violet lines

46. Select correct order of thermal stabilities?
(a) $NH_3 > PH_3 > AsH_3 > BiH_3 > SbH_3$
(b) $NH_3 < PH_3 < SbH_3 > AsH_3 > BiH_3$
(c) $BiH_3 > SbH_3 > AsH_3 > PH_3 > NH_3$
(d) $NH_3 > PH_3 > AsH_3 > SbH_3 > BiH_3$

47. The rare halogens element is
(a) Astatine (b) Iodine (c) Fluorine (d) Chlorine

48. The charaistic colour of chlorine gas is
(a) Reddish brown (b) Pale yellow (c) Grayish black (d) Greenish yellow

49. _____ has stronger Vander Waals forces
(a) F_2 (b) I_2 (c) Cl_2 (d) Br_2

50. Following is the most powerful oxidizing agent among the halogens
(a) I_2 (b) Cl_2 (c) Br_2 (d) F_2

51. _____reacts spontaneously with Au (gold) to form Au^{+3}
(a) Br_2 (b) Cl_2 (c) I_2 (d) F_2

52. Borax is also known as?
(a) Sodium borate monohydrate (b) Sodium thioborate
(c) Sodium metaborate (d) Sodium tetraborate

53. _____contain banana bond.
(a) $AlCl_3$ (b) BCl_3
(c) B_2H_6 (d) MgO

54. In orthoboric acid, B has _____hybridization.
(a) sp^3 (b) sp^2
(c) sp (d) dsp^2

55. _____ do not give borax bead test.
(a) Copper salts (b) Nickel salts
(c) Aluminum salts (d) Cobalt salts

56. _____is called inorganic graphite.
(a) BF_4 (b) B_2H_6

(c) BN (d) $AlCl_3$

57. Borazole has?
(a) 10σ, 3π (b) 10σ, 2π
(c) 9σ, 4π (d) 12σ, 3π

58. Concentrated nitric acid is stored in ____ container?
(a) Cu (b) Al
(c) Fe (d) Wood

59. Bleeding can be stopped effectively by _____?
(a) AlF_3 (b) Potash alum
(c) $AlBr_3$ (d) $AlCl_3$

60. _____is the weakest acid in water
(a) HCl (b) HI (c) HBr (d) HF

61. Folowing is the correct order of boiling points?
(a) $PH_3 < AsH_3 < NH_3 < SbH_3 < BiH_3$
(b) $PH_3 < AsH_3 < SbH_3 < BiH_3 < NH_3$
(c) $PH_3 < AsH_3 < SbH_3 < NH_3 < BiH_3$
(d) $NH_3 < PH_3 < AsH_3 >> SbH_3 < BiH_3$

62. _____ is the correct order of basic strengths?
(a) $PH_3 > NH_3 > AsH_3 > SbH_3 > BiH_3$
(b) $NH_3 > PH_3 > AsH_3 > SbH_3 > BiH_3$
(c) $BiH_3 > NH_3 > PH_3 > AsH_3 > SbH_3$
(d) $NH_3 > PH_3 > SbH_3 > AsH_3 > BiH_3$

63. The halogen _____ reacts very slowly with halogen is
(a) Chlorine (b) Iodine (c) Fluorine (d) Bromine

64. Select correct electronic configuration of VII A group elements in the ground state?
(a) ns^2p^5 (b) ns^2p^2 (c) ns^2p^4 (d) ns^2p^6

65. Phosphene gas on _____ of phosphorous acid
(a) Oxidation (b) Decomposition (c) Reduction (d) Both b & c

66. Phosphoric acid will be produced on reaction of _____ with water
(a) PCl_5 (b) P_2O_5 (c) P_2O_3 (d) All

67. Pure quartz is not?
(a) Coloured solid (b) Hard (c) Brittle (d) All

68. The meaning of Phosphorus (a Greek word) is ____
(a) Tetrahedral (b) Fire (c) Impure (d) Light bearing

69. Aqueous solution of borax above 62°C gives crystals of
(a) $Na_2B_4O_7.5H_2O$ (b) $Na_2B_4O_7.4H_2O$
(c) $Na_2B_4O_7.2H_2O$ (d) $Na_2B_4O_7.10H_2O$

70. Silicon differ from silica by a group of
(a) OH (b) OCH_3 (c) CH_3 (d) O_2

71. Formation of _____ forms colored glassy mass in borax bead test
(a) Metal meta borate (b) Metal boride
(c) Metal borate (d) Metal silicateborane

72. The main ore of Al is
(a) $Al_2O_3.2H_2O$ (b) $Al_2O_3.H_2O$

(c) Na_3AlF_6 (d) $Al_2O_3.3H_2O$

73. Boric acid is not used in
(a) Soft drinks (b) Medicine
(c) Enamel and glazes (d) Washing eyes

74. _____ decompose to produce litharge
(a) Pb_2O (b) PbO_2 (c) Pb_3O_4 (d) b,c

75. The poisonous allotropic form of phosphorus is
(a) Violet (b) Black (c) White (d) Red

76. A reaction between ethanol and _____can be carried out to produce acetic anhydride
(a) H_2SO_4 (b) P_2O_5 (c) Both a and b (d) PCl_5

77. The composition of brown ring in nitrate test is
(a) $FeSO_4.NO_3$ (b) $FeSO_4.NO$ (c) $FeSO_4.NO_2$ (d) $FeSO_4.N_2O$

78. Decomposition of phosphorous acid yields _____
(a) Phosphorus (b) Phosphorus pentoxide
(c)Phosphine (d) Water

79. _____ compounds usually smells like garlic?
(a) P_2O_5 (b) H_3PO_3 (c) P_2O_3 (d) All

80. Sublimation of P_2O_5occurs at
(a) 260°C (b) 630°C (c) 620°C (d) 360°C

81. The metallic propereites of Al is due to
(a) Small size (b) High nuclear charge
(c) Both a and b (d) None

82. The dried up lakes of Tibet and California contains _____
(a) Calcium carbonate (b) Boric acid (c) Colemanite (d) Tincal

83. In thermite process _____ is used.
(a) Al (b) Zn (c) Cu (d) Fe

84. The nature of oxide of aluminium is
(a) Acidic (b) Amphoteric (c) Basic (d) It does not exists

85. Inert pair effect is shown by?
(a) C (b) B (c) Si (d) Sn

86. Which of following metals exhibit allotropy?
(a) Na (b) K
(c) Ca (d) Sn

87. C atoms have _____ geometry in diamond?
(a) Linear (b) Trigonal
(c) Planar (d) Tetrahedral

88. _____ is used in solar cells?
(a) Si (b) Ni
(c) Cs (d) Cu

89. _____ givered color to glass
(a) Cu_2O (b) MnO_2
(c) CoO (d) CdS

90. _____give blue color to glass
(a) Co^{2+} (b) Al^{3+} (c) Fe^{3+} (d) Mg^{2+}

91. What is correct order of acidity of oxides?
(a) $CO_2 > SiO_2 > GeO_2 > SnO_2 > PbO_2$
(b) $CO_2 < SiO_2 < GeO_2 < SnO_2 < PbO_2$
(c) $CO_2 < SiO_2 < GeO_2 < PbO_2 < SnO_2$
(d) $CO_2 < SiO_2 < SnO_2 < PbO_2 < GeO_2$

92. _____is a chain silicate
(a) Zeolite (b) Tremolite
(c) Beryl (d) Olivine

93. Group VA contains_____elements.
(a) 7 (b) 8
(c) 5 (d) 6

94. Select correct order of reducing nature?
(a) $NH_3 > PH_3 > AsH_3 > SbH_3 > BiH_3$
(b) $PH_3 < AsH_3 < SbH_3 < BiH_3 < NH_3$
(c) $NH_3 < PH_3 < AsH_3 < SbH_3 < BiH_3$
(d) $PH_3 > AsH_3 > SbH_3 << BiH_3 > NH_3$

95. The general electronic configuration of group IIIA is?
(a) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^1$
(b) $1s^2\ 2s^2\ 2p^3$
(c) $1s^2\ 2s^2\ 2p^4$
(d) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^1$

96. Tincal is a mineral of
(a) B (b) Al (c) Si (d) C

97. In network of silica (SiO_2) each silicon atom is surrounded by _____ atoms of oxygen
(a) 1 (b) 4 (c) 2 (d) 6

98. Which is not a semiconductor?
(a) Sn (b) Si (c) Ge (d) Se

99. Orthoboric acid is 2.6% soluble in water at 40 °C and _____at 107°C.
(a) 66% (b) <3.6% (c) 12.7% (d) 37%

100._____ process is used for aluminium extraction
(a) Contact process (b) Thermite process
(c) Hall process (d) Haber process

ANSWERS

1	a	28	c	55	c	82	d	109	136
2	b	29	d	56	c	83	a	110	137
3	a	30	a	57	d	84	b	111	138
4	a	31	a	58	b	85	d	112	139
5	a	32	a	59	b	86	d	113	140
6	b	33	d	60	d	87	d	114	141
7	d	34	d	61	a	88	c	115	142
8	c	35	b	62	b	89	a	116	143
9	a	36	c	63	b	90	a	117	144
10	b	37	b	64	a	91	a	118	145
11	a	38	a	65	d	92	b	119	146
12	a	39	d	66	d	93	c	120	147
13	a	40	c	67	a	94	c	121	148
14	d	41	a	68	d	95	d	122	149
15	c	42	c	69	a	96	a	123	150
16	b	43	c	70	c	97	b	124	151
17	d	44	a	71	a	98	a	125	152
18	c	45	b	72	a	99	d	126	153
19	a	46	d	73	a	100	c	127	154
20	b	47	a	74	c	101		128	
21	a	48	d	75	c	102		129	
22	a	49	b	76	c	103		130	
23	b	50	d	77	b	104		131	
24	d	51	b	78	c	105		132	
25	c	52	d	79	c	106		133	
26	d	53	c	80	d	107		134	
27	c	54	b	81	c	108		135	

9. d- BLOCK ELEMENTS

Groups 3-12 of the periodic table conatins d block elements in which the d oribital a progressively filled. There are mainly 3 series of d block elements including 3d series (Sc to Zn), 4d serie (Y to Cd) and 5d series (La to Hg omitting Ce to Lu). The fourth 6d series which begins with Ac is sp incomplete. Tranisition metals are the elements having partially filled d orbitals in ground or in th excited state. Transitions metals are placed in the centre of period table between s block and p bloc elements. One of the mostly abundant and widly used metal is iron. Tansition metals have th electronic configuration $(n-1)d^{1-10}ns^{0-2}$, Zn, Cd, Hg, the end members of the first three series hav general electronic configuration $(n-1)d^{10}ns^2$.Group 11 contains copper (Z = 29), silver (Z=47) and gol (Z=79) called as coinage metals. Standard electrode potential of coinage metals is negative and alka metalsis positive. Coinage metals ions are paramagnetic and colored whereas alkali metal ions a diamagnetic and colorless. Hydroxide of alkali metals are strong caustic bases and are high soluble i water. Coinage metal hydroxides are water insoluble and less basic. Important ores of copper inclus azurite ($Cu_3(CO_3)_2.Cu(OH)_2$), tenorite (CuO), cuprite (Cu_2O), bornite (Cu_5FeS_4), chalcopyrite ($CuFeS_2$ covellite (CuS), chalcocite (Cu_2S) , ($CuCO_3.Cu(OH)_2$), and native copper. Copper gives green color Bunsen flame. Cu(II) shows following important reactions.Cupric sulphate ($CuSO_4.5H_2O$) is also know as blue vitriol. Copper salts are used as disinfectant, fungicides, and for coloring glass. Copper forms number of alloys with various metals such as brass with Zn, monel metal with Ni, duralumin with A bronze with tin etc.Silver is little harder than gold and has a brilliant white metallic luster and is ve ductile and malleable. Only gold and palladium are more ductile and malleable than silver. Silver c be extracted from pyrargyrite or ruby silver ($3Ag_2S$, Sb_2S_3), silver copper glance ($Cu, Ag)_2S$, argentite silver glance (Ag_2S, silver sulfide), and horn silver or chloragyrite (AgCl). Silver extraction is usually do by Parke's process, Pattinson's process, cupellation, and cyanide process. Although gold is a nob metal, it forms many and diverse compounds. Gold is present in −1 to +5 oxidation states, but +1 a +3 are most common one.Au(I) is known as the aurous ion and Au(III) is auric ion. Gold dissolves in aq regia (HNO_3 (1): HCl (3).

Group 12 elements Zn (Z = 30), Cd (Z = 48) and Hg (Z = 30) having following general electron configuration $d^{10}s^2$. The common oxidation state for all the Group 12 elements is +2, and the chemis of zinc and cadmium compounds in particular is very similar to the analogous magnesium derivatives. group 12 elements form sulphides and sulphites. Density increases down a group while boiling poi melting point, and specific heat decrease. Malleability and ductility decrease Zn to Cd. Hg is only liqu metal. Atmospheric resistance increase from Zn to Hg. Cold water do nto affect Zn, Cd and Hg. Caus alkali do not decompose Cd and Hg, however Zn dissolves in these to form zincates. Sulphides a oxides of these metals are water insoluble. Sulphides have acid and oxides have basic nature. As solubility of sulphides decreases from Zn to Hg. Cd and Zn form more stable peroxide than alkali a alkaline earth metals. Hg does not form peroxides. Hg has anomalous behavior and exhibits tw oxidation states +1 and +2. Hgs is insoluble in concentrated acid but ZnS and CdS are soluble. Mercur salts are diamagnetic in nature. Cd and Zn are more electropositive than hydrogen whereas Hg is le electropositive and does not displace hydrogen from H_2SO_4 or HCl. The important Zn ores are calami ($ZnCO_3$), zinc blende (ZnS), zincite or red zinc (ZnO), zinc ferrite or franklinite [$ZnOFe_2O_3$ or $Zn(FeO$ and hydrated siliceous zinc or hemimorphite ($Zn_2SiO_4.H_2O$). Philosopher's wool is white powder ZnO. Calomel (Hg_2Cl_2) is used to make electrodes. On heating calomel undergoes sublimation. Mercu tree is form when Hg is poured in $AgNO_3$. To check presence of NH_4^+ ion Nessler's reagent, $K_2[HgI$ used.

MULTIPLE CHOICE QUESTIONS

1. Gold is present in _____to +5 oxidation states,
   (a) +1 (b) -1 (c) -3 (d) +3
2. Most common oxidation states of Au are _____and _____
   (a) 2, 3 (b) 1, 5
   (c) 1,3 (d) 5, 3
3. Lunar caustic is
   (a) $Cu(NO_3)_2$ (b) $NiSO_4$
   (c) AgCl (d) $AgNO_3$
4. Pyrargyrite has _____ formula.
   (a) Ag_2S (b) $3Ag_2S,Sb_2S_3$
   (c) $(Cu, Ag)_2S$ (d) AgCl
5. $CuFeS_2$ is _____.
   (a) Bornite (b) Cuprite
   (c) Azurite (d) Chalcopyrite
6. Standard electrode potential of coinage metals is _____and alkali metals is _____.
   (a) Negative, positive (b) Positive, negative
   (c) Negative, negative (d) Positive, Positive,
7. _____ is soluble in ammonia?
   (a) $Al(OH)_3$ (b) $Fe(OH)_3$
   (c) $Cu(OH)_2$ (d) $Cr(OH)_3$
8. _____correct order of density, malleability and ductility?
   (a) Au < Ag < Cu (b) Ag < Au < Cu
   (c) Ag < Cu < Au (d) Cu < Ag < Au
9. _____ has diamagnetic nature.
   (a) Cu^+ (b) Fe^{3+}
   (c) Fe^{2+} (d) Mn^{2+}
10. _____ is added to hair dyes.
    (a) $Cu(NO_3)_2$ (b) $CuSO_4$
    (c) AgCl (d) $AgNO_3$
11. _____element does not form nitride?
    (a) Ag (b) Al
    (c) Ca (d) Mg
12. Cu_2Cl_2 or CuCl can absorbs _____ gas?
    (a) CO (b) SO_2
    (c) CO_2 (d) SO_3
13. _____ process is used to remove lead impurity in silver.
    (a) Solvay process (b) Parke's process
    (c) Amalgam process (d) Cyanide process
14. _____ can not be differentiated using H_2S gas.
    (a) Zn, Mn (b) As, Cu
    (c) Hg, Pb (d) Cd, Pb
15. Formula of Nessler's reagent is _____
    (a) $KHgI_4$ (b) $K_2[HgI_4]$
    (c) $K_2[HgI_4] + NH_4OH$ (d) NH_4OH

16. Insulin contains _____ metal?
(a) Zn (b) Cu
(c) Hg (d) Ni

17. A combustible gas is produced when _____ is heated with causticsoda.
(a) Zn (b) Cu
(c) Hg (d) Ag

18. Zinc oxide is also known as?
(a) Philosopher's wool (b) Chinese white
(c) Calcite (d) a & b

19. Hemimorphite formula is _____
(a) $ZnCO_3$ (b) ZnS
(c) $Zn(FeO_2)_2$ (d) $Zn_2SiO_4.H_2O$

20. Vitamin B_{12}contains _____.
(a) Co (b) Fe
(c) Ni (d) Cu

21. d-block elements generally _____ hydrides?
(a) Ionic (b) Covalent
(c) Interstitial (d) Metallic

22. Transition metals can show negative oxidation states only in?
(a) Halides (b) Complex
(c) Sulphates (d) Sulphite

23. Which of following is colored ion?
(a) Cd^{3+} (b) Lu^{3+}
(c) La^{3+} (d) Eu^{3+}

24. What is chemical composition of rust?
(a) Fe_2O_3 and $Fe(OH)_3$ (b) FeO and $Fe(OH)^2$
(c) Fe_2O_3 and $Fe(OH)_2$ (d) Fe_2O_3

25. Percentage of carbon in steel is?
(a) 0.1-0.2 (b) 0.5-1.5
(c) 0.1-2 (d) 2-6

26. Stainless steel contains _____ Cr.
(a) 2 (b) 15
(c) 25 (d) 14

27. Name following complex compound $[Cr(NH_3)_3(H_2O)_3]Cl_3$
a. triaquatriamminechromium(III) chloride
b. triaquatriamminemonochromium trichloride
c. triamminetriaquachromium(III) chloride
d. triamminetriaquamonochromium(III) trichloride

28. Name following complex compound $[Pt(H_2NCH_2CH_2NH_2)_2Cl_2]Cl_2$
a. bis-(ethylenediaminedichloroplatinum(IV) chloride
b. dichlorobisethylenediaminemonoplatinum(II) chloride
c. dichlorobisethylenediamineplatinum(IV) chloride
d. dichlorobis(ethylenediamine)platinum(IV) chloride

29. Name following complex compound $[Pt(NH_3)_3Cl]Br_3$
a. pentaamminechloroplatinum(IV) bromide

b. pentaamminechloroplatinum(II) bromide
c. pentaamminechloroplatinum(III) bromide
d. pentaamminechloroplatinum(VI) bromide

30. Name following complex compound or $Fe(CO)_5$
(a) pentacarbonyliron(3) (b) pentacarbonyliron(0)
(c) pentacarbonyliron(2) (d) pentacarbonylferate(2)

31. Give the systematic name for sodium monochloropentacyanoferrate(III)
(a) $[Na_3FeCl(CN)_5]$ (b) $Na_3[FeCl(CN)_5]$
(c) $Fe_3[NaCl(CN)_5]$ (d) $Na_3[Fe(CN)_5Cl]$

32. Coordination number of the transition element in $[Pt.Cl.NO_2(NH_3)_4]^{2+}$ is
(a) 6 (b) 2 (c) 4 (d) 8

33. Select correct statement for $K_2(Cu(CN)_4)$
(a) Central atom is present in avionic sphere
(b) Ligand is positively charged
(c) Potassium tetra cyano cupperate
(d) Co-ordination number is 7

34. Central metal atom in $[Ni(CO)_4]$ has _____ oxidation state.
(a) 4 (b) 0 (c) 2 (d) 6

35. Group 6 of transition elements contains
(a) Cu Te Re (b)Cr Mo W
(c) Zn Cd Hg (d) Fe Ru Ni

36. _____ are elements in which d or f orbitals are in the process of completion
(a) Outer transition elements (b) Typical transition elements
(c) Inner transition elements (d) Transition elements

37. The location of transition elements is in between
(a) Chalcogens and halogens (b) d and f block elements
(c) Lanthanides& actinides (d) s and p block elements

38. The melting points and boiling points _____ upto meddle of 3d series
(a) Decreases (b) Remain same (c) Increases (d) No regular trend

39. _____ attracted by applied strong magnetic field are called
(a) Paramagnetic compounds (b) Diamagnetic compounds
(c) Conductive compounds (d) Ferromagnetic compounds

40. The correct electronic configuration of Cr is
(a) $[Ar]4s^23d^8$ (b) $[Ar]4s^03d^7$
(c) $[Ar]4s^13d^5$ (d) $[Ar]\ 4s^23d^5$

41. On interaction of light with transition element electrons excited from lower orbitals to higher orbitals in _____
(a) p-subshell orbitals (b) f-subshell orbital
(c) d-subshell orbital (d) b & c

42. _____ are non-stoichiometric compounds
(a) Hydrates (b) Interstitial compounds
(c) Binary compounds (d) Hydrides

43. On dissolving transition elements compounds _____ is produced in solution
(a) Simples ions (b) Double salts
(c) Strong anions (d) Complex ions

44. _____ donates electrons to central metal atom in coordination sphere

(a) Anion (b) Ligand (c) Cation (d) Acid

45. ____ donate two electron pairs in a coordination compound
(a) Poly-dentate ligand (b) Ligand
(c) bi-dentate ligand (d) mono-dentate ligand

46. ____ compound can form a chealate
a) Oxalato (b) Ammine (c) Carbonyl (d) Cyano

47. The compoumd that contains the central atom attached to a ligands is called
(a) Complex compound (b) Coordination sphere
(c) Complex ion (d) Ligand

48. The compound or complex ion has a ring structure in
(a) Chelate (b) Polydentate ligand
(c) Monodentate ligand (d) Hydrate

49. Oxidation number in complex compounds is written in
(a) Roman numeral (b) Arabic numeral
c) English (d) Greek

50. Complex compounds geometry mostly depends on
(a) Types of hybridization in the elements of ligands
(b) Type of ligands (c) Hybridization of central metal (d) All

51. If sp^3d^2 hybridizide central atom is present in coordination compound, its geometry will be
(a) Octahedral (b) Tetrahedral (c) Square planar (d) Trigonal bipyramidal

52. Mg Si and P are removed in the form of _____ in the production of wrought iron
(a) Slag (b) Oxides (c) Carbonates (d) Silicates

53. The open hearth furnace is lined with _____
(a) CaO MgO (b) SiO_2 (c) FeO (d) Fe_2O_3

54. $[MnO_4]^{-2}$oxidation number is
(a) 6 (b) 7 (c) -6 (d) -7

55. Which of following is a sold fertilizer
(a) $MnSiO_3$ (b) $Ca_3(PO_4)_2$ (c) Na_2SiO_3 (d) $CaSiO_3$

56. ____ cell is produced on connecting Al with Cu
(a) Electrolytic cell (b)Dry cell (c) Galvanic cell (d) a and b

57. _____ is typical transition metal?
(a) Co (b) Y (c) Na (d) Mg

ANSWERS

1	b	11	a	21	c	31	b	41	d	51	a
2	c	12	b	22	b	32	a	42	b	52	a
3	d	13	b	23	d	33	a	43	d	53	a
4	b	14	c	24	a	34	a	44	b	54	a
5	d	15	b	25	b	35	b	45	c	55	b
6	a	16	a	26	d	36	d	46	a	56	c
7	c	17	a	27	c	37	d	47	a	57	a
8	d	18	d	28	d	38	c	48	a		
9	a	19	d	29	a	39	a	49	a		
10	d	20	a	30	b	40	c	50	c		

10. f- BLOCK ELEMENTS

The f-block, or f-sub-shell contains the elements on the periodic table between atomic numbers 57 - 70 and 89 - 102, which are inner transition metals with general electronic configuration of f – block elements is $(n-2)f^{1-14}(n-1)d^{0-1}ns^2$. In f-block elements the last electron enters penultimate i.e. (n – 2)f f orbital. The 14 elements immediately following lanthanum, i.e., Cerium (58) to Lutetium (71) are called lanthanoids. In lanthanides ($[Xe]4f^{1-14}5d^{0-1}6s^2$) the differentiating electron enters 4f orbital. The 14 elements immediately following actinium (89), with atomic numbers 90 (Thorium) to 103 (Lawrencium) are called actinoids. In actinides ($[Rn]5f^{1-14}6d^{0-1}7s^2$)the differentiating electron enters 5f orbitals.Lanthandides show following characteristics propereities: similar physical properties throughout the series, mainly of the +3 oxidation state (usually found in crystalline compounds), +2 or +4 are other oxidation states, coordination numbers greater than 6 (usually 8-9) in complex compounds, preferrrly react to more electronegative elements (such as O or F), ionic complexes undergo rapid ligand-exchange, oxidize rapidly in moist air, dissolve quickly in acids, very small crystal-field effects, little dependence on ligands,reaction with oxygen is slow at room temperature, react with X, S, H, C and N upon heating, all are radioactive due to instability. In the Lanthanides, there is a decrease in atomic size from La to Lu. This decrease is known as the Lanthanide Contraction. Lanthanides important ores are monazite (mostly the lighter Lanthanides), Xenotime (mostly the heavier Lanthanides), Euxenite (contains a fairly even distribution of the Lanthanides). The actinides have following general properities: the energy in the 6d orbitals is lower in energy than in the 5f orbitals so the 5f orbitals are not shielded by the filled 6s and 6p subshells, a small energy gap between the $5f^n\ 7s^2$ and $5f^{n-1}\ 6d\ 7s^2$ configurations, the energies of the 5f orbital drop rapidly with increasing atomic number.Plutonium (Pu) and Uranium (U) are used as nuclear fuels and in weaponry.Thorium (ThO_2) is used as an incandescent gas mantle. The atomic bomb dropped on Nagasaki had a plutonium charge. Glenn T. Seaborg and his group at the University of California at Berkeleysynthesized Pu, Am, Cm, Bk, Cf, Es, Fm, Md, No and element 106, which was later named seaborgium in his honor while he was still living. They also synthesized more than 100 atomic actinide isotopes.

MULTIPLE CHOICE QUESTIONS

1. f- block elements are also called
(a) Gun metals (b) Coinage metal
(c) Outer transition metals (d)Inner transition metals

2. f block element have following general configuration?
(a) $(n-1)f^{1-14}(n-2)d^{0-1}ns^2$ (b) $(n-2)f^{1-14}(n-1)d^{0-1}ns^2$
(c) $(n-1)f^{1-14}(n-1)d^{0-1}ns$ (d) All

3. Lanthanides have _____ total elements and actinides have _____ total elements.
(a) 14, 15 (b) 14, 14 (c) 15, 14 (d) 15, 15

4. The general electronic configuration of lanthanides is given as?
(a) ($[Xe]4f^{1-14}5d^{0-4}6s^2$) (b) ($[Xe]4f^{1-14}5d^{0-2}6s^2$)
(c) ($[Xe]4f^{1-14}5d^{0-1}6s^2$) (d) ($[Xe]4f^{1-14}5d^{0-10}6s^2$)

5. The general electronic configuration of actinides is given as?
(a) ($[Rn]5f^{1-14}6d^{0-2}7s^2$) (b) ($[Rn]5f^{1-14}6d^{0-1}7s^2$)
(c) ($[Rn]5f^{1-14}6d^{0-3}7s^2$) (d) ($[Rn]5f^{1-14}6d^{0-9}7s^2$)

6. The main oxidation state of lanthanides is
(a) +2 (b) +3 (c) + 4 (d) +2, +3

7. All actinides are
(a) Radioactive (b) Very stable (c) Non- radioactive (d) Any one of above
8. _____ ore mostly contains the light lanthanides
(a) Monazite (b) Xenotime (c) Euxenite (d) All
9. _____ ore mostly contains the heavier lanthanides
(a) Monazite (b) Xenotime (c) Euxenite (d) All
10. _____ ore contains fairly even distribution of lanthanides
(a) Monazite (b) Xenotime (c) Euxenite (d) All
11. The most common oxidation state of actinides is
(a) +2 (b) +3 (c) + 4 (d) +2, +3
12. The oxidation states of lanthanides other than +3 are
(a) +1,+2 (b) +2, +4 (c) + 4; +5 (d) +2, +5
13. The oxidation states of actnides other than +3 are
(a) +1,+2 (b) +4, +5, +6 (c) + 4, +5 (d) +2, +5
14. Which of following has stronger tendency towards complex formation?
(a) Actinides (b) Lanthanides (c) Both (d) None
15. Which block elements are more electropositive in modern periodic table?
(a) s (b) p (c) d (d) f
16. Which block elements are less electropositive in modern periodic table?
(a) s (b) p (c) d (d) f
17. Which block elements transist between more electropositive and less electropositive elements
(a) s (b) p (c) d (d) f
18. _____ is an electronic configuration at Th?
(a) $[Rn]5f^06d^27s^2$ (b) $[Rn]5f^16d^27s^2$
(c) $[Rn]5f^56d^27s^2$ (d) $[Rn]5f^56d^27s^2$
19. Why Th is included in f-block ?
(a) According to electronic configuration (b) According to physical properties (c) According chemical properties (d) According to practical properties
20. _____ are first transition elements?
(a) Ac, Rt (b) Ac, Re (c) Rf, La (d) Y, Rf
21. _____are include in Lanthanoide series ?
(a) La to Lu (b) Ce to Lu (c) La to yb (d) Ce to yb
22. _____ general symbol is used to represent Lanthanoides ?
(a) Ln (b) La (c) Le (d) Li
23. _____ are included in actinide series?
(a) Th to Lr (b) Ac to Lr (c) Ac to No (d) Th to No
24. _____ has very close similarity with Lanthanoides ?
(a) Lr (b) Ce (c) Lu (d) La
25. Lanthanoides hydroxides basic properities are
(a) greater than $Al(OH)_3$ but less than $Ca(OH)_2$
(b) greater than $Ca(OH)_2$ but less than $Al(OH)_3$
(c) greater than $Ca(OH)_2$ and $Al(OH)_3$
(d) less than $Ca(OH)_2$ and $Al(OH)_3$
26. Lanthanoides elements are separated on the basis of their

(a) chemical properties (b) difference in basicity
(c) physical properties (d) difference in acidity
27. _____ radioactive elements in Lanthanodies.
(a) Promethium (b) Lutetium (c) Yetterbium (d) Samarium
28. _____ is used in gas lighters?
(a) CeO_2 (b) Pyrophoric Misch metal
(c) Gadolinium sulphate (d) Ceric compounds
29. _____ is used as oxidizing agent in volumetric analysis?
(a) CeO_2 (b) Pyrophoric Misch metal
(c) Gadolinium sulphate (d) Ceric compounds
30. _____ is used in preparation of optical glass of camera having high refractive index?
(a) CeO_2 (b) Oxides of lanthanoids
(c) Gadolinium sulphate (d) Ceric compounds
31. _____ is used to produce very low temperature by magnetic field?
(a) Pyrophoric misch metal (b) U (c) Th (d) Gadolinium sulphate
32. ____ is the constitution of metals in pyrophoric misch metal?
(a) ce-50%, ca-40%, Fe-10% (b) Ce-50%, La-40%, Fe-7%, other-5%
(c) Ce-40%, La-50%, Fe-5%, other-5% (d) Ce-40%, La-50%, Fe-10%
33. If the radius of La^{3+} is 1.06 A°, then what will be value of radius of Lu^{3+}?
(a) 1.61 A° (b) 1.42 A° (c) 0.85 A° (d) 2.06 A°
34. What is wrong statement for Ce? [
(a) The general oxidation state of Ce is +3 and +4
(b) +3 oxidation state of Ce is more stable than +4
(c) +4 oxidation state of Ce is not available in its aqueous solution
(d) Ce (IV) behave as oxidizing agent

ANSWERS

1	d	8	a	15	a	22	a	29	d
2	b	9	b	16	b	23	a	30	b
3	b	10	c	17	c	24	d	31	d
4	c	11	b	18	a	25	a	32	b
5	b	12	b	19	d	26	b	33	c
6	b	13	b	20	a	27	a	34	a
7	a	14	a	21	b	28	b		

PART II: PHYSICAL C. EMISTRY

11. FUNDAMENTALS OF PHYSICAL CHEMISTRY

Chemistry is a science that deals with the properties, structure and the changes occurring in matter. Chemistry is based on the theory of atoms, molecules, the law of conservation of matter, and the theory of chemical structure. An atom is the smallest particle preserving its identity during chemical changes. Molecules are formed by the interaction of atoms. Consequently, a molecule is a system consisting of atoms bonded together. This system, as an integral entity, has a new set of properties. A molecule is the smallest particle of a material substance retaining its characteristic chemical properties.

pH is the measure of hydrogen ion concentration, (degree of acidity or alkalinity of a solution) is reffered as pH value and is defined as

$$pH = -\log [H^+]$$

pH is evaluated by Taste, Litmus paper, pH paper, Indicators, pH meter and ,Potentiometric (pH meter) method, pH meter is the most accurate method.

$$pH + pOH = 14$$

Importance of pH measurements

pH has got a significance importance in various biochemical reactions such as working of enzymes digestion of food, etc. Different qualitative and quantitative analyses are carried out at definite pH values. In agricultute, pH has a great importance Because soil is often tested to decide whether basic or acidic or fertilizers are helpfulfor a particular crop. Food preservation also requires some definite pH values.

Avogadro's Law tthe same condition of pressure andtemperature, equal volumes of all gasescontain the same number of molecules.

Mole is the amount of substance of a system that contains as many elementary entities as there are carbon atoms in 0.012 kg of ^{12}C, i.e., Avogadro's number ($N_A = 6.02 \times 10^{23}$) ofentities is termed as a mole of substace

For example, one mole of H_2SO_4 contains 6.02×10^{23} entities.

Molar Mass

The mass of one mole of a substance is called molar mass M.

Avogadro Number ($N_{(a)}$)

The collection of 6.02×10^{23} entities is called one mole of a substance, and is called the Avogadro Number (N_A.

The molar mass (M) , the number of moles (n), and the mass of a substance in gram (m) are related to one another by the formula

$$n = m/M$$

Atomic Masses: The mass of an atom of an element in atomic mass unit.

Atomic Mass Unit: The $1/12^{th}$ of the mass of carbon isotope atom (C-12) is taken as the unit of mass. It is called the atomic mass unit (amu).

Relative Atomic Mass is the mass of an atom of an element as compare to the mass of carbon-12 isotope atom with a mass number of 12.

Absolute mass = Relative mass × 1amu

Molecular Mass is the mass of a molecule expressed in atomic mass units is called molecular mass. **The relative molecular mass** of simple and complex substances equals the sum of relative atomic masses of the atoms their molecules have. For example, the relative atomic mass of oxygen is 16 thereforee the relative molecular mass of oxygen O_2 is 32 nad

Standard Temperature and Pressure (STP)

The temperature and pressure at which the volume was measured is required in order to mention the volume of a gas It is usual to give the volume at 0 °C and 1 atm. These conditions are called standard temperature and pressure (STP). A mole of gas occupies 22.4 L at STP. 22.4 L is also reffered as gas molar volume at STP.

Limiting Reactant are the reactant that determines the theoretical product yield in a given reaction is called limiting reactant

Percentage Yield is the amount of product that is formed during a chemical reaction when limiting reactant is completeluy utilized is called the **theoretical yield** of that product. The theoretical yield (calculated from balanced chemical equation) is hardly obtained. during a chemical reaction. Therefore, the actual yield is expressed as a percentage by mass of the theoretical yield obtained in achemcial reaction and is called the percent yield.

Percent Yield = Actual yield/Theoretical yield × 100 percent

Concentration is the amount of solute in a given amount o f solvent. A number of ways are used to express the concentration. Molarity andnormality are commonly used units for the concentration along with molality, formality, mole fraction, percentage, parts per m illion (ppm), parts per billion (ppb) etc.

Molarity(M) is defined as the number of moles of solute per liter of solution.

- Molarity =Number of moles of solute/ volume of solution in liter
- Molarity = Number of millimoles of solute/ volume of solution in mL
- Molarity of solution changes with change in temperature.

Normality(N) of a solution is defined as the number of gram equivalents of the solute per litre of the solution. Normality is an intensive quantity and changes with change in temperature.

N = No. of gram equivalents of solute/Volume of solution in litres

Gram equivalents = mass of solute in grams/equivalent mass

(i) Equivalent mass of an element = atomic weight/valency
(ii) Equivalent mass of an acid = molecular weight of acid/basicity of acid
(iii) Equivalent mass of base = MW/Acidity
(iv) Equivalent mass of salt = MW/No. of cation ×valency of cation
(v) Equivalent mass of an ion = formula mass of ion/charge on the ion
(vi) Equivalent mass of an oxidizing agent or reducing agent = Molecular mass or atomic mass/No. of electron lost or gained by one molecule of substance

Normality and molarity are related to each other by

Normality (N) = Molarity (M) × Molecular mass/Equivalent mass

Standard Solution is a solution of know concentration

In volumetric analysis, the concentration of a solution is found by measuring the volume of solution that will react with a known volume of a standard solution. The procedure of adding one solution to another in a measured way until the reaction is complete is called **titration**. Volumetric analysis is often referred to as titrimetric analysis or **titrimetry**.

MULTIPLE CHOICE QUESTIONS

1. Which of the following contains maximum number of electrons?
   (a) 1.6 g CH_4 (b) 4.4 g CO_2
   (c) 1.2 CO_2 (d) 1.8 H_2O
2. The percentage of oxygen present in NaOH is
   (a) 1 (b) 8
   (c) 16 (d) 40

3. 1.725 g of a metal carbonate is mixed with 100 mL of decinormal HCl. 10 mL of seminorma NaOH are required to neutralise excess of the aci(d) Choose the correct statements.
   (i) The equivalent mass of metal carbonate is 138
   (ii) The number of moles of excess HCl is 5.0×10^{-3}
   (iii) The equivalent mass of metal carbonate is 69.
   (iv) The number of gram equivalent of HCl used to neutralize metal carbonate is 2.5 $\times 10^{-2}$.
   (a) ii, iii, iv (b) i & iv
   (c) i & ii (d) i,ii,iii
4. Mass of 1 amu in grams
   (a) 1.008 (b) 1.66×10^{-24}
   (c) 1.66×10^{24} (d) 2.008
5. Copper forms two oxides cuprous and cupric oxides, which law can be proved by the weight of Cu and O.
   (a) Reciprocal Proportions (b) Multiple Proportions
   (c) Constant composition (d) Definite Proportions
6. Molar mass of Mg atoms is 24 g. What is the mass of one Mg atoms in grams?
   (a) 3.99×10^{-23} (b) 6.02×10^{23}
   (c) 6.02×10^{-23} (d) 3.99×10^{23}
7. The relative molecular mass of ^{12}CO is 27.9949. The relative molecular mass of $^{12}CO_2$ is
   (a) 47.9847 (b) 43.9898
   (c) 43.9949 (d) 39.9949
8. How many moles of Al_2O_3 will be formed when a mixture of 5.4 g of Al and 3.2 g of O_2 is heated
   (a) 1/20 (b) 1/15
   (c) 1/10 (d). 1/5
9. One mole of a mixture of CO and CO_2 requires exactly 20 grams of NaOH in solution t complete conversion of all the CO_2 into Na_2CO_3. How many grams of more of NaOH would require for conversion into Na_2CO_3 if the mixture (1M) is completely oxidized to CO_2.
   (a) 60 g (b) 40 g
   (c) 50 g (d) 80 g
10. The amount of zinc (atomic Wt. 65) required to produce 224 mL of H_2 at STP on treatment wi dilute H_2SO_4 will be
   (a) 0.65 g (b) 0.065 g
   (c) 65 g (d) 6.5 g
11. Which of the following solutions contains the greatest number of ions?
   (a) 0.6 dm^3 of 2 M $CaCl_2.6H_2O$
   (b) 0.7 dm^3 of 0.5 M $K_2SO_4.Al_2(SO_4)_3.24H_2O$
   (c) 0.8 dm^3 of 1 M $Cr_2(SO_4)_3.18H_2O$
   (d) 0.8 dm^3 of 2 M $Na_2SO_4.10H_2O$
12. How many grams of KCl must be added to 75.0 g of H_2O to produce a solution that is 2.1 molal (m)?
   (a) 126 g (b) 63 g
   (c) 33.1 g (d) 12.6 g
13. B has two isotopes ^{10}B (19 %). ^{11}B (81 %). The atomic mass of B is
   (a) 10.81 (b) 10^5
   (c) 11 e. 23.1

14. Con(c) H_2SO_4 is 98 % by mass and has density of 1.84 g/cm^3. What volume of con(c) acid is required to make 5 litre of 0.5 M H_2SO_4 solution?
   (a) 250 cm^3 (b) 136 cm^3
   (c) 136 L (d) 13.6 cm^3
15. A metal displaced 16.8 mL of H_2 in standard conditions from an aci(d) What volume of N_2 is needed to combine with this amount of H_2 into NH_3?
   (a) 8.4 mL (b) 5.6 mL
   (c) 11.2 mL (d) 10.23 mL
16. The maximum number of atoms are present in
   (a) 16 g O-O (b) 16 g O_2
   (c) 16 g O (d)All contains same number of atoms
17. After 25 mL of 0.02 M $Ca(OH)_2$ is mixed with 25 mL of 0.288 M $HClO_4$. Then the concentration of OH^{-1} is
   (a) 0.116 M (b) 0.058 M
   (c) 1.45×10^{-3} M (d) 2.90×10^{-3} M
18. The mass of ferric oxide that will be obtained by complete oxidation of 2 g of iron is (atomic mass Fe = 56)
   (a) 2.86 g (b) 4.86 g
   (c) 1.86 g (d) 3.86 g
19. 2 L of N_2 and 2 L of H_2 on complete reaction would give ———— litres of NH_3
   (a) 10. L (b) 1.0 L
   (c) 4.0 L (d) 1.33 L
20. Which of the following weighs most?
   (a) 32 g oxygen (b) 3 g atom of nitrogen
   (c) 0.5 M of iron (d) 3.01×10^{23} atoms of carbon
21. The molarity of a 500 mL solution containing 4g NaOH (Mol mass = 40) is
   (a) 0.4 (b) 0.3
   (c) 0.2 (d) 0.1
22. Which of the following concentration term is used in respect of standard solutions?
   (a) Molality (b) ppm
   (c) Molarity (d) All of above
23. One ppm solution of NaOH contains 1000 mg of the solute per how much of the volume of the solution?
   (a) 10 mL/ (b) 1 mL
   (c) 1000 mL (d) 100 mL
24. Which of the following solutions of sulphuric acid will exactly neutralize 25 mL of 0.2 M NaOH?
   (a) 25 mL of 0.2 M solution (b) 50 mL of 0.1 M solution
   (c) 20 mL of 0.1 M solution (d) 12.5 mL of 0.1 M solution
25. One litre solution of NaOH contains 4.0 g of it. What will be the difference between molarity and normality? (Moler mass = 40)
   (a) 0.01 (b) 0.02
   (c) Zero (d) 0.05
26. The normality of 2.3M H_2SO_4 solution is
   (a) 0.046N (b) 4.6N
   (c) 0.023N (d) 0.23N

27. The pH of water is 7 at 25°C. If water is heated to 70°C, which of the following should be h
(a) pH will increase
(b) pH will decrease
(c) pH will remain constant
(d) Concentration of H^+ will increase and OH^- will remain same

28. The number of gram equivalents of the solute per dm^3 of the solution is called
(a) Molality (b) Molarity
(c) Formality (d) Normality

29. Which of the following solutions has highest normality?
(a) 1N H_3PO_4
(b) 0.5N H_2SO_4
(c) 6g NaOH per 100 cm^3
(d) 8g KOH per dm^3

30. How much amount of NaOH is required to prepare 100 mL of 1N solution?
(a) 40 g (b) 4.0 g
(c) 20 g (d) 80 g

31. The pink colour of phenolphthalein in basic medium is due to the
(a) anionic form
(b) Neutral form
(c) Cationic form
(d) OH^- ions of the base

32. 20 mL of an acid solution is neutralized by 10 mL of 0.2N base. The strength of acid solut
(a) 0.4N (b) 0.3N
(c) 0.2N (d) 0.1N

33. The pKa of an acid having ionization constant 1×10^{-5} is
(a) −5 (b) 10
(c) 9 (d) −9

34. A 10% solution of sucrose contains 10g of sucrose in how much volume of the solution?
(a) 1000 mL (b) 100 mL
(c) 10 mL (d) 1 mL

35. The pH of a buffer solution containing an acid and its salt is
(a) $\frac{1}{2}pKa - \log\frac{|A|}{|S|}$
(b) $pKa + \log\frac{|A|}{|S|}$
(c) $pKa + \log\frac{|S|}{|A|}$
(d) $\log pKa + \log\frac{|S|}{|A|}$

36. The number of moles of solute dissolved in 1000 gram of the solvent is called
(a) Molality (b) Molarity
(c) Formality (d) Mole fraction

37. The pH of a buffer solution containing a weak base and its salt can be related to pKb as
(a) $pH = pKb - \log\frac{|S|}{|A|}$
(b) $pH = 14 - pKb - \log\frac{|S|}{|A|}$
(c) $pH = \frac{1}{2}pKb - \frac{1}{2}\log\frac{|S|}{|A|}$
(d) $pH = pOH - pKb + \log\frac{|S|}{|A|}$

38. The number of moles of the solute dissolved per dm^3 of the solution is called
(a) Molarity (b) Molality
(c) Normality (d) Formality

39. The number of formula weight of the solute dissolved per dm^3 of the solution is called
(a) Mole fraction (b) Molality
(c) Normality (d) Formality

40. Which of the following will have the largest pH?
(a) 0.1 N HCl
(b) 0.1 N CH_3COOH
(c) 0.01 N NaOH
(d) 0.1 N NaOH

41. A 2M solution of H_2SO_4 would have how many moles of H^+ ion in one liter?
(a) 4.0 (b) 3.0
(c) 2.0 (d) 1.0

ANSWERS

1	B	2	D	3	A	4	B	5	B	6	A	7	B
8	B	9	A	10	A	11	D	12	D	13	A	14	B
15	B	16	D	17	A	18	A	19	D	20	A	21	C
22	D	23	C	24	D	25	C	26	B	27	B	28	D
29	C	30	B	31	A	32	D	33	A	34	B	35	C
36	A	37	B	38	A	39	D	40	D	41	A		

12. ATOMIC STRUCTURE AND QUANTUM CHEMISTRY

Mechanics is the a branch of physical science that deals with the behavior of matter under the action of forces. Two main branches of mechanics a re (Newtonian Mechanics and Quantum Mechanics)

Newtonian Mechanics is based on Newton's laws of motion and provides an accurate means of determining the motions of bodies (in daily life) possessing ordinary velocities.

uantum Mechanics is based on the Schroendinger wave equation, It is a method of interpreting physical phenomena occurring on very small scale (e.g., the motion of electron and nuclei within atoms).

The quantum theory states that the energy exists in discrete units, only whole numbers of which can exist; each unit is called **a quantum** (plural 'quanta'). The quantum of electromagnetic radiation is called **photon**.The energy of electromagnetic radiation is given by the product of Planck's constant and the frequency of radiation.

A quantity is said to be quantized if, in accordance with quantum mechanics, it can only have certain discrete values. Such a quantity cannot vary continuously.

Photoelectric effect and Compton effect

The emission of electron from a clean metal surface occurs when a beam of visible or ultraviolet light falls on it. This effect is known as photoelectric effect.

When a beam of light strikes on an electron and is , scattered, its frequency is shifted towards lower frequencies. This shift of frequency is independent of the frequency of incident radiation. This behaviour is called the Compton effect.

Wave mechanical model of the atom

The wave mechanical model takes into account the wave and particle nature of the electron. This model was proposed by an Austrian Physicist E. Schrödinger in 1926.Schrodinger wave equation describes the wave motion of an electron along one and three-dimensional axes. This equation is used to calculate energy and wave function of electron and other small particles. in a one-dimensional as well as in three-dimensional box.This equation introduces the concept of atomic orbitals, energy level, transition between the various energy level etc.

Important applications of the equation are:

1. This equation has been used to calculate the energy and wave function of a particle such as electron in a one-dimensional box.
2. This equation can be used to calculate the energy and wave function of a particle in a three-dimensional box.
3. This equation has been used to derive an expression for the energy of an electron in H-atom.
4. This equation introduces the concept of atomic orbital.

In wave mechanics, electrons are treated as three-dimensional standing wave systems represented by a **wave function, ψ**, the magnitude of which represents the varying amplitudes of the wave system at various points around the nucleus.

When an operator operates on a function and the same function is reproduced with some numerical value or constant, then the function is called **eigen function** and numerical value is called its **eigen value.**

A function is said to be normalized wave function if it satisfies the following condition

$$\int_{-\infty}^{+\infty} \psi^2 \, d\tau = 1$$

Such a condition is called **normalization** of the wave function.

The wave functions are **orthogonal** when the integral of the product of two different wave functions is equal to zero,.

$$\int_{-\infty}^{+\infty} \psi_p \psi_q \, d\tau = 0 \qquad p \neq q$$

Quantum numbers

Integral or half integral numbers which specify the state of a system or its components in quantum mechanics. An electron within an atom is specified by four quantum numbers:

The principal quantum number, n, defining the energy level in which the electron occurs;

The azimuthal quantum number, *l*, defining the shape and multiplicity of the orbital within that shell,

The magnetic quantum number, m, which determines the orientation of orbital with reference to a strong magnetic field; and

The spin quantum number, s, which determines the direction of spin of an electron in a magnetic field.

Pauli exclusion principle states that no two electrons in an atom can have the same set (values) of all the four quantum numbers.

What is Hund's rule: If there are several orbitals of same energy, the electrons would prefer to reside in separate orbitals and remain unpaired rather than to live in the same orbital and leave the other empty.

Define Aufbau principle The orbitals are filled up in order of increasing energy. As a working rule, a new electron enters the orbital where n + *l* value is minimum.

MULTIPLE CHOICE QUESTIONS

1. Which is the correct order of wave length of the following radiations: infrared, ultraviolet, radio waves, X-rays and visible light?
   (a) X-rays > ultraviolet > infrared > visible > radio waves
   (b) X-rays > ultraviolet > visible > infrared > radio waves
   (c) radio-waves > infrared > visible > ultraviolet > X-rays
   (d) X-rays > radio waves > visible > ultraviolet > infrared
2. Which of the following statement is not correct according to Dalton's atomic theory?
   (a) Every element consists of small particles called atoms.
   (b) Atoms of same element are alike.
   (c) Atoms of the same element have same mass.
   (d) Atoms are destructible.
3. Which of the following statements is not correct regarding the electromagnetic spectra?
   (a) Cosmic rays have shorter wavelength than radio waves.
   (b) X-rays have smaller wave number than cosmic rays.
   (c) The velocity of X-rays is more than that of microwaves
   (d) The frequency of microwaves is less than that of ultraviolet rays
4. Matter is regarded as being made up of particles, each having a certain mass is a statement of which branch of science
   (a) Quantum Mechanics (b) Classical mechanics
   (c) Wave mechanics (d) Chemical kinetics
5. Which of the following statement is not correct about the black body?
   (a) A black body absorbs all the radiation falling on it.
   (b) It also acts as perfect radiator when heate(d)
   c The radiation emitted by body is independent of temperature.

(d) The radiation emitted by body is independent of nature of material

6. Which of the following statements is not correct regarding the electromagnetic radiation?
   (a) Radiation can propagate through space with the support of medium.
   (b) These are produced by the oscillation of electric and magnetic fields.
   (c) These travel with same velocity.
   (d) These are characterized by wavelength, frequency and energy.
7. Which of the following statements is wrong with respect to cathode rays?
   (a) The rays carry a negative change
   (b) The rays produce a mechanical effect
   (c) The charge/mass ratio is smaller than the positive rays
   (d) The charge/mass ratio is independent the nature of gas
8. According to Maxwell's theory the energy carried by an electromagnetic wave is proportional to the square of what
   (a) Wave number (b) Frequency
   (c) Wavelength (d) Amplitude
9. Which of the following observations is false about the photoelectric effect?
   (a) The threshold frequency is different for different metals.
   (b) The number of photoelectrons ejected from the metal surface depends upon the intensity of the incident radiation
   (c) The threshold frequency is the same for all metals
   (d) The kinetic energy of ejected electrons is independent of the intensity of radiation
10. Which of the following statements is not correct with regard to Rutherford's nuclear model of an atom?
   (a) An atom consists of a nucleus surrounded by electrons revolving around it.
   (b) The number of protons and neutrons in the nucleus of an atom are always equal.
   (c) The nucleus is extremely small as compared to the atom.
   (d) Most of the atom has empty space.
11. The units of wavelength in common use are:
   (a) nm (b) cm
   (c) Å (d) All above units
12. The radiation of wavelength 350 nm falls in which region of the spectrum.
   (a) Visible region (b) Micro-wave
   (c) Radio wave (d) Ultraviolet
13. Azimuthal quantum number defines
   (a) Shape of the orbital
   (b) Spatial distribution of the electron
   (c) Orientation of an orbital
   (d) Energy of an orbital
14. Which of the following relations between wave length, frequency and speed is correct?
   (a) $\nu = c/\lambda$ (b) $c \times \lambda = \nu$
   (c) $\nu \times \lambda = c$ (d) All are correct
15. Which of the following statement is not correct about the quantum theory?
   (a) An oscillator absorbs radiation continuously.
   (b) An oscillator absorbs radiation discontinuously.
   (c) An oscillator emits radiation discontinuously.

(d) An oscillator emits radiation in the form of energy packets called quant

16. It is generally observed that when X-rays are scattered by crystals, the wavelength of the scattered radiation is greater than that of incident radiation. This observed change in wavelength or frequency of the scattered radiation is known as
   (a)Stark effect (b)Compton effect (c)Photoelectric effect (d)Salt effect
17. When an electron of charge, e and mass, m moves with velocity v around the nuclear charge Ze describing the circular orbit, the potential energy of the electron is
   (a) Ze^2/r (b) Ze^2/r^2
   (c) $-Ze^2/r$ (d) me^2/r
18. The designation of an orbital with n=4 and *l*=1 is
   (a) 4s (b) 4p
   (c) 4d (d) 4f
19. Which of the following statement is wrong according to Bohr,s theory?
   (a) Electrons can move around the nucleus in definite paths called orbits.
   (b) These orbits do not radiate energy.
   (c) These orbits are called moving orbits.
   (d) During absorption or emission of energy, Planck quantum concept is obeyed
20. Which is the correct order of wave number of the following radiations: infrared, ultraviolet, radio waves, X-rays and visible light?
   (a) X-rays > ultraviolet > infrared > visible > radio waves
   (b) X-rays > ultraviolet > visible > infrared > radio waves
   (c) radio-waves > infrared > visible > ultraviolet > X-rays
   (d) X-rays > radio waves > visible > ultraviolet > infrared
21. The de Broglie relationship can be expressed as
   (a) $h = \lambda/mv$ (b) $h = \lambda/mp$
   (c) $\lambda = h/mp$ (d) $\lambda = h/mv$
22. Which of the following conditions is incorrect for well-behaved wave function?
   (a) Wave function must be finite
   (b) Wave function must be single valued at any particular point
   (c) Wave function must be positive
   (d) Wave function and its derivative must be continuous
23. Heisenberg's uncertainty principle precludes the exact simultaneous measurement of
   (a) Charge density and probability (b) Position and momentum
   (c) Velocity and energy (d) Charge density and energy
24. The radius of the nth Bohr orbit is given by
   (a) $4\pi^2me^2/n^2h^2$ (b) $n^2h^2/4\pi^2me^2$
   (c) $4\pi^2me^2/nh$ (d) $2\pi^4e^2/nh$
25. If the principle quantum number n=4, the quantum number *l* can have the values
   (a) 1, 2, 3 and 4 (b) 0, 1, 2 and 3
   (c) 1, 2 and 3 only (d) 2, 4 and 6 only
26. Which of the following statement does not form a part of Bohr,s model?
   (a) Energy of the electron in the orbit is quantize(d)
   (b) The energy and momentum of the electron in the orbit can be determined simultaneously.

(c) The electron revolves in different orbits.
(d) The position and velocity of the electron in the orbit cannot be determined simultaneously

27. The presence of unpaired electrons can be explained by
(a) Pauli's exclusion principle (b) Aufbau principle
(c) Hund's rule (d) Uncertainty principle

28. The spectral line obtained when an electron jumps from n = 6 to n = 2 belongs to the
(a) Balmer series (b) Lyman series
(c) Paschen series (d) Pfund series

29. The maximum number of electrons in the s, p d and f orbital are
(a) 2 in each (b) 2, 6, 10, 14
(c) 2, 6, 8, 10 (d) 2,3,5,7

30. Heisenberg uncertainty principle is expressed by the equation
(a) $\Delta x.\ \Delta p \approx h/2\pi$ (b) $\Delta v.\ \Delta p \approx h/2\pi$
(c) $\Delta x.\ \Delta m \approx h/2\pi$ (d) $\Delta m.\ \Delta p \approx h/2\pi$

31. The movement of an electron from one atom to another in several redox reactions as well as reactions at the electrodes has been explained by which phenomenon?
(a) Photoelectric effect. (b) Compton effect
(c) Common ion effect. (d) Tunnel effect.

32. Magnetic quantum number specifies
(a) Shape of the orbital
(b) spatial distribution of the electron
(c) Orientation of an orbital
(d) Distance of the orbital

33. If uncertainty in the position of an electron is zero, the uncertainty in its momentum will be
(a) Zero (b) $> h/2\pi$
(c) $< h/2\pi$ (d) Infinite

34. Which of the following orbitals does not make sense?
(a) 6f (b) 7s
(c) 2d (d) 5g

35. Energy of atomic orbitals in a particular shell is in the order of
a $s < p < f < d$ (b) $s > p > d > f$
(c) $p < d < s < f$ (d) $s < p < d < f$

36. The designation of an orbital with n = 4 and / = 1 is
a 4s (b) 4p
(c) 4d (d) 4f

37. The Schrodinger wave equation for a particle such as electron in a potential field V, in three dimensions is (where the symbols have their usual meanings)
(a) $\partial^2\psi/\partial x^2 + \partial^2\psi/\partial y^2 + \partial^2\psi/\partial z^2 + 8\pi m/h^2 (E-V)\psi = 0$
(b) $\partial^2\psi/\partial x^2 + \partial^2\psi/\partial y^2 + \partial^2\psi/\partial z^2 + 8\pi^2 m/h (E-V)\psi = 0$
(c) $\partial^2\psi/\partial x^2 + \partial^2\psi/\partial y^2 + \partial^2\psi/\partial z^2 + \pi^2 m/h^2 (E-V)\psi = 0$
(d) $\partial^2\psi/\partial x^2 + \partial^2\psi/\partial y^2 + \partial^2\psi/\partial z^2 + 8\pi^2 m/h^2 (E-V)\psi = 0$

38. A wave function is acceptable only if it
(a) is continuous (b) is single valued

(c) is finite (d) All above

39. Which of the following set of quantum number is possible?
(a) n = 4, / = 3, m = –3 s = 0 (b) n = 4, / = 0, m = 0 s = +1/2
(c) n = 4, / = 4, m = –4 s = – 1/2 (d) n = 4, / =0, m = +2 s = – ½

40. Which of the following statements is not correct regarding electromagnetic spectra?
(a) The frequency of microwave is less than uv.
(b) . Cosmic rays have shorter wave length than radio waves.
(c) The velocity of X-rays is more than uv
(d) The frequency of uv is greater than visible rays.

41. Which of the following relations between wave number ($\bar{\nu}$), frequency (ν) and speed is correct?
(a) $\bar{\nu} = \frac{\nu}{c}$ (b) $\bar{\nu} = \frac{\lambda}{c}$
(c) $\nu = \frac{c}{\nu}$ (d) $\bar{\nu} = \frac{c}{\lambda}$

42. Which of the following statements is not relevant to the Plank's Quantum Theory?
(a) Radiant energy is not absorbed or emitted continuously.
(b) The energy associated with photon of radiation is directly proportional to the wavelength.
(c) Radiant energy is emitted or absorbed in the form of small packets of energy.
(d) The quantum of light energy is called photon.

43. The Schrodinger wave equation for an electron, in a potential field V, in three dimensions is (where the symbols have their usual meanings)
(a) $\frac{\partial^2\psi}{\partial x^2} + \frac{\partial^2\psi}{\partial y^2} + \frac{\partial^2\psi}{\partial z^2} + \frac{8\pi^2 m}{h^2}(E+V)\psi = 0$
(b) $\frac{\partial^2\psi}{\partial x^2} + \frac{\partial^2\psi}{\partial y^2} + \frac{\partial^2\psi}{\partial z^2} + \frac{8\pi^2 m}{h^2}(E-V)\psi = 0$
(c) $\frac{\partial^2\psi}{\partial x^2} + \frac{\partial^2\psi}{\partial y^2} + \frac{\partial^2\psi}{\partial z^2} + \frac{8\pi^2 m}{h}(E+V)\psi = 0$
(d) $\frac{\partial^2\psi}{\partial x^2} + \frac{\partial^2\psi}{\partial y^2} + \frac{\partial^2\psi}{\partial z^2} + \frac{8\pi^2 m}{h}(E-V)\psi = 0$

44. Isotopes are atoms whose nuclei have the same atomic number but different mass numbers. A specific isotope has an atomic number of 18 and a mass number of 35. How many electrons are there in the neutral atom?
(a) 34 (b) 35 (c) 18 (d) 17

45. A theoretical link between quantum mechanics and thermodynamic is
(a) Electrochemistry
(b) Kinetic theory of gases
(c) Statistical thermodynamics
(d) Spectroscopic analysis

46. Which of the following pairs of fundamental particles are present in equal numbers in a neutral atom?
(a) Electron and neutron
(b) Proton and positron
(c) Electron and proton
(d) Neutron and proton

47. Heisenberg's uncertainty principle precludes the exact simultaneous measurement of
(a) position and momentum
(b) velocity and time
(c) velocity and energy
(d) charge density and probability

48. The Schrodinger equation when solved for any system gives
(a) The energy function
(b) The polarizability
(c) The mean force path
(d) The wave function

49. The branch of Physics that mathematically describes the wave properties of electron in atoms is called
(a) Statistical Mechanics
(b) Chemical Statistics
(c) Quantum Mechanics
(d) Thermodynamics

50. Zero period energy of an electron in one-dimensional box is given by
(a) $E = n^2h^2/8ma^2$
(b) $E = h^2/8ma^2$
(c) $E = 2h^2/8ma^2$
(d) $E = h/8ma^2$

51. Visible light is just a portion of radiation emitted by atoms. Which of the following statements is not related with visible light?
(a) The wave number of light is directly proportional to its wave length.
(b) Visible light is electromagnetic in nature.
(c) It travels with the speed of light
(d) It is a wave.

52. Which is the correct order of wave number of the following radiations?
(a) X-rays > uv > visible > infrared > radio waves
(b) X-rays > uv > infrared > visible > radio waves
(c) X-rays > uv > radio waves > visible > infrared
(d) X-rays > radio waves > uv > visible > infrared

53. The principal quantum number determines the overall size of the orbital and energy of the electron when it is associated with the orbital. It may have the values
(a) n = 1, 3, 5, ..., infinity
(b) n = 1, 2, 3, 4, ..., infinity
(c) n = 5, 10, 15, ..., infinity
(d) n = 2, 4, 6, ..., infinity

54. Which of the following operator/function combinations would yield eign value equation?
(a) d/dx (sin x)
(b) d/dx (e^x)
(c) d/dx (sin 4x)
(d) d/dx (cos x)

55. Which of the following conditions is incorrect for well behaved functions (ψ)?
(a) ψ must be positive
(b) ψ must be normalized
(c) ψ must be single valued at any particular point.
(d) ψ must be finite

56. Two isotonic nuclcide X and Y have mass numbers 35 and 37 respectively. If the atomic number of X is 17, the atomic number of Y will be
(a) 19
(b) 17
(c) 18
(d) 15

57. Which of the following phenomena is not explained by the classical mechanics?
(a) Blackbody radiate
(b) Photoelectric effect
(c) Atomic and molecular spectra
(d) All of the above.

58. An electron in an atom or molecule can jump from lower level to higher level. The wavelength of light absorbed is related to the energy gap between two levels by following expression
(a) $\Delta E = hc/\lambda$
(b) $\Delta E = hc/v$
(c) $\Delta E = h\upsilon$
(d) $Ch = \Delta E$

59. Which of the following expressions represent the deBroglie equation?
(a) $\lambda = \frac{h}{mv}$
(b) $h = \frac{mv}{\lambda}$
(c) $\lambda = \frac{mv}{h}$
(d) $\lambda = hv$

ANSWERS

1	C	2	A	3	C	4	B	5	C	6	A	7	C
8	D	9	C	10	B	11	D	12	D	13	A	14	C
15	A	16	B	17	C	18	A	19	C	20	B	21	D
22	C	23	B	24	B	25	B	26	D	27	C	28	A
29	B	30	A	31	D	32	C	33	D	34	C	35	D
36	B	37	D	38	D	39	B	40	C	41	A	42	B
43	B	44	C	45	D	46	C	47	A	48	D	49	C
50	B	51	A	52	A	53	B	54	B	55	A	56	A
57	D	58	A	59	A								

13. STATES OF MATTERS

Boyle's law is stated as the volume (of a given quantity) of a gas is inversely proportional to the pressure of the gas at constant temperature.

Charles law states that for a contant presseure, the volume (of certain mass) of a gas is directly proportional to the absolute temperature.

Avogadro's law states that equal volumes of all the gases contain the same number of molecules at the same conditions of pressure and temperature

Ideal gas law is expressed as $PV = nRT$

where R is gas constant, P is pressure,V is volume of gas T is temperature.

Different units of gas constant

$R = 8.314\ Nm\ K^{-1}\ mol^{-1} = 8.314\ JK^{-1}\ mol^{-1} = 0.0821\ litre\ atm\ K^{-1}\ mol^{-1}$

$= 1.987\ cal\ K^{-1}\ mol^{-1}$

Dalton's law of partial pressure

The total pressure exerted by a mixture of gases in a definite volume is equal to the sum of the partial pressures of all the gases, which would exert by each gas if present alone in the same volume at constant temperature.

Graham's law of diffusion

The rates of diffusion of different gases are inversely proportional to the square roots of their densities at constant temperature and pressure.

Important postulates of kinetic theory of gases

Gas consists of large number of tiny particles called atoms/molecules.

Gas molecules collide with one another and with the walls gas molecules of the container. The collisions are perfectly elastic between the molecules and with the walls of the container.

The volume the gas molecules is negligible as compared with the total volume of the gas.

Between the gas molecules, there are no forces of attraction or repulsion.

Mean or average velocity of gas molecules is defined as the sum of the velocities of all the molecules divided the by total number of molecules. Mathematically,

$$\bar{u} = \frac{u_1 + u_2 + u_3 + ... + u_n}{n}$$

Root mean square Velocity is given by the following equation

$$\bar{u}^2 = \frac{u_1^2 + u_2^2 + u_3^2 + ... + u_n^2}{n}$$

Where $\bar{u}^2$ is the mean square velocity. The square root of the mean square velocity is known as root mean square velocity.

Most probable velocity is the velocity possessed by the maximum number of gas molecules at a given temperature.

Relation between molecular velocities

It has been found that

Mean velocity, $\bar{u} = \sqrt{\frac{8RT}{\pi M}}$

Most probble velocity, $u_{mp} = \sqrt{\frac{2RT}{M}}$

Root mean square velocity, $u_{rms} = \sqrt{\frac{3RT}{M}}$

Thus $u_{rms} : u : u_{mp} = 1.00 : 0.92 : 0.82$

Most probable velocity = $0.82 \times u_{rms}$

Average velocity = $0.92 \times u_{rms}$

Mean free path the average distance travelled by a molecule between two successive collisions.

Collision frequency is the number of collisions made bv a molecule of a gas per unit time per unit volume.

Degree of freedom is the number of co-ordinates necessary to describe the position of a particle. A molecule having N atoms, has 3N degrees of freedom.

Law of equipartition of energy states that the total energy possessed by a molecule is equally distributed amongst its different degrees of freedom.

Specific heat capacity of a substance is defined as the quantity of heat required to raise the temperature of 1 g of that substance through 1^oC or 1K.

The molar heat capacity is likewise the quantity of heat required to raise the temperature of 1 mole of substance by 1^oCor 1K.

relation between C_p and C_V $C_p - C_v = R$

Ideal and non-ideal gases

Gases which obey gas laws under all conditions of temperature and pressure are termed as ideal gases.

Gases which show deviations from ideal behaviour are called non-ideal or real gases.

Why gases show deviations from ideal behavior

In the discussion of kinetic theory, it was assumed that the volume occupied by gas molecules is negligibly small as compared to the total volume of the gas and the molecules do not exert forces of attraction on each other. But in reality both these assumptions are wrong. All gas molecules have a definite volume and exert forces of attraction.

Critical temperature is the temperature above which a gas cannot be liquefied and below which a continuous increase of pressure would result in the liquefaction of a gas.

Critical pressure is defined as the pressure required to liquefy the gas at the critical temperature is called critical pressure.

N.T.P. or S.T.P: Normal (standard) temperature and pressure. A pressure of 101325 Pascal and a temperature of 0^oC; standard conditions under which volumes of gases are compared.

Liquefaction of a gas

A gas can be liquefied by applying high pressure and low temperature. Compression of the gas brings the molecules closer and a decrease in temperature, reduces the kinetic energy of the molecules.

The principle involved in the liquefaction is: A gas must be at or below its critical temperature. Lower the temperature below the critical value, easier would be the liquefaction.The gas is cooled either by doing external work or by expanding against the internal molecular forces.

Applications of liquefaction: Liquefied gases find numerous applications in many fields. For example,

It is possible to obtain high vacuum by using liquefied gases.

Liquid chlorine has almost replaced bleaching powder.

Liquid oxygen when mixed with powdered charcoal and detonated can be employed for preparing explosives.

Absolute zero

It is the lowest temperature theoretically possible; the zero of thermodynamic temperature. 0°K = 273.15°C = 459.67°F.

Effusion of gases

The passage of gases through small apertures under pressure is called effusion of gases. In diffusion, molecules of all gases move freely and tend to distribute themselves equally within the limits of the vessel enclosing the gas.

Addictive properties are the sum of the corresponding properties of the individual components of a system are called additive properties. Mass, volume and molecular weight.

Constitutive properties depend primarily on the arrangement of atoms in the molecule and to some extent on their nature. For example, surface tension, optical activity, viscosity etc.

Vapour pressure and effect of temperature on it

It is the pressure exerted by the vapours in equilibrium with the liquid at constant temperature.

The vapour pressure of a liquid increases with rise in temperature.

Boiling point of a liquid

It is the temperature at which the vapour pressure of a liquid becomes equal to the atmospheric (or external) pressure. When the external pressure is one atm, the term normal boiling point is used.

Viscosity

The resistance to flow exhibited by liquids and gases is known as viscosity. Because of this property some liquids flow slowly than others.

The coefficient of viscosity, η may be defined as the force per unit area required to maintain unit difference of velocity between two layers in the liquid unit distance apart. The unit of viscosity is dynes cm^{-2} s and is known as poise. In SI units, it is expressed in Nm^{-2} s or $kgm^{-1}s^{-1}$ which is equal to 1 pascal second

$$1\ kg\ m^{-1}\ s^{-1} = 1\ Pas$$

The viscosity of a liquid is measured with the help of apparatus known as viscometer. The viscosity of a liquid decreases with rise in temperature. Due to rise in temperature, the intermolecular forces become weak and viscosity decreases.

Measurements of viscosity of solutions have been used in the determination of molar masses of polymers by using he following empirical relationship.

$$[\eta] = KM^{a}$$

here M' is the molar mass, 'K' and 'α' are constants depending on the solvent, polymer and temperature.

Difference between relative and specific viscosity

If η and η_o are the coefficients of viscosity of the solution and the pure solvent at the same temperature, then the relative viscosity is defined as

$$\eta_r = \frac{\eta}{\eta_o}$$

The specific viscosity η_{sp}, is defined as

$$\eta_{sp} = \eta_r - 1 = \frac{\eta - \eta_o}{\eta_o}$$

Rheochor may be defined as the molar volume of a liquid at a temperature where its viscosity is unity.

$$R = \frac{M}{D}\eta^{1/8}$$

Use of rheochor as an additive and constitutive property in elucidating the structure of compounds has met with little success.

Surface tension is a measure of contracting tendency of a liquid, and is defined as the force in Newton's acting at right angles along the surface of a liquid one meter in length. It is expressed in Nm^{-1} or dynes cm^{-1} and is dented by γ (gamma).

Example: Liquids drops form spherical shape due to surface tension. Every liquid tend to minimize its surface area and since a sphere has the smallest surface area for a given volume, so a tiny drop of liquid would assume a spherical shape.

Intermolecular forces and properties of water

The rise or fall of liquid levels in a container depends on the interactions between the liquid surface and the walls of the container. If the intermolecular forces between liquid molecules are weaker than the forces between the liquid and the solid surface, the liquid will rise and wet the solid surface. If the solid-liquid interactions are weaker than the intermolecular forces in the liquid, its level will fall and the liquid will not wet the solid surface.

When two immiscible or partially miscible liquids A and B are in contact, then the force operative at the surface of separation between the two liquids is called the **interfacial tension** and is denoted by $\gamma_{a(b)}$

.There are many methods which can be employed for the measurement of surface tension. Two of the commonly used methods are (a) capillary rise method, and (b) the drop weight method.

Surface tension decreases with increase of temperature and vanishes at the critical temperature.

Parachor is defined as the molar volume of a liquid at a temperature where its surface tension is unity. It is an additive and constitutive property and is used to get information about the structures of compounds.

$$[P] = \frac{M}{D}\gamma^{1/4}$$

The degree of polarity of a molecule can be expressed in terms of **dipole moment.** It is the product of magnitude of charge and the distance between them and expressed as

$$\mu = q \times r$$

Two methods normally used to determine dipole moment are:

The vapour temperature method, and

The refractometric method

Units:The unit of dipole moment is Debye.

$$1\ D = 10^{-18}\ esu.cm$$

Dipole moment gives the information about the geometry and shapes of molecules. The measurement of dipole moments also gives an idea about the extent of polar character of a chemical bond.

Electrical polarization

Under the influence of an electric field, the electrons are attracted towards positive plate and the positive nuclei towards negative plate. Under these conditions, there will be an electrical distortion of the molecule to form an electric dipole. Such a distortion is called electrical polarization or distortion polarization of the molecule.

Solid state of matter

In solid state, the constituent atoms, molecules, or ions have no translatory motion although they vibrate about the fixed positions, which they occupy in a crystal lattice.

Characteristics: The solids are characterized by their definite shape and volume and also their considerable mechanical strength and rigidity.

The rigidity of solids is due to the absence of translatory motion of structural units (atoms, ions or molecules) of solids.

In **crystalline solids**, the structural units (atoms, ions et(c)) are arranged in a definite pattern giving a definite geometrical configuration. They posses sharp melting points. **Amorphous solids** are the substances which have no regular internal structure. Amorphous solids do not have sharp melting points.

Isotropic substances have the same value for any property in all directions.

Anisotropic substances have different value of a property in different directions.

Crystal is defined as a homogeneous portion of a solid substance in which the atoms or ions are packed closely together in such a way that the total potential energy is at a minimum.

Crystal lattice or space lattice is defined as a highly ordered three dimensional structure formed by atoms, ions or molecules.

Unit cell is the smallest building unit of the crystal. A unit cell in three- dimensional lattice is characterized by definite lengths and angles between them. The simplest unit cell having the lattice points at the corners is called a **simple or primitive unit cell**. The unit cell, when it contains more than one lattice point is called a non-primitive or muitiple unit cells.

Bravais showed that there are 14 different unit cells to account for the lattice points at the corners of the unit cell as well as those at the centers and some of the faces. These 14 unit cells or space lattices are known as **Bravais lattices.**

Crystallography is the branch of science which study the geometry, structure and related properties of crystals and crystalline substances is called Crystallography

Law of constancy of interfacial angles This law states that for a given substance the corresponding faces or planes forming the external surface of a crystal always intersect at a definite angle and that this angle remains constant no matter how the faces develop.

Law of rationality of indices: This law states that the ratio between the intercepts on the axes for the different faces of a crystal can always be expressed by rational numbers.

Function of goniometer

It is an instrument which is used for measuring interfacial angle.

X-ray diffraction (XRD): X-ray diffraction (XRD) is an analytical technique primarily used for phase identification of a material and provide information about unit cell dimensions as well as average bulk composition.

X-rays are electromagnetic radiations of short wave-length of the order of 0.1 nm. This wavelength is comparable with the spacings of the atoms in the crystals.

Bragg's equation

The Bragg's equation is

$$2d \sin\theta = n\lambda$$

This equation forms the basis of X-rays crystallography, and connects wavelength (λ) of X-rays, spacings between successive lattice points (d) and the angle () of maximum reflection.

MULTIPLE CHOICE QUESTIONS

1. The most important characteristic of a crystalline solid is
   (a) geometrical distribution of atoms/molecules/ions (b)definite shape

(c) definite volume (d) resistance offered to change of shape

2. The intrinsic viscosity is related to the molecular weight (M) by the relation (k and α are constants)
   (a) $\eta_{int} = kM^{\alpha}$ (b) $\eta_{int}/M = K^{\alpha}$
   (c) $\eta_{int} = kM\, e^{\alpha}$ (d) $\eta_{int} = Ke^{\alpha}M$
3. Molecular mass of a given polymer is determined by measuring is
   (a) pH value
   (b) Viscosity
   (c) Conductivity
   (d) all above
4. Sodium chloride crystallizes in an face lattice. The number of atoms in the unit cell is
   (a) 2 (b) 4
   (c) 6 (d) 8
5. A non-linear triatomic molecule has vibrational degrees of freedom
   (a) 3N – 6 (b) 3N – 5
   (c) 2N – 6 (d) N – 6
6. Which of the following are the laws of crystallography?
   (a) the law of constancy of interfacial angle
   (b) the law of rational indices
   (c) the law of symmetry
   (d) all of the above
7. The total number of possible crystal forms is
   (a) 230 (b) 150
   (c) 350 (d) 400
8. Under what conditions the real gases behave ideally
   (a) at low pressure and fairly high temperature,
   (b) at low temperature and high pressure
   (c) high temperature and high pressure
   (d) low temperature and low pressure
9. According to Gay Lussac Law "if the volume of a gas is maintained constant and its temperature is raised the pressure will
   (a) be constant (b) remain same
   (c) decrease (d) increase
10. Copper metal can be drawn into wires because
    (a) Copper atoms are held by covalent bonds
    (b) copper has unique configuration
    (c) copper has a variable valency
    (d) copper atoms are held together by non directional bon(d)
11. At a temperature absolute zero, an intrinsic semi conductor is
    (a) an insulator (b) a *p-type* semi conductor
    (c) an *n-type* semiconductor (d) a conductor
12. Rate of diffusion of a gas is
    (a) directly proportional to its density
    (b) directly proportional to its molecular mass

(c) directly proportional to square root of its molecular mass
(d) inversely proportional to square root of its molecular mass

13. For a given mass of a gas at constant temperature, if the volume "V" becomes three times, then pressure p will become
(a) 3 P (b) P/3
(c) 3 P/T (d) $9P^2$

14. According to the kinetic theory of gases, for a diatomic molecule
(a) pressure exerted by the gas is proportional to the mean velocity of the molecule
(b) pressure exerted by the gas is proportional to the root mean velocity of the molecule
(c) the mean translational kinetic energy of the molecule is proportional to the absolute temperature.
(d) the root mean square velocity of the molecule is inversely proportional to the temperature

15. The law that equal volumes of all the gases at the same temperature and pressure contain equal number of molecules is called
(a) General Gas law (b) Avogadro's law
(c) Boyle's law (d) Graham's law

16. According to kinetic molecular theory, kinetic energy of molecules increases when they are
(a) mixed with other molecules at low temperature. (b) frozen into a solid
(c) melted from solid to liquid state (d) condensed into a liquid

17. Which of the following is not a correct postulate of the kinetic theory of gases?
(a) The gas molecules are in random motion.
(b) The gaseous collisions are perfectly elastic
(c) The average kinetic energies of different gases are equal at a particular temperature.
(d) The pressure exerted on the walls of the container is due to the intermolecular forces.

18. The gases H_2, N_2, O_2 and NH_3 having molar masses 2, 28, 32 and 17 respectively will effuse in the order
(a) $H_2 > N_2 > O_2 > NH_3$ (b) $H_2 > N_2 > NH_3 > O_2$
(c) $NH_3 > O_2 > N_2 > H_2$ (d) $H_2 > NH_3 > N_2 > O_2$

19. At constant volume, for a fixed number of moles of a gas, the pressure of a gas increases with rise in temperature due to
(a) Decrease in mean free path.
(b) Increased rate of collision amongst molecules
(c) Increase in molecular attraction
(d) Increase in average molecular speed

20. What law correlates the volumes and temperature of gas?
(a) Gay Lussca's law (b) Charle's law
(c) Boyles law (d) Graham's law

21. For a given mass of a gas, if pressure is reduced to half and temperature is doubled, then volume *V* will become
(a) 3*V* (b) $2V^2$
(c) *V*/4 (d) 4*V*

22. According to kinetic molecular theory of gases, the average kinetic energy
(a) is proportional to temperature
(b) high temperature and low pressure

(c) is always constant for a particular gas
(d) is zero at 0°C

23. The molecular speed of a gas is
(a) independent of temperature
(b) proportional to absolute temperature
(c) proportional to square root of temperature
(d) proportional to square root of absolute temperature

24. One mole of any gas at STP occupies volume in dm^3
(a) 20.4 (b) 22.4
(c) 30.2 (d) 32.4

25. Which of the following statements is not correct regarding the constant R in the ideal gas equation *PV*= nRT?
(a) Its value is independent of temperature or pressure
(b) Its value is independent of the nature of a gas.
(c) It is called the universal gas constant.
(d) In SI units its value is 8.314 $JK^{-1}mole^{-1}$.

26. Which of the following expressions represent the most prabable velocity?
(a) $\sqrt{3RT/M}$ (b) $\sqrt{3RT/V}$
(c) $\sqrt{2RT/M}$ (d) $\sqrt{8RT/M}$

27. The total pressure exerted by a mixture of gases is sum of the partial pressure of all the gases present is the statement of
(a) Gay lussac's law (b) Avogadro's law
(c) Dalton's law of partial pressure (d) Charles law

28. Poise is a unit of
(a) Refractive index
(b) Optical activity
(c) Fluidity
(d) Viscosity

29. The rate of diffusion of two gases is inversely proportional to the square roots of their densities or molecular weight at the same pressure and temperature is called
(a) Graham's law (b) Dalton's law
(c) Avogadro's law (d) Boyel,s law

30. Which of the following factor has no effect on boiling point?
(a) Impurities in the liquid (b) amount of liquid
(c) Intermolecular forces p. pressure

31. The force in Newton's acting at right angle on a unit length (1m) along the surface of a liquid is known as
(a) vapour pressure (b) surface tension
(c) capillary action (d) viscosity

32. Which of the following contains maximum number of molecules?
(a) 4 g hydrogen (b) 90 g glucose
(c) 22 g carbon dioxide (d) 16 g oxygen

33. The rate of diffusion of methane at a given temperature is twice as that of a gas X. The molecular weight of the X is
(a) 64 (b) 32
(c) 4 (d) 8

34. If we plot dNc/N (fraction of the total number of molecules) against velocity, C at different temperature, it is seen that the values of C_{mp}, C_{av} and C_{rms}
(a) constant (b) increases
(c) decreases (d) same.

35. Which of the following expressions represent the root mean square velocity?
(a) $\sqrt{3RT/M}$ (b) $\sqrt{3RT/V}$
(c) $\sqrt{2RT/M}$ (d) $\sqrt{8RT/M}$

36. If Cp is the heat capacity at constant pressure and Cv is the heat capacity at constant volume, then for noble gases Cp/Cv is
(a) 2.33 (b) 1
(c) 1.67 (d) 1.33

37. The increase in kinetic energy of 1 mole of an ideal gas at temperature T is given by
(a) 3/2 RT (b) 1/2RT
(c) 5/2 RT (d) 7/2RT

38. The number of collisions made by a single molecule with the other molecules present in one cubic meter of a pure gas, per second is called
(a) collision frequency (b) collision diameter
(c) grazing collision (d) right angle collision

39. Gases deviate from ideal behavior because their molecules
(a) possess negligible volume
(b) have forces of attraction between them
(c) are polyatomic
(d) are not attracted to one another

40. At constant temperature volume of given mass of a gas is inversely proportional to pressure exerted on it is called
(a) General Gas law (b) Charles law
(c) Boyle's law (d) None of the above

41. The temperature of a gas below which only the gas cools when allowed to expand is known as
(a) critical temperature (b) ideal temperature
(c) Joule Thomson effect (d) inversion temperature

42. The spontaneous change in which a liquid changes into the vapour state at the surface is known as
(a) vapour pressure (b) evaporation
(c) boiling point (d) freezing pint

43. The correct representation of van der Waal,s equation is
(a) $PV = RT$ (b) $(P + a/V^2)(V - b) = RT$
(c) $(P - a/V^2)(V - b) = RT$ (d) $(P + a/V^2)(V + b) = RT$

44. In Vander Waal,s equation of state for a non ideal gas, the term that accounts for intermolecular force is
(a) $(V - b)$ (b) RT
(c) $(P + a/V^2)$ (d) V

45. Evaporation is accelerated by
(a) cooling (b) heating
(c) adding more liquid (d) All above

46. Vander Waal,s equation reduces itself to ideal gas equation at
(a) high pressure and low temperature
(b) high pressure and high temperature
(c) low pressure and high temperature
(d) low pressure and low temperature

47. The vapor pressure of a liquid depends on
(a) nature of the liquid molecule
(b) magnitude of the intermolecular forces
(c) both nature and intermolecular forces
(d) all above factors

48. The rising of liquids in the capillary tubes is due to what?
(a) osmosis (b) surface tension
(c) viscosity (d) refractive index

49. The temperature at which the vapour pressure of a liquid becomes equal to the external atmospheric pressure (i.e., 1atm) is called as
(a) vapour pressure (b) boiling point
(c) evaporation (d) surface tension

50. The units of surface tension in the SI system are
(a) dynes per cm (b) $N\,m^2$
(c) Nm^{-1} (d) Nm

51. If n and ρ are the refractive index and density of the liquid and M molar mass, then molar refraction is defined as
(a) $R_m = m/d \,.\, n^2 - 1/m^2 + 2$ (b) $R_m = m/d \,.\, n^2 - 1/n^2 + 2$
(c) $R_m - m/d \,.\, n^2 - 1/n^2 - 2$ (d) $R_m = 1/md \,.\, n^2 - 1/n^2 + 2$

52. In the drop-number method, if we take two liquids whose surface tensions are γ_1 and γ_2, number of drops n_1 and n_2, and densities ρ_1 and ρ_2, then?
(a) $\gamma_1/\gamma_2 = \rho_2 n_2/\rho_1 n_1$ (b) $\gamma_1/\gamma_2 = \rho_2 n_1/\rho_1 n_2$
(c) $\gamma_1/\gamma_2 = \rho_1 n_2/\rho_2 n_1$ (d) $\gamma_1/\gamma_2 = \rho_1 n_1/\rho_2 n_2$

53. The rotation of plane polarized light when it passes through 1dm of a solution containing 1g of substances per cm^3 of the solution is called
(a) specific refraction (b) specific rotation
(c) molar refraction (d) rheochor

54. A real gas obeying the Vander Waals equation will closely resemble an ideal gas if
(a) the parameters *a* and *b* are small
(b) *a* is large but *b* is small

(c) *a* is small but *b* is large
(d) both *a* and *b* are large

55. Which one of the following is not the characteristic of a real gas?
(a) The molecules attract each other.
(b) The mass of the molecules is negligible.
(c) It shows deviation from ideal gas laws.
(d) All the above

56. Liquids diffuse slowly as compared to gases because
(a) liquids have no fixed shape
(b) the molecules of liquids are heavy
(c) the mean free path of the molecules of liquids is very short
(d) the molecules are held together by strong intermolecular forces

57. An ideal gas is one which obeys all the gas laws at
(a) all conditions of temperature and pressure
(b) high temperature and low pressure
(c) low temperature and high pressure
(d) low pressure and less volume

58. Mechanism of polarization due to stretching or bending of the bonds in the polar molecules is known as
(a) electronic polarization (b) orientation polarization
(c) induced polarization (d) atomic polarization

59. Which one of the following is an additive property?
(a) optical activity (b) osmotic pressure
(c) molecular weight (d) depression in freezing point

60. Empirically, it has been seen, if the Reynold' s number is greater than 4000 , then the flow is
(a) turbulent b Newtonian
c laminar (d) non-turbulent

61. Atoms, molecules or ions arranged at random and lack the ordered crystalline lattice and do not exhibit sharp melting point are
(a) crystalline solid (b) amphorous solid
(c) crystal lattice (d) semi-liquids

62. The ratio among the most probable velocity, mean velocity and root mean square velocity is
(a) 0.8 : 0.92 : 1.00 (b) 0.8 : 0.62 : 1.00
(c) 0.8 : 0.92 : 2.00 (d) 0.8 : 0.72 : 1.00

63. Two gases A and B have molecular weights of 144 and 64 respectively. Their rates of diffusion. will be in the ration of
(a) 144 : 64 (b) 64 : 44
(c) 8 : 12 (d) 12 : 8

64. A pressure cooker works on the principles that with the increase in pressure the boiling point of a liquid
(a) decreases (b) increases
(c) remains constant (d) first increases then decreases

65. Among the unit cells given below, which has the highest symmetry
(a) Monoclinic
(b) Cubic
(c) Hexagonal

(d) Orthorhombic

66. The phenomenon of x-ray diffraction was studied by
(a) Huygen (b) Bragg
(c) Max Planar (d) Becquerel

67. The over all arrangement of particles in a crystal is called
(a) crystal lattice (b) space lattice
(c) both a & b (d) Bragg's lattice

68. Stalagmometer is used to measure
(a) the resistance to flow of a liquid
(b) capillary action of a liquid
(c) refractive index of the liquid
(d) surface tension of the liquid

69. The smallest volume of a crystal showing all the characteristics of its lattice is called
(a) lattice site (b) lattice points
(c) unit cell (d) a & b

70. The crystal system is of
(a) 7 types (b) 10type
(c) 5type (d) 8type

71. The system in which all three axes are angled and unequal is called
(a) Monoclinic (b) Hexagonal
(c) Triclinic (d) Orthorhombic

72. Many ionic crystals dissolve in water because
(a) water is an amphiprotic solvent
(b) water is a high boiling liquid
(c) the process is accompanied by heat evolution
(d) water decreases the interionic attraction in the crystal lattice due to solvent

73. A unit cell having dimensions, $a = b = c$; $\alpha = \beta = \gamma = 90^\circ$ is known as
(a) Cubic
(b) Hexagonal
(c) Orthorhombic
(d) Tetragonal

74. Super conductors are generally
(a) metals (b) non- metals
(c) alloys and metal oxide (d) silicates

75. Octahedral holes are one
(a) in which sphere are packet together in one plane
(b) in which sphere are packet together in one plane and fourth sphere is placed above
(c) in which it is surrounded by six spheres
(d) in which it is surrounded by eight sphere

76. Which type of the solids are generally good conductors of electricity?
(a) Covalent (b) Ionic
(c) Metallic (d) Molecular

77. A unit cell having dimensions, $a = b \neq c$, $\alpha = \beta = 90°$, $\gamma = 120°$ is known as
(a) Hexagonal (b) Monoclinic
(c) Trigonal (d) Cubic

78. Which of the following has hexagonal structure?
(a) Sodium chloride
(b) Potassium chloride
(c) Diamond
(d) Graphite

79. Which of the following is not a characteristic of solids?
(a) Definite shape
(b) Definite mass
(c) Definite volume
(d) Fluidity

80. The crystallographers have been able to divide ———— point groups and ———— Bravais lattices into seven crystal system
(a) 32, 43 (b) 31, 14
(c) 32, 14 (d) 43, 14

81. The structure of graphite is called
(a) trigonal (b) hexagonal
(c) octahedral (d) tetragonal

82. The particle motion in solids is
(a) Only vibratory
(b) Only translatory
(c) vibratory and rotatory
(d) Vibratory and translatory

83. Instrument used for measuring the interfacial angle is known as
(a) goniometer (b) parthenometer
(c) potentiometer (d) reflectometer

84. How many vibrational degrees of freedom a linear diatomic molecule has
(a) 3N – 6 (b) 3N – 5
(c) 2N – 6 (d) N – 6

85. Which of the following statement is true regarding Maxwell law of distribution of velocities?
(a) At constant temperature, velocities of all gas molecules are same
(b) Fraction of molecules with higher velocities increase with rise in temperature
(c) Fraction of molecules with higher velocities decrease with rise in temperature
(d) There will be no change in the distribution of velocities on changing temperature.

86. A p- type semi-conductor
(a) possesses electric dipole
(b) possesses conductance near to metals
(c) possesses conductance due to the movement of excess electrons
(d) possesses conductance due to the movement of excess positively charged holes.

87. Intercepts of crystal planes on three suitably chosen axes, set in the crystal, can be expressed as integral multiples of three basic unit cell dimensions belong to which law
(a) The law of symmetry (b) Hany's law
(c) Bragg's law (d) law of symmetry

88. The structure of diamond is called
(a) cubic (b) tetragonal
(c) orthorhombic (d) monoclinic

89. The coordination number for a body-centered cubic lattice is
(a) 8 (b) 10
(c) 12 (d) 16

ANSWERS

1	a	2	a	3	b	4	b	5	a	6	d	7	a
8	a	9	d	10	d	11	a	12	d	13	b	14	c
15	b	16	c	17	d	18	d	19	a	20	a	21	d
22	a	23	c	24	B	25	D	26	C	27	C	28	D
29	A	30	B	31	B	32	A	33	A	34	B	35	A
36	C	37	A	38	A	39	B	40	C	41	D	42	B
43	h	44	C	45	B	46	C	47	b	48	B	49	B
50	C	51	B	52	c	53	B	54	A	55	B	56	C
57	A	58	D	59	A	60	A	61	B	62	A	63	C
64	B	65	B	66	B	67	C	68	D	69	C	70	A
71	B	72	D	73	A	74	C	75	C	76	C	77	A
78	D	79	D	80	C	81	B	82	A	83	A	84	b
85	C	86	D	87	B	88	A	89	a				

14. CHEMICAL THERMODYNAMICS

Chemical thermodynamics is the study of general laws governing processes which involve heat changes and the conservation of energy. It can predict whether a given process will occur spontaneously or not under a given set of conditions. A **system** is that part of the universe which is under thermodynamic study and the rest of the universe is called its **surroundings**. Both are separated by a real or an imaginary suface called boundary.

A system which can exchange both matter and energy with the surroundings is known as **open system**. A system which can exchange energy but not matter with the surroundings is called a **closed system**, while a system which can neither exchange matter nor energy with the surroundings is called an **isolated system**.

Thermochemistry is the branch of physical chemistry that deals with the heat changes accompanying various physical and chemical transformations.

Extensive properties are those properties of a system whose magnitudes depend on the amount of matter present in the system. Mass, volume, internal energy and free energy are examples of extensive properties.

Intensive properties are the properties whose magnitudes do not depend on the quantity of matter present in the system are called intensive properties. For example, surface tension, refractive index, temperature etc.

Thermodynamic process is defined as the path or process by which a system changes from one state to another. A system is said to be in **thermodynamic equilibrium** if its state variables do not change with time and space.

Type of thermodynamic processes

A process which takes place under constant temperature condition is known as **isothermal process**. A process in which no heat is exchanged between the system and surroundings is called **adiabatic process.** If the volume of the system remains constant during a thermodynamic process, then such process is called **isochoric process**. When the pressure of the system remains constant, the process is refffered as **isobaric process.**

Internal energy of a system: It is the energy possessed by a system due to translational vibrational and rotational motions of the molecules along with the electronic energy.

First law of thermodynamics states that the total energy of a system and its surroundings remains constant.

Enthalpy is the total heat content of a system is called its enthalpy. ΔH is positive for endothermic reactions and negative for exothermic reactions.

Heat capacity: The heat capacity of a system is defined as the amount of heat required to raise the temperature of the system by one degree.

Heat of reaction: It is the amount of heat evolved or absorbed when molar quantities of the reactants shown by the balanced equation react completely at a given temperature.

Heat of formation: It is the enthalpy change (ΔH) involved in the formation of 1 mole of a compound from its elements. If the elements are in their standard states, the heat of formation is called standard heat of formation or standard enthalpy of formation.

Heat of neutralization is defined as the change in heat content when one gram equivalent of an acid is neutralized by one gram equivalent of a base. It has been observed that the heat of neutralization of

any strong acid by a strong base is practically the same i.e., 57.32 kJ mol^{-1}. The neutralization reaction involves the combination of H^+ and OH^- ions to form unionized water.

Heat of combustion of a compound or element is the enthalpy change during the complete combustion of 1 mole of the substance. Heats of combustion are important from the industrial purposes to calculate the calorific value of gaseous and liquid hydrocarbons.

The heat evolved or absorbed during a chemical reaction is measured with the help of an apparatus known as **calorimeter**. The **bomb calorimeter** is used for determining the heats of combustion of organic compounds.

Spontaneous process: A process which takes place of its own without any external intervention is known as spontaneous process. For example, water flows from a higher level to the lower level.

Second law of thermodynamics

It is impossible for self acting machine to convey heat from a body at lower temperature to another at higher temperature without the expenditure of energy.

Or

The entropy of the universe remains constant in a reversible process but it increases in an irreversible process.

Thermodynamic temperature

The thermodynamic temperature is a physical quantity, which depends on the concept of temperature as a measure of thermal energy of random motion of the particles of a system in thermal equilibrium. Originally, thermodynamic temperature was defined in terms of the ice point and steam point of water using a gas thermometer. However, in 1954, this was replaced by a definition using only one fixed point, the triple point of water which was fixed as 273.16 Kelvins exactly. The magnitude of the unit of thermodynamic temperature, the Kelvin, is the same as the degree on the International practical Scale of Temperature.

Entropy

The measure of disorder or randomness in a system is called entropy.

$$dS = \frac{\delta q}{T}$$

Gibbs free energy Gibbs free energy is a measure of useful work that can be obtained from a reversible process taking place at constant pressure and temperature. Mathematically,

$$G = H - TS$$

Helmholtz free energy Helmholtz free energy or work function is a measure of maximum work that can be obtained from the process. The maximum work includes both mechanical and non-mechanical work. Mathematically,

$$A = E - TS$$

Significance of free energy: For spontaneous reaction, ΔG° is negative. If the reaction is non-spontaneous ΔG° is positive, and ΔG° is zero for the reaction at equilibrium.

Third law of thermodynamics

The entropy of a pure perfect crystal is zero at absolute zero of temperature (0° K).

MULTIPLE CHOICE QUESTIONS

1. The standard free energy change (ΔG°) is related to equilibrium constant as
   (a) $\Delta G^\circ = RT \ln K$ (b) $-\Delta G^\circ = RT \ln P$
   (c) $-\Delta G^\circ = 2.303\ RT \log K$ (d) $-\Delta G^\circ = RT/2.303 \log K$

2. In an isochoric process which factor remains constant?
(a) volume remains constant (b) pressure remains constant
(c) temperature remains constant (d) energy remains constant

3. For a reversible isothermal process in equilibrium, the entropy change is given by the expression.
(a) $\Delta S = T/q_{rev}$ (b) $\Delta S = q_{rev}/T$
(c) $\Delta S = \Delta V/T$ (d) $\Delta S = \Delta E/T$

4. Which of the following has highest entropy?
(a) 10 g of ice at – 100°C (b) 10 g of water 0 °C
(c) 10 g of water at 100°C (d) 10 g of steam at 100°C

5. During the reversible expansion of an ideal gas from volume V_1 to V_2, at constant temperature T, the work done on the gas is
(a) $-nRT \ln V_2/V_1$ (b) $nRT/2.303 \log V_1/V_2$
(c) $-nR/T \ln V_1/V_2$ (d) $-nRT(V_2-V_1)$

6. The Helmholtz free energy A of any system is defined as
(a) A= U+TS (b) A= U–TS
(c) A= U–PV (d) A= H–TS

7. The entropy of the universe
(a) tends towards a maximum (b) tends towards a minimum
(c) tends to be a zero (d) remains constant

8. The relationship between ΔH and ΔE is
(a) $\Delta E = \Delta H + P\Delta V$ (b) $\Delta H = \Delta E + P\Delta V$
(c) $\Delta H = \Delta E - P\Delta V$ (d) $\Delta E = \Delta G - P\Delta V$

9. All the naturally occurring processes proceed spontaneously in a direction which leads to
(a) decreases of entropy (b) increase of enthalpy
(c) increase of free energy (d) decrease of free energy

10. At constant temperature, the decrease in Helmholtz free energy is equal to the
(a) reversible work done by the system
(b) decrease in entropy
(c) total work done minus pressure volume work in a reversible manner
(d) irreversible work done by the system

11. When ice melts into water, entropy
(a) becomes zero (b) decreases
(c) increases (d) remains same

12. At constant P and T the change in Gibbs free energy (ΔG) may be expressed as
(a) $\Delta G = \Delta H - T\Delta S$ (b) $\Delta G = \Delta H + T\Delta S$
(c) $\Delta G = \Delta U - T\Delta S$ (d) $\Delta G = \Delta H - \Delta U + PV$

13. During the isothermal expansion of an ideal gas, its
(a) internal energy increases (b) enthalpy decrease
(c) enthalpy remains constant (d) enthalpy reduces to zero

14. The chemical composition of the system must be uniform and must remain constant throughout the system is said to be in which state
(a) chemical equilibrium (b) mechanical equilibrium
(c) thermal equilibrium (d) simple equilibrium

15. When a system reaches equilibrium
(a) ΔG will be a minimum (b) ΔS will be a minimum
(c) ΔG will be equal to zero (d) ΔE will be a minimum

16. A system which can exchange matter as well as energy with its surroundings is said to be an
(a) isolated system (b) open system
(c) inert system (d) closed system

17. At constant P and T, the criterion of spontaneity is
(a) $dG > 0$ (b) $dA < 0$
(c) $dA > 0$ (d) $dG < 0$

18. In an adiabatic expansion of an ideal gas in vacuum
(a) H = 0 (b) U = 0
(c) H = U (d) H = U+RT

19. The relation ship between the Gibbs free energy (G) and Helmholtz free energy is
(a) G = A–TS (b) G = A+H–PV
(c) G = A + PV (d) A = G–TS

20. Any property whose magnitude is independent of the amount of substance present is called an
(a) colligative property (b) intensive property
(c) extensive property (d) structural property.

21. If heat absorbed by the system is q, work done on the system is w, and change in internal energy is U, then the first law of thermodynamics may be expressed as
(a) U+ q + w = 0 (b) U = q + w
(c) F–U = w (d) U = q/w

22. A closed system is one which can exchange, with surroundings
(a) matter as well as energy (b) matter but not energy
(c) energy but not matter (d) neither energy nor matter

23. Which of the following is not true of the statements of the second law of thermodynamics?
(a) The entropy of the universe is always increasing
(b) It is impossible to transfer heat from a heat source to a hotter body without doing some work
(c) It is not possible to construct a perpetual motion machine which can work endlessly without the expenditure of energy
(d) It is not possible to take heat from a source and convert all of it into work without losing some of it to a colder reservoir.

24. When a system in a given state goes through a number of different process and finally returns to its initial state, the overall process is called
(a) isobaric process (b) isochoric process
(c) cyclic process (d) adiabatic process

25. Which of the following are the state functions?
(a) pressure (b) temperature (c) internal energy (d) all above

26. The overall energy change during Carnot cycle is
(a) equal to w (b) zero
(c) maximum (d) equal to q

27. A process in which no heat enters or leaves the system is called
(a) isothermal (b) isobaric
(c) adiabatic (d) isochoric

28. At equilibrium the free energy change (ΔF) for a reaction is
(a) Maximum (b) Minimum
(c) Zero (d) Infinite

29. The occurrence of a reaction is impossible if
(a) ΔH is +ve; ΔS is also +ve (b) ΔH is +ve; ΔS is also –ve
(c) ΔH is –ve; ΔS is also +ve (d) ΔH is +ve; ΔS is –ve

30. The condensation of any gas to a liquid is expected to have
(a) A positive ΔH and a negative ΔS
(b) A negative ΔH and a positive ΔS
(c) A negative ΔH and a negative ΔS
(d) A positive ΔH and a positive ΔS

31. A closed system is one which can exchange, with surroundings
(a) Energy but not matter
(b) Matter but not energy
(c) Both matter and energy
(d) Neither matter nor energy

32. ΔH and ΔE are related as
(a) $\Delta H = \Delta E + \Delta T$
(b) $\Delta E = \Delta H + P\Delta F$
(c) $\Delta H = \Delta E - P\Delta S$
(d) $\Delta H = \Delta E + P\Delta V$

33. Any property whose magnitude is independent of the amount of substance present is called a/an
(a) Extensive property
(b) Colligative property
(c) Intensive property
(d) Structural property

34. Which of the following is not an extensive property?
(a) Entropy (b) Work
(c) Free energy (d) Volume

35. Which of the following statements is not related with entropy?
(a) It is a path function
(b) It is a measure of unavailable energy
(c) It is a function of thermodynamic probability
(d) It is a measure of disorder

36. Which of the following statements is not related to applications and limitations of first law of thermodynamics?
(a) It does not tell us about the reversible process
(b) It is silent about the source of heat
(c) It is silent about the direction of heat
(d) This law explains why chemical reactions proceed to completion

37. Which of the following does not represents the criterion of spontaneity of a reaction?
(a) $\Delta F \leq 0$ (at constant T and P)
(b) $\Delta S \leq 0$ (at constant V and E)
(c) $\Delta E \leq 0$ (at constant S and V)

(d) $\Delta H \leq 0$ (at constant S and P)

38. Which of the following is not an intensive property?
(a) Melting point
(b) Entropy
(c) Specific gravity
(d) Refractive index

39. Which of the following enthalpies is always negative?
(a) Enthalpy of combustion
(b) Enthalpy of melting
(c) Enthalpy of solution
(d) Enthalpy of formation

40. The entropy of the universe
(a) Tends towards a minimum
(b) Tend towards a maximum
(c) Tends to be zero
(d) Remains constant

41. The entropy change accompanying any physical or chemical transformation approaches zero as T approaches zero. This statement refers to
(a) Second law of thermodynamics
(b) Third law of thermodynamics
(c) Nernst heat theorem
(d) Helmholtz law

42. If P_1, T_1 represent the initial state and P_2, T_2 the final state of an ideal gas, then entropy change may be expressed as
(a) $\Delta S = C_p \ln \frac{T_2}{T_1} + R \ln \frac{P_2}{P_1}$
(b) $\Delta S = C_v \ln \frac{T_2}{T_1} + R \ln \frac{P_2}{P_1}$
(c) $\Delta S = C_p \ln \frac{T_1}{T_2} + R \ln \frac{P_1}{P_2}$
(d) $\Delta S = C_p \ln \frac{T_2}{T_1} + R \ln \frac{P_1}{P_2}$

43. A process in which no heat enters or leaves the system is called
(a) Isochoric (b) Isobaric
(c) Reversible (d) Irreversible

44. How would you express the absolute temperature at which a reaction occurs in terms of free energy change of the reaction, enthalpy change and entropy change
(a) $\frac{\Delta H - \Delta F}{\Delta S}$
(b) $\frac{\Delta H - \Delta S}{\Delta F}$
(c) $\frac{\Delta F - \Delta H}{\Delta S}$

(d) $\Delta H - \Delta F + \Delta S$

45. Which of the following is the statement of third law of thermodynamics?
(a) Entropy and enthalpy of a substance become equal at T = 0
(b) Entropy of a perfectly crystalline substance is zero at standard state conditions
(c) Entropy of perfectly crystalline substance is zero at T = 0
(d) Free energy of a crystalline substance is zero at T = 0

46. In an isochoric process
(a) Volume remains constant
(b) Energy remains constant
(c) Pressure remains constant
(d) Temperature remains constant

47. Which of the following causes decrease in entropy?
(a) Precipitation of sucrose from water
(b) Conversion of ice into water
(c) Vaporisation of camphor
(d) Rusting of iron

48. At constant T and P, the change in Gibbs free energy is represented by
(a) $\Delta F = \Delta A + T\Delta S$
(b) $\Delta F = \Delta H - T\Delta S$
(c) $\Delta F = \Delta A - T\Delta S$
(d) $\Delta F = \Delta H - T\Delta S$

49. The heat flow of a system under isochoric conditions is a direct measurement of
(a) ΔS (b) ΔE
(c) ΔH (d) ΔF

50. Which of the following statements is not correct with respect to second law of thermodynamics?
(a) It helps in determining the direction of energy transfer
(b) It helps to know the position of chemical equilibrium
(c) It defines entropy
(d) It is based on Nerst heat theorem

51. For the expression $dF = Vdp - sdt$, which of the following is correct
(a) $\left(\frac{\partial F}{\partial P}\right)_T = V$ (b) $\left(\frac{\partial F}{\partial T}\right)_P = V$
(c) $\left(\frac{\partial F}{\partial T}\right)_S = V$ (d) $\left(\frac{\partial F}{\partial P}\right)_T = -S$

52. Which of the following expression is correct regarding entropy change of a reversible process?
(a) $\Delta S > 0$ (b) $\Delta S < 0$
(c) $\Delta S = 0$ (d) $\Delta S = 1$

53. If n_1 and n_2 represent moles of two components and μ_1 and μ_2 their chemical potentials, respectively, then Gibbs-Duhem equation for this binary system is written as
(a) $n_1 du_1 + n_2 du_2 = 0$
(b) $n_1 du_2 = n_2 du_1 = 0$
(c) $n_1 du_1 + n_2 du_2 > 0$
(d) $n_1 du_1 - n_2 du_2 = 0$

54. A process will be non-spontaneous when
(a) ΔH^O is positive and ΔS^O is positive
(b) ΔH^O is positive and ΔS^O is negative
(c) ΔH^O is negative and ΔS^O is negative
(d) ΔH^O is negative and ΔS^O positive

55. All naturally occurring processes processed spontaneously in a direction leads to
(a) Decrease in free energy (b) Increase of entropy
(c) Decrease of entropy (d) Increase in temperature

56. Which of the following is always true for the adiabatic expansion of a gas?
(a) Temperature rises (b) $\Delta E = 0$
(c) $W = 0$ (d) $Q = 0$

57. At constant temperature and pressure, the decrease in Gibbs free energy (F) is equal to
(a) Increase in entropy (b) Decrease in entropy
(c) Reversible work done by the system
(d) All types of work except the work of expansion

58. Which law of thermodynamics helps in calculating the absolute entropics of varies substances?
(a) Ist law (b) Second law
(c) Third law (d) Zeroth law

59. Which of the following expression represent the chemical potential or partial molar free energy?
(a) $\bar{V}_j = \left(\frac{\partial V}{\partial n_i}\right)_{T,P,n_1,n_2}$
(b) $\bar{E}_j = \left(\frac{\partial E}{\partial n_i}\right)_{T,P,n_1,n_2}$
(c) $H_j = \left(\frac{\partial H}{\partial n_i}\right)_{T,P,n_1,n_2}$
(d) $\bar{F}_j = \left(\frac{\partial F}{\partial n_i}\right)_{T,P,n_1,n_2}$

60. In an adiabatic system, if work is done, the temperature must
(a) Decrease (b) Increase
(c) Remain the same (d) Increases then decreases

61. The change of chemical potential of any component with temperature, at constant P and composition, is equal to
(a) Negative of the partial molar entropy (b) Partial molar volume
(c) Partial molar free energy (d) Partial molar enthalpy of that component

62. The Gibbs-Helmholtz equation may be expressed as
(a) $\Delta H = \Delta F + T\left(\frac{\partial(\Delta F)}{\partial T}\right)_P$
(b) $\Delta F = \Delta H - T\left(\frac{\partial \Delta F}{\partial T}\right)_P$
(c) $\Delta F = \Delta E + T\left(\frac{\partial AF}{\partial T}\right)_P$

(d) $\Delta F = \Delta H + T\left(\frac{\partial \Delta F}{\partial T}\right)_P$

63. Which of the following expressions describes the exact relationship between standard free energy and equilibrium constant?

(a) $\Delta F^O = -RT \ln K$
(b) $\Delta F = RT \ln K$
(c) $\Delta F = \Delta H - TAS$
(d) $\Delta F = nRT \ln \frac{P_2}{P_1}$

64. The chemical potential of a component *i*(having partial pressure P_i) of a mixture of ideal gases is expressed as

(a) $\mu_i^o = \mu_i + RT \ln P_i$
(b) $\mu_i = \mu_i^o + \frac{\ln P_i}{RT}$
(c) $\mu_i = \mu_i^o - RT \ln P_i$
(d) $\mu_i = \mu_i^o + \ln P_i$

65. The statement that heat cannot flow spontaneously from a colder to a hotter body is the result of

(a) Henry's law
(b) The first law of thermodynamics
(c) The second law of thermodynamics
(d) The third law of thermodynamics

ANSWERS CHAPTER 4

1	C	2	A	3	B	4	D	5	A	6	B	7	A
8	B	9	D	10	A	11	C	12	A	13	C	14	A
15	C	16	B	17	D	18	B	19	A	20	B	21	B
22	C	23	C	24	C	25	D	26	B	27	C	28	C
29	b	30	C	31	A	32	D	33	C	34	B	35	A
36	D	37	B	38	B	39	A	40	B	41	C	42	D
43	C	44	A	45	C	46	A	47	A	48	D	49	A
50	D	51	A	52	C	53	A	54	B	55	A	56	D
57	D	58	C	59	D	60	A	61	A	62	D	63	A
64	D	65	C										

15. CHEMICAL EQUILIBRIUM

Chemical equilibrium represents a state of a system at which there is no apparent change in the observable properties (concentration, pressure, colour, density etc.) of a system under a given set of conditions.

Reversible reactions proceed in both directions (forward as well as backward.

Homogeneous and heterogeneous equilibria

In homogeneous equilibria all the components occur in only one phase, while in heterogeneous equilibria, more than one phase exist.

Law of mass action states that the rate of a chemical reaction is proportional to the active masses of the reacting substances at constant temperature.

Activity or active mass is defined as the effective concentration of a reactant

Equilibrium constant

It is defined as the ratio of the product of the molar concentration of the products to that of the reactants. Let us consider the following reversible reaction

$$A + B \rightleftharpoons C + D$$

The equilibrium constant of the above reaction can be written as

$$K_c = \frac{[C][D]}{[A][B]}$$

K_c tells about the extent to which a reaction will proceed before equilibrium is reached. It also enables to calculate equilibrium concentration if the starting concentrations are known.

Phase rule is an important generalization, dealing with heterogeneous equilibria. It predicts qualitatively the effect of temperature, pressure and concentration on poly-phase equilibria. This rule states that the number of degrees of freedom (F) of the system is related to the number of components and phases (P) present in the system at equilibrium by the equation.

$$F = C - P + 2$$

Phase: A phase is defined as a homogeneous, physically distinct and mechanically separable part of the system.

Components: The number of components of a system is the smallest number of independently variable constituents by means of which the composition of each phase can be expressed.

Degrees of freedom: The degree of freedom or variance of a system is defined as the smallest number of independent variables such as pressure, temperature and concentration that must be specified in order to define the system completely.

Univariant, bivariant and invariant

A system having one degree of freedom is called univariant. A bivariant system has two degrees of freedom and an invariant system is that which has no degree of freedom.

Phase diagrams are the graphs showing interdependence of variables. With the help of these diagrams, the coexistence of different phases in a multiphase system can be studied.

Triple point is defined as a point in the phase diagram where three phases coexist in equilibrium.

A solid solution of two or more substances with the lowest freezing point of all the possible mixtures is known as **eutectic mixture.** The minimum freezing point attainable, corresponding to the eutectic mixture, is termed the **eutectic point.**

Distribution Law: A substance solute when dissolved in two immicible solvents distributes itself between the solvents in such a way that (at equilibrium) the ratio of the concentrations of the substance in two layers is constant at any given temperature.

$$K_D = \frac{C_A}{C_B}$$

Where K_D is the distribution constant or partition coefficient and C_A and C_B are the concentrations of the substance in two media.

MULTIPLE CHOICE QUESTIONS

1. The equilibrium concentration of $2HI \rightarrow H_2+I_2$ is 0.25, the equilibrium constant for $H+I_2 \rightarrow 2HI$ is:
   (a) 1 (b) 2
   (c) 3 (d) 4
2. In the equilibrium reaction $N_2+3H_2 \rightarrow 2NH_3$ +22.9 kcal.
   The equilibrium shifts to the forward direction on
   (a) increasing the pressure and decreasing the temperature
   (b) decreasing the pressure as well as the temperature
   (c) increasing the pressure as well as the temperature
   (d) decreasing the pressure and increasing the temperature
3. According to the Le-Chatelier,s principle, the formation of NO_2 at equilibrium in the reaction $2NO + O_2 \rightarrow 2NO_2$ + heat should be favored by
   (a) high temperature, high pressure
   (b) low temperature, low pressure
   (c) low temperature, high pressure
   (d) high temperature
4. The reaction rates of many spontaneous reactions are actually very slow. Which of the following is the best explanation for this observation?
   (a) K_p for the reaction is less than one
   (b) The activation energy of the reaction is large
   (c) ΔG° for the reaction is positive
   (d) Such reaction are endothermic
5. For the equilibrium reaction $2HI \rightarrow H_2+I_2$
   (a) $K_p = K_c$ (b) $K_c = 2K_p$
   (c) $K_c > K_p$ (d) $K_c < K_p$
6. Which of the following is not correct regarding K_p, K_c and K_x?
   (a) $K_c = K_p(RT)$ (b) K_x does not have any units
   (c) $K_x = K_c(RT/P)$ (d) $K_c(RT) = K_x \cdot P$
7. Equilibrium constants K_p and K_c are related as
   (a) $K_c = K_p (RT)$ (b) $K_p = K_c (RT)$
   (c) $K_p = (K_c/RT)$ (d) $K_p - K_c = (RT)$
8. For the reaction: $2SO_2 + O_2 \rightleftharpoons 2SO_3$; $\Delta H = -198$ kJ
   The formation of SO_3 is favored by

   (a). Increase in temperature (b) Increase of pressure
   (c) Removal of oxygen (d) Increase of volume
9. Four moles of A are mixed with 4 moles of B when 2 moles of C are formed at equilibrium, according to the equation $A + B \leftrightarrow C+$ (d) The value of equilibrium constant is
   (a) ¼ (b) ½
   (c) 1 (d) 4
10. Which one of the following equilibrium shifts forward, when the pressure is decreased?
   (a) $N_2 + 2\,H_2 \rightleftharpoons 2NH_3$ (b) $H_2 + I_2 \rightleftharpoons 2HI$
   (c) $PCl_2 \rightleftharpoons PCl_3 + Cl_2$ (d) $PCl_3 + Cl_2 \rightleftharpoons PCl_5$
11. The equilibrium $SO_2Cl_2 \rightarrow SO_2+Cl_2$ is attained at 25°C in a closed container and an inert gas, helium is introduce(d) Which of the following statements is correct?
   (a) concentrations of SO_2, Cl_2 and SO_2Cl_2 change
   (b) more chlorine is formed
   (c) concentration of SO_2 is reduced
   (d) More SO_2Cl_2 is formed
12. In which of the reactions $K_p \neq K_c$?
   (a) $N_2\,(g) + O_2\,(g) \rightleftharpoons 2NO\,(g)$ (b) $H_2\,(g) + I_2\,(g) \rightleftharpoons 2\,HI\,(g)$
   (c) $PCl_3\,(g) + Cl_2\,(g) \rightleftharpoons PCl_5$ (d) $2\,NO\,(g) \rightleftharpoons N_2\,g) + O_2\,(g)$
13. The value of K for an endothermic reaction
   (a) Increases with the increase in temperature
   (b) Decreases with the increase in temperature
   (c) Is independent in temperature
   (d) Sufficient information is not available to answer the question
14. Which of the following statements is not true regarding chemical equilibrium?
   (a) At equilibrium, the concentration of all the reactants and products become stationary
   (b) The rate of the forward reaction is equal to the rate of the backward reaction
   (c) The product of the concentrations of the reactants should be equal to the product of the concentration of the products
   (d) The reaction appears to have come to a stop
15. In $2HI \rightleftharpoons H_2+ I_2$, the forward reaction is affected by change in
   (a) Catalyst (b) Pressure
   (c) Volume (d) all above
16. When a catalyst is added to a system in equilibrium the equilibrium concentration of reactants
   (a) decreases (b) increases
   (c) remains constant (d) none of the above
17. Consider the reaction: $PCl_5\,(g) \rightleftharpoons PCl_3\,(g) + Cl_2\,(g)$ in a closed container at equilibrium. At a fixed temperature, what will be the effect of adding more PCl_5 on the equilibrium concentration of $Cl_2\,(g)$?
   (a) It decreases
   (b) It increase
   (c) It remains unaffected
   (d) It cannot be predicted without the value of Kp

18. When a system is at equilibrium
(a) the concentrations of the reactants and the products become equal
(b) the rate of the backward reaction becomes very low
(c) the rate of the forward and backward reactions become equal
(d) the opposing reactions (backward and forward) stop

19. In a reversible reaction, two substances are in equilibrium. If the concentration of each one is doubled, the equilibrium constant will be
(a) Reduced to half its original value
(b) Reduced to one fourth of its original value
(c) Double
(d) Constant

20. Reactions which proceed in the forward direction and go to completion are called
(a) equilibrium reaction (b) reversible reaction
(c) irreversible reaction (d) cyclic reactions

21. According to law of mass action the rate of chemical reaction is proportional to which of the following
(a) size of the container
(b) molar concentrations of the reactant
(c) nature of the reactants
(d) temperature of the reactios

22. When the concentrations of substances are taken in molar units, then the equilibrium constant is represented by
(a) K_c (b) K_p
(c) K_f (d) Kd

23. When rate of forward reaction is equal to the rate of backward reaction then the equilibrium is called
(a) state equilibrium (b) dynamic equilibrium
(c) chemical equilibrium (d) thermal equilibrium

24. Which law states that at constant temperature, the partial pressure of a gas is directly proportional to its molar concentration in the gas phase?
(a) Henry's law (b) Charle's law
(c) Daltion's law (d) Raoult,s law

25. In which of the following reactions $K_p = K_c$?
(a) $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$
(b) $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$
(c) $N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$
(d) $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$

ANSWERS

1	D	2	A	3	C	4	C	5	A	6	D	7	B
8	B	9	C	10	C	11	A	12	C	13	A	14	B
15	B	16	A	17	D	18	C	19	C	20	C	21	B
22	A	23	B	24	A	25	c						

16. CHEMICAL KINETICS

Chemical kinetics

Chemical kinetics deals with the study of rates of chemical reactions and the mechanisms by which they occur.

Rate of a chemical reaction is defined as the change in the reactant (or product) concentration per unit time.

Rate law: It states that rate of a chemical reaction is proportional to the concentration of the reactants taking part in a chemical reaction.

Rate constant or velocity constant is defined as the rate of reaction when molar concentrations of reactants are unity. It has specific value for a particular reaction at a given temperature.

Order of a reaction is described as the number of atoms, ions or molecules whose concentration changes during a chemical reaction. It may also be defined as the some of the exponent terms present in the rate equation.

Molecularity of a reaction is defined as the number of atoms, molecules or ions taking part in the reaction as given by the balanced chemical equation.

Zero order is reffered to the reaction whose rate of reaction is independent of concentrations of reactant.

First order reactions are those where the rate of a reaction is proportional to the concentration of only one of the reactants and is independent of others, if present. **Second order** reaction are involve the rate of a reaction is directly proportional to the product of the concentrations raised to the power unity, of two different reactants.

Opposing reactions

Reactions which can proceed in farward and backward direction are called opposing reactions e.g.

$$2HI \rightleftharpoons H_2 + I_2$$

Consecutive reactions take place in more than one stage are called successive step or consecutive reactions.

Half-life is the time in which half (half of its initial value) of the reactant are converted into product. The half-life period for first order reaction is independent of initial concentration. For a second order reaction, it is inversely proportional to the first power of the initial concentrations. In general.

$$t_{½} \propto \frac{1}{a^{n-1}}$$

Where n is the order of a reaction.

Activated complex: An activated complex is an unstable arrangement of atoms which is very short lived. **Activation energy** is defined as the minimum amount of energy required by the molecules before the reaction can take place.

Photochemical reactions

Chemical reactions which are initiated by exposure to light are called photochemical reactions. They are independent of temperature, while ordinary reactions depend on the temperature. Grotthus-Draper law states that only those radiations which are absorbed by the reacting systems are effective in producing chemical change. Einstein Law of photochemical equivalence states that any atom or molecule activated by light absorbs only one quantum of light causing the reaction.

Quantum yield or efficiency. It is defined as the number of molecules of reactants consumed or product formed per quantum of light absorbed, i.e.,

$$\phi = \frac{\text{Number of molecules formed or decomposed in a given time}}{\text{Number of quanta absorbed in the same time}}$$

Chemiluminescence is defined as the emission of light by a system at ordinary temperature as a result of chemical reactions. In a sense it may be regarded as the reverse of a photochemical reaction.

Fluorescence an excited atom or molecule formed in the primary process may emit the radiation of either the same or of different frequency. The emission is either fluorescence or phosphorescence. In **fluorescence** the emitted radiation ceases mmediately when the exciting source is removed, but in **phosphorescence** it may persist for longer periods.

MULTIPLE CHOICE QUESTIONS

1. The sum of the exponents of the concentrations of reactants is called
   (a) rate of reaction (b) order of reaction
   (c) molecularity (d) rate constant
2. The half -life period of any first order reaction
   (a) is half the specific rate constant
   (b) is independent of the initial concentration
   (c) is always the same whatever the reaction
   (d) is directly proportional to the initial concentration of the reactant
3. The equation for the rate constant is given by $k = PZe^{-Ea/RT}$ a chemical reaction will proceed more rapidly if there is a decrease in
   (a) T (b) Z
   (c) Ea (d) P
4. A zero order reaction is one
   (a) in which reactants do not react
   (b) in which one of the reactants is large excess
   (c) whose rate is not affected by concentration
   (d) in which product does not form
5. The number of reactant particles which collide to form the activated complex in an elementary process
   (a) rate of reaction (b) order of reaction
   (c) molecularity (d) rate constant
6. Consider the following statements. For the second order reaction
   2A → products
   1. the unit of the rate constant in concentration $^{-1}$time $^{-1}$
   2. t ½ is directly proportional to the initial concentration
   3. the plot of 1 / concentration versus time would give a straight line.
   Of these statements
   (a) 1 & 2 correct (b) 1 & 3 correct
   (c) 2 & 3 correct (d) 1,2 & 3 correct
7. Consider the first order reaction, A→B: if the initial concentration of A is "*a*" and B zero, and at any time t the concentration of B is x, then the rate equation can be written as
   (a) $k = 1/t \ln (a-x)/a$ (b) $kt = \ln (a-x)$
   (c) $kt = \ln a/(a-x)$ (d) $k/t = \ln a/(a-x)$

8. The collision theory of bimolecular is based on the following assumption
   (a) the molecule in order to react must collide
   (b) the molecule must possess at least a certain minimum energy necessary to rearrange outer electrons
   (c) the molecules must collide with correct orientation
   (d) all the above
9. In a reaction: 2A+B→C+D The molecularity of a reaction is:
   (a) 2 (b) 0
   (c) 3 (d) 1
10. Which one of the following statements regarding catalysts is not true
    (a) a catalyst remains unchanged at the end of the reaction
    (b) a catalyst can initiate a reaction
    (c) a catalyst does not alter the equilibrium in a reversible reaction
    (d) catalysts are sometimes very specific in terms of reactions
11. The change of concentration of reactants and products in a unit time is called
    (a) rate of reaction (b) order of reaction
    (c) molecularity (d) equilibrium constant
12. Of doubling the concentration of A increases the rate 4 times and tripling the concentration of A increases the rate 9 times, the order of reaction is:
    (a) 0 (b) 1
    (c) 2 (d) 1/2
13. A catalyst increase the rate of a chemical reaction by
    (a) increasing the activation energy (b) decreasing the activation energy
    (c) reacting with reactants (d) reacting with products
14. For the first-order reaction with rate constant *k*, the half life period (initial concentration = *a*) is equal to
    (a) $\ln 2/k$ (b) $1/ka$ (c) $0.693/ka$ (d) $1/2ka$
15. For the reaction of the type A+B→products, it is observed that doubling the concentration of A causes the reaction rate to be four times as great, but doubling the amount of B there is no apparent effect on the rate. The rate equation is
    (a) rate = $k[A][B]$ (b) rate = $k[A]^2$
    (c) rate = $k[A]^2[B]$ (d) rate = $k[A]^2[B]^2$
16. The reaction X+2Y+2→ N, occur by the following mechanism:
    (i) X+Y→M (fast) (ii) M+Z→O (slow) (iii) O+Y→N (very slow),
    What is the rate law for this reaction?
    (a) $k[Z]$ (b) $k[X][Y]^2[Z]$
    (c) $k[N]$ (d) $k[M[Z]$
17. For the single-step reaction $2A+B \rightarrow A_2B$ the rate law
    (a) Rate = $k[A][B]$ (b) Rate = $k[2A][B]$
    (c) Rate = $k[A]^2[B]$ (d) Rate = $k[A]^2[B]/[A_2B]$
18. The branch of chemistry which deals with the study of reaction rates is known as
    (a) chemical kinetics (b) chemical equilibrium
    (c) electrochemistry (d) chemical thermodynamics

41. The change in the concentration of the reactant or product per unit time is called
(a) Order of the reaction (b) Rate of reaction
(c) Rate constant (d) Molecularity of the reaction

42. Suppose that the rate law for reaction is
Rate = k [A] [B]
and the initial concentration of A and B are equal. If C represents the concentration of both A and B at any time t, a straight line will be obtained if
(a) log C is plotted against time (b) $1/C^2$ is plotted against time
(c) 1/C is plotted against time (d) $\log C^2$ is plotted against time

43. Which of the following is true for the reaction?
$N_2 + 3H_2 \rightleftharpoons 2NH_3$
(a) $\frac{2}{3}\frac{d|H_2|}{dt} = \frac{d|NH_3|}{dt}$ (b) $-\frac{3d|H_2|}{dt} = \frac{2d|NH_3|}{dt}$
(c) $-\frac{d|N_2|}{dt} = \frac{3d|H_2|}{dt}$ (d) $-\frac{d|N_2|}{dt} = \frac{1}{3}\frac{d|H_2|}{dt}$

44. For a reaction of the type (second order in A)
$A \longrightarrow$ Product
if the initial concentration of A is a and at a given time t, the concentration of product is x, the rate constant (k) can be put as
(a) $k = t(a-x)$ (b) $k = t\left(\frac{1}{(a-x)} - \frac{1}{a}\right)$
(c) $k = \frac{1}{t}\left(\frac{1-x}{a}\right)$ (d) $k = \frac{1}{t}\left(\frac{1}{(a-x)} - \frac{1}{a}\right)$

45. For the reaction
$2SO_2 + O_2 \rightleftharpoons 2SO_3$
the rate of disappearance of O_2 is 2.0×10^{-4} mol $l^{-1} s^{-1}$. The rate of appearance of SO_3 is
(a) 1.0×10^{-4} mol $l^{-1} s^{-1}$ (b) 2.0×10^{-4} mol $l^{-1} s^{-1}$
(c) 4.0×10^{-4} mol $l^{-1} s^{-1}$ (d) 6.0×10^{-4} mol $l^{-1} s^{-1}$

46. Consider a system containing NO_2 and SO_2, in which NO_2 is consumed in the following parallel reactions
$2NO_2 \overset{k_1}{\rightleftharpoons} N_2O_4$ $NO_2 + SO_2 \overset{k_2}{\rightleftharpoons} NO + SO_3$
the rate of disappearance of NO_2 will be equal to
(a) $k_1 [NO_2]_2 + k_2 [NO_2]$ (b) $2k_1 [NO_2]^2 + k_3 [NO_2] [SO_2]$
(c) $2k_1 [NO_2]^2$ (d) $k_1 [NO_2]^2 + k_2 [NO_2] [SO_2]$

47. For a reaction of the type
$A + B \longrightarrow$ Products
It is observed that doubling the concentration of A causes the reaction rate to be four times as great, but doubling the amount of B there is no apparent affect on the rate. The rate equation is
(a) Rate = $k|A|^2|B|^2$ (b) Rate = $k|A|^2$
(c) Rate = $k|A|^2|B|$ (d) Rate = $k|A||B|^2$

48. Consider the third order rat equation $K = \frac{1}{2t}\left(\frac{1}{C_o^2} - \frac{1}{C_2}\right)$
where C_o is the initial concentration and C is the concentration at time t. The half life period ($t_{1/2}$) is
(a) $t_{1/2} = \frac{3}{2k C_o}$ (b) $t_{1/2} = \frac{3}{2k C_o^2}$
(c) $t_{1/2} = \frac{3k}{2C_o^2}$ (d) $t_{1/2} = \frac{1}{k C_o}$

49. Which of the following statements is not related to collision theory?
(a) Molecules must process a minimum amount of energy
(b) Collision theory is applicable to liquids only
(c) Molecules must have proper orientation
(d) Molecules must collide with each other to do a chemical reaction

50. The minimum amount of energy that the reacting molecules must possess at the time of collisions in order to produce effective collisions is called
(a) Threshold energy (b) Activation energy
(c) Free energy (d) Internal energy

51. Chemical reactions of the type $A \xrightarrow{k_1} B \xrightarrow{k_2} C$ are called
(a) Pseudo 1st chemical reactions (b) Fast reactions
(c) Parallel reactions (d) Consecutive reactions

52. In a reversible reaction $2NO_2 \underset{k_2}{\overset{k_1}{\rightleftharpoons}} N_2O_4$
the rate of disappearance of NO_2 is equal to
(a) $2k_1 [NO_2]^2 - k_2 [N_2O_4]$ (b) $2k_1 [NO_2]$
(c) $(2k_1 - k_2) [NO_2]$ (d) $2k_1/k_2 [NO_2]$

53. Point out the incorrect statement.
(a) Rate law is more informative than law of mass action
(b) Rate law is an experimental fact whereas law of mass action is a theoretical in nature
(c) Rate law is always different from the expression of law of mass action
(d) Order of the reaction is equal to the sum of the exponents of concentration terms in the rate law

54. Consider the first order reaction $A \longrightarrow B$
If the initial concentration of A is a and B zero, and at any time t the concentration of B is x, then the rate equation can be written as

(a) $kt = \ln \frac{a}{(a-x)}$ (b) $kt = \ln (a-x)$

(c) $k = \frac{1}{t} \ln \frac{(a-x)}{a}$ (d) $\frac{k}{t} = \ln \frac{a}{(a-x)}$

55. In the kinetic study of a reaction $A \longrightarrow$ Products

A straight line was observed when a graph between time and $1/C^2$ was plotted, the reaction is

(a) 1st order (b) 2nd order

(c) 3rd order (d) zero order

56. For a chemical reaction $A \longrightarrow$ products, the rate of the reaction doubles when the concentration of A is increased by 4 times. The order of the reaction is

(a) 2 (b) 1

(c) $\frac{1}{2}$ (d) 0

57. The experimental relationship between rate of the reaction and concentration of the reactants is called

(a) Rate constant (b) Law of mass action

(c) Le-chatelicr's principle (d) Rate law

58. The hydrolysis of methyl acetate is a reaction of

(a) 1st order (b) zero order

(c) 3rd order (d) 2nd order

59. For the reaction $2A + B \longrightarrow C + D$

The rate of the reaction increases eight times when the concentrations of both A and B are doubled. The rate of the reaction increase four times when the initial concentration of only B is doubled. The rate expression for the reaction is

(a) $r = k|A||B|$ (b) $r = k|A^2||B|$

(c) $r = k|A||B|^2$ (d) $r = k|B|^2$

60. From an elementary reaction of the type $A + 2B \longrightarrow C + D$,

the order of the reaction is

(a) Zero (b) 2

(c) 3 (d) only determined experimentally

61. Which of the following expressions represent the Arrhenius equation

(a) $k = A e^{-E_a/T}$ (b) $k = A e^{-E_a T/R}$

(c) $k = e^{-E_a/RT}$ (d) $k = A e^{-E_a/RT}$

ANSWERS

1	B	2	B	3	C	4	C	5	C	6	B	7	C
8	D	9	C	10	B	11	A	12	C	13	B	14	A
15	B	16	D	17	C	18	A	19	B	20	B	21	D
22	A	23	D	24	D	25	C	26	A	27	C	28	B
29	B	30	c	31	D	32	D	33	B	34	A	35	A
36	B	37	D	38	B	39	D	40	D	41	B	42	C
43	A	44	D	45	C	46	B	47	B	48	B	49	B
50	A	51	D	52	A	53	C	54	A	55	B	56	C
57	D	58	A	59	C	60	D	61	D				

17. COLLOIDS

Colloid is a system in which one substance is dispersed (dispersed phase), as a very fine particles in another substance (dispersed media). For example, fog contains liquid droplets (dispersed phase) suspended in air (dispersion medium).

The most important difference between a solution and a colloid is the size of the particle. Colloidal particles are larger than simple molecules but small enough to remain suspended. It is classifified as micro-heterogeneous. The diameter of the particle in the colloid is in the range of **1 nm to 1000 nm.**

Sols is the dispersion of a solid in liquid are called Sol. Sols are divided into two categories, depending on the interaction between the dispesed phaseand the dispersion medium.

Lyophilic (Liquid-loving) sols have strong interaction between dispesed phase and the dispersion medium. When water is used as dispersed medium, these are termed as hydrophilic sols. They are thermodynamically stable.

Lyophobic (Liquid-hating) sols have weak interaction of dispersed phase with the liquid. The formation of these sols accompanied by an increase in their free energy. Therefore, these are thermodynamically unstable and kinetically stable. When water is used as dispersion medium, such sols are called hydrophobic sols.

Preparation of Sols

Simple dissolution of solids in the liquids yield Lyophilic sol. No further purification is required if if the starting substances are pure. Following methods are generally used to prepare lyophobic sols:

Dispersion methods

The bulk material is disintegrated in the form of colloidal dimensions in dispersion medium. This is generally done by mechanical grinding.

Condensation methods

In this method, the colloid particles are formed from atoms, molecules or ions by a physical or a chemical process. This includes:

(i) **Chemical reactions:** Some chemical reactions lead to insoluble products which aggregate to in the form of colloidal sols.

(ii) **Bredig arc method** is suitable for metal sols. The evaporation of metals is caused by striking an electric arc between two metal electrodes dipping in a suitable liquid medium.

(iii) **Change of solvent:** The solution is prepared in a liquid in which substance is easily soluble. To this is added a liquid which leads to decrease in solubility and results in colloidal sol.

Purification of Sols

Sometimes, the sol contains impurities, e.g. soluble electrolytes or non electrolytes. These affect the stability and other properties of sol, therefore, it is.necessary to purify them. Following methods can be used for this purpose:

Ultrafiltration: Colloidal particles pass through ordinary filter paper. However, the pore size of an ordinary filter paper can be decreased by impregnating the filter paper with suitable material. The filter

paper thus prepared is known as an ultrafilter paper. F :tration through this removes impurities, leaving the colloid on the paper.

Dialysis: The sol is suspended in a suitable membrane (e.g. cellophane) through which small molecules are permeable. This is surrounding by distilled water or any other appropriate liquid. The colloidal particles are left behind.

Electrodialysis: If the impurity is an electrolyte, the dialysis process can become fast by applying an electric field across the membrane. The ions move faster under the field and get out of the membrane quickly.

Properties of Colloidal Sols

The following are the important properties of colloidal sols:

Optical Properties

A colloidal sol seems to be transparent to the naked eye. However, when a beam of light is passed through a colloidal solution, the path of the light beam becomes visible. The visibility is due to **the scattering of light** from the surfaces of colloidal particles. This phenomenon is called the **Tyndall effect**. The scattering of light by the colloidal particles has been used to determine the molecular weights/shapes and sizes of colloidal particles and macromolecules.

Electrical Properties

Colloidal particles in a dispersion medium carry electrical charges. Some of these are positively charged while others are negatively charged depending upon the method of preparation. The origin of charge may be due to the following reasons.

(a) Direct ionization of surface groups
(b) Selection adsorption of ions

Colligative Properties

The number of colloidal particles per litre of the sol are relatively much lesser than in a true solution. Therefore, the sol boil and freeze at almost the same temperature as the pure dispersion medium and lowering of its vapour pressure is almost negligible. The osmotic pressure for colloidal system, though smaller than true solutions, is measurable and gives information regarding the number of particles present per kilogram of the dispersion medium.

Electrophoresis: The migration of colloidal particles towards the electrode in an electric field is called electrophoresis. The terms **cataphoresis** and **anaphoresis** refer to the movement of positively charged colloidal particles to the cathode and negatively charged particles to the anode, respectively.

Coagulation of Colloids

The phenomenon of conversion of colloidal particles to the precipitates is known as coagulation or flocculation. The mechanism of coagulation for lyophilic and lyophobic sols is different.

Flocculation value

The flocculation value of an electrolyte is defined as the minimum number of milli-moles of an electrolyte per litre of the sol required for its coagulation.

Gel is a colloidal system in which a liquid is dispersed in a solid. Under certain conditions, the lyophilic sol may be coagulated to give a semi-rigid jelly like mass which encloses all the liquid present in the sol. The product so obtained is called a gel. Gels are of two types: elastic gels and non-elastic gels.

Emulsions are colloidal systems in which both the dispersed phase and the dispersion medium are liquids which are immiscible. In most cases, one of the liquid phases is water and the other an oil. Accordingly, we come across two types of emulsions–oil-in-water and water-in-oil.

Emulsifiers are the substances which are used to stabilize the emulsions. These are generally long chain molecules with polar groups. The stabilization of an emulsion by means of an emulsifier is called emulsification.

MULTIPLE CHOICE QUESTIONS

1. The Tyndall effect was used by Zsigmondy to devise
   (a) The ultramicroscope (b) The ultracentrifuge
   (c) The osmometer (d) Electrodialysis
2. The process of removing dissolved impurities from a colloidal system, by means of diffusion through a suitable membrane under the influence of an electric field, is called
   (a) Electrosmosis (b) Electrodialysis
   (c) Electrophoresis (d) Peptization
3. An emulsifier is an agent which
   (a) Stabilizes an emulsion (b) Homgeneises an emulsion
   (c) Causes coagulation of an emulsion (d) Helps in the formation of an emulsion
4. A colloidal system in which a liquid is dispersed in a solid is called a/an
   (a) Emulsion (b) Sol
   (c) Gel (d) precipitate
5. Which one of the following statements is not correct about the lyophilic sols?
   (a) They carry charge The particle are hydrated
   (b) These are quite stable and are not easily coagulated
   (d) There is a considerable interaction between the dispersed phase and dispersion medium
6. Which of the following statements is false regarding lyophilic sols?
   (a) The colloidal particles show a liking for the dispersion medium
   (b) These are generally easy to prepare
   (c) These are more stable than lyophobic sols
   (d) The stability of the sols is mainly due to the electrical double layer
7. Gold number represents
   (a) Quantity of gold in alloys
   (b) Charge on the sol
   (c) Colloid protective power
   (d) Percentage quantity of gold in colloidal gold
8. What happens when an electrolyte is added to a sol in large amount?
   (a) Scattering of light is observed
   (b) Particles starts moving towards their respective electrodes
   (c) Coagulation takes place
   (d) Brownian movement is observed
9. Fog is a colloidal system of
   (a) Gas in liquid (b) Liquid in gas
   (c) Gas in gas (d) Gas in solid
10. Colloids can be purified by
    (a) Peptization (b) Coagulation
    (c) The Breeding arc method (d) Dialysis

11. Which of the following can act as a protective colloid?
(a) Gelatin (b) Silica gel
(c) Oil-in-water emulsion (d) All three

12. On which of the following properties the coagulation power of an ion depends?
(a) Size of the ion
(b) The magnitude of charge on ion
(c) The sign of charge on the ion alone
(d) Both magnitude and sign of the charge on ion

13. Lyophilic sol is more stable than lyophobic sol due to
(a) Charge on their particles
(b) A layer of dispersion medium on their particles
(c) The smaller size of their particles
(d) The larger size of their particles

14. The process of passing of a precipitate into colloidal solution, on adding an electrolyte, is called
(a) Dialysis (b) Peptization
(c) Electrophoresis (d) Electrosmosis

15. $Fe(OH)_3$ sol contain sodium chloride as an impurity. This can be removed by
(a) Condensation (b) Peptization
(c) Coagulation (d) dialysis

16. The protective power of a lyophilic sol is
(a) Defined by Hardy-Schulze rule
(b) Determined by size of its colloidal particles
(c) Measured in terms of gold number
(d) Proportional to the quantity of electrical charge on it

17. The Tyndall effect is not observed in
(a) Suspensions (b) Emulsions
(c) Colloidal solutions (d) True solutions

18. Emulsifying agent is a substance which
(a) Accelerates the dispersion
(b) Makes the emulsions homogeneous
(c) Stabilizes the emulsion
(d) Helps in coagulation the emulsion

19. The Brownian movement is due to
(a) Attraction and repulsion between charges on colloidal particles
(b) Impact of the molecule of the dispersion medium on the particles of the dispersed phase
(c) Impact of the colloid particles on the molecules of a dispersion medium
(d) Temperature fluctuation within the dispersion medium

20. Smoke is a dispersion of
(a) Gas in gas (b) Gas in solid
(c) Solid in gas (d) Liquid in gas

21. Which of the following will be most effective in the coagulation of $Fe(OH)_3$ sol?
(a) NaCl (b) $MgSO_4$
(c) $Mg_3(PO_4)_2$ (d) $AlCl_3$

22. In the process of electro-osmosis
(a) Colloidal particles move towards the electrodes
(b) Both, colloidal particles and dispersion medium, move
(c) Only dispersion medium moves to carry the current
(d) Positively charged colloidal particles move, but negatively charged particles remains stationary

23. Scattering of light is observed in each of the following except in
(a) Sodium chloride solution (b) Ferric hydroxide sol
(c) Solution of egg albumin (d) Solution of arsenous sulphide

24. When a strong beam of light is passed through a colloidal solution, the light will
(a) Be reflected
(b) Be scattered
(c) Pass unchanged
(d) Be dispersed

25. Which of the following colligative properties can be used to characterize colloidal particles?
(a) Lowering in vapour pressure (b) Elevation in boiling point
(c) Depression in freezing point (d) Osmotic pressure

26. Smoke is a dispersion of
(a) Gas in gas (b) Gas in solid
(c) Solid in gas (d) Liquid in gas

27. Which of the following is an example of gel?
(a) Cheese (b) Milk
(c) Rubber (d) smoke

28. The movement of colloidal particles towards their respective electrodes in the presence of an electric field is known as
(a) Dialysis (b) Cataphoresis
(c) Brownian movement (d) Electrolysis

29. Colloids can be purified by
(a) Peptization (b) Coagulation
(b) the Bredig arc method (d) dialysis

30. The blue of water in the sea is due to
(a) Refraction of the blue light by the impurities in sea water
(b) Reflection of blue sky by sea water
(c) Scattering of blue light by water molecules
(d) Absorption of other colours except blue by water molecules

31. The tydall effect associated with colloidal particles is due to
(a) Presence of electrical charge (b) Scattering of light
(c) Absorption of light (d) Reflecting of light

ANSWERS

1	A	2	B	3	A	4	C	5	C	6	D	7	C
8	C	9	B	10	D	11	A	12	D	13	B	14	B
15	D	16	C	17	D	18	C	19	B	20	C	21	D
22	C	23	A	24	B	25	D	26	C	27	A	28	B
29	D	30	C	31	B								

18. ELECTROCHEMISTRY

The branch of physical chemistry which deals with the study of all physical and chemical changes which are brought about by electrical energy and the changes which proceed with the generation of electrical energy is called Electrochemistry. The substances which allow the passage of electric current through them are called **conductors**, e.g. metals and molten salts. Those substances which do not conduct electric current are known as **insulators**, e.g. wood, rubber etc.

Metallic conductors: In metallic conductors, the conduction of electric current is due to the movement of free electrons without producing chemical changes.

Electrolytic conductors: While in electrolytic conductors, the flow of current is due to the migration of charged particles called ions.

Electrolysis is a phenomenon in which chemical changes take place at the electrodes due to the passage of electric current. The electrode connected to the positive terminal of the battery is called **anode**, while the electrode connected to the negative terminal of the battery is known as **cathode**.

Faraday's laws of electrolysis:

The **first law** states that the amount of any substance deposited or liberated at an ele9ctrode is directly proportional to the quantity of electricity passed through the electrolyte.

The **second law** states that if the same quantity of electricity is passed through different electrolytes, the amounts of different substances deposited or dissolved are proportional to their chemical equivalent masses.

Ohm's law

According to Ohm's law, the strength of an electric current flowing through a conductor is directly proportional to the potential difference applied across the conductor and is inversely proportional to the resistance. Mathematically. $I = \frac{V}{R}$

Useful units in electrochemistry

The unit of current is **ampere**. It is defined as the invariable current of such strength that on passing through an aqueous solution of silver nitrate will deposit 0.001118 g of silver in 1 second.

The unit of resistance is **ohm**. It is the resistance at 0°C of a column of mercury of uniform cross section, 106.3 cm long, and containing 14.4521 g of mercury.

The unit of potential difference is **volt**. It is defined as the potential difference required to send a current of one ampere through a resistance of 1 ohm.

The unit of charge or quantity of electricity is **coulomb**. It is the quantity of electricity passes, when a current of one ampere flows in one second.

Joule is the electrical unit of energy, and is the amount of work performed by a current of 1 ampere flowing for 1 second under a potential drop of 1 volt.

Watt is the unit of electrical power and is equal to the work done at the rate of 1 joule per second.

Specific conductance is defined as the conductance of a metre cube of the solution. The units of specific conductance are $ohm^{-1}\ m^{-1}$ or Sm^{-1}.

The molar conductance is defined as the conductance of a volume of solution containing one mole of the solute, when placed between parallel electrodes 1 m apart, and large enough to contain between them all of the solution.

Equivalent conductance of an electrolyte is defined as the conductance of a volume of solution containing one gram equivalent of dissolved substance, when placed between two parallel electrodes 1 m apart and large enough to contain between them all of the solution.

Cell constant is defined as the ratio of the specific conductance to the observed conductance. It is determined by using a solution of potassium chloride having known concentration.

Degree of ionization or dissociation of an electrolyte is defined as the fraction of the total number of molecules of solute present in the solution as ions. It is usually determined by measuring the equivalent conductance of the solution of an electrolyte at any given dilution.

$$\alpha = \frac{\Lambda_c}{\Lambda_o}$$

Where Λ_o is the equivalent conductance at infinite dilution.

Substances whose aqueous solutions are good conductors of electricity are known as **strong electrolytes** e.g. solutions of acids, bases and salts. On the other hand, there are many substances whose aqueous solutions are poor conductors of electricity. These are called **weak electrolytes**. These include many organic acids and bases.

Ostwald's dilution law

Ostwald's dilution law is defined as

$$K_a = \frac{\alpha_2}{(1-\alpha)V}$$

It represents the variation of degree of dissociation of weak electrolyte with dilution. It states that the degree of dissociation for weak electrolytes is directly proportional to the square root of dilution.

Electrochemical cell is a device for the conversion of electrical energy into chemical energy and vice virsa. It consists of two electrodes dipping into an ionic solution and connected by an external metallic conductor.

Galvanic cell and electrolytic cell

A galvanic cell is a device where the chemical energy is converted into electrical energy, such as a dry cell or lead storage battery. In **an electrolytic cell**, the electrical energy from an external source is used to bring about a physical or a chemical change. Charging of a lead storage battery or electrolytic purification of metals are examples where electrical energy brings about chemical changes.

Electrode potential is the potential difference that exists across the metal-solution interface is known as electrode potential. If the ions in the solution are at unit activity, the electrode potential is termed as the standard electrode potential.

Electromotive force (EMF) is an abbreviation for electromotive force, and is defined as the difference of potential between the electrodes which causes the current to flow from one electrode to the other.

Buffer solution

A buffer solution is an aqueous system that tends to resist changes in its pH value. It consists of a weak acid and its conjugate base or a weak base and its conjugate acid. For example, acetic acid and sodium acetate, ammonium hydroxide and ammonium chloride etc.

$$\text{Buffer capacity} = \frac{\text{No. of equivalents of acid/base added per dm}^3}{\text{Unit change in pH value}}$$

The three main buffer systems in living materials are protein, bicarbonate and phosphate.

MULTIPLE CHOICE QUESTIONS

1. The pKa of acetic acid is 4.74, which implies that
   (a) pH of 1N solution is 4.74
   (b) At pH 4.74, the dissociation of acetic acid is maximum
   (c) At pH 4.74, half of the acetic acid molecules are dissociated in the solution
   (d) At pH 4.74, the dissociation of acetic acid is minimum

2. An acid solution of pH = 6 is diluted 1000 times, the pH of final solution becomes
   (a) 6.95 (b) 6
   (c) 4 (d) 9
3. Which is not a buffer?
   (a) $NH_4Cl + NH_4OH$ (b) $CH_3COOH + CH_3COONa$
   (c) $CH_3COONH_4 + NH_4OH$ (d) Borax + Boric acid
4. Which of the following statements is not correct?
   (a) The conductance of one cm^3 of a material is called specific conductance.
   (b) Specific conductance increases while equivalent conductance decreases on progressive dilution.
   (c) The limiting equivalent conductance of weak electrolytes cannot be determined by extrapolation of the plot ^ against concentration
   (d) The conductivity of metals is due to the movement of electrons.
5. Weak electrolytes are only partly dissociated in solutions. The degree of dissociation of weak electrolyte in aqueous solution
   (a) Is inversely proportional to the initial concentration of the electrolyte
   (b) Is directly proportional to the initial concentration of the electrolyte
   (c) Does not depend on the initial concentration of the electrolyte
   (d) Depends on the equilibrium concentration of the electrolyte
6. Equal volumes of two solutions of pH 3 and 4 are mixe(d) The pH of the resultant solution is
   (a) 7 (b) 3.5
   (c) 2.96 (d) 3.26
7. Equivalent conductance is expressed in the units
   (a) S/cm/eq (b) $S\,cm^2/eq$
   (c) $S\,cm^2/eq$ (d) $S\,cm^2\,eq$
8. Conductance measurements may also provide very important information about the one of the following properties
   (a) structure of chemical complexes
   (b) size of ions &solutions of ions
   (c) in medical research
   (d) all above
9. One beaker contains 100 cm^3 of 0.1 *M* oxalic acid solution and other beaker contains 50 cm^3 of 0.1 *M* acetic acid solution which one of the following statements is correct in this regar(d)
   (a) Both solution have the same pH
   (b) The pH of oxalic acid solution is double that of acetic acid solution
   (c) The pH of oxalic acid solution is greater, but not double that of acetic acid solution
   (d) The pH of the oxalic acid solution is less than that of acetic acid solution
10. During the titration of a weak acid against NaOH, the conductance of the solution after the neutralization point
    (a) Is constant (b) decreases
    (c) varies irregularly (d) increases

11. The conductivity of a 0.1*N* KCl solution at 25C is 0.021886/ohm/cm. The resistance of this solution, placed in conductivity cell, found to be 100 ohm. The cell constant of the conductivity cell is
    (a) $12.866\ cm^{-1}$ (b) $1.2886\ cm^{-1}$
    (c) $1.2886\times10^{-6}\ cm^{-1}$ (d) $0.0012886\ cm^{-1}$
12. The molar conductance of an electrolyte at infinite dilution is equal t the sum of the ionic molar conductance of the component ions was stated by which law
    (a) Kohlraush's Law (b) Ostwald law
    (c) Hittorf's law (d) none of the above
13. The pH of a 6.78×10^{-2} *M* NaOH solution is
    (a) 12.83 (b) 2.17
    (c) 11.82 (d) 6.71
14. Which of the following have high mobility in water
    (a) H^- (b) OH^-
    (c) Cl^- (d) A & B
15. When a concentrated solution of an electrolyte is diluted
    (a) its specific conductance increases
    (b) its equivalent conductance decreases
    (c) its specific conductance decreases and equivalent conductance increases
    (d) both specific and equivalent conductance increase
16. With increase in temperature the transport numbers of the cation and anion tend to equalize and approach a value of
    (a) 0.225 (b) 0.5
    (c) 0.4 (d) 0.92
17. Which of the following is a buffer solution?
    (a) $CH_3COOH + CH_3COONa$ (b) $CH_3COOH + HCl$
    (c) $CH_3COOH + NaOH$ (d) $CH_3COOH + KOH$
18. The extrapolation to obtain ^o is made readily for ———— electrolytes
    (a) weak (b) constant
    (c) strong (d) all the above
19. What weight of nickel will be liberated by a current of 5 amperes flowing for 193s through $NiCl_2$ solution?
    (a) 3.2935 g (b) 0.587 g
    (c) 2.835 g (d) 5.870 g
20. Electrolytic conduction is due to the movement of
    (a) electrons (b) ions
    (c) atoms (d) electrons as well as ions
21. Diet cola drinks have a pH of about 3.0, whole milk has a pH of about 7.0, how many times greater is the H_3O^+ concentration in diet cola than in milk?
    (a) 2.3 times higher in diet cola than in milk
    (b) 400 times higher in diet cola than in milk
    (c) 0.43 times higher in diet cola than in milk

(d) 10000 times higher in diet cola than in milk

22. Which of the following solutions of NaCl will have the highest specific conductance?
(a) 0.001 *N* (b) 0.01*N*
(c) 0.1*N* (d) 1.0 *N*

23. If a strip of Cu metal is placed in a solution of $FeSO_4$:
(a) Cu will be precipitated out (b) Fe is precipitated out
(c) Cu and Fe both dissolve (d) no reaction takes place

24. A solution f NaCl in contact with the atmosphere has a pH of about
(a) 3.5 (b) 7
(c) 5 (d) 14

25. The value of pKw at 25°C
(a) 14 (b) 1×10^{-14}
(c) 0.14 (d) 1.4

26. Equivalent conductance can be expressed in terms of specific conductance (k) and concentration (c) gram equivalent per dm^{-3} as
(a) $k \times C$ (b) $k \times 1000/C$
(c) $k \times C/1000$ (d) $k \times C \times 1000$

27. The degree of dissociation of weak acid increases with
(a) Decreasing pressure (b) Increasing pressure
(c) Increasing concentration (d) Decreasing concentration

28. Stronger the oxidizing agent, greater is the
(a) oxidation potential (b) reduction potential
(c) redox potential (d) e.m.f of cell

29. The pH of a buffer solution containing an acid and its salt is
(a) $pKa + \log \frac{|S|}{|A|}$ (b) $pKa + \log \frac{|A|}{|S|}$
(c) $\frac{1}{2} pKa - \log \frac{|A|}{|S|}$ (d) $\log pKa + \log \frac{|S|}{|A|}$

30. The pH of a buffer solution containing a weak base and its salt can be related to pKb as
(a) $pH = pKb - \log \frac{|S|}{|A|}$ (b) $pH = \frac{1}{2} pKb - \frac{1}{2} \log \frac{|S|}{|A|}$
(c) $pH = 14 - pKb - \log \frac{|S|}{|A|}$ (d) $pH = pOH - pKb + \log \frac{|S|}{|A|}$

31. Which of the following solution has pH = 11?
(a) 1×10^{-11} m NaOH (b) 1×10^{-11} M HCl
(c) 1×10^{-3} M NaOH (d) 1×10^{3} M NaOH

32. The pH of beer which has hydrogen ion concentration 6.3×10^{-5} *M* is
(a) 4.20 (b) 4.80
(c) 5.63 (d) 9.8

33. Which of the following solids is a best conductor of electricity?
(a) Graphite (b) Diamond (c) NaCl crystals (d) Marble pieces

34. Which of the following expressions represent the equivalent conductance?
(a) $\Lambda = Ls/V$ (b) $\Lambda = \frac{Ls \times 1000}{V}$
(c) $\Lambda = Ls \cdot \frac{l}{A}$ (d) $\Lambda = \frac{Ls \times 1000}{C}$

35. Which of the following statements is not correct?
(a) The conductance of one cm^3 of a material is called specific conductance
(b) The conductivity of metals is due to the movement of electrons
(c) The limiting equivalent conductance of weak electrolytes cannot be determined by extrapolation of the plot of Λ against concentration
(d) Specific conductance increase while equivalent conductance decreases on progressive dilution

36. During the titration of weak acid against NaOH, the conductance of the solution after the neutralization point
(a) Increases (b) Decreases
(c) Varies irregularly (d) Is constant

37. According to the Debye-Hackle theory of strong electrolytes, an ion moving in an atmosphere of oppositely charged ions experiences a drag. This effect is known as
(a) Concentration effect (b) Electrophoretic effect
(c) Inter-ionic effect (d) Asymmetric effect

38. The branch of chemistry which is concerned with the interrelation of electrical and chemical energy is called
(a) Reaction mechanics (b) Electrochemistry
(c) Quantum chemistry (d) Kinetics

39. Which of the following is a cathodic reaction?
(a) $Fe^{2+} \longrightarrow Fe^{3+}$ (b) $2H_2O \longrightarrow 2OH^- + H_2$
(c) $4OH^- \longrightarrow 2H_2O + O_2$ (d) $2SO_4^{2-} \longrightarrow S_2O_8^{2-}$

40. The device that converts the chemical energy of fuel directly into electrical energy is called
(a) Electrolytic cell (b) Galvanic cell
(c) Concentration cell (d) Fuel cell

41. Equivalent conductance is expressed in the units
(a) $S\ cm^2\ eq^{-1}$ (b) $S\ cm\ eq^{-1}$
(c) $S\ cm^{-1}\ eq^{-1}$ (d) $S\ cm^2\ eq$

42. The blue color of $CuSO_4$ disappears on adding Zn granules to it. It is because of
(a) Oxidation of Cu atm (b) Oxidation of Zn^{2+}
(c) Reduction of Zn^{2+} (d) Reduction of Cu^{2+}

43. The units of specific conductance will be
(a) Ohm cm^{-1} (b) Ohm cm
(c) $S\ cm^{-1}$ (d) Mho cm

44. Free energy change (ΔG) is related to the e.m.f. of a cell (E) as

(a) $\Delta G = -nFE$ (b) $\Delta G = -\frac{RT}{nF} \ln E$

(c) $E = nF\Delta G$ (d) $\Delta G = -\frac{nFE}{RT}$

45. When a concentrated solute of an electrolyte is diluted

(a) Its specific conductance increases
(b) Its equivalent conductance decreases
(c) Both specific and equivalent conductance increase
(d) Its specific conductance decreases and equivalent conductance increases

46. According to the latest convention, the e.m.f. of a cell may be expressed in terms of the reduction potentials RHS electrode (E_R) and LHS electrode (E_L) as

(a) $E_{cell} = E_L - E_R$ (b) $E_{cell} = E_R/E_L$

(c) $E_{cell} = E_R + E_L$ (d) $E_{cell} = E_R - E_L$

47. The conductance of 1 cm^3 of an electrolyte solution is called its

(a) Specific resistance (b) Equivalent conductance
(c) Molar conductance (d) Specific conductance

48. The equivalent conductance ($\wedge$) and molar conductance ($\wedge_m$) of $BaSO_4$ are related as

(a) $\wedge = \frac{\wedge_m}{4}$ (b) $\frac{\wedge}{2} = \wedge_m$

(c) $\wedge = \wedge_m$ (d) $\wedge = \frac{\wedge_m}{2}$

49. Which of the following statements is not true with reference to ionic conductors?

(a) It decreases with rise in temperature
(b) It involves the transfer of matter
(c) It involves oxidation reduction reaction
(d) Ionic conductance is due to movement of the ions

50. Which of the following electrodes has $E^o_{red} = 0$?

(a) Cu^{2+}/Cu (b) Cl_2/Cl^-, Pt

(c) $Cl_2/Ag^+, Ag^+_{(aq)}$ (d) $H_2/2H^+$, Pt

51. The expression of specific conductance is given by

(a) $Ls = \frac{1}{L} \cdot \frac{A}{l}$ (b) $Ls = R \cdot \frac{l}{A}$

(c) $Ls = \frac{1}{R} \cdot \frac{l}{A}$ (d) $Ls = L \cdot \frac{l}{A}$

52. During reaction of copper with aqueous solution of silver nitrate

(a) Silver ions are reduced (b) Cu^{2+} ions are reduced
(c) Silver atoms are reduced (d) NO_3^- ions are reduced

53. Which of the following statements is not correct with reference to cell constant

(a) It is measured with KCl solution
(b) It is used to determine the specific conductance
(c) The dimensions of cell constant is cm^{-1}
(d) Specific conductance does not vary with concentration

54. Electrolytic conduction is due to the movement of

(a) Ions (b) Atoms
(c) Electrons (d) both a and b

55. In the cell reaction

$Cu_{(s)} + 2Ag^+_{(aq)} \longrightarrow Cu^{2+}_{(aq)} + 2Ag_{(s)}$

the reduction half reaction is

(a) $Cu_{(s)} - 2e \longrightarrow Cu^{2+}_{(aq)}$ (b) $Cu^{2+}_{(aq)} + 2e \longrightarrow Cu_{(s)}$

(c) $2Ag_{(s)} \longrightarrow 2Ag^+_{(aq)} + 2e$ (d) $2Ag^+_{(aq)} + 2e \longrightarrow 2Ag_{(s)}$

56. For which of the following cell, the standard voltage is zero

(a) Daniel cell (b) Electrolytic cell
(c) Concentration cell (d) Fuel cell

57. Which of the following statements is not correct regarding galvanic cells?

(a) Oxidation occurs at the anode (b) Ions carry current inside the cell
(c) When the e.m.f. of the cell is positive cell reaction is spontaneous
(d) Electrons flow around the external circuit, from cathode to anode

58. The Nernst equation for the e.m.f. of the cell for the

$aA + bB + dD$ is

(a) $E = E^\circ - \frac{RT}{nF} \ln \frac{a_C^c \cdot a_D^d}{a_A^a \cdot a_B^b}$ (b) $E + E^\circ = \frac{RT}{nF} \ln \frac{a_C^c \cdot a_D^d}{a_A^a \cdot a_B^b}$

(c) $E = E^\circ - \frac{nRT}{F} \ln \frac{a_C^c \cdot a_D^d}{a_A^a \cdot a_B^b}$ (d) $E = E^\circ + \frac{RT}{nF} \ln \frac{a_C^c \cdot a_D^d}{a_A^a \cdot a_B^b}$

59. The entropy change (ΔS) of a cell reaction is given by

(a) $-nF\frac{\partial E}{\partial T}$ (b) $nF\left(\frac{\partial E}{\partial T}\right)_P$

(c) $nF\left[E - T\left(\frac{\partial E}{\partial T}\right)_P\right]$ (d) $-\frac{RT}{nF} \ln \left(\frac{\partial E}{\partial T}\right)_P$

60. Which of the following solutions of NaCl will have the highest specific conductance?

(a) 1.0 N (b) 2.0 N
(c) 0.01 N (d) 0.001 N

61. Which of the following is not a buffer?

(a) CH_3COOH/CH_3COONa (b) NH_4Cl/NH_4OH

(c) H_2CO_3/HCO_3^- (d) NH_4OH/CH_3COOH

62. The pKa of acetic acid is 4.74, which implies that
(a) pH of 1N solution is 4.74
(b) At pH 4.74, the dissociation of acetic acid is minimum
(c) At pH 4.74, half of the acetic acid molecules are dissociated in the solution
(d) At pH 4.74, the dissociation of acetic acid is maximum

63. The e.m.f. of a concentration cell with transference of cations from the solution of higher activity (a_1) to that lower activity (a_2) is given by

(a) $E = -\frac{2.303RT}{nF}\log\frac{a_1}{a_2}$ (b) $E = -\frac{RT}{nF}\log\frac{a_1}{a_2}$

(c) $E = -\frac{RT}{nF}\ln\frac{a_2}{a_1}$ (d) $E = -\frac{RT}{nF}\ln\frac{a_1}{a_2}$

64. Which parametre of a chemical reaction will change with the use of a catalyst?
(a) k, the rate constant (b) ΔS, change in entropy
(c) ΔE, change in internal energy (d) ΔF, change in free energy

65. Equivalent conductance can be expressed in terms of specific conductance (k) and concentration (c) gram equivalent per dm^{-3} as

(a) $k \times C$ (b) $\frac{k \times C}{1000}$

(c) $\frac{k \times 1000}{C}$ (d) $k \times C \times 1000$

66. The equilibrium constant (K) for a cell reaction can be calculated from the e.m.f. of the cell (E°) by the relation

(a) $K = \frac{2.303\ RT}{nFE^\circ}$ (b) $K = \frac{2.303\ nF}{RT}\log E^\circ$

(c) $K = \frac{2.303\ RT}{nF}\log E^\circ$ (d) $\log K = \frac{nFE^\circ}{2.303\ RT}$

67. If 2.303 RT/F = 0.059 and the activities of the solids are constant, then e.m.f. of the cell $Zn/Zn^{2+}(a_1)||Cu^{2+}(a_2)||Cu$ is

(a) $E = E^\circ - \frac{0.059}{2}\log\frac{a_1}{a_2}$ (b) $E = E^\circ + 0.059\log\frac{a_1}{a_2}$

(c) $E = E^\circ - 0.059\log\frac{a_2}{a_1}$ (d) $E = E^\circ + \frac{0.059}{2}\log\frac{a_2}{a_1}$

68. Which of the following is a buffer solution?
(a) $CH_3COOH + NaOH$ (b) $CH_3COOH + HNO_3$
(c) $CH_3COOH + CH_3COONa$ (d) $CH_3COOH + KOH$

69. For the galvanic cell

$Zn[Zn^{2+}[a_{(Zn^{2+})}]||Cu^{2+}[a_{(Cu^{2+})}]|Cu$

Where $a_{(Zn^{2+})}$ and $a_{(Cu^{2+})}$ are the activities of the Zn^{2+} and Cu^{2+} ions. The e.m.f. of the cell
(a) Increases with increase of $a_{(Cu^{2+})}$ when $a_{(Cu^{2+})}$ = constant

(b) Increases with decrease of $a_{(Cu^{2+})}$ when $a_{(Zn^{2+})}$ = constant
(c) Decreases when $a_{(Zn^{2+})}$ decrease and $a_{(Cu^{2+})}$ increases
(d) Increases when $a_{(Zn^{2+})}$ decreases and $a_{(Cu^{2+})}$ increases

70. A pH of a neutral solution at 100°C when $Kw = 1.0 \times 10^{-12}$ is
(a) 0 (b) 2
(c) 6 (d) 7

71. If 20 ml of 0.5 N salt solution is diluted to one litre, what is the new concentration?
(a) 0.001 N (b) 0.0 1N
(c) 1N (d) 10 N

ANSWERS

1	B	2	A	3	C	4	B	5	A	6	D	7	C
8	D	9	D	10	D	11	B	12	D	13	A	14	C
15	B	16	B	17	A	18	A	19	B	20	B	21	D
22	D	23	A	24	C	25	B	26	B	27	D	28	B
29	A	30	C	31	C	32	a	33	A	34	D	35	D
36	A	37	D	38	B	39	B	40	D	41	A	42	D
43	C	44	A	45	D	46	D	47	D	48	D	49	A
50	D	51	D	52	A	53	D	54	A	55	D	56	C
57	D	58	A	59	B	60	A	61	A	62	D	63	C
64	A	65	C	66	D	67	A	68	C	69	D	70	C
71	B												

19. SURFACE CHEMISTRY & PHOTOCHEMISTRY

Surface chemistry

The study of properties of the particles (may be atoms or ions or molecules) present at the surfaces or interfaces is called surface chemistry. There are many physicochemical changes which occur only at the surface of the solids. For example, corrosion of metals starts at the surface. The subject of surface chemistry finds many applications in industry, analytical work and daily life situations.

The accumulation of particles at a surface is called **adsorption.** Adsorption is limited to the surface only, while in absorption the molecules of the absorbed substances are dispersed throughout the bulk. McBain proposed the common term **Sorption** for both these phenomena. The molecular species or substance, which concentrates, or accumulate at the surface is called **adsorbate** and the material on the surface of which the adsorption takes place is called **adsorbent.**

The reverse of adsorption is called **desorption** i.e., the process of removing an adsorbed substance from a surface on which it is adsorbed.

Types of Adsorption

Most important type of adsorption is of the gas on solid surface. Molecules and atoms of gas can stick to the solid surfaces in two ways:

(i) Physisorption (ii) Chemisorption

Physisorption: In physisorption, molecules of the adsorbate are held to the surface by Van der Waals type of interactions. The term physisorption is proposed for physical adsorption. Adsorption generally decreases with increase of temperature and the activation energy for physical adsorption is nearly zero.

Chemisorption: Chemisorption involves a chemical reaction between adsorbed molecules and the molecules (or atoms) of the adsorbent on the surface. Like chemical reaction, there are activation energies for chemisorption. Therefore, the rate of chemisorptions increases with increase of temperature, although the amount of a substance chemisorbed at equilibrium decreases with increase of temperature as for any other exothermic reaction.

Adsorption isotherms

The extent of the adsorption of a gas on a solid is generally expressed as x/m where x is the number of moles of the adsorbate and m is the number of moles of the adsorbent when equilibrium is attained. A relation or graph between x/m and the pressure P of the gas at constant temperature is called adsorption isotherm. The most common types of adsorption isotherm are given below:

Freundlich Adsorption Isotherm: The Freundlich adsorption isotherm is represented by the equation;

$$x/m = k C^{1/n} \text{ (for solutions)}$$

$$x/m = k P^{1/n} \text{ (for gases)}$$

The parameters k and n depend upon the nature of the adsorbent and the adsorbate and is determined by plotting log (x/m) against log C (or log P).

$$\log x/m = \log k + 1/n \log P$$

This should be a straight line with the slope equal to n and the intercept equal to log k.

Langmuir Adsorption Isotherm

One of the drawbacks of the Freundlich adsorption isotherm is that it fails at high pressure of gas. Langmuir derived an adsorption isotherm on theoretical considerations based on kinetic theory of gases. This is called Langmuir adsorption isotherm. Langmuir isotherm is based on the following assumption

(a) The surface is uniform, i.e., all molecules are adsorbed with the same enthalpy and entropy of adsorption and there is no interaction between the adsorbed molecules.

(b) Only a unimolecular adsorbed layer is forme(d) At equilibrium, two opposing processes, viz. Adsorption of molecules from the gas phase and desorption of the adsorbed molecules, have equal rates.

Langmuir Adsorption Isotherm is represented by the relation,

$$x/m = ap/1+bp$$

In order to determine the parameters a and b, the equation may be written in its inverse form:

$$m/x = 1+bp/ap = b/a + 1/ap$$

A plot of m/x against 1/p gives a straight line with slope and intercept equal to 1/a and b/a, respectively.

Catalysis

Substances, which alter the rate of a chemical reaction and themselves remains chemically and quantitatively unchanged after the reaction are known as catalysts and the phenomenon is known as catalysis.

(a) Homogeneous catalysis: In homogeneous catalysis, the reactants and the catalyst are in the same phase. For example $No_{(g)}$ is used as catalyst in the following reaction: $2SO_{2(g)} + O_{2(g)} \rightarrow 2SO_{3(g)}$

(b) Heterogeneous catalysis: In heterogeneous catalysis, the reactants and the catalyst are in different physical state (different phase). For example Ni in solid phase is used as a catalyst in the following reaction: $C_2H_{4(g)} + H_{2(g)} \rightarrow C_2H_{6(g)}$

Promoters are the substances that enhance the activity of a catalyst while **poisons** decrease the activity of catalyst. For example, in Haber's process for ammonia, molybdenum acts as a promoter for iron which is used as catalyst. In the reduction of ethyne to ethene using H_2/Pd, $BaSO_4$ acts as a catalytic poison which prevents the further reduction of ethene to ethane. In most cases, the poisoning is due to the inhibitor or poison being preferentionally adsorbed on the surface.

Photochemistry

Photochemistry deals with the absorption of light by molecules and the process followed by them after excitation. It also includes the study of reverse reactions in which the chemical energy released is emitted as light. Reactions which occur with the absorption of light are called Photochemical reactions. These include oxidation, reduction, decomposition, polymerization, isomerisation etc.

Lambert-Beer's Law

Lambert's law states that when a beam of monochromatic light passes through absorbing medium, the light absorbed by each infinitesimally small layer is proportional to the intensity of the light entering it and the thickness of the layer. Beer's law is an extension of Lambert's law, put forward by Beer (1852). According to this law, the absorption coefficient of the medium is also proportional to the concentration of the solution and can be expressed as

$$A = \varepsilon cl$$

Where ε is called the molar absorption coefficient and c is molar concentration of the solute and l is the path length.

Grotthus Draper's Law is discovered independently by Grotthus and Draper (1839), states that only the light absorbed by the system can be effective in producing a chemical change.

Law of photochemical equivalence states that each molecule taking part in a photochemical reaction takes up one quantum of the radiation causing the reaction.

Radiative and Non-radiative Transitions

The excited molecules may lose energy and come to their ground state, either by emitting radiation (called **radiative transitions)** or without emitting radiation (called **non-radiative transitions)** or In case of non- radiative transitions the energy is lost as heat. Radiative transitions give rise to two

phenomena: fluorescence and phosphorescence. **Fluorescence** is the emission of light when the molecule returns to the ground state from an excited state of the same multiplicity. **Phosphorescence** is the emission of light when the molecule returns to the ground state from an excited state of a different multiplicity.

When the transition occurs between states of the same multiplicity without emitting light, it is called **internal conversion.** On the other hand, if the transition takes place between states of different multiplicity without emitting light, it is called **intersystem crossing.**

Chemiluminescence and Bioluminescence

Chemiluminescence is the emission of light in certain chemical reactions. For example, in the reaction of sodium vapour with alkyl halides, we get an emission from the alkali metal atoms. The glow of yellow phosphorus is also due to chemiluminescence as a result of slow oxidation in air. The emission of light in a biological reaction is called **bioluminescence.** In other words, bioluminescence is the chemiluminescence in a biological reaction. For example, the glow of the firefly is due to the oxidation of luciferin.

Quantum Yield

The quantum yield ϕ for a process is defined by the equation,

ϕ = Number of molecules undergoing process (N_m)/Number of photons absorbed (N_p)

or $\phi = N_m/N_p$

Lasers and Masers

Generally, when a beam of light is passed through a medium, it loses its intensity. However, if there are more molecules of the medium in the excited state than in the ground state (population inversion), stimulated emission can occur and the light beam gains intensity. This is called laser action and it leads to the production of the intense, coherent and monochromatic beam of light. The name LASER is the acronym for Light Amplification by Stimulated Emission of Radiation. Similarly, if the radiation is in the microwave region, it is called MASER. This is the acronym for Microwave Amplification by Stimulated Emission of Radiation.

MULTIPLE CHOICE QUESTIONS

1. A molecule returns from the fist excited triplet sate to the ground state singlet. The light emitted is known as
   (a) Inter-system crossing
   (b) Fluorescence
   (c) Phosphorescence
   (d) Quenching
2. When a transition between states of the same multiplicity occurs without emitting light, the process is called
   (a) Fluorescence
   (b) Quenching
   (c) Internal conversion
   (d) Intersystem crossing
3. The forces of attraction between the adsorbent and the adsorbate in case of physisorption are
   (a) Hydrogen bonds (b) Dipole-dipole interaction
   (c) Covalent bonds (d) Van der Waals forces
4. The branch of chemistry dealing with the study of reactions in the uv-visible region of the spectrum is known as
   (a) Kinetics
   (b) Photochemistry

   (c) Surface chemistry
   (d) Cryoscopy

5. The kinetics of the decomposition of ammonia on the tungsten surface follows
   (a) Zero order
   (b) First order
   (c) Second order
   (d) Third order
6. The correct statements includes
   (i) Physical adsorption is due to Van der Waal's forces
   (ii) Chemical adsorption decreases at high temperature and low pressure
   (iii) Physical adsorption is reversible
   (iv) Adsorption energy for a chemical adsorption is generally greater than that of physical adsorption
   (a) (i), (ii) (b) (i), (iv)
   (c) (ii), (iii) (d) (i), (iii), (iv)
7. Reactions in which molecules absorbing light do not themselves react but induce other molecules to react are called
   (a) Chain reactions (b) Photosensitized reactions
   (c) Reversible reactions (d) Free radical reactions
8. The extent of adsorption increases
   (a) With increase in temperature
   (b) With increase in surface area of the adsorbent
   (c) With decrease in surface area of the adsorbent
   (d) With decrease in pressure of gas
9. "Only those radiations which are absorbed by the system can bring about chemical change." This is a statement of the
   (a) Beer-Lambert law
   (b) Grotthus-Draper law
   (c) Einstein law
   (d) Photochemical equivalence law
10. "Only those radiations which are absorbed by the system can bring about chemical change". This is the statement of the
    (a) Beer-Lambert law (b) Grotthus-Draper's law
    (c) Einstein law (d) Photochemical equivalence law
11. Catalytic poisons act by
    (a) Getting adsorbed on active centres on the catalyst surface
    (b) Chemical combination with any one of the reactants
    (c) Increasing the rate of the backward reaction
    (d) Making the products inert
12. A substance which lowers the catalytic activity of a catalyst is called a/an
    (a) Auto catalyst (b) Negative catalyst
    (c) Promoters (d) Poisons
13. The reverse of a photochemical reaction is called
    (a) Phosphorescence
    (b) Chemiluminescence

(c) Fluorescence
(d) Photosensitization

14. If θ is the fraction of the surface occupied by adsorbate molecules at equilibrium, then, according to the Langmunir theory, the rate of condensation is given by
(a) $\alpha\theta$ (b) $\alpha\theta p$
(c) $\alpha(1-\theta)p$ (d) $\alpha(1-\theta)$

15. In the Langmuir adsorption isotherm, when $p \to 0$, the amount of substance adsorbed per gram of the adsorbent is proportional to
(a) p^2 (b) $1/p$
(c) p (d) p^0

16. The quantum yield of a photochemical reaction is
(a) Always less than unity
(b) Always equal to unity
(c) Always greater than unity
(d) Can have any value greater than zero depending on the reaction

17. The wavelength of fluorescent light is related to the wavelength of absorbed light (λ_f) by
(a) $\lambda_f > \lambda_{ab}$ (b) $\lambda_f < \lambda_{ab}$
(c) $\lambda_f \propto \lambda_{ab}$ (d) $\lambda_f \propto 1/\lambda_{ab}$

18. Retarded reaction are those
(a) In which the rate of the reaction is independent of pressure
(b) In which products are strongly adsorbed on the surface of the solid catalyst
(c) Which are reversible under all conditions
(d) For which ΔG is positive

19. According to the Langumir isotherm, when the pressure of the gas is very large, the adsorption
(a) Is directly proportional to pressure
(b) Is inversely proportional to pressure
(c) Is directly proportioal to the square of the pressure
(d) Is independent of pressure

20. The reverse of a photochemical reaction is called
(a) Phosphorescence (b) Chemiluminescence
(c) Fluorescence (d) Photosensitization

21. According to Langmuir isotherm, when the pressure of gas is very large, the adsorption
(a) is directly proportional to pressure
(b) is inversely proportional to pressure
(c) is directly proportional to the square of the pressure
(d) is independent of pressure

22 According to the Grotthus-Draper law
(a) Only absorbed light is effective in producing photochemical changes
(b) Only light between certain wavelengths is effective in photochemical changes
(c) Light is effective only for photochemical reactions in solution
(d) The light absorbed is proportional to its intensity

23. Which of the following characteristics of adsorption is wrong?
(a) Adsorption on solids is reversible in nature

(b) Adsorption, in general, increase with increase in temperature
(c) Adsorption is generally selective in nature
(d) Both enthalpy and entropy of adsorption are negative

24. When a transition between states of same multiplicity occurs without emitting light, the process is called
(a) Fluorescence (b) Quenching
(c) Internal conversion (d) Inter-system crossing

25. Optical density of a solution, with reference to the solvent, is 0.3. the extinction coefficient of the solute is 3000 and the cell length is 10 cm. The concentration of the solute is
(a) 1×10^{-5} M (b) 0.3 M
(c) 1×10^{3} M (d) 1×10^{-4} M

26. Which of the following equations is correct for the extent of adsorption at one atmospheric pressure and at constant temperature?
(a) $x/m = 1$ (b) $x/m = k$
(c) $x/m = P$ (d) $x/m = kP$

27. A molecule returns from the first excited triplet state to the ground singlet state. The light emitted is known as
(a) Inter-system crossing (b) Fluorescence
(c) Phosphorescence (d) Quenching

28. Which of the following methods gives the number-average molecular weight of a polymer?
(a) Light scattering method
(b) Osmotic method
(c) Sedimentation equilibrium method
(d) Viscosity method

29. The quantum yield for the decomposition of HI is 2. If in an experiment, 0.01 moles of HI are decomposed, the number of photons absorbed is equal to
(a) 6.02×10^{21} (b) 3.01×10^{21}
(c) 2.04×10^{21} (d) 3.01×10^{23}

30. A colloidal system in which both the dispersion phase and dispersed phase are liquid is
(a) Smoke
(b) Emulsion
(c) Whipped cream
(d) Mist

31. Catalytic poisons act by
(a) Getting adsorbed on active centres on the catalyst surface
(b) Chemical combination with any one of the reactants
(c) Increasing the rate of the backward reaction
(d) Making the products inert

32. Which of the following characteristics of adsorption is wrong?
(a) Adsorption on solids is reversible in nature
(b) Adsorption, in general, increases with increase in temperature
(c) Adsorption is generally selective in nature
(d) Both enthalpy and entropy are negative

33. According to Grotthus-Draper'law,
(a) Only absorbs light is effective in producing photochemical changes
(b) Only light between certain wavelength is effective in photochemical changes
(c) Light is effective only for photochemical reactions in solution
(d) The light absorbed is proportional to its intensity

34. In emulsions, the dispersed phase and the dispersion medium are
(a) Both solids
(b) Both liquids
(c) Both gases
(d) Phase is liquid and medium is solid

35. The enrichment of chemical substances at the surface of a solid is called
(a) Adsorption (b) Absorption
(c) Sorption (d) Isotherm

36. In terms of the amount of the substance adsorbed per gram of the adsorbent (x/m), and pressure p of the gas, the Freudlich adsorption isotherm is represented as

(a) $\frac{x}{m} = \frac{k}{p^n}$ (b) $\frac{x}{m} = kp^n$

(c) $p = k\left(\frac{x}{m}\right)^n$ (d) $\frac{x}{m} = \left(\frac{k}{p}\right)^n$

37. The adsorption theory explains
(a) Homogeneous catalysts (b) Acid-base catalysis
(c) Heterogeneous catalysis (d) Enzyme catalysis

38. The adsorption theory can explain the action of all these except
(a) Heterogeneous catalysis (b) Catalytic poisons
(c) Acid-base catalysis (d) Promotors

39. The Langmuir adsorption isotherm shows that the amount of adsorbed gas per gram of the solid is equal to
(a) ap/1+bp (b) ap+1/1-bp
(c) 1+ap/1-bp (d) a(1+bp)

40. The substance on whose surface adsorption takes place is called the
(a) Absorbent
(b) Adsorbate
(c) Active substance
(d) Porous substance

41. The adsorption theory can explain the action of all these except
(a) Heterogeneous catalysis
(b) Catalytic poisons
(c) Acid-base catalysis
(d) Promoters

42. The Langmuir adsorption isotherm shows that the amount of adsorbed gas per gram of the solid is equal to

(a) $\frac{ap}{1+bp}$ (b) $\frac{ap+1}{1-bp}$

(c) $\frac{1+ap}{1-bp}$ (d) a(1 + bp)

43. The Langmuir theory of unimolecular adsorption is generally valid at
(a) Low pressures and low temperatures
(b) Low pressures and high temperatures
(c) High pressures and low temperatures
(d) High pressures and high temperatures

44. Which of the following is an example of a heterogeneous catalysed reaction?

(a) $SO_2 + \frac{1}{2}O_2 \xrightarrow{NO} SO_3$ (b) $CH_3COOC_2H_5 \xrightarrow{H^+} CH_2COOH + C_2H_5OH$

(c) $H_2O_2 \xrightarrow{Pt} H_2O + \frac{1}{2}O_2$ (d) $CH_2CHO \xrightarrow{I_2\ vapour} CH_4 + CO$

45. A substance which lowers the catalytic activity of a catalyst is called a/an
(a) Autocatalyst (b) Negative catalyst
(c) Promoter (d) Poison

46. Which of the following is not an example of heterogeneous catalysis?

(a) $SO_2 + \frac{1}{2}O_2 \xrightarrow{V_2O_5} SO_2$

(b) $RCH_3 + \frac{3}{2}O_2 \xrightarrow{CoBr_2} RCOOH + H_2O$

(c) Unsaturated oil + $H_2 \xrightarrow{Ni}$ Saturated oil

(d) $SO_2 + \frac{1}{2}O_2 \xrightarrow{NO} SO_3$

47. Which of the following state is not correct regarding Langmunir adsorption theory?
(a) Adsorbent has specific equivalent sites
(b) One site can adsorbs only one molecule
(c) Adsorbed molecules cannot interact with each other
(d) Adsorption is a static process

47. The Langmuir theory of unimolecular adsorption is generally valid at
(a) Low pressure and low temperature
(b) Low pressure and high temperature
(c) High pressure and low temperature
(d) High pressure and high temperature

48. Which of the following is a natural polymer
(a) Nylon (b) Leucite
(c) Cellulose (d) Polystyrene

ANSWERS

1	C	2	C	3	D	4	B	5	A	6	A	7	B
8	B	9	B	10	B	11	A	12	D	13	B	14	C
15	C	16	D	17	A	18	B	19	D	20	B	21	D
22	A	23	B	24	C	25	A	26	B	27	C	28	B
29	B	30	B	31	A	32	B	33	D	34	B	35	A
36	B	37	C	38	C	39	A	40	A	41	C	42	A
43	B	44	C	45	D	46	D	47	D	48	C		

20. NUCLEAR CHEMISTRY

The branch of chemistry which is concerned with the structure of the nucleus and how this structure influences the nuclear stability is called nuclear chemistry. It also deals with phenomena by means of which one nucleus is changed into another, such as the process of radioactivity and of nuclear transformation. In ordinary chemical reactions, there is a rearrangement of the atomic electrons but the atomic nuclei remain unaffected. On the other hand, in a nuclear reaction, there is a change in the number of protons or neutrons (or both), thus resulting in the formation of new nuclei. The energy released in ordinary chemical reactions is usually less and therefore, does not affect the stability of the nucleus. However, the energy released during nuclear changes, is sufficiently high to break the chemical bonds and is used to induce chemical reactions. The nuclear chemistry is subdivided into two branches (a) radiochemistry, and (b) radiation chemistry.

(*a*) **Radiochemistry.** It deals with the study of radioactive atomic species and their applications in various fields.

(*b*) **Radiation Chemistry.** It is now limited to chemical effects produced by radiation while interacting with a system.

Radioactivity

The phenomenon of radioactivity was discovered by **H. Becquerel** in 1895. He observed that when a photographic plate wrapped in black paper was exposed to certain uranium salts, it was fogged. He concluded that fogging of the plate was due to the radiation emitted from the uranium salt. Subsequently, it was shown that radiation can cause ionization of air and is not affected by factors like temperature, pressure, chemical environment or source of uranium. The spontaneous emission of radiation of this type by an element is called radioactivity and the element which exhibits this behavior is said to be radioactive. The name radioactivity was proposed by a Polish pupil of Becquerel, Marie Sklodowska, who later became the illustrious scientist Marie Curie, the recipient of two Nobel Prizes.

Detection and measurement of radioactivity

Decaying of a radioactive material in unit time is called its activity. The standard unit of radioactivity is Curie (Ci), which is defined as that amount of any radioactive material which gives 3.70×10^{10} disintegrations per second (dps). The disintegration per second is abbreviated as dps. One gram of radium-226 undergoes 3.70×10^{10} disintegrations per second and is also equal to one Curie. In practice, activities are expressed in terms of megacuries, curies, millicuries and microcuries.

$$1 \text{ curie (Ci)} = 3.70 \times 10^{10} \text{ dps}$$

The SI unit of radioactivity is Becquerel (Bq) which is defined as the activity due to one disintegration per second.

$$1 \text{ Ci} = 3.70 \times 10^{10} \text{ Bq} \qquad \& \qquad 1 \text{ Bq} = 1 \text{ disintegration per second}$$

Atomic Number. The number of protons in the nucleus is called the atomic number Z.

Neutron Number. The number of neutrons in the nucleus is called neutron number N.

Mass Number. The sum of numbers of neutrons and protons in the nucleus is called mass number (a)

Thus $A = Z + N$

Nuclide. Any species of atoms with a definite number of protons and neutrons is called a nuclide. The composition of a nucleus is indicated by its nuclide symbol. It consists of the symbol for element (E) with atomic number (Z) written as the subscript at the lower left and the mass number (a) as the superscript at the upper left.

$${}^{A}_{Z}E, \quad {}^{4}_{2}He, \quad {}^{14}_{7}N$$

Isotopes. Nuclides with the same number of protons are called isotopes. For example, Isotopes of hydrogen (Z = 1); ${}^{1}_{1}H$, ${}^{2}_{1}H$, ${}^{2}_{1}H$

Isobars. Nuclides with the same mass number are isobars. For example,

Isobars of A = 3 ; ${}^{6}_{1}H$, ${}^{6}_{2}He$

Isobars of A = 14 ; ${}^{14}_{6}C$, ${}^{14}_{7}N$

Isotones. Nuclides with the same number of neutrons are Isotones. For example, ${}^{3}_{1}H$ *and* ${}^{4}_{2}He$

Isomers. Nuclides having the same atomic number and mass number but differing in their energy contents or radioactive properties are called nuclear isomers. The isomers are denoted as ${}^{A}_{Z}X$ *and* ${}^{Am}_{2}X$

Kinetics of radioactive decay

Radioactive nuclei decay by first order kinetics. The rate of radioactive decay does not depend on the physical or chemical state of the sample. Since radioactivity is a huclear phenomenon, a radioactive nuclide will emit the same type of radiation at the same rate, regardless of its chemical composition, its temperature, applied pressure or the presence of electrostatic or magnetic fields. The rate of decay at any instant of time is proportional to the number of radioactive atoms present.

$$-\frac{dN}{dt} \propto N \qquad \text{or} \qquad -\frac{dN}{dt} = \lambda N$$

Half life,and Average life

Half life of radioactive element is defined as the time is which the radioactive atoms are reduced to half of their initial atoms. Mathematically:

$$t_{0.5} = \frac{0.693}{\lambda}$$

Half life periods a useful property for the identification of various radioactive species. The average life of a radioactive element is equal to the sum of all possible life times divided by the total number of atoms. The reciprocal of the decay constant gives the average life of a radioactive element.

$$\text{Average life} = 1.44\, t_{0.5}$$

Nuclear fission and nuclear fusion

Nuclear fission is a procession which a heavy nucleus is broken into two intermediate nuclei with the release of energy. For example

$$U + {}^{1}_{0}n \longrightarrow {}^{140}_{56}Ba + {}^{93}_{36}Kr + 3\,{}^{1}_{0}n + Q$$

Nuclear fusion may be considered as the reverse of fission. It may be defined as the process of combining two lighter nuclei to form a heavier nucleus with the release of energy. For example

$${}^{2}_{1}H + {}^{3}_{2}He \longrightarrow {}^{4}_{2}He + {}^{1}_{1}H + 18.4 \text{ Mev.}$$

Nuclear reactor

Nuclear reactor is a device to obtain the nuclear energy in a controlled way to be used for peaceful purposes. It is also known as atomic pile. A typical nuclear reactor consist of the following major components.

(I) Fuel rods, (ii) Moderator, (iii) Coolant, (iv) Control rods (v) Shielding

Medical application of radioisotopes

(i) Sodium-24 is used to locate obstruction in the circulatory system.

(ii) Iodine-131 is used to monitor goiter and other thyroid problems.

(iii) Thallium-201 tends to concentrate in the healthy heart muscle tissue, while technetium-99 concentrate in the abnormal heart tissue.

(iv) Co-58 is used to determine uptake of vitamin B_{12}, while Co-60 is used for the radiation treatment of cancer.

Nuclear weapons and nuclear fuel.

Nuclear weapon in which the explosive power is derived from nuclear fission or a combination of nuclear fission and nuclear fusion eg; atomic bomb and H-bomb.

Nuclear fuel is a substance which undergoes nuclear fusion or nuclear fusion in a nuclear reactor, a nuclear weapon, or a star, e.g, u-235 and Pu-239.

H-bomb

The fusion bomb, thermo nuclear bomb or H-bomb consists of a fusion bomb surrounded by a layer of hydrogenous material (lithium deuteride). At the temperature resulting from explosion of the fission bomb, fusion of hydrogen nuclei to form helium nuclei takes place with the evolution of even greater quantities of energy. The explosive effect of fusion bomb is comparable to the explosion of tons of megatons of T.N.T.

MULTIPLE CHOICE QUESTIONS

1. When uranium emits an α-particles it yield
   (a) Thorium (b) Protactinium
   (c) Thulium (d) Pollunium
2. An atom of mass number 15 and atomic number 07 captures an α-particle and then emits a proton. The mass number and atomic number of the resulting product will respectively be
   (a) 14 and 2 (b) 15 and 3
   (c) 16 and 4 (d) 18 and 8
3. The radioactive decay constant of a material is:
   $\lambda = 4.28 \times 10^{-4}\ yr^{-1}$
   Its half-life a nearly
   (a) 5,000 yr (b) 4,000 yr (c) 3,000 yr (d) 2,000 yr
4. Phosphorus-32 is used to investigate
   (a) Absorption of fertilizers (b) Impurities in ores
   (c) Choice of fertilizer for soil (d) All above
5. Autoradiography is a process
   (a) Chemical (b) Biochemical
   (c) Photochemical (d) Biological
6. The best projectile for artificial transmutation of elements is
   (a) proton (b) neutron
   (c) α-particle (d) deutron
7. The energy released in an atomic bomb explosion is mainly due to
   (a) emission of electrons (b) emission of neutrons
   (c) lesser mass of products than of initial material
   (d) greater mass of products than of initial material
8. The reaction shown below is responsible for creating ^{14}C in the atmosphere. What is the bombarding particle? $^{14}_{7}N + \_\_\_\_ \rightarrow {}^{14}_{6}C + {}^{1}_{1}H$
   (a) alpha particle (b) electron
   (c) neutron (d) All

9. In passing through matter, alpha particles lose energy chiefly by causing
   (a) fermentation (b) neutralization
   (c) ionization (d) condensation
10. The fuel used in atomic pile is
    (a) thorium (b) sodium-24
    (c) uranium-235 (d) petroleum
11. Energy of nuclear reaction is represented by Q. Its positive value indicate?
    (a) Nuclear fission (b) Exoergic reaction
    (c) Nuclear fusion (d) Endoergic reaction
12. Isotopes are atoms whose nuclei have the same atomic number but different mass numbers. A specific isotope has an atomic number of 18 and a mass number of 35. How many electrons are there in the neutral atom?
    (a) 34 (b) 18
    (c) 17 (d) 35
13. Carbon-14 is formed by bomardment of nitrogen nuclei in the upper atmosphere by
    (a) cosmic rays (b) carbon-13
    (c) boron-5 (d) carbon-12
14. Bombardment of uranium-235 with a neutron ($_0n^1$) generates tellurium-135, 3 neutrons, and _____.
    (a) zirconium-98. (b) krypton-101.
    (c) krypton-103. (d) strontium-99.
15. The rate of disintegration (decay rate)
    (a) increases with the amount of radioactive sample
    (b) increases with rise in temperature
    (c) decreases with the decrease in pressure
    (d) remains unaffected by all above factors
16. The activity of radioactive isotope change with
    (a) temperature (b) pressure
    (c) chemical environment (d) none of the above
17. Which one of the following is not a fissile material
    (a) $^{235}_{92}U$ (b) $^{238}_{92}U$
    (c) $^{33}_{92}U$ (d) $^{239}_{94}Pu$
18. Nuclear fission experiments show that the neutrons split the uranium nuclei into two fragments of about same size. This process is accompained by the emission of several
    (a) protons and positrons (b) α-particles
    (c) neutrons (d) protons and α-particles
19. What happens to the mass number and the atomic number of an element when it emits gamma radiation?
    (a) The mass number decreases by four and the atomic number decreases by two.
    (b) The mass number increases by four and the atomic number increases by two.
    (c) The mass number remains unchanged while the atomic number increases by one.
    (d) The mass number and atomic numbers remain unchange(d)

20. The radioactive decay of $^{88}_{35}X$ by a beta emission produces an unstable nucleus, which spontaneously emits a neutron. The final product is
(a) $_{37}X^{88}$ (b) $_{35}Y^{89}$
(c) $_{34}Z^{88}$ (d) $_{36}W^{87}$

21. Which type of radioactive decay results in no change in mass number and atomic number for the starting nucleus?
(a) alpha (b) beta
(c) electron capture (d) gamma

22. What fraction of radioactive atoms remains in a sample after six half-lives?
(a) Zero (b) 1/64
(c) 1/16 (d) 1/6

23. In natural radiative disintegration, uranium-238 emits one alpha and two beta and then five alpha particle successively. The end product obtained is
(a) $^{210}_{82}Pb$ (b) $^{212}_{82}Pb$
(c) $^{214}_{82}Pb$ (d) $^{200}_{82}Pb$

24. Nuclides having the same atomic number and mass number but differing in their energy contents or radioactive properties are called
(a) Isotopes (b) Isobars
(c) Isotones (d) Nuclear Isomers

25. This reaction is an example of $^{41}_{20}Ca \rightarrow {}^{41}_{19}K$
(a) alpha decay (b) beta decay
(c) electron capture (d) gamma emission

26. Atoms containing radioactive nuclei are called
(a) radionuclides. (b) nucleons.
(c) nuclides. (d) radioisophores.

27. This reaction is an example of $^{210}_{84}Po \rightarrow {}^{206}_{82}Pb +$ ____
(a) alpha decay (b) beta emission
(c) gamma emission (d) positron emission

28. In the nuclear reaction: $_7N^{14} + {}_2He^4 \rightarrow {}_qX^p + {}_1H^1$ the nucleus X is
(a) nitrogen of mass 16 (b) nitrogen of mass 17
(c) oxygen of mass 16 (d) oxygen of mass 17

29. The missing product from this reaction $^{121}_{53}I \rightarrow {}^{121}_{52}Te +$ _??__
(a) ^4_2He (b) $^0_{-1}e$
(c) ^1_0n (d) ^0_1e

30. Which one of the following processes results in an increase in the atomic number?
(a) gamma emission (b) beta emission
(c) alpha emission (d) corrosion

31. Alpha (α) particles are helium nucleus consist of
(a) 2 electron & 2 protons (b) 2 protons & 2 neutrons
(c) 2 electrons & 2 neutrons (d) 1 proton & 1 neutron

32. In balancing the nuclear reaction $^{238}_{92}U \rightarrow {}^{234}_{x}E + {}^4_2He$, the value of X is

(a) 92 (b) 94
(c) 90 (d) 234/2

33. The magic numbers are
(a) 2, 8, 20, 28, 50, 82, or 136 (b) 2, 8, 28, 50, 82, or 126
(c) 2, 8, 20, 28, 50, 82, or 126 (d) 2, 8, 20, 28, 50, or 126

34. Of the following processes, which one changes the atomic number?
(a) alpha emission (b) beta emission
(c) electron capture (d)All of these processes change the atomic numbers.

35. Which of the following statement are *true* regarding radioactivity?
1. All radioactive elements decay exponentially with time
2. Half-time of the radioactive element is time required for one-half of the radioactive atoms to disintegrate
3. Age of the earth can be determined with radioactive dating
4. Half-life time of a radioactive element is fifty percent if its aver age life perio(d)
Codes: (a) 1 and 2 (b) 1, 3 and 4 (c) 1, 2 and 3 (d) 2 and 3

36. What happens to the mass number and the atomic number of an element when it undergoes beta decay?
(a) Neither the mass number nor the atomic number change.
(b) The mass number decreases by 4 and the atomic number decreases by 2.
(c) The mass number does not change and atomic number increases by 1.
(d) The mass number increases by 2 and the atomic number increases by 1.

37. Radioactive substance loses 95.0% of its activity in 110 minutes, its half life is
(a) 25.44 hours (b) 25.44 minutes
(c) 44.25 hours (d) 44.25 minutes

38. The energy equivalent of 1 amu is
(a) 5.0×10^{-19} J (b) 5.4×10^{43} J
(c) 6.6×10^{9} J (d) 1.5×10^{-10} J

39 1.0 Curie (Ci) is equal to
(a) 3.7×10^{4} dps (b) 3.7×10^{7} dps
(c) 3.7×10^{10} dps (d) 3.7×10^{13} dps

40. Nuclei above the belt of stability can lower their neutron-to-proton ratio by
(a)beta emission (b) gamma emission (c) positron emission (d) e capture

41. All atoms of a given element have the same
(a) mass number (b) number of nucleons (c) atomic mass (d) atomic no.

42. Which type of radioactive decay results in no change in mass number and atomic number for the starting nucleus?
(a) alpha (b) beta (c)electron capture (d)gamma

ANSWERS

1	A	2	D	3	D	4	D	5	C	6	B	7	C
8	C	9	C	10	C	11	B	12	B	13	A	14	A
15	D	16	D	17	B	18	C	19	D	20	D	21	D
22	B	23	C	24	D	25	C	26	A	27	A	28	D
29	D	30	B	31	B	32	C	33	C	34	D	35	C
36	C	37	B	38	D	39	C	40	A	41	D	42	D

21. SYMMETRY AND SPECTROSCOPY

Symmetry is important at a molecular level as well as within crystalline systems. The understanding of symmetry is essential in calculations of molecular properties and to dicsuss molecular spectroscopy.

Group theory is the mathematical treatment of symmetry. The systematic discussion of symmetry is also called group theory. The group theory refferes to fundamental discussion of symmetry operator, symmetry element, point group and character table etc. A **symmetry operation** is an operation performed on an object which leaves the object in a configuration that looks the same (indistinguishable) as the original.

A symmetry operation is carried out with respect to points, lines or planes, these are called the **symmetry elements**. There are five symmetery operation

Identity:

The identity, E, consists of doing nothing; the corresponding symmetry element is the entire object.

Rotation

The rotation (symmetry operation) about an n-fold axis (symmetry element) is denoted by the symbol C_n, in which the angle of rotation is $2\pi/n$; n is called fold and is an integer, e.g. 2, 3,4.... The axis with highes fold (lowest angle) is called principal axis.

Reflection

If the molecule contains an imaginary plan which bisect the molecule and one half of the molecule sis mirror image of the other half, the molecules posess refelction symmetery and plane is caleed mirror plane (plane of symmetery). If the plane is parallel to the principal axis, it is called **'vertical mirror plance'** and denoted σ_v. If the plane is perpendicular to the principal axis, it is called **'horizantal mirror plance** and denoted σ_h. A vertical mirror plane that bisects the angle between two C_2 axes is called a **'dihedral plane'** and is denoted σ_d

Inversion:

In an inversion (the operation) through a centre of symmetry, i (the element), we imagine taking each point in a molecule, moving it to the centre of the molecule, and then moving it out the same distance on the other side; that is, the point (x, y, z) is taken into the point (-x, -y, -z).

Improper rotation:

An n-fold improper rotation (the operation) about an n-fold axis of improper rotation or an n-fold improper rotation axis, S_n, (the symmetry element) is composed of two successive transformations. The first component is a rotation through 360°/n, and the second is a reflection through a plane perpendicular to the axis of that rotation; neither operation alone needs to be a symmetry operation.

.Spectroscopy

It is the study of interaction of electromagnetic radiations with matter.

Atomic spectroscopy is concerned with the interaction of electromagnetic radiations with atoms which are most commonly in their lowest energy state known as ground state.

Molecular spectroscopy is concerned with the interaction of electromagnetic radiations with molecules. In this case transitions occur between rotational and vibrational energy levels in addition to electronic transitions.

Emission spectroscopy is based on the detection of a transition from a state of high energy to a state of lower energy. **Absorption spectroscopy** is based on the detection of the net absorption of nearly monochromatic incident radiation as the radiation is swept over a range of frequencies. In **Raman spectroscopy** molecular energy levels are explored by examining the frequencies present in scattered radiation. **Stokes and anti-Stokes** radiation are scattered radiation at a lower and higher frequency, respectively, than the incident radiation. Rayleigh radiation is the component of radiation scattered into the forward direction without change of frequency.

Lambert-Beer's law.

According to this law the intensity of the emitted light decreases exponentially as the thickness and concentration for the absorbing medium increases arithmetically. Mathematically it is expressed as:

$$A = \log \frac{I_o}{I} = \varepsilon.cl$$

where A =Absorbance, I_O = Intensity of incident light, I =Intensity of transmitted light., ε =Molar absorptivit, c =Concentration in moles per dm^3, l =Path length in centimeters.

Thus ε is the absorbance of a solution whose conentration is 1 mole per litre and the path length is 1cm. The values for ε is usually very large, the absorption intensity can be alternatively expressed as log ε.

Transmittance The transmittance is defined as

$$T = \frac{I}{I_o}$$

where T =Transmittance; I =Intensity of transmitted light; I_O=Intensity of incident light. It is related to absorbanc as %T = 100 x T.

MULTIPLE CHOICE QUESTIONS

1. Visible light is just a portion of radiation emitted by atoms. Which of the following statements is not related with visible light?
   (a) Visible light is electromagnetic in nature.
   (b) It travels with the speed of light.
   (c) It is a wave.
   (d) The wave number of light is directly proportional to its wave length.
2. Which of the following pairs of fundamental particles are present in equal numbers in a neutral atom?
   (a) Proton and neutron
   (b) Proton and positron
   (c) Electron and proton
   (d) Neutron and electron
3. The selection rule for transitions in rotational energy levels of a diatomic molecule is
   (a) $\Delta J = +1$ (b) $\Delta J = -1$
   (c) $\Delta J = \pm 1$ (d) $\Delta J = \pm 2$
4. Which of the following statements is not correct regarding electromagnetic spectra?
   (a) The frequency of microwave is less than uv.
   (b) The velocity of X-rays is more than uv.
   (c) Cosmic rays have shorter wave length than radio waves.
   (d) The frequency of uv is greater than visible rays.
5. The Lambert-Beer law states that
   (a) Transmission is directly proportional to path length
   (b) Transmission is directly proportional to concentration
   (c) Absorbance is inversely proportional to transmission
   (d) Absorbance is directly proportional to concentration
6. An electron in an atom or molecule can jump from lower level to higher level. The wavelength of light absorbed is related to the energy gap between two levels by following expression
   (a) $\Delta E = h\upsilon$ (b) $\Delta E = hc/v$

(c) $\Delta E = hc/\lambda$ (d) $Ch = \Delta E$

7. Which of the following radiation has larger wavelength?
(a) Gamma rays (b) Ultraviolet
(c) Microwave (d) Radio wave

8. The best flame temperature for an analysis is determined empirically and depends upon.
(a) excitation energy of the element
(b) how it is combined in the sample
(c) the sensitivity required
(d) presence of other elements

9. Which is the correct order of wave number of the following radiations?
(a) X-rays > uv > infrared > visible > radio waves
(b) X-rays > uv > visible > infrared > radio waves
(c) X-rays > uv > radio waves > visible > infrared
(d) X-rays > radio waves > uv > visible > infrared

10. Two isotonic nuclcide X and Y have mass numbers 35 and 37 respectively. If the atomic number of X is 17, the atomic number of Y will be
(a) 15 (b) 17
(c) 18 (d) 19

11. The isosbestic point of a dye is determine by the instrument
(a) Polarimeter
(b) Spectrophotometer
(c) Conductivity meter
(d) pH meter

12. In the case of saturated ketones, the most intense band due to $\pi \rightarrow \pi^*$ transition is around
(a) 175 nm (b) 150 nm
(c) 190 nm (d) 210 nm

13. Microwave region of electromagnetic spectrum generally lies between
(a) 0.1–100 cm (b) 50–100 cm
(c) 500–1000 cm (d) 50–150 cm

14. The triatomic linear CO_2 molecule has the following fundamental vibrations.
(a) 4 (b) 2
(c) 3 (d) 6

15. The spectral position and shape of an absorbance maximum due to specific chromophore are affected by
(a) relative acidic nature of the auxochromic group
(b) the polarity of the substituent
(c) the possibility of resonance stabilization
(d) All of the above

16. The energy associated with photon of light is
(a) $C = \upsilon\lambda$ (b) $E = hc$
(c) $E = h\upsilon$ (d) $E = mc^2$

17. Which of the following radiation has valence electron transitions?
(a) Visible (b) X-rays
(c) γ-rays (d) Microwave

18. The difference between the incident and scattered frequencies in the Raman spectrum is called the
(a) Stoke's line (b) Anti-Stoke's line
(c) Raman frequency (d) P-branch

19. For a particular molecular species, this of the following terms is function of concentration
(a) absorbance (b) percent transmission
(c) transmission (d) all

20. Which of the following relations between wave number ($\bar{\nu}$), frequency (ν) and speed is correct?
(a) $\bar{\nu} = \frac{c}{\nu}$ (b) $\bar{\nu} = \frac{\lambda}{c}$
(c) $\bar{\nu} = \frac{\nu}{c}$ (d) $\bar{\nu} = \frac{c}{\lambda}$

21. Which of the following molecules show rotational spectra?
(a) HCl (b) CO
(c) CH_3Cl (d) a, b and c

22. Which of the following regions of the spectrum would be used to determine the structure of the crystalline solids?
(a) Microwave (b) X-rays
(c) Visible (d) Infrared

23. The n-electrons can undergo the following types of transitions
(a) $n \rightarrow \pi^*$ (b) $n \rightarrow \sigma^*$
(c) $n \rightarrow \pi$ (d) all

24. Which of the following groups when substituted in the benzene ring causes bathochromic shifts as well as large increases in the intensity of absorption?
(a) – HO (b) $-NH_2$
(c) NO_2 (d) – all

25. Which of the following diamtomic molecules will not give a rotational spectrum.
(a) NO (b) HF
(c) N_2 (d) CO

26. The commonly used units for wavelength is
(a) Centimetre (b) Micrometre
(c) Nanometre (d) All above

27. The extinction coefficient has the units
(a) $cm^2\ mol^{-1}$ (b) $cm^3\ mol^{-1}$
(c) $mol\ cm^{-2}$ (d) $mol\ cm^{-3}$

28. The composition of complex ion formation is determine by Job's method using
(a) Spectrophotometer
(b) Polarimeter
(c) Conductivity meter
(d) pH meter

29. Which of the following bonds absorb in the region 2300–2000 cm^{-1} (4.4–5.0μm).
(a) C≡C (b) C≡N

(d) a and b

(c) C – C

30. Which of the following statements are correct?
(a) NO, CO, HCl and $CHCl_3$ are infrared active
(b) CO_2, H_2O, CH_4 and C_2H_4 are infrared active
(c) both are correct
(d) none is correct

31. Which of the following technique is used for functional group identification
(a) Rotational spectroscopy
(b) Electronic spectroscopy
(c) NMR spectroscopy
(d) FTIR spectroscopy

32. Which of the following radiation has high frequency?
(a) Radiowaves (b) γ-rays
(c) Infrared (d) X-rays

33. Which of the following are classified as heat detectors?
(a) thermocouple (b) thermister
(c) bolometer (d) all

34. Photomultipliers are very sensitive and rapid in their response to radiations in the spectral range
(a) 1000–12000 Å (b) 1000–500 Å
(c) 500–20000 Å (d) 1–1000 Å

35. The most widely used flame in atomic absorption is
(a) air-coal gas (b) air-propane
(c) air-acetylene (d) oxyacetylene

36. Which of the following devices is most commonly used for the formation of an atomic vapour in atomic absorption?
(a) Flame atomization (b) Electric atomization
(c) Sputtering devices (d) Ovens

37. In vibrational rotational bands, the frequency or wavelength of absorption depends on.
(a) relative masses of the atoms (b) the force constant of the bonds
(c) geometry of the atoms (d) all

38. Which of the following radiation has rotational phenomenon?
(a) Microwave (b) Infrared
(c) Visible (d) X-rays

39. Far ultraviolet or vacuum ultraviolet region generally lies between
(a) 10–200 nm (b) 200–400 nm
(c) 400–750 nm (d) 300–500 nm

40. Which of the following statements are correct?
(a) molecule of N atoms has 3N degrees of freedom
(b) in a non-linear molecule, 3 degrees of freedom describe rotation and three describe transition.
(c) In non linear molecule 3N – 6 degrees of freedom are vibrational degrees of freedom
(d) all are correct

41. Far infrared region of the electromagnetic radiation generally lies between
(a) 50–200 μm (b) 100–400 μm

(c) 50–1000 μm (d) 1–20 μm

42. Which of the following bonds generally absorb in the region 1900–1500 cm^{-1} (5.3 – 6.7 μm)
(a) N = O (b) C = N
(c) C = O (d) C = C

43. Which of the following radiation has vibrational transitions?
(a) X-rays (b) γ-rays
(c) Microwave (d) Infrared

44. Which of the following statements are correct for n – electrons?
(a) these are non bonding electrons found on atoms such as N, O, S and halogens
(b) these are less firmly held than σ – electrons
(c) the energy of ultraviolet and visible region sufficient to cause the excitation process
(d) all are correct

45. Which of the following bonds absorb in the region 3800 – 2700 cm^{-1} (2.6 – 3.7 μm)
(a) O – H (b) N – H (c) C – H (d) a, b and c

46. Radio waves region of the spectrum generally lies between
(a) 1–100 m (b) 500–1000 m
(c) 1–1000 m (d) 100–500 m

47. Which of the following molecules are micro wave active?
(a) HCl (b) CO
(c) $CHCl_3$ (d) CH_3Cl

48. Which of the following involve a change in bond angle with reference to a set of co-ordinates arbitrarily set up within the molecule?
(a) rocking (b) Twisting
(c) torsional vibration (d) all

49. Which of the following is not involved in bending vibrations?
(a) Scissoring (b) rocking
(c) wagging (d) All

50. Strong polarity is directly related to infrared absorption. Thus there are no polar solvents that are transparent over large ranges of the infrare(d) Which of the following solvents are used in limited regions in infrared?
(a) Chloroform (b) dioxane
(c) dimethyl formamide (d) all

51. Which of the following process may occur in flames?
(a) translational, vibrational and rotational motions
(b) excitation
(c) ionization
(d) dissociation

52. Which of the following statements are correct?
(a) the transition of polar bonds like carbonyl. But not ethylene are affected by solvent polarity
(b) the $\pi \rightarrow \pi^*$ bands under go red shifts as solvent polarity is increased
(c) the $\pi \rightarrow \pi^*$ bands under blue shifts as solvent polarity is increased
(d) all are correct.

53. Which of the following is expected to have longer λ_{max} (nm) in hexane solvent?
(a) 1,3 – butadiene (b) 1,3 – cyclohexadiene
(c) 1,3 – cyclopentadiene (d) 1,3,5 – hexatriene

54. Electronic transitions in organic molecules in majority of cases involve transitions of
(a) σ – electrons (b) n – electrons
(c) π – electrons (d) all

55. Which of the following compounds absorb appreciably only in far UV region (below 200nm).
(a) $CH_2 = CH_2$ (b) CH_2COCH_3
(c) $CH_2 = CH - CH = CH_2$ (d) a and b

56. Which of the following compounds involves n→ σ* transition
(a) saturated halides (b) alcohols
(c) aldehydes (d) all

57. An absorption band around 170 – 190 nm is observed in unconjugated alkenes due to the transition.
(a) n→ σ* (b) n→ π*
(c) π→ π* (d) σ→π*

58. In order to excite the spectra of many metals in flame photometry which of the following is /are good oxidants
(a) oxygen (b) nitrogen
(c) nitrous oxide (d) a and c

59. The lowest energy transition is saturated aliphatic ketones around 280 nm is due to the transition
(a) n→ σ* (b) π→ π*
(c) n→ π* (d) none

60. Ethylene belongs to
(a) C_{2v} group (b) $D_{\infty h}$ group
(c) C_{2v} group (d) D_{2h} group

61. Which of the following symmetry operations is not correct?
(a) $i^2 = E$ (b) $\sigma^2 = E$
(c) $\vec{C_3} = \overleftarrow{C_3}$ (d) $\vec{C_3} \times \vec{C_3} = \overleftarrow{C_3}$

62. Which of the following statements is not correct with respect to group theory?
(a) Each group element has no reciprocal
(b) An element combines with itself to form another element of the group
(c) Each element of the group obey associative law of combination
(d) Two elements of a group combine to form a third element of a group

63. Which of the following items is not symmetry element?
(a) Inversion centre
(b) Plane of symmetry
(c) Optical activity
(d) Improper rotation

64. Linear molecules have ——— axis of rotation
(a) C_1 (b) C_∞ (c) C_3 (d) C_2

65. Which of the following symmetry element leaves the molecule or an object unchanged?
(a) Improper notation
(b) Proper notation
(c) Inversion axis
(d) Identity

66. The point group of $XeOF_4$ is
(a) C_{4v} (b) C_{6v}
(c) D_{3h} (d) D_{2h}

67. In proper rotation (C_n), an object is rotated through an angle of
(a) 4π/n radians (b) 2π/n radians
(c) 3π/n radians (d) π/n radians

68. In C_4-axis of rotation, an object is rotated through an angle of
(a) 90° (b) 180°
(c) 100° (d) 120°

69. Which of the following symmetry operations is not correct according to group theory?
(a) $\sigma_v \cdot \sigma_d = \sigma_v$ (b) $C_2 \cdot \sigma_v = \sigma_v'$
(c) $i^2 = E$ (d) $C_2E = EC_2$

70. Which of the following molecules belongs to C_3V point group?
(a) H_2O_2 (b) H_2S
(c) NH_3 (d) BF_3

71. Methane belongs to
(a) Tetrahedral group
(b) Octahedral group
(c) Special group
(d) $D_{\infty h}$

72. Which of the following molecules have centre of symmetry?
(a) CO_2 (b) HCl
(c) H_2O (d) H_2SO_4

73. How many planes of symmetry are present in benzene?
(a) 3 planes (b) 4 planes
(c) 6 planes (d) 7 planes

74. CO belong to which group?
(a) $D_{\infty h}$ (b) D_{2h}
(c) $C_{\infty v}$ (d) C_{2v}

75. PF_5 belongs to which point group
(a) D_{5h} (b) D_{4h}
(c) D_{3h} (d) D_{2h}

76. The energy associated with photon of light is
(a) $C = \upsilon\lambda$ (b) $E = h\upsilon$
(c) $E = hc$ (d) $E = mc^2$

77. Which of the following radiation has rotational phenomenon?
(a) Microwave (b) Ultra voilet
(c) Infrared (d) X-rays

78. Which of the following relationship is correct regarding molecular energy levels?
(a) E(rotational) > (E(vibrational) > E(electronic)
(b) E(electronic) > E(vibrationl) > E(rotational)
(c) E(vibrational) > E(electronic) > E(rotational)
(d) E(electronic) > E(rotational) > E(vibrational)

79. Which of the following radiation has high energy?
(a) Ultraviolet (b) Visible
(c) Microwaves (d) Radiowaves

80. If ν is the vibrational quantum number and ν_0 is the fundamental frequency (in cm^{-1}), the vibration energy is given by
(a) $E_\upsilon = \frac{1}{2} hc\,\nu_0$ (b) $E_\upsilon = \left(\upsilon - \frac{1}{2}\right) h\,\nu_0$
(c) $E_\upsilon = \left(\upsilon + \frac{1}{2}\right) hc\nu_0$ (d) $E_\upsilon = \left(\upsilon + \frac{1}{2}\right) h\,\nu_0$

81. Which of the following radiation has larger wavelength?
(a) Gamma rays (b) Ultraviolet
(c) Radio wave (d) Microwave

82. Which of the following radiation has vibrational transitions?
(a) γ-rays (b) Microwave
(c) Visible (d) Infrared

83. Which of the following technique is used for functional group identification
(a) ESR spectroscopy (b) FTIR spectroscopy
(c) NMR spectroscopy (d) UV-Vis spectroscopy

84. Which of the following radiation has high frequency?
(a) X-rays (b) Microwaves
(c) Infrared (d) γ-rays

ANSWERS

1	D	2	C	3	C	4	B	5	D	6	C	7	D
8	C	9	B	10	D	11	B	12	B	13	A	14	A
15	D	16	C	17	A	18	C	19	D	20	C	21	D
22	B	23	A	24	D	25	C	26	D	27	A	28	A
29	D	30	C	31	D	32	B	33	D	34	A	35	C
36	C	37	D	38	A	39	A	40	D	41	A	42	C
43	D	44	D	45	D	46	A	47	C	48	D	49	D
50	D	51	C	52	C	53	D	54	D	55	D	56	D
57	C	58	D	59	C	60	D	61	C	62	A	63	C
64	B	65	D	66	A	67	B	68	A	69	A	70	C
71	A	72	A	73	D	74	C	75	C	76	B	77	A
78	B	79	A	80	C	81	C	82	D	83	B	84	D

22. SOLUTION CHEMISTRY

A true solution is defined as a homogeneous mixture of two or more substances that form a single phase. **Solute**: The constituents of a solution are generally referred to as the solute and the solvent. A solute is frequently a substance that dissolves and a solvent is one in which dissolution takes place.**Solvent:** The solvent is generally present in large amount in comparison to the solute. A solution containing only two components is called a **binary solution**.

When a solution contains, at a given temperature as much solute as can be dissolved, the solution is said to be **saturated** If the quantity of solute is less than this amount, it is known as **unsaturated** solution. A **dilute solution** is one in which the quantity of solute is very small as compared to that of solvent. A **concentrated solution** contains relatively higher amount of solute.

Mass percent of a solution

The mass percent of component B in a solution is given by

$$\text{Mass percent of B} = \frac{W_B}{W_A + W_B} \times 100$$

where W_A and W_B are the masses of A and B respectively.

Molarity of a solution is defined as the no. of moles of solute per dm^3 of the solution at a given temperature. It is represented by M.

$$\text{Molarity} = \frac{\text{Number of moles of solute}}{\text{Volume in } dm^3 \text{ of the solution}}$$

Formality is used for solutions of ionic substances. It is the number of formula weights dissolved per dm^3 of the solution at a given temperature. It is usually denoted by F.

Normality of a solution is defined as the number of gram equivalents of the solute dissolved per dm^3 of the solution at a given temperature. It is denoted by N.

$$\text{Normality} = \frac{\text{Number of gram equivalents of solute}}{\text{Volume in } dm^3 \text{ of the solution}}$$

Molality is defined as the number of moles of solute dissolved in one kg of the solvent. It is usually denoted by m.

$$\text{Molality} = \frac{\text{Number of moles of solute}}{\text{Weight of solvent in kg}}$$

Mole fraction of a component in a solution is given by the ratio of the number of moles of that component to the number of moles of all the components present in the solution. $X_A = \frac{n_A}{n_A + n_B}$

Henry's law states that the s olubility of a gas in a given volume of the liquid at constant temperature is directly proportional to the pressure of the gas.

Raoult's law states that at a given temperature, the vapour pressure of any volatile component of a solution is equal to the vapour pressure of pure component multiplied by mole fraction of that component in a solution.

Ideal and non-ideal solutions

Solutions which obey Raoult's law over the whole range of concentrations are called ideal solutions. Moreover, in ideal solutions, there is complete uniformity in cohesive forces. The solutions which do not obey Raoult's law are known as non-ideal or real solutions.

The deviations from ideal behavior are due to the differences in the molecular structures of the two components which result in the difference in the intermolecular forces.

Concentration and activity: The concentration of a solution is defined as the number of moles of solute dissolved per unit volume of the solution or in a given amount of the solvent. The effective concentration of a solute in a solution is called its activity.

Colligative properties: Colligative properties are those properties which depend only on the number of particles of the solute in the solution and not any way on the nature of particles. For example, lowering of vapour pressure, evaluation in boiling points, depression in freezing points and osmotic pressure.

Elevation of boiling points: The difference between the boiling point of a solution and a pure solvent is known as the elevation of boiling point.

Ebullioscopic constant: It is defined as the elevation is boiling point of a solution of unit molality. It is also known as molal elevation constant.

Freezing point of a liquid: It is the temperature at which the solid phase begins to separate out from the liquid. At this temperature, solid and liquid phases are in equilibrium and have equal pressures.

Cryoscopic constant: It is defined as the depression in freezing point of a solution of unit molality. It is also known as molal depression constant.

Osmosis and osmotic pressure: When a solution is separated from a pure solvent by a suitable membrane, there is a spontaneous flow of solvent into the solution. This phenomenon is known as osmosis. By applying a certain pressure to the solution, osmosis can be prevented The minimum pressure required to prevent osmosis is known as osmotic pressure.

Difference between osmosis and diffusion: In osmosis, there is a flow of solvent into the solution through a semi-permeable membrane. On the other hand, diffusion involves a flow of both the solute and solvent and no semi-permeable membrane is require(d)

Application of colligative properties: The colligative properties are used to determine molecular mass of non-volatile and non-electrolyte solute.

Van't Hoff factor: It is defined as the ratio of the experimental value of a colligative property to the calculated value of that property.

$$i = \frac{\text{Experiental value of any colligative property}}{\text{Calculated value of that colligative property}}$$

Azeotropic mixture: A mixture of two or more liquids which distils at a given constant temperature and has a constant composition, at a given pressure.

MULTIPLE CHOICE QUESTIONS

1. Under constant pressure, the solubility of a gas
   (a) increases with increase in temperature
   (b) decrease with increase in temperature
   (c) is generally independent of temperature
   (d) increases with increase in temperature at first and then becomes constant

2. Excess of pressure which must be applied to the solution in order to prevent the passage of solvent molecules into solution from pure water or solution of lower concentration through a semi permeable membrane
   (a) osmotic pressure (b) osmosis
   (c) turgor pressure (d) none of the above

3. Solutions with components which obey Raoult's law over the entice composition range are said to be
   (a) real solutions (b) dilute solutions
   (c) binary solutions (d) ideal solutions

4. The law which relates the solubility of a gas to its pressure is called
   (a) Raoult's law (b) The distribution law
   (c) Henry's law (d) Ostwald's law

5. The osmotic pressure of a solution with a definite concentration
   (a) varies directly as the volume and temperature
   (b) varies directly as the temperature
   (c) varies inversely as the volume and directly as the temperature
   (d) independent of temperature but varies inversely as the volume

6. In a binary solution X_1 and X_2 are the mole fractions of the two components having P_1 and P_2 vapour pressure, respectively. The total pressure above the solution (assuming to be ideal) is
   (a) $(P_1-P_2)X_1+P_2$ (b) $P_1X_1-P_2X_2$
   (c) $(P_2+P_1)X_2-X_1P_2$ (d) $(P_2-P_1)X_1-(P_1-P_2)X_1$

7. Sugar is soluble in water due to
   (a) High solvation energy (b) High dipole moment of water
   (c) Ionic character of sugar (d) Hydrogen bond formation

8. The ratio between the effective concentration and actual concentration of ion in solution is called
   (a) Effective concentration (b) apparent concentration
   (c) activity coefficient (d) none of the above

9. The experimental molecular mass of an electrolyte will always be less than its calculated value because the value of Van't Hoff factor (*i*) is
   (a) Less than 1 (b) greater than 1
   (c) equal to 1 (d) zero

10. In which mode of expression the concentration of a solution remains independent of temperature
    (a) Molarity (b) Normality
    (c) Formality (d) Molality

11. At constant temperature, the osmotic pressure of a solution is
    (a) Directly proportional to the concentration
    (b) Inversely proportional to the concentration
    (c) Directly proportional to the square of the concentration
    (d) Directly proportional to the square root of the concentration

12. The temperature at which two conjugate solutions change into one homogeneous solution is called the
    (a) azeotropic (b) conjugate temperature
    (c) consolute temperature (d) transition temperature

13. Mixtures corresponding to either a minimum or maximum in boiling point curves are called
    (a) eutectic mixtures (b) azeotropic mixtures
    (c) consolute mixtures (d) ideal mixtures

14. A 2M solution of H_2SO_4 would have how many moles of H^+ ion in one liter?
    (a) 1.0 (b) 2.0
    (c) 3.0 (d) 4.0

15. The relative lowering of vapour pressure of a solution containing a non-volatile, non-electrolyte solute is equal to the mole fraction of the solute was stated by
    (a) Raoult's law (b) Henry's law

(c) Cottrell's law (d) none of the above

16. Which of the following aqueous solutions would exhibit abnormal osmotic pressure?
(a) 0.1*M* NaCl (b) 0.1*M* glucose
(c) 0.01*M* glucose (d) 0.1*M* urea

17. The number of moles of solute dissolved in 1000 gram of the solvent is called
(a) Formality (b) Molality
(c) Molarity (d) Mole fraction

18. Colligative properties depend upon the
(a) relative number of solute molecules in solution and the nature of the solvent
(b) relative number of solute molecules in solution and their nature
(c) relative number of solute molecule and the nature of solute and solvent
(d) relative number of solute molecules, irrespective of the nature of the solute and solvent

19. A pH of a neutral solution at 100°C when Kw = 1.0×10^{-12} is
(a) 0 (b) 7
(c) 6 (d) 2

20. If one component obeys Raoult's law over the entire range of compositions then, for an ideal solution
(a) the second component must obey Henry's law over the entire composition range
(b) the second component must obey Raoult's law over the entire composition range

21. The relative lowering of vapour pressure of a solution on the addition of a non-volatile solute
(a) is equal to the mole fraction of solute
(b) is equal to the sum of the mole fraction of solute and solvent
(c) depends upon the nature of the solute
(d) depends upon the nature of the solute and solvent

22. The weight of the solute dissolved per dm^3 of the solution is called
(a) Mole fraction (b) Normality
(c) Formality (d) Molality

23. An azeotropic mixture of two liquids has a boiling point lower than either of them, when it
(a) Shows (–) ve deviation from Raoult's law
(b) Shows (+) ve deviation from Raoult's law
(c) Shows no deviation from Raoult's law
(d) Is saturated

24. How much amount of NaOH is required to propane 100 mL of 1N solution?
(a) 40 g (b) 80 g
(c) 4 g (d) 0.4 g

25. The pink colour of phenolphthalein in basic medium is due to the
(a) Cationic form (b) anionic form
(c) Neutral form (d) OH^- ions of the base

26. Which of the solution has highest normality
(a) 8 g of KOH per dm^3 (b) 1 *N* H_3PO_4
(c) 6 g of NaOH per 100 cm^3 (d) 0.5 M H_2SO_4

27. One ppm solution of NaOH contains 1000 mg of the solute per how much of the volume of the solution?
(a) 1000 mL (b) 100 mL
(c) 10 mL (d) 1 mL

28. By adding a non-volatile solute to a solvent, the boiling point of the solvent
(a) will increase (b) will decrease
(c) will not change d may increase or decrease

29. The number of gram equivalents of the solute per dm^3 of the solution is called
(a) Formality (b) Normality
(c) Molality (d) Molarity

30. The normality 2.3 *M* H_2SO_4 solution is
(a) 0.46 *N* (b) 0.23 *N*
(c) 2.3 *N* (d) 4.6*N*

31. The depression in freezing method is called
(a) cryoscopy (b) intoscopy
(c) azeotropic (d) none of the above

32. According to Arrhenius theory, an acid is defined as substance which
(a) Accepts an electron pair (b) Donates H^+ ion in ammonia
(c) Contains Cl^- ions (d) Furnishes H_3O^+ ion in water

33. Addition of common salt to a sample of water will
(a) Increase its freezing point and increase the boiling point
(b) Decrease its freezing point and increase the boiling point
(c) Increase both the boiling point and the freezing point
(d) Decrease both the boiling point and the freezing point

34. The sum of pH and pOH in aqueous solution is equal to
(a) 14 (b) Zero
(c) pKw (d) 7

35. The number of moles of the solute dissolved per dm^3 of the solution is called
(a) Molality (b) Formality
(c) Normality (d) Molarity

36. The correct order of acidic strength is
(a) HF < HCl < HI < HBr (b) HI < HBr < HCl < HF
(c) HI < HBr < HF < HCl (d) HF < HCl < HBr < HI

37. The process by which solvent molecules pass through a semipermeable membrane from a pure solvent into a solution is called
(a) diffusion (b) osmosis
(c) dialysis (d) none of the above

38. A molal solution is one that contains one mole of a solute in
(a) 1000 g of the solvent (b) One liter of the solvent
(c) One liter of the solution (d) 22.4 liters of the solution

39. One litre solution of NaOH contains 4.0 g of it. What will be the difference between molarity and normality? (Moler mass = 40)
(a) 0.10 (b) 0.05
(c) 0.02 (d) Zero

40. A 10% solution of sucrose contains 10g of sucrose in how much volume of the solution?
(a) 10 mL (b) 100 mL
(c) 1000 mL (d) 1 mL

41. Which of the following solution will have the highest boiling point?
(a) 1% solution of glucose in water (b) 1 % solution of sucrose in water
(c) 1% solution of sodium chloride in water (d) 1% solution of calcium chloride in water

42. 30 cm^3 of an acidic solution is neutralized by 15 cm^3 of 0.2 *N* base. The strength of acid solution is
(a) 0.1 *N* (b) 0.15 *N*
(c) 0.3 *N* (d) 0.4 *N*

43. The pKa of an acid having ionization constant 1×10^{-5} is
(a) −5 (b) 5
(c) 9 (d) −9

44. Which of the following will have the largest pH?
(a) 0.1 N HCl (b) 0.1 N CH_3COOH
(c) 0.1 N NaOH (d) 0.01 N NaOH

45. Which of the following will have the highest boiling point at one atmospheric pressure?
(a) 0.1*M* solution of common salt (b) 0.1*M* solution of sucrose
(c) 0 1*M* solution of barium chloride (d) 0.1*M* solution of potassium chloride

46. Which of the following solutions would have the largest depression in freezing point?
(a) 1% glucose (b) 1%KCl
(c) 1% $BaCl_2$ (d) 1% sucrose

47. The molarity of a 500 mL solution containing 4g NaOH (Mol mass = 40) is
(a) 0.1 (b) 0.2
(c) 0.3 (d) 0.4

48. Which of the following concentration term is used in respect of standard solutions?
(a) Normality (b) Formality
(c) Molarity (d) All of above

49. If 20 ml of 0.5 N salt solution is diluted to one litre, what is the new concentration?
(a) 0.01 N (b) 0.00 1N
(c) 1N (d) 10 N

50. Which of the following 0.1 M aqueous solutions will have the Lowest freezing point
(a) Potassium sulphate (b) Sodium chloride
(c) Urea (d) glucose

ANSWERS

1	A	2	A	3	D	4	C	5	C	6	A	7	D
8	C	9	B	10	D	11	A	12	A	13	B	14	D
15	A	16	A	17	B	18	A	19	C	20	A	21	A
22	C	23	B	24	C	25	B	26	C	27	A	28	A
29	B	30	A	31	A	32	D	33	B	34	c	35	d
36	D	37	B	38	A	39	D	40	B	41	B	42	A
43	B	44	C	45	C	46	C	47	B	48	D	49	A
50	a												

PART III: ORGANIC CHEMISTRY

23. INTRODUCTION TO ORGANIC CHEMISTRY

Introduction

Previously, Organic chemistry was defined as the chemistry of substances found in living organisms and it was thought at that time that the organic compounds cannot be synthesized outside the living organisms in the laboratory. This theory was called vital force theory which was rejected by Friedrick Wohler when he successfully synthesized urea, an organic compound, from the urine of the mammals. This lead to the modification of the definition of the organic compounds broadly defined as "the compounds of the carbon, hydrogen and their derivates" hence also called hydrocarbons. In this regard, it is important to mention that the basic frame work of the organic compounds is originated from the self linking property of the carbon which is termed as catenation. There are few exceptions including CO, CO_2, carbonates and bicarbonate which are not considered as organic compounds due to historical and conventional reasons. All other compounds are considered as inorganic compounds. The Organic compounds differ in various properties from inorganic compounds as the earlier has lower melting and boiling point, form more complex products, reaction rates are slow, requires higher temperature for reactions, produce more side products, less stable and more numerous than the later. The main sources of the hydrocarbons include.coal natural gas and petroleum. The purification of organic compounds can be carried out using two types of methods including physical and chemicals methods.

1. Physical methods of purification:

A large number of methods are available for the purification of substances. The choice of method, however, depends upon the nature of substance (whether solid or liquid) and the type of impurities present in it. Following methods are commonly used for this purpose,

i. Simple crystallisation
ii. Fractional crystallisation
iii. Sublimation
iv. Simple distillation
v. Fractional distillation
vi. Distillation under reduced pressure
vii. Steam distillation
viii. Azotropic distillation
ix. Chromatography
x. Differential extraction

Crystallization:

The organic compounds can be purified by dissolving a substance containing the organic compound of interest in such a solvent, in which it is more soluble at higher temperature as compared to the room temperature followed by crystallization. The fractional crystallization of sample in compounds is carried out to remove the impurities.

Sublimation:

The sublimation is a process in which a solid substance directly changes into its vapors without being converted into liquid. This method is used for the separation of volatile substances from the non volatile ones. Moreover, two immiscible solvents or liquids can be separated from each other using a separatory funnel. For example essential oils can be separated from water using a separatory funnel.

Distillation:

One or two liquids can be separated by heating the mixture of the liquids followed by the condensation of their vapors separately. This process is termed as distillation. For separation of two or

more liquids, the process of fractional distillation is used. Fractional distillation is based on the boiling points of liquids. Fractional distillation of liquid mixture components is possible only if they do not form a constant boiling mixture. Notably, the vacuum distillation is useful for those substances which decompose at their boiling points. In vacuum distillation, the substance starts boiling at lower temperature than their boiling point at atmospheric pressure. For example essential oils are purified from traces of organic solvents using vacuum distillation or vacuum evaporation. Many substances become volatile in steam as their boiling point reduce in steam which leads to the separation/purification of these compounds. Steam distillation is the one of the most widely used methods for extraction of essential oil form different parts of the plants.

Solvent extraction:

Solvent extraction can also be used as purification method for organic compounds. This method is based on distribution of substance between two immiscible solvents, for example, water and benzene. When two substances of different boiling points in a mixture give a single boiling point such a mixture is termed as azotropic mixture. In this regard, mixture of water and ethanol can be considered a good example of this which form azotropic mixture in the ratio of 4.13: 95.87, respectively boiling at 78.13°C. The azotropic mixtures can be purified using dehydrating agents which pose depressing effect on one of the component of the mixture. The low boiling point dehydrating agents such as diethyl ether, benzene, carbon tetrachloride cause a depression in the partial pressure of alcohol than water. Whereas high boiling point dehydrating agents such as glycerol or ethylene glycol depress the partial pressure of water than alcohol. Hence, in both cases the separation of components of azotropic mixture is easily possible separating the alcohol first followed by water.

Chromatography:

The chromatography, discovered by Tswett (1906), is considered one of the well established methods used for the separation of the compounds. The separation of the mixture by this method involves two phases including stationery phase (liquid or solid) and mobile phase (gas or liquid). The substances to be separated are dissolved in the mobile phase which leads to the separation of the components of substances due to their varying affinity with the stationary and mobile phases.

Gas chromatography can only be applicable to the volatile compounds. The commonly used stationary phases in this type of chromatography include silica, alumina, carbon, diatomaceous earth or kieselguhr whereas higher molecular weight hydrocarbons supported on stationary phases used in gas solid chromatography. The most commonly used mobile phases in gas chromatography are nitrogen, helium and argon etc. Notably, the hydrogen is less commonly used due to its explosive nature.

In liquid chromatography the mobile phase may be hydrophilic or hydrophobic liquid. In normal phase chromatography mobile phase is hydrophilic (e.g. H_2O) and stationary phase is hydrophobic in nature. On the other hand, in the reversed phase chromatography the mobile phase is hydrophobic (e.g. HC's) and stationary phase is hydrophilic. The Ion-exchange chromatography can be cation exchange or anion exchange chromatography. In the cation exchange chromatography, the cations of solution mixture are exchanged with the stationary phase while in the anion exchange chromatography, anions are exchanged with the stationary phase resin.

Gel exclusion chromatography, also known as molecular sieving chromatography, separates the molecules on the basis of their sizes. The large molecules are eluted first from the column followed by the elution of the smaller molecules. This chromatographic technique is very important analytical technique in biological separation e.g. purification of proteins. The distillation is used to separate liquid from solid, fractional distillation to separate two or more liquids and fractional crystallization to purify solids.

2. Purification of organic compounds by chemical methods

Although physical methods are more suitable for purification purposes, but sometimes chemical methods are also employed. In chemical methods, the substance to be purified is converted to some other substance. Few examples are presented here for the better understanding:

1. The aldehydes and ketones on treating with saturated solution of sodium bisulphite are converted into crystalline sodium bisulphite compounds called ketals. The newly formed crystals will be free from impurities and aldehydes and ketones are regenerated from these crystals.
2. The purity of organic substances can be identified from sharp melting point. These methods rely upon the differentiating chemical properties of one class of organic compounds from the others. For example, the Phenols can be separated from carboxylic acids on treatment with an aqueous solution of $NaHCO_3$ as the carboxylic acids get dissolved in the solution evolving CO_2 but phenols usually do not give any reaction.
3. The destructive distillation of wood leads to pyroligneous acid which acetic acid, acetone and methanol. The acetic acid can be separated out from this mixture by treating it with milk of lime which leads to the formation of calcium salt of acetic acid which on on distillation gives a mixture of acetone and methanol while the calcium salt of acetic acid remains as residue in the flask. The calcium salt is decomposed with dil HCl and distilled to get acetic acid.
4. Another example is the separation of the mixture of 1, 2 and 3 amines by using either benzenesulphonyl chloride (Hinsberg's reagent) or diethyl oxalate (Hoffmann's method).
5. The commercial benzene acquired from distillation of the coal-tar contains 3-5% thiophene as an impurity which can be removed by extraction with conc.H_2SO_4. This separation is due to the reason that the thiophene is sulphonated much easily compared to benzene. Thus, if commercial benzene is mixed with conc.H_2SO_4 in a separating funnel, thiophene undergoes sulphonation to form thiophene-2-sulphonic acid which dissolves in conc.H_2SO_4 while benzene does not go through this reaction and its layer is removed, washed with water to remove unreacted conc.H_2SO_4, dried over anhydrous $CaCl_2$ followed by distillation to obtain pure benzene.
6. Absolute alcohol from rectified spirit (ethanol: water is 95.87:4.13, by weight) is treated with quick lime (CaO) for few hours followed by reflux. This leads to formation of $Ca(OH)_2$ by the combination of water present in rectified spirit with quick lime. From the resulting mixture, on distillation, absolute alcohol distils leaving $Ca(OH)_2$ behind.

Drying of Organic Substances

i. Solid organic compounds are dried by pressing them between folds of filter papers. The compounds which does not decompose or melt on heating below 100 Ć can be dried by keeping them in steam or oven maintained at 110 Ć. The substances which decompose on heating are dried by putting them in a vacuum desiccator which has a appropriate dehydrating/ desiccating agent like fused $CaCl_2$, conc.H_2SO_4, solid KOH or NaOH.

ii. Liquid organic compounds are generally dried by keeping them over night in contact with a dehydrating/desiccating agent which does not react chemically with the liquid to be dried. Few examples of the dehydrating/desiccating agents include quick lime, anhydrous $CaCl_2$, fused $CuSO_4$ or $CaSO_4$ or KOH, metallic sodium or potassium.

Purity of organic compounds: The purity of an organic compound can be confirmed by the determination of its some physical properties including melting point, boiling point, specific gravity, refractive index and viscosity. Generally, sharp melting point and boiling point are considered as criteria for the purity of the organic compounds.

Mixed melting point: The melting point of two thoroughly mixed substances is termed as mixed melting point which can also be used for determining the purity of the organic compounds. The substance which

is to be tested for the purity is mixed with a pure sample of the same compound and melting point of the mixture is determined. If the melting point of the mixture is sharp and comes out to be the same as that of pure compound, it indicates that the compound under investigation is pure. On the other hand, if the melting point of the mixture is less than the melting point of the pure compound, the compound is not pure.

(i) Qualitative analysis of organic compounds

Qualitative analyses of organic compounds are performed to determine the identity (elements) of that compound. For example, Lassaign's sodium fusion technique can be used for detection of nitrogen, sulphur, halogens and phosphorus.

(a) Lassaign's Test

(b) Beilstein test for halogen detection

A small amount of organic compound heated on a copper wire. A green or bluish green color in the Bunsen flame due to formation of cupric halide confirms the presence of halogen in the substance under investigating.

(ii) Quantitative analysis of organic compounds

(A) Estimation of carbon and hydrogen

It can be easily done using Heibig's method. In the method, an organic compound is heated with copper oxide in the presence of constant supply of air and oxygen. The produced CO_2 vapors are absorbed in potash solution whereas H_2O vapors are absorbed in $CaCl_2$ solution. Thus weights of C and H can be determined from gain of potash and $CaCl_2$ solution containing tubes.

(B) Estimation of nitrogen

(a) Duma's Method

$$\text{Organic compound + cupric oxide} \xrightarrow[\text{Atmosphere of } CO_2]{\text{Heated in an}} N_2$$

(b)Kjeldahl's method

It is used for determination of nitrogen

(c) Estimation of halogens, sulphur and phosphorus

Carius method is used for the estimation of halogen, sulphur and phosphorus.

(d) Halogen estimation

Organic compound + Conc. HNO_3 + $AgNO_3$ ⟶ CO_2 + H_2O + Silver halide (weighed)

(e) Sulphur estimation

Organic compound + Conc HNO_3+$BaCl_2$ ⟶ $BaSO_4$ (weighed)

(f) Phosphorus Estimation

Org comp + Conc.HNO_3 + Ammonium molybdate ⟶ $(NH_4)_3PO_4.12MoO_3$ (weighed)

Ammonium phosphomolybdate

(g) Estimation of Oxygen:

% oxygen = 100 – (% of all other elements)

(h) Detection of metal by traditional methods

In this method organic compound is heated in a furnace to form residual metal oxide. This residual metal oxide is analyzed by inorganic qualitative analysis.

Summery of separation methods

- **Filteration**
  For the separation of insoluble solid in liquid
- **Sublimation**
  To separate volatile solid from non-volatile one
- **Distillation**
  To separate soluble solid from liquid
- **Fractional Crystallization**
  For separation of two soluble solids from a liquid
- **Fractional distillation**
  To separate two or more miscible liquids

MULTIPLE CHOICE QUESTIONS

Select the correct choice:

1. Sugar juice can be purified and concentrated by?
   (a) Vacuum distillation (b) distillation
   (c) Fractional crystallization (d) sublimation
2. In which method of steam distillation the vapor pressure of volatile organic compound becomes?
   (a) less than atmospheric pressure (b) Equal to atmospheric pressure.
   (c) More than atmospheric pressure (d) None of these
3. Hexane and acetone present in mixture can be purified or separated by?
   (a) Steam distillation (b) Hydro distillation
   (c) Vacuum distillation (d) Fractional distillation
4. An organic compound present in water can be easily separated by?
   (a) Evaporation (b) Solvent extraction.
   (c) Distillation (d) Steam distillation
5. Fractional distillation is useful to separate liquids with a difference in their boiling point at least of?
   (a)5 °C (b)25°C
   (c)30 °C (d)15 °C
6. Two liquids can be separated by steam distillation is difference in their boiling points is more than?
   (a)20 °C (b)10 °C
   (c) 30 °C (d)2 °C
7. Chromatographic methods are useful to separate?
   (a) Color compounds (c) Volatiles
   (d) Stable compounds (d) All of these.
8. Non-volatiles cannot be separated and analyzed using?
   (a) HPLC (b) GC
   (c) Ion-exchange (d) Column chromatography
9. Halogen can be estimated by?
   (a) Duma's method. (b) Carius method
   (c) Leibig's method (d) All of the above
10. Nitrogen in organic compounds can be analyzed by?
    (a) Duma's method (b) Carius method
    (c) Beibigs method (d) None of these.

11. C and H presence in an organic compound ca be easily confirmed by?
(a) Duma's metdod (b) Carius method
(c) Beibigs method (d) None of these.

12. Phorsphorus is conveted into ——— for its estimation?
(a) H_3PO_4 (b) $Mg_2P_2O_7$
(c) P_2O_5 (d) P_2O_3

13. Determine the empirical formula of compound containing C = 80% H = 6.7% and O = 53.3%?
(a) CH_2O (b) C_2H_2O
(c) CHO_2 (d) $C_2H_4O_2$

14. % of C present in CO_2 is?
(a) 2.5% (b) 33.33%
(c) 27.27% (d) 50%

15. If empirical molecular weight of a substance is 30 g and molecular weight is 6 0g. Then what will be its possible molecular formula?
(a) $C_2H_4O_2$ (b) CH_3COOCH_3
(c) HCOOH (d) C_2H_5OH

16. In kjeldah's method, nitrogen present in estimated as?
(a) NH_3 (b) N_2O
(c) N_2 (d) NO_2

17. P-nitrophenol can be separated from nitrophenol by steam distillation due to its?
(a) Higher boiling point (b) Lower boiling point
(c) Same boiling point. (d) Can't be separated.

18. In Lassaigne's test N is converted into?
(a) NH_3 (b) NH_2CONH_2
(c) NH_4Cl (d) Ferri-ferrocyanide

19. $NH_2NH_2.2HCl$ ——— detected by Lassaigne's test?
(a) Can not be (b) Can be
(c) May be (d) A and b

20. Nitrogen in an organic compound is determined in the from of?
(a) NH_3 (b) NaCN
(c) Gaseous N_2 (d) N_2O

21. Nitrogen, sulphur and halogen can be detected by?
(a) Dama's test (b) Caruiss method
(c) Lassaigne's test (d) All of these

22. Following gas can not be used as a carrier gas in gas chromatography?
(a) Hydrogen (b) Nitrogen
(c) Helium (d) Oxygen

23. Which of following effects will occur by slow injection of a large sample volume?
(a) No considerable effect (b) Increased resolution
(c) Decreased resolution (d) linear detector response

24. Following is used for layering _____ in thin layer chromatography.
(a) Quartz (b) Opal
(c) Carboxylic acid (d) Silicon dioxide

25. Crude petroleum can be separated on the basis of boiling points into various fractions by?
(a) Preparative chromatography (b) Cracking

(c) the contact process (d) fractional distillation

26. Physical methods can be used to separate?
(a) a pair of diastereomers (b) a pair of enantiomers
(c) a pair of identical atoms (d) a pair of identical molecules

27. Physical methods can be used to separate?
(a) (R)-2-bromobutane and (S)-2-bromobutane
(b) cis-2-bromo-2-butene and trans-2-bromo-2-butene
(c) (R)-3-bromo-1-butene and (S)-3-bromo-1-butene
(d) (2R,3S)-1,2-dibromobutane and (2S,3R)-1,2-dibromobutane

28. The reagent that can distinguish aldehydes and ketones is
a) Schiff's reagent (b)Fehling's solution
(c) Tollen's reagent (d)All are correct

29. Which of the following ketone will give positive iodoform test
a) 2-pentanone (b)3-hexanone
(c) 3-heptanone (d)4-hexanone

30. Diazotization is done at
(a)5-10 °C (b)0-5 °C (c)10-20 °C (d)0-(-5) °C

31. In which of the following solvents would the reaction of 1-bromobutane with sodium azide, NaN_3, proceed the fastest?
a) Ethanol (b)Water (c)Acetic Acid (d) Acetonitrile

32. In Organic analysis Lassaigne test is employed for
a) Nitrogenous functional groups
b) Halogens and sulphur based functional groups
c) Elemental analysis
d) Both A & B

33. In Lassaigne test nitrogen is identified by detecting
a) Cyanide (b)Amine (c)Nitride (d)None of these

34. In Lassaigne test, sulphur is identified by detecting
a) Sulphate ion (b)Thiols (c)Sulphide (d)None of these

35. Chloroform layer test is employed for detection of
a) Halogens (b)Carbonyls (c)Amines (d)None of these

36. Bromine test is employed to detect
(a)Unsaturation (b) Carbohydrates (c) Carbonyls (d)None of these

37. Aromatic alcohols can be identified by
(a)Natural ferric chloride (b) btest Baeyer test
(c)Dinitrophenyl Hydrazine test (d) None of these

38. Which one is not a test for detection of carbonyls
a) Dinitrophenylhydrazine (b)Tollen test
(c) Schiff test (d)Molisch test

39. Which one is not a test for detection of amine
a) Locas test (b)Hydrooxamic acid test
(c) Diazotization test (d)Tollen test

40. Phenolphthalein is an indicator for
a) Mild to strong alkaline condition (b)Acidic conditions
(b) Neutral conditions (c)Both A & B

41. Which one is not a test for detection of carbohydrats
(a) Molisch test (b) Conc. H_2SO_4
(c) Benedict test (d) Formalin test

42. Main source of organic compounds is.
(a) Animal (b) Fossil
(c) Coal (d) Plants

43. Octane number can be improved by?
(a) Isomerization (b) Adding (C2H5)4 Pb
(c) Adding (CH3)4 Pb (d) All

44. Hydro carbons which burn with smoky flame are called?
(a) Aliphatic (b) Alicyclic
(c) Aromatic (d) Aldehyde

45. Octane number 2 2 4-trimethyl pentane is?
(a) 100 (b) 90
(c) 80 (d) 60

46. Propene can exhibit
(a) cis-trans isomerism (b) geometric isomerism
(c) both a & b (d) none of the above

47. Geometric isomerism is usually found in?
(a) Alkanes (b) Alkenes
(c) Alkynes (d) Esters

48. Pentane and 2-methyl butance have the same?
(a) Boiling point (b) Melting point
(c) Percentage composition (d) Structural formula

49. Organic compounds that are essentially nonpolar and exhibit weak intermolecular forces have
(a) Low melting points (b) Low vapour pressure
(c) High boiling points (d) High electrical conductivity

50. The first organic compound was synthesized in laboratory by?
(a) Wohler (b) Kolbe
(c) Berzilius (d) Berthelot

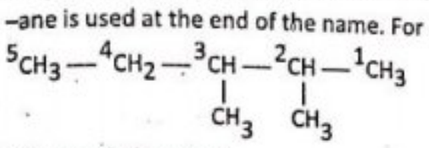
ANSWERS

1.	a	2.	a	3.	d	4.	b	5.	c
6.	c	7.	d	8.	b	9.	b	10.	a
11.	c	12.	b	13.	b	14.	c	15.	a
16.	a	17.	a	18.	d	19.	d	20.	c
21.	c	22.	d	23.	c	24.	d	25.	d
26.	a.	27.	b	28.	d.	29.	a.	30.	b.
31.	d.	32.	c.	33,	a.	34.	c.	35.	a.
36.	a.	37.	a.	38.	d.	39.	d.	40.	a.
41.	d.	42.	a.	43.	d.	44.	c.	45.	a.
46.	d.	47.	b.	48.	c.	49.	a.	50.	a.

24. NOMENCLATURE ORGANIC COMPOUNDS

Organic compounds widely differ from their common names. Each compound has unique name according to International Union of Pure and Applied Chemistry (IUPAC). But some compounds has common name such as vitamin A, benzene, acetone, cholesterol etc .and in use and still stay famous.

Alkanes are also called as paraffins and are represented by general formula C_nH_{2n+2}. Common suffix –ane is used at the end of the name. For example



2,3-dimethyl pentane

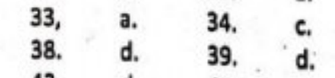
The names of alkanes are derive from Greek prefix. In alkane the name of the compounds depend on the particular number of carbon atom and it can also end with ane The name of first ten alkanes are shows in the following table.

Name	Molecular formula	Condensed Structural Formula	Boiling point (°C)
Methane	CH_4	CH_4	–161
Ethane	C_2H_6	$CH_3\ CH_3$	–89
Propane	C_3H_8	$CH_3\ CH_2\ CH_3$	–44
Butane	C_4H_{10}	$CH_3\ CH_2\ CH_2CH_3$	–0.5
Pentane	C_5H_{12}	$CH_3\ CH_2\ CH_2\ CH_2CH_3$	36
Hexane	C_6H_{14}	$CH_3\ CH_2\ CH_2\ CH_2\ CH_2\ CH_3$	68
Heptane	C_7H_{16}	$CH_3\ CH_2\ CH_2\ CH_2\ CH_2\ CH_2CH_3$	98
Octane	C_8H_{18}	$CH_3\ CH_2\ CH_2\ CH_2\ CH_2\ CH_2\ CH_2\ CH_3$	125
Nonane	C_9H_{20}	$CH_3\ CH_2\ CH_2\ CH_2\ CH_2\ CH_2\ CH_2\ CH_2CH_3$	151
Decane	$C_{10}H_{22}$	$CH_3\ CH_2\ CH_2\ CH_2\ CH_2\ CH_2\ CH_2\ CH_2\ CH_2\ CH_3$	174

Alkenes are also called as Olefins. They have general formula C_2H_{2n} and contain at least one double bond. By replacing the suffix ane by ene they are named. For example.

Propene

Alkynes are also called as acetylenes. There name ends with suffix –yne and represented by general formula C_nH_{2n-2} and they have atleast one triple bond. For example



2-Pentyne

Alcohols

These are also known as alkanol and alcohol are named by replacing the –e in alkane by –ol .

For example

Butanol

Dihydric alcohol and diols :are those alcohol that contain two hydroxyl group .for exampleF

$HOCH_2 — CH_2OH$

Ethane-1,2-diol (Ethylene glycol)

Triols or trihydric alcohols : Are those alcohol that have three hydroxyl groups. For example

$HOCH_2CH_2(OH)CH_2OH$

Propane-1,2,3-triol

(Glycerol)

Mericaptans: Thio alcohol are also called as mericaptans. Their name ends with "thiol". For example

$CH_3CH_2 — SH$ Ethane thiol

Aldehydes

The name of an aldehyde is derived by replacing "–e" of the corresponding alkane with "al according to IUPAC system". For example

HCHO Methanal

The general formula for aldehydes is C_nH_{2n+1} CHO.

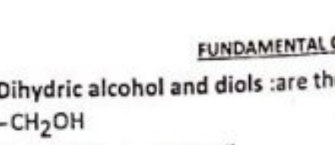
Ketones

In the numbering of the ketones chain the carbonyl carbon has the lowest possible position and their name ends with suffix "–one".

2-hexanone

Ethers

Ethers are also called as alkoxy hydro- carbon Ethers (–RO, HC's). In the parent hydrocarbon are large alky group. For example



2-methoxy butane

According to IUPAC system thioethers are also known as alkylthio alkanes. For example

$CH_3 — S — CH_3$ (Methyl thiomethane)

Carboxylic acid

The carboxylic acid name e are derived from alkanes by replacing replacing terminal "-e" by the suffix "Oic acid". For example

CH_3CH_2COOH Propanoic acid

$HOCCCH_2CH_2COOH$ Butanedioic acid

Acid halides or acylhalides

C_2H_{2n+1} COX is the general formula of acyl halides and their name ends with –oyl halide. For example

CH_2COCl Ethanoyl Chloride

Acid anhydrides

They are named by placing "anhydride" at the end of name of parent acid according to IUPAC system

$CH_3 — CO — O — COCH_3$ Ethane anhydride

Acid amides

The word amide is placed at the end by of naming acid amides. For example

$C_4H_9CONH_2$ Pentanamide

Esters

In IUPAC system Suffix "–ate" is to esters name.

e.g $CH_3COOC_2H_5$ Ethyl ethanoate

Amines

These are named as amino derivatives of alkanes.

e.g. $CH_3 — CH(NH_2) — C_2H_5$ 2-amino butane

$C_2H_5 — N(H) — C_2H_5$ N-ethyl amino ethane

$CH_3 — N(CH_3) — CH_3$ N, N, N, trimethyl amino methane

Nitroalkanes at nitroparaffins

They are name by adding prefix "nitro" to parent name according to IUPAC naming system.

e.g. $C_2H_5NO_2$ Nitroethene

Must always be given number 1 if the carbon chain terminating functional groups such as —CHO, $CONH_2$, —COOH, —CN etc.

Alkyl cyanides

The alkyl cyanides are called nitriles according to IUPAC naming system. The —CN group is numbered to lowest position. For example

C_4H_9CN Pentane nitrile

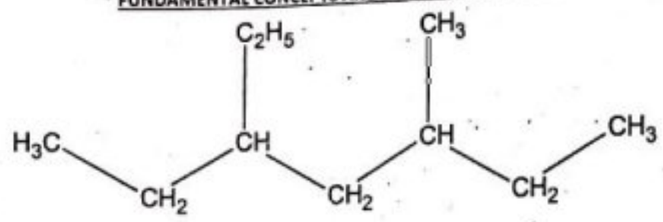
Alkyl Isocyanides

They are represented as- CN group and the word carbylamines is used as parent nammme according to IUPAC system .

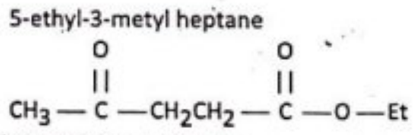
e.g. C_3H_7NC Propyl carbylamine

IUPAC rules for naming poly functional groups

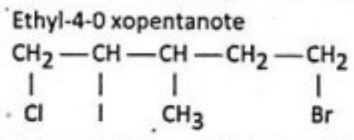
1. In poly functional group chain order of preference is as follows:
   Acids > Acid derivatives except nitrides > Aldehydes > Nitrides > Ketones > Alcohols > Amines > Ethers > Alkenes > Alkynes.
2. Including principleThe selected parent chain must have maximum number of functional groups in it.
3. In following orders the preference should be giving to lower number.
   Principle functional group > Double bond > Triple bond > Substituents.
4. Multiple bonds and functional groups is present in the side chain, then it is numbered separately so that the C-atom in side chain bonded to parent chain is designate as 1.
   Some examples



5-ethyl-3-metyl heptane



Ethyl-4-0 xopentanote

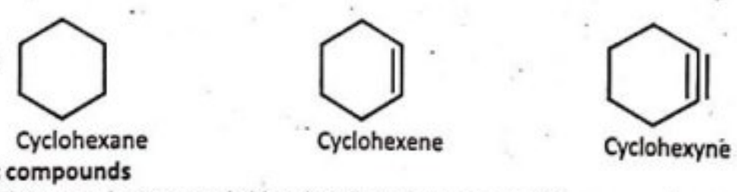


5-bromo,1-chloro,2-iodo,3-methyl pentane

1-bromo-5-chloro-pentane

Cyclic aliphatic compounds

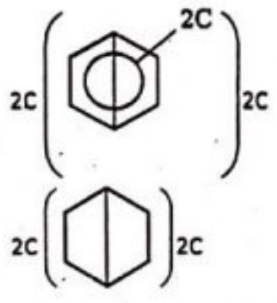
According to IUPAC rules the word "cyclo" should be used as prefix in naming of cyclic aliphatic compound. For example



Cyclohexane Cyclohexene Cyclohexyne

Bicyclic compounds

They are known as bridge heads and represented in saqure bracket .These are bicyclic compounds and as parent name they are corresponding to the total number of carbon atom. And the atoms which are unique to each ring are used to name the compounds.

e.g. 

Bicyclo-[2, 2, 2] octane

Bocyclo-[2, 2, 0] hexane (No carbon bridged in the ring)

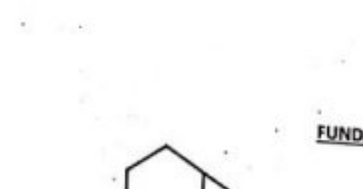
Bicyclo-[4, 1, 0] heptane

4,8-dimethyl bicycle [4, 3, 0]

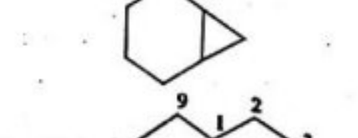
Aromatic Compounds

Benzene ring is also used as group and nucleus attached to side chain. IUPAC names are also in use but common and trivial names of benzene derivatives are very popular. In benzene ring if another functional group is attached it is designated as number 1. For example

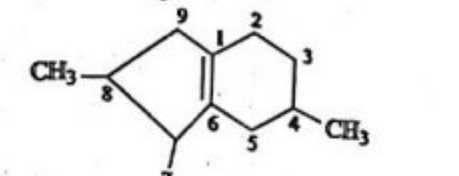
2-methyl phenol (o-cresol)



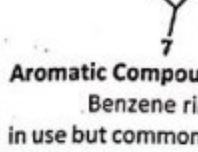
2-hydroxy benzoic acid (Salicylic acid)



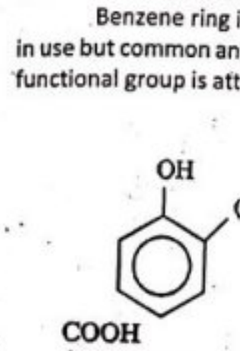
Diphenyl amine (N-phenyl aniline)



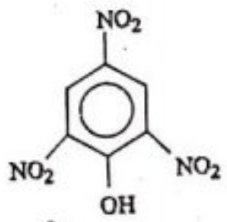
Benzoic anhydride



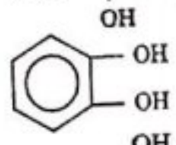
Phenyl carbamide (Phenyl isocyanide)



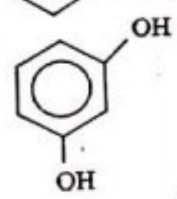
2,4,6-trinitrotoluene (TNT)



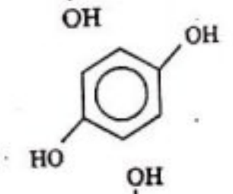
2,4,6-trinitrophenol (Picric acid)



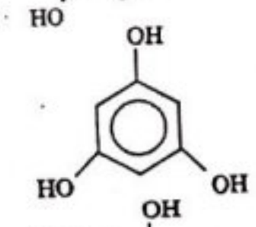
1,2-dihydroxy benzene (Catechol)



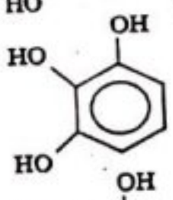
1,3-dihydroxy benzene (Resorcinol)



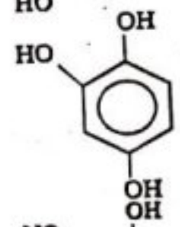
1,4-dihydroxy benzene (Quinol)



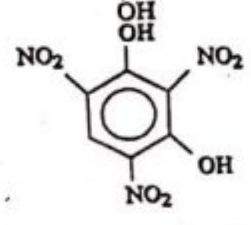
1,3,5-trihydroxy benzene (phloroglucinol)



1,2,3-trihydroxy benzene (pyrogallol)



1,2,4-trihydroxy benzene (Hydroxy quinol)



2,4,6-trinitroresorcinol (Styphinic acid)

2,4,6-trinitro aniline (Picramide)

In polysubstituted benzens: For selection of principle functional groups the order of preference is as follows.

Carboxylic acid > Sulphonic acid > Acid halide >
Amide > Aldehyde > Cyanide > Isocyanide > Ketone
Alcohol > Phenol > Thioalcohol > Amine > Imine

Their names are arranged in alphabetical order .The principle functional group is given position 1 while other substituents are numbered in the clockwise direction.

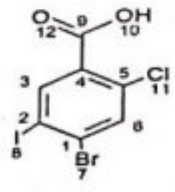
e.g.

4-bromo-2-chloro-5-iodobenzoic acid

GRE QUIZ

1. This is a general formula C_nH_{2n+1}
   (a) Aldehyde (b) Carboxylic acid
   (c) Ketone (d) None of this
2. The IUPAC name of the following compounds is

   (a) Ethyl-0-4-xopentanote (b) xopentanote-0-4-Ethyl
   (b) Ethyl-4-0 xopentanote (d) xopentanote-4-0-Ethyl
3. The following structure is of:

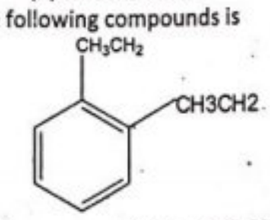


   (a) 5-bromo-2-chloro-4-iodobenzoic
   (b) 4-bromo-5-chloro-2-iodobenzoic acid
   (c) 2-bromo-5-chloro-4-iodobenzoic acid

(d) 4-bromo-2-chloro-5-iodobenzoic acid

4. The IUPAC name of the following $CH_3CH_2CH_2CH_2COOH$ compounds is
(a)Hexanoic acid (b)Propanoic acid
(c)Pentanoic acid (d)None of these

5. The IUPAC neme of the following compounds is



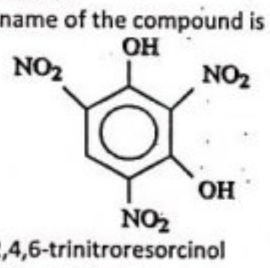
(a) Para- diethylbenzene (b) m- diethyl benzene
(c) O-diethylbenzene (d) None of these

6. The IUPAC name of Phloroglucinol is
(a) 1, 5,3- trihydroxyy benzene (b) 1, 3,5-trihydroxy benzene
(c) 1, 3,4- trihydroxy benzene (d) 1, 2, 3- trihydroxy benzene

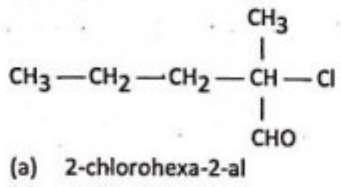
7. Bicyclic compounds are known as
(a) Bridge head (b) Bridge tail
(c) Both a and b (d) None of these

8. By heating the calcium salt of acetic acid _____ is produced
(a) Pentanone (b) butanone
(c) Acetone (d) None of these

9. The name of the compound is



(a) 2,4,6-trinitroresorcinol (b)Styphinic acid
(c) 2,4,6-trinitrotolunene (d) Both of these

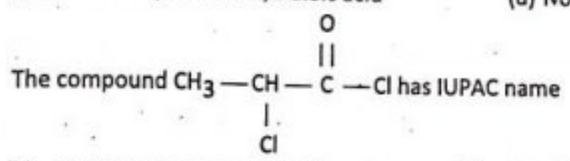
10. 

(a) 2-chlorohexa-2-al (b) 2-chloro-2-methyl pentanal
(c) 4-chlorohexa-4-al (d) None of these

11. IUPAC name of compound $C{\equiv}C-C-C{\equiv}C$
(a) 1-pentene-4-yne (b) 4-pentene-1-yne
(c) Pent-1-en-4-yne (d) Pent-4-en-1-yne

12.

(a) Butane-1,2,4-tricarboxylic acid (b) Hexane trioic acid
(c) 3-carboxy hexane-1,6-dioic acid (d) None of these

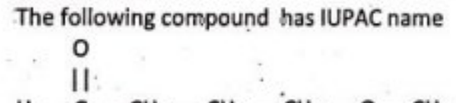
13. The compound  has IUPAC name

(a) 2-chloropropanoyl chloride (b) 1,2-dichloropropanone
(c) Chloroformyl chloroetnane (d) 1,2-dichloropropanal

14. The compound $C_2H_5OCH_2CH_2CH_2CH_2OCH_3$ IUPAC name is
(a) Ethoxy butane oxymethane (b) 2,6-dioxy heptane
(c) 3-ethoxy,1-methoxy butane (d) 1-methoxy,3-ethoxy butane

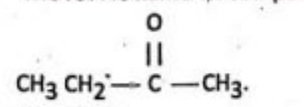
15. The name of $CH_3-CH=CH=CHO$ the compound is
(a) Prop-2-ene-1-al (b) Crotonaldehyde
(c) Butenal (d) Butene-1-al

16. The following compound has IUPAC name

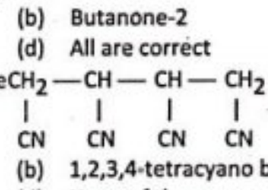


(a) 2-formyl methoxy propane (b) 2-methoxy butanal
(c) Methoxy butanal (d) 4-methoxy butanal

17. The IUPAC name of compound

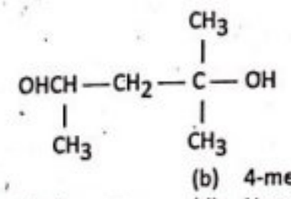


(a) 2-Butanone (b) Butanone-2
(c) Butane-one (d) All are correct

18. The following compounds has IUPAC name 

(a) 1,2,3,4-cyano butane (b) 1,2,3,4-tetracyano butane
(c) 3,4-dicyanohexane-1,t-dinitrile (d) None of these

19. IUPAC name of



(a) 3-methyl butanol (b) 4-methyl-2,4-pentanediol
(c) 2-methyl-2,4-pentanediol (d) None of these

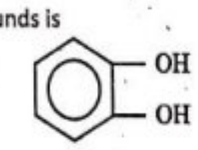
20. Acraldehyde has IUPAC name
(a) Propenal (b) Butanal
(c) Prop-2-en-1-al (d) None of these

21. The compound $C_2H_5OC_3H_7$ has IUPAC name
(a) Ethyl propyl ether (b) Propyl ethyl ether
(c) Proxy ethane (d) Ethoxy propane

22. The compound has OHC — CHO IUPAC name
(a) Ethanedial (b) Ethanediol
(c) 1,2-ethanedial (d) 1,2-ethanedione

23. To the same homologous series which of the following are belong ?
(a) C_2H_2, C_3H_4, C_4H_8 (b) C_4H_{10}, C_5H_{10}, C_6H_6
(c) CH_4, C_3H_6, C_3H_4 (d) C_4H_8, C_5H_{10}, C_6H_{12}

24. The IUPAC name of the following compounds is



(a)1,3-dihydroxy benzene
(b)1,2-dihydroxy benzene
(c)1,4-dihydroxy benzene
(d)1,3,5-trihydroxy benzene

25. Ethers are also called as
(a) Alkoxy (b) hydro- carbon Ethers
(c) both a and b (d) None of this

26. The name of following compounds is

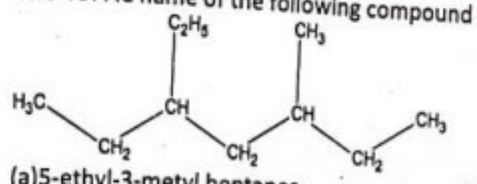
(a)Cyclohexane (b)Cyclohexene
(c)Cyclohexyne (d) None of this

27. The name of the compound is

(a) Bicyclo-[2, 2, 2] octane
(b) Bocyclo-[2, 2, 0] hexane (No carbon bridged in the ring)
(c) Bicyclo-[4, 1, 0] heptane
(d) 4,8-dimethyl bicycle [4, 3, 0]

28. In carbylamines which of the functional group is used
(a)CN (b) OH
(c) COOH (d) None of these

29. The IUPAC name of the following compound is



(a)5-ethyl-3-metyl heptanes (b)1-bromo-5-chloro-pentane
(c) none of these (d) Both a and b

30. The IUPAC name of the glycerol is $HOCH_2CH_2(OH)CH_2OH$
(a)Propane 2,3,1, triol (b)Propane-1,2,3-triol
(c)Propane 3,2,1,triol (d) Both a and b

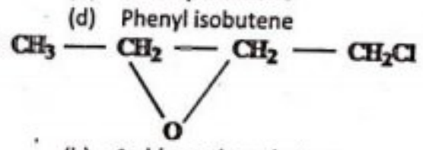
30. The order of preference in polyfunctional chain is as follows
(a) Acid derivatives expect nitride> Nitride> Alkenes > Alkynes > Ether > Ketones > Acohol
(b) Alcohol> Amine> Ether> Alkenes > Ketone> Acid> Acid derivatives except nitrides
(c) Acid>Aldehyde> Amines> Ether> Alkyne> Ketone > Acid derivatives except nitrides
(d) Acids > Acid derivatives except nitrides > Aldehydes > Nitrides > Ketones > Alcohols > Amines > Ethers > Alkenes > Alkynes.

31. Cyclic dienes are also called as
(a) Xantnenes (b) Annulene
(c) Heterocyclic compound (d) Aromatic compound

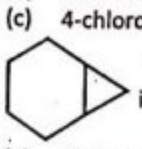
32. The compound has IUPAC name

(a) Cumene (b) Isobutyl benzene
(c) 2-phenyl butane (d) Phenyl isobutene

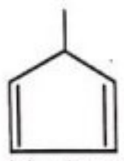
33. The IUPAC name of the compound is



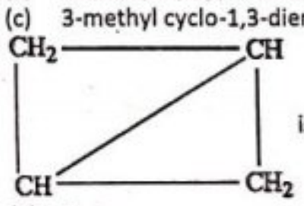
(a) 1-chloro-2,3-expoxy butane (b) 1-chloroethoxy butane
(c) 4-chloro-2,3-ethoxy butane (d) None of these

34.  is knowns as

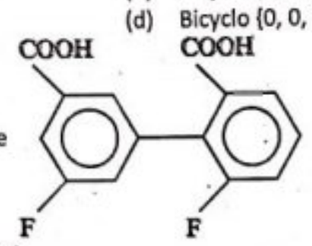
(a) Cyclooctane (b) Methyl cyclohexane
(c) Neoprene (d) Noracane

35. 

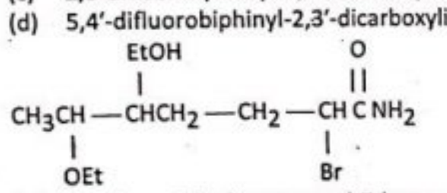
(a) 2-methyl cyclopenta-1, 4-diene (b) Cyclopenta-1,4-diene
(c) 3-methyl cyclo-1,3-diene (d) 3-methyl cyclopenta-1,4-diene

36.  is also known as

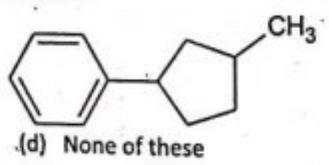
(a) Butane (b) Bicyclo {1, 1, 0} butane
(c) Bicyclo {1, 1, 1} butane (d) Bicyclo {0, 0, 1} butane

37. The compound has IUPAC name 

(a) Difluoro dicarboxyl biphenyl
(b) 2,3-difluorobiphenyl-5,4-dicarboxylic acid
(c) 2,3-difluoridiphenyl-5,4-dicarboxylic acid
(d) 5,4′-difluorobiphinyl-2,3′-dicarboxylic acid

38. 

(a) 2-ethoxy-3-hydroxy propyl-7-bromo heptanamide
(b) 2-bromo-5(2-ethoxy propyl)-7-methyl heptanamide
(c) 2-bromo-5(2-ethoxy propyl)-7-hydroxy heptanamide
(d) None of these

39. The compound IUPAC name is 

(a) 1-(3-methyl cyclopentyl) benzene
(b) 3-(3-methyl cyclopentyl) benzene
(c) 2-2(2-methyl cyclopentyl) benzene (d) None of these

ANSWERS

1 a	2.c	3.d	4.a	5.c	6.b	7.a	8.c
9.d.	10.b	11.a	12.c	13.a	14.c	15.b	16.d
17.d	18.c	19.c	20.c	21.d	22.d	23.d	24.b
25.c	26.c	27.b	28.a	29.a	30.d	31.b	32.c
33.c	34.d	35.d	36.b	37.d	38.c	39.a.	

25. GENERAL CONCEPTS IN ORGANIC CHEMISTRY

The science of organic chemistry is based between properties and molecular structure relationship. Organic compounds has as an carbon atom as essential part. Carbon is tetravalent that can be explained on the basis of hybridization and has tetra valency. Hybridization is a process in which same energy atomic orbitals combine to produce hybrid orbitals of identical energy. In Sp (alkynes) Sp^2 (alkenes Sp^3 (alkanes), one S-orbital combines with 1, 2 and 3, p-orbitals, respectively to produce hybrid orbitals. Sp linear structure and angle of 180° is present in alkynes. Sp^2 hybridization has trigonal structure and a bond angle of 120°. Sp^3 hybridization has tetrahedral structure and 109.28° bond angle.

Greater the S character more the stability of hybrid orbital. In following order the stability of hybrid orbitals are represented:

Sp (50%) > Sp^2 (33.3%) > Sp^3 (25%) > p (0%)

In brackets S-character is given:

The bonds formed by atomic orbital are less stable than those bonds are formed by hybrid orbitals.

Non –ionic compound are covalent compounds and they are held together by three types of forces: Hydrogen bonding, dipole –dipole interaction and van der waals forces Hydrogen bonding is bonding between hydrogen and a highly electronegative element such as F, O, N etc. Hydrogen bonding may intermolecular or intramolecular. In polar molecules dipole –dipole interaction is present and in non polar molecules van der waals forces is exist .

The strength of three types of forces is as follows.

Hydrogen bonding > Dipole-dipole interaction > Van der Waals forces

From number of sigma bonds in organic compound the state of hybridization of particular cabon atom can be judge.

$$\underset{Sp^3}{CH_3} - \underset{Sp^2}{CH} = \underset{Sp^2}{CH} - \underset{Sp^3}{CH_2} - \underset{Sp}{C} \equiv \underset{Sp}{C} - \underset{Sp^3}{CH_3}$$

⇒ S orbital is smaller in size than p orbital.

Organic reactions occur by the cleavage or breaking of bond in two ways. After homolytical fission each fragment carries one unpaired electron. Homolytic fission always results in formation of free radicals.

$$CH_3CH_2CH_2CH_3 \longrightarrow CH_3\dot{C}H_2 + \dot{C}H_2CH_3$$

In heterolytic fission, the two bond electrons are gained by a single atom. Thus two fragments one with positive and other with negative charge generated.

$$CH_3CH_2CH_2CH_3 \longrightarrow \underset{\text{Carbocation}}{CH_3\overset{+}{C}H_2} + \underset{\text{Carbonion}}{\overset{-}{C}H_2CH_3}$$

Homolytical reactions are also called as free radical mechanism reaction whereas heterolytic reactions are also known as ionic reactions.

Carbocation is also known as carbonium ion. It has 6 electrons and its central atom is Sp^2 hybridized. It has three Sp^2 hybrid orbitals with a bond angle of 120° between them. CH_3 group in carbonium ion

exhibits the electron releasing inductive effect (+ I). Th stability of different carbocations is in following order:

Tertiary > Secondary > Primary > Methyl

Hyperconjugation has less stability than resonance. Carbonium ions are diamagnetic.

Carbonion It is trivalent Sp^3 hybridized and have two electron. It has pyramidal structure and it is an isoelecronic with an amine carbonic.

Increasing the S character carbon is stabilized by electron withdrawing inductive effect (–I), conjugation of lone pair with multiple bond and aromatization.

Stability of carbanions follows the order given below.

$(CH_3)_3\bar{C} < (CH_3)_2\bar{C}H < CH_3\bar{C}H_2 < \bar{C}H_3$

Methyl > Primary > Secondary > Tertiary

$CH_3\bar{C}H_2 < CH_2{=}\bar{C}H_2 < CH{\equiv}\bar{C}, (C_6H_5)\bar{C}H_2 < (C_6H_5)_2\bar{C}H < (C_6H_5)_3\bar{C}$

Triphenyl methyl > Benzyl > Allyl > 1° > 2° > 3°

Carbanions are also diamagnetic.

Carbanions are nucleophiles. They can initiate addition and substitution reactions.

Free Radicals:

Free radicals contain odd number of electrons. In alkyl radicals have central carbon is Sp^2 hybridized and have planer structure. In the follows the order the stability of free radicals is given as below.

Triphenyl methyl > Diphenyl methyl > Benzyl > Alkyl > Tertiary alkyl > Secondary alkyl > Primary alkyl free radicals. Free radicals are paramagnetic in nature.

Carbenes:

These are neutral carbon intermediates and have two non-bonded electron in sextet. Electrons spins are paired in single state whereas in triplet state these are unpaired singlet carbon show Sp^2 – hybridization and trigonal-geometry whereas triplet carbenes show linear geometry and sp-hybridization. Biradicals or bivalent free radicals are also known as triplet carbenes.

Inductive Effect

Through the chain of atoms the shift of electron is due to presence of a polar covalent bond. Sometimes it is also known as transmission effect. Electron with drawing groups (e.g. Cl) show – I effect and electron donating group (e.g. CH_3) show + I effect.

The electron withdrawing inductive (– I) effect of some atoms and groups given as follows.

$(CH_3)_3\overset{+}{N} > NO_2 > CN > F > COOH > Cl > Br > I > OCH_3 > OH > C_6H_5$

The electron releasing inductive (+ I) effect of some atoms and groups given below.

$(CH_3)_3C > (CH_3)_2C > C_2H_5 > CH_3 > H$

By increasing electro-negativity and dipole movement the inductive effect will be increased.

Electron donating groups reduced the stability and decrease the ability as they inverse the negative charge on carboxylate ion (in case of carboxylic acids) . Vice versa is true for electron with drawing groups.

Resonance

It is the theoretical representation of electronic structures of molecules. Higher the stability of molecule for more resonance structure.

Mesomeric Effect

In unsaturated systems it is a electron redistribution through the π-orbitals. Electron releasing groups show + M or + R effect Electron withdrawing groups show —M effect (or —R effect) e.g. —C ═O, —CN, —COOR, $—NO_2$ etc. For example

$\bar{Cl}, \bar{I}$, —OH, $—NH_2$, —NHR etc.

In substituted aromatic systems this effect is more prominenet. Nitrobenzene is less readily attached by oxidizing agent. Whereas phenol is readily attach by these agents. Due to mesomeric effect the phenol has acidity.

Electromeric Effect:

The compounds have multiple bonds this effect is temporary generated such as C═O, C═C, C═N etc. due to presence of attacking reagents in reaction mixture.

$>C{=}O \longleftrightarrow [>\overset{+}{C}—\bar{O} \equiv \overset{\delta+}{C} — \overset{\delta-}{O}]$

Steric hindrance:

Due to large groups mechanical interference is produced. But All steric effects don't decrease the reaction rate but generally bulky group decrease the rate of reaction.

Hyperconjugation:

Due to delocalization of σ-electrons of an alkyl group into an adjacent π-bond. More stable the compound , more the hyperconjugative structure. There is no hyperconjugative structure for methyl radicals Istability of different radicals is as follows:

Tertiary(9 hyperconjugative structure) > Secondary (6 hyperconjugative structures) > Primary (3 hyperconjugative structures) > Methyl (No hyperconjugative structures).

Electrophiles:

These are positive charged and electron deficient compound. Electrophile are also Lewis acids.

Following are examples of electrophiles. $\overset{+}{H}, \overset{+}{Ag}, Br_2, H_2O_2, O_3, \overset{+}{NO_2}, \overset{+}{Br}, \overset{+}{Cl}, H_3\overset{+}{O}, \overset{+}{RN_2}, \overset{+}{C_2H_5}, AlCl_3, BF_3, ZnCl_2, FeCl_3$, etc.

Substitution Reaction

In a compound it is a replacement of an atom or group of atom without any structural change. In these reactions free radicals, nucleophiles or electrophiles are reactive intermediates.

Addition Reactions

In this reaction, a single molecule is formed by combining of two molecules. These reactions may be initiated by electrophiles and free radicals nucleophiles.

Markownikoff's Rule

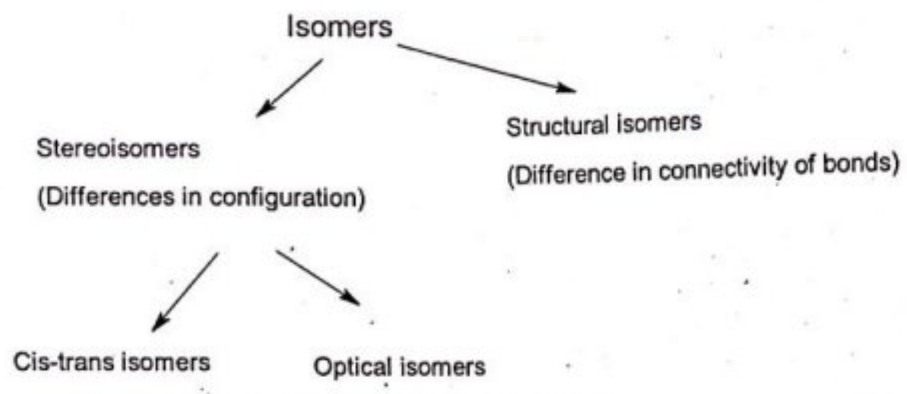
In addition reactions of double bonds, double bond C –atom which has more H-atoms then attacking reagent hydrogen will be attached on that carbon atom .

Elimination

With loss of hydrogen halide there is a formation of double bond.

Isomerism

These compounds have different structural but same molecular formula. They have different chemical and physical properties as well.



Isomerism can be broadly divided into following types:

(a) Structural Isomers

These are arise due to differences in structure of molecules of same molecular formula. Structural isomers are also known as constitutional isomers.

$CH_3CH_2CH_2CH_2OH$ $\quad$ $H_3C-CH_2-\underset{\displaystyle OH}{\underset{|}{C}}H-CH_3$

These may be chain, position, functional, metamerism or ring chain isomerism.

(i) Chain Isomerism

Chain isomerism arises due to difference in linkages in carbon chains.

$CH_3CH_2CH_2CH_2CH_3$ $\quad$ $H_3C-\underset{\displaystyle CH_3}{\underset{|}{\overset{\displaystyle CH_3}{\overset{|}{C}}}}-CH_3$

(ii) Position Isomerism

In position isomer substitution occupied the different position.

$CH_3CH_2CH_2OH$ $\quad$ $H_3C-\underset{\displaystyle OH}{\underset{|}{C}}H-CH_3$

(iii) Functional Isomerism

These are due to presence of different functional groups.

CH_3CH_2OH — Ethyl alcohol $\quad$ CH_3OCH_3 — Diethyl ether

(iv) Metamerism

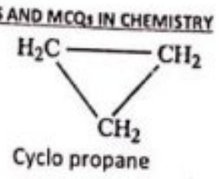
In a same functional group there is a different arrangement of atoms.

$CH_3CH_2COCH_2CH_3$ — Diethyl ketone $\quad$ $CH_3COCH_2CH_2CH_3$ — Methyl propyl ketone

(v) Ring Chain Isomerism

In this isomerism open or closed chain structure are formed due to the difference in linking of carbon atom.

$CH_3-CH=CH_2$
Propene


Cyclo propane

(vi) Tautomerism or Desmotropism

This isomers have reversible inter conversion.

$CH_3-\overset{\displaystyle O}{\overset{||}{C}}-CH_3$ — Acetone (ketoform) $\quad$ $CH_3-\overset{\displaystyle OH}{\overset{|}{C}}=CH_2$ — (Enol form)

In α-hydrogen containing aldehydes and ketones keto-enol tautomerism is possible. It is not possible in benzophenone ($C_6H_5COC_6H_5$) and benzaldehyde (C_6H_5CHO).

Stereoisomerism may be optical or geometrical in nature.

(b) Stereoisomerism

This compounds have different arrangement of atoms or groups in a space and have same structural and molecular formula.

(I) Geometrical Isomerism

The substance that contain double bond show this type of isomerism and there is a restriction in free rotation of atoms or groups. Two similar groups are on same side in cis form and two similar groups are on opposite side in trans form . Relevant to double bond or ring the Cis –trans configuration can be determined.

Due differences in the configuration at one stereocentre compared to the second stereocentre Cis – trans isomerism are formed.

$H-\underset{\displaystyle H-C-Cl}{\overset{\displaystyle Cl}{\overset{||}{C}}}$ — Cis form of 2-Dichloroethylene $\quad$ $Cl-\underset{\displaystyle H-C-Cl}{\overset{\displaystyle H}{\overset{||}{C}}}$ — Trans form of 2-Dichloroethylene

Trans isomer has less dipole moment as compared to Cis isomers. For example fumaric acid is trans-isomer, maleic acid is cis isomer.

(ii) Optical Isomers

In 1815,The physicist Jean- Baptist Biot was discovered the optical activity at the college de France. Optical isomer arise at single stereocentre that has different configuration. They have same molecular and structural formula

And they rotate the plane polarized light to the same extent in different directions.

In absence of a chiral carbon no enantiomers can exist. The compounds have plane and centre of symmetry and have at least one chiral carbon atom. Optical active compounds have mirror image that are not superimposable.

Chiral carbon: Is asymmetric carbon to which four different groups or atoms are attached. Due to asymmetry in their molecular structure molecule even without one chiral carbon can exhibit optical activity

2^n = no. of optical isomers

n = no. of asymmetric carbons.

Enantiomers or antimers or optical antipodes:

Pairs of optically active isomers having non-superimposble images are also called enantiomer.

Dextorotatoy:

The isomer that rotate the light to right side are called dextorotatory and represented by d-or (+).

Levorotatory:

Those rotate to left side are levorotatory, and are represented by l – or (–).

dl mixture is also known as ± variety or a racemic modification.

For the different compounds the possible numbers of isomers can be calculated as fellows.

(a) Unsymmetrical Molecules

No. of d and l isomers (a) = 2^n

0 =No. of meso forms (m)

Total no. of optical isomers (a + m) = 2^n

Suppose if a compound contains 3 asymmetric carbon atoms. Then n = 3

$2^n = 2^3 = 8$ =No. of d and l isomers (a)

0= No. of meso forms (m)

(4 + 0) = 4 =Total no. of optical isomers

(b) Symmetrical Molecules with even C-atoms

No. of d – and l – isomers (a) = $2^{(n-1)}$

No. of meso forms (m) = $2^{(n/2-1)}$

(a + m) =Total no. of optical isomers

Suppose a symmetrical compounds has two chiral carbon, then n = 2.

No. of d and l isomers (a) $2^{(2-1)} = 2$

$2^{(2/2-1)} = 2^0 - 1$= No. of meso forms (m)

(a + m) = 2 + 1 = 3 =Total no. of optical isomers

(c) Symmetrical Molecule with odd C-atoms

No. of d and l isomers (a) = $2^{(n-1)} - 2^{(n/2-1/2)}$

No. of mesoforms (m) = $2^{(n/2-1/2)}$

Total no. of optical isomers = (a + m) = $2^{(n-1)}$

Suppose n = 3, then

No. of d and l forms (a) = $2^{(3-1)} - 2^{(3/2-1/2)} = 2^2 - 2^{1/2} = 4 - 1 = 3$

No. of meso forms (m) = $2^{(3/2-1/2)} = 2^{1/2} = 1$

(a + m) + 3 + 1 = 4 or $2^{(3-1)} = 2^2 = 4$ =Total no. of optical isomers

Optical isomers have different rate of reaction towards optically active reagents but same physical properties.

Diastesolsomers or diastereomers:

This optical isomer are not mirror image of each other and they have different physical and chemical properties.

Waden Inversion:

Optically active dextro rotatory isomer is change to levo rotatory isomer of same compound or another compound.

Resolution: The process of separation of dl-mixture into components is also known as resolution.

Enantiomers:

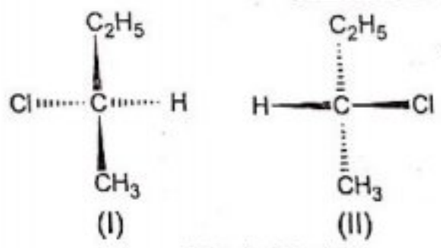
Isomers that are mirror images of each other are called enantiomers. They rotate light plane polarized light in different direction up to same extent. Only in chira medium enantiomers show different physical or chemical properties. Enantiomers of lactic acid are shown below

A racemic modification (±):

This are a mixture of equal parts of enantiomers. The rotation caused by one molecule is cancelled by the other molecule a racemic modification is optically inactive. One isomer must be present in excess of other to represent the optica activity of the compounds.

Configuration

On the basis of arrangement of its atoms it is used to characterize a stereocentre and to its structure a specific isomer can also be linked. For example in case of sec-Butyl chloride, it is needed to link "+" or "–" form to structure one or two.

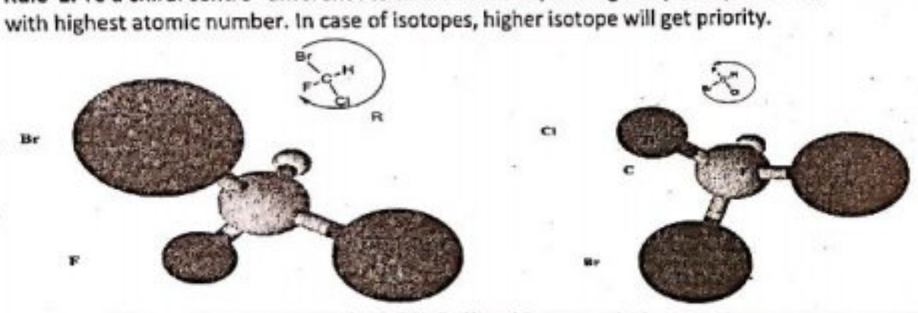


(I) (II)

sec- Butyl chloride

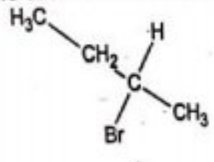
For the solution of this problem a specification of configuration was made as R (Latin: rectus, right) or S (Latin: sinister, left). After considering that lowest priority ligand is away from us, from highest priority ligands to lowest priority ligand the sequence of priorities of igands is clockwise it is designated as R, and if it is counterclockwise, the configuration is S. Before assigning the priorities of ligands the following rules must be kept in mind.

Rule 1. To a chiral centre different atoms are attached, The highest priority are assigned to the group with highest atomic number. In case of isotopes, higher isotope will get priority.



1, 9, 17 and 35 are the atomic number of H, F, Cl and Br respectively. As H has lowest atomic number, it will stay away from viewer in deciding priority of other groups. The priority order of other groups will be Br > Cl > F.

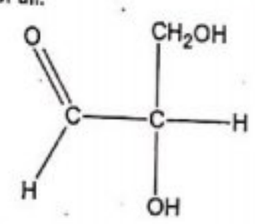
Rule 2. To chiral centre if the attached two carbon atoms are same, the priorities will be decided by comparison of the atoms to each of these first atoms.



sec-Butyl bromide

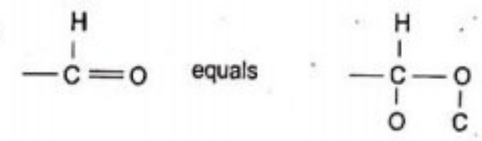
For example, in sec-butyl chloride to chiral carbon four atoms are attached, two of them are C's, one H and one Br. In CH_3 the second atoms are H,H,H and in C_2H_5 C, H, H. C_2H_5 has priority over CH_3 as second C- atom in C_2H_5 has higher atomic number than H in CH_3. The overall priority order will be as follows: Br > C_2H_5 > CH_3 > H. The configuration of structure will be S.

Rule 3 (use only if first two rules don't apply): Duplicated or triplicated is considered if double or triple bond is present. For example, Among the chiral centre O has highest atomic number hence –OH group has the highest priority of all.



Glyceraldehyde

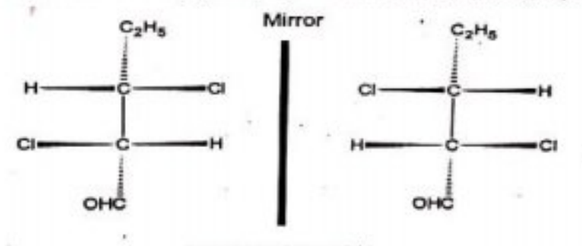
–CHO or $-CH_2OH$ group has second highest priority.



Duplicated that groups have double, hence the O, O, H of –CHO takes priority over the O, H, H of $-CH_2OH$. The complete priority order in case of glyceraldhyde is then: –OH > –CHO > $-CH_2OH$ > H.

Diasteromers

They have more than one chiral centre that are not a mirror image of each other are also known as Diasteromers. They have different physical properties and same chemical properties

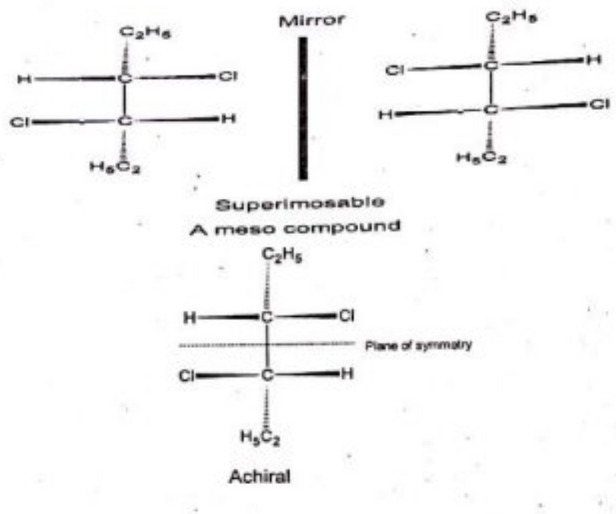


Not superimosable

Enantiomers

Meso Compound

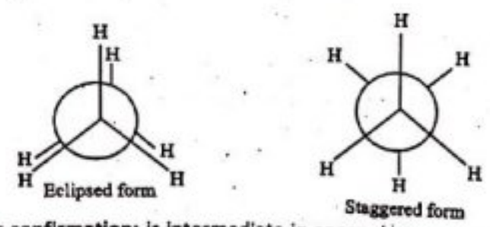
They contain chiral centre and have superimposable mirror images though they contain chiral centers.



Conformation

The special arrangement of atoms/groups of molecules arises due to restricted rotation about a single bond is called conformation.

On C-atoms the presence of bulky group restricts the free rotation about a single bond. The heavy bulky groups can completely stop free rotation. **In eclipsed form** in bond pairs of two central carbons atoms are very close to each other. This form has highest energy and thus least stable confirmation form. Whereas in **staggered form** the bond pairs of two central C-atoms are as far away from each other as possible. This form is of lowest energy and most stable. Gauche or skew forms are infinite number of possible rotation of one atom with respect to other.

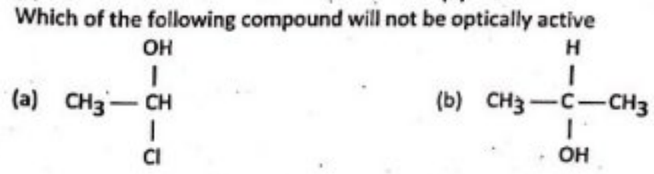


Gauche or skew confirmation: is intermediate in energy between eclipsed and staggered forms. The angle through which one methyl group is rotated while keeping the other fixed is called dihedral angle or angle of strain.

MULTIPLE CHOICE QUESTIONS

1. In neo-pentane how many tertiary carbon atoms are present
   (a) 1 (b) 2
   (c) 4 (d) 0

2. With s characters the stability will ———— with increase in s character as the bond energy increase .
   (a) No change (b) Increases
   (c) Decreases (d) None of these
3. From following statements which one is not relevabnt resonance?
   (a) It increases reactivity of molecule
   (b) It decreases reactivity of molecule
   (c) It increases stability of molecules
   (d) It leads to similar type of bonds
4. In inductive effect which one electrons are not involved ?
   (a) π-electrons (b) σ-electrons
   (c) None (d) Both
5. There is a complete transfer of electronic effect
   (a) π-electrons (b) σ-electrons
   (c) Both (d) Outermost electrons
6. Arrange following on the order of leaving group ability
   (a) $-OAC > -OMe > -OSO_2Me > -OSO_2CF_3$
   (b) $-OSO_2CF_3 > -OSO_2Me > -OMe > -OAC$
   (c) $-OSO_2CF_3 > -OSO_2Me > -OAC > OMe$
   (d) $-OSO_2CF_3 > -OAC > -OSO_2Me > -OMe$
7. In singlet state of carbine the carbon atom has following hybrid state
   (a) Sp^2-hybridized (b) Sp-hybridized
   (c) Sp^3-hybridized (d) None of these
8. The halogenated total products from which ethane can form are
   (a) 2 (b) 16
   (c) 4 (d) 7
9. Which of the following is a cumulated diene that have a double bond in succession
   (a) Allylene (b) Allene
   (c) 1,3-butadiene (d) None
10. Geometrical isomerism is present in which of the following substance ?
    (a) Propene (b) 1-Phenyl propene
    (c) 1-butene (d) None
11. In alkene the least number of carbon atom is present to exhibit isomerism is
    (a) 4 (b) 5
    (c) 3 (d) 6
12. Which of the following compound will not be optically active



(c) (d) None of these

13. Which of the following stability order of carbonium ions $C_6H_5\bar{C}H_2$ (1), $CH_3\bar{C}H_2$ (2), $(CH_3)_2\bar{C}H$ (3), $(CH_3)_3\bar{C}$(4)
(a) 1 > 3 > 4 > 2 (b) 4 > 3 > 2 > 1
(c) 1 > 2 > 3 > 4 (d) 3 > 2 > 1 > 4

14. D (+) tartaric acid optically active is given name on the basis of
(a) pH in the organic solvent
(b) Optical rotation derived from D (+) glucose
(c) Optical rotation derived from D (+) glyceraldehyde
(d) None of these

15. Which of the following is the carbogen mixture
(a) C and N (b) CO and CO_2
(c) O_2 and CO_2 (d) CO_2 and air

16. For following compounds select the correct order of boiling points for same chain length Carboxylic acid (1), Alcohol (2), Aldehydes (3)
(a) 1 > 2 > 3 (b) 3 > 2 > 1
(c) 2 > 3 > 1 (d) 1 > 2 > 3

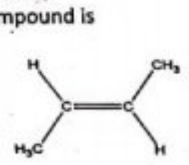
17. How many isomer possible for pentane
(a) 2 (b) 3
(c) 4 (d) 5

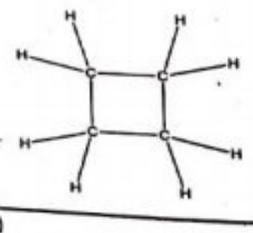
18. The difference in geometrical isomers is due to
(a) Position of atoms (b) Functional group
(c) Arrangement of atoms (d) None of these

19. In which of the form the Lactic acid will exist
(a) L-isomer (b) D-isomer
(c) Dl-mixture (d) Optically inactive compound

20. Entiomers have
(a) Superimposible mirror image
(b) Non-superimpossible mirror image
(c) Centre of symmetry
(d) Axis of symmetry

21. The following compound is



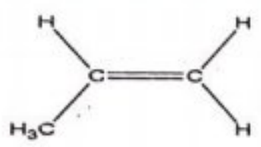


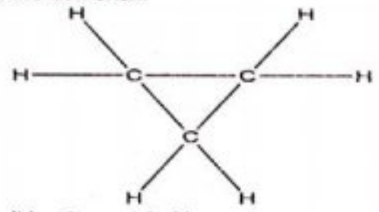
(a) Alkanes (b) Isomers
(c) Non-isomers (d) None of these

22. Which type of isomerism is exhibit in the following compound?

(a) Not isomers (b) Geometrical isomerism
(c) Positional isomerism (d) Functional groups isomerism

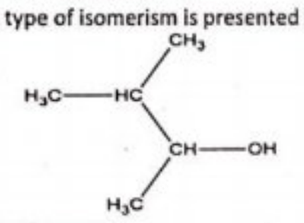
23. The following compounds has which type of the isomerism

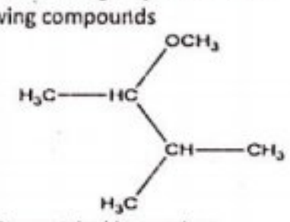




(a) Not isomers (b) Geometrical isomerism
(c) Positional isomerism (d) Functional groups isomerism

24. Which type of isomerism is presented in the following compounds





(a) Not isomers (b) Geometrical isomerism
(c) Positional isomerism (d) Functional groups isomerism

25. Which of the following statement is false for organic compound?
(a) Most common smells are caused by organic molecules
(b) Organic chemistry is the study of carbon containing compounds
(c) Organic compounds are present in living organisms
(d) Organic compounds are used in many industries

26. Which of the following atom is presented in the Chiral centre ?
(a) C (b) Si
(c) N (d) All

27. Which of these could be a chiral centre . Carbocation (A) and carbon radical (B) both are sp^2 hybridized.
(a) only A (b) only b
(c) both can be (d) both can not be

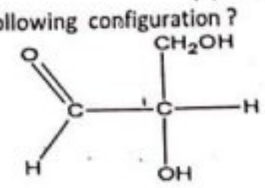
28. In determining configuration of a compound what is priority order of alkyl groups?
(a) $3º > 2º > 1º > CH_3$ (b) $3º < 2º < 1º < CH_3$
(c) $3º > 2º < 1º > CH_3$ (d) $3º < 2º > 1º > CH_3$

29. In enantiomer racemization can occur only if?
(a) Physical change occurs (b) No breaking of bond occurs
(c) Breaking of bond occurs (d) Temperature change occurs

30. The change of erythro to a stereoisomer always occurs due to?
(a) Changes in configuration at one chiral C
(b) Changes in configuration at achiral C
(c) Chemical changes
(d) Physical changes

31. D isomer is referring relative to?
(a) Sign of rotation towards right (b) Configuration
(c) Confirmation (d) D-glyceraldehyde

32. The compound has the following configuration ?



Glyceraldehyde

(a) R (b) S
(c) Achiral (d) none

33. On sp3 hybridization
(a) All p-orbitals are involved (b) One s and 3 p-orbitals are involved
(c) one p-orbital is involved (d) four p-orbitals are involved

34. Geometry of simple molecule having sp3 hybrid orbital is
(a) Triangular (b) Tetrahedral
(c) Square planner (d) Linear

35. Pi bonds are produced by overlapping of
(a) Un-hybrid orbitals (b) Hybrid orbitals
(c) Hybrid and un hybrid orbitals (d) atomic orbital and hybrid orbital

36 According to VESPR Model the geometry of molecule having 5 bond pair in outer most shell will be
(a) Triangular (b) Square planner
(c) Trigonal bipyramidal (d) Octahedral

37. Molecular orbital which have higher energy than atomic orbitals is called
(a) Bonding molecular orbital (b) Antibonding molecular orbital
(c) Hybrid orbital (d) Super atomic orbital

38. Unpaired electron in a molecule gives _____ character.
(a) Ferromagnetic (b) Paramagnetic
(c) Diamagnetism (d) Both a & b

39. Which molecule has a linear arrangement of all component atoms?
(a) CH4 (b) H2O
(c) CO2 (d) NH3 (e) BF3

40. Which of the following species is planar?
(a) NH3 (b) H3O+
(c) SO32- (d) NO3-

41 A neutral molecule having the general formula AB3 has two unshared pair of electrons on A. What is the hybridization of A?
(a) sp (b) sp2
(c) sp3 (d) sp3d

42. A π (pi) bond is the result of the
(a) overlap of two s orbitals.
(b) overlap of an s and a p orbital.
(c) overlap of two p orbitals along their axes.
(d) sidewise overlap of two parallel p orbitals.

43. A triple bond contains ___ sigma bond(s) and ___ pi bond(s).
(a) 0, 3 (b) 3, 0
(c) 2, 1 (d) 1, 2

44. Among the following, the linear molecule is
(a) CO2 (b) NO2
(c) SO2 (d) ClO2

45. Two optical isomers are formed from carbon atoms to create bond
(a) 4 atoms (b) 2 atoms
(c) 1 atom (d) 3 atoms

46. There is a difference in effect of optical isomer on
(a) heat (b) temperature
(c) polarized light (d) pressure

47. Types of stereoisomerism are optical isomerism and
(a) cis-isomerism (b) trans-isomerism
(c) cis-trans isomerism (d) all of them

48. Compounds which have different arrangements of atoms in space while having same atoms bonded to each other are said to have
(a) position isomerism (b) functional group isomerism
(c) chain isomerism (d) stereoisomerism

49. Types of structural isomerism are
(a) position isomerism (b)functional group isomerism
(c) chain isomerism (d) all of them

50. Compounds which have same molecular formula but different structural formula is called
(a) structural isomer (b) molecular isomer
(c) optical isomer (d) position isomer

51. If different functional groups are present it is termed as
(a) position isomerism (b) functional group isomerism
(c) chain isomerism (d) all of them

52. A group that can donate an electron pair is
(a) Bronsted acid (b) Bronsted base
(c) Lewis acid (d) Lewis base

53. Which one of most acidic among the following
(a) Propynoic acid (b) Propenoic acid
(c) Propanoic acid (d) none of them

54. Hendersen Hasselbalch equati n is represented by
(a) Ka=[A][H+]/[HA] (b) pKa+pKb=14
(c) pKa=pH+log[HA]/[A-] (d) both a and c

55. Which of the following is the ease of distortion of the electron cloud?
(a) Field effect (b) Inductive Effect
(c) Resonance effect (d) Polarizability

56. Which of the following occurs as a result of electronegativity differences?
(a) Field effect (b) Inductive Effect
(c) Resonance effect (d) None of the above

57. Which of the following involves the actual movement of electrons through a pie-bond system?
(a) Field effect (b) Inductive Effect
(c) Resonance effect (d) None of the above

58. The movement of electrons through a conjugated system allows for charges to be dispersed over several atoms. This phenomenon is
(a) Localization (b)Delocalization
(c) Polarization (d) Depolarization

59. Which of the following is less influenced by distance?
(a) Field effect (b) InductiveEffect
(c) Resonance effect (d) both a and c

60. Which of the following is a carbonyl based group?
(a) esters (b)nitro-
(c) alcohols (d) ethers

61. Which of the following shows electron withdrawing groups?
(a) phenyl (b)ethers
(c) amines (d) alkyl groups

62. Which of the following shows electron donating group?
(a) amides (b)esters
(c) ketones (d) amines

63. Sigma-bonding electrons, especially those from C-H bonds can be donated in a process known as
(a) conjugation (b) Hyperconjugation
(c) polarization (d) depolarization

64. Which of the following has neutral pKa value?
(a) Water (b)Ether
(c) Amide (d) All of the above

65. Amongst the following, the most basic compound is
(a) Benzylamine (b) Aniline
(c) Acetanilide (d) p-nitroaniline.

66. Hyperconjugation involves overlap of the overlap of the following orbitals
(a) $\sigma - \sigma$ (b) $\sigma - p$
(c) $p - p$ (d) $\pi - \pi$

67. Among the following, the molecule with the highest dipole moment is
(a) CH_3Cl (b) CH_2Cl_2
(c) $CHCl_3$ (d) CCl

68. Which statement or statements concerning (2R, 3S)-2,3-dichloropentane and (2R, 3R)-2,3-dichloropentane is/are true?
I. They have the same melting point.
II. They have the same density.
III. They have equal but opposite rotation of plane-polarized light.
(a) None of these (b) I
(c) II (d) III

69. Which is a meso compound?
(a) (2R,3R)-2,3-Dibromobutane (b) (2R,3S)-2,3-Dibromopentane
(c) (2R,4R)-2,4-Dibromopentane (d) (2R,4S)-2,4-Dibromopentane

70. Which of these is a comparatively insignificant factor affecting the magnitude of specific optical rotation?
(a) Concentration of the substance of interest.
(b) Purity of the sample.
(c) Temperature of the measurement.
(d) Length of the sample tube.

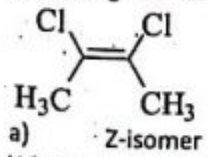
71. Enantiomers are:
(a) molecules that have a mirror image.
(b) molecules that have at least one stereogenic center.
(c) non-superposable molecules.
(d) non-superposable molecules that are mirror images of each other

72. Which of the following is NOT true of enantiomers? They have the same:
(a) boiling point: (b)melting point.
(c) specific rotation. (d)chemical reactivity toward achiral reagents.

73. Which of the following is true of any (S)-enantiomer?
(a) It rotates plane-polarized light to the right.
(b) It rotates plane-polarized light to the left.
(c) It is a racemic form.
(d) It is the mirror image of the corresponding (R)-enantiomer.

74. How many chiral stereoisomers can be drawn for CH3CHFCHFCH(CH3)2
(a) 1 (b) 2
(c) 3 (d) 4

75 According to Cahn-Ingold-Prelog Rules for geometrical isomers following compounds



is
a) Z-isomer (b)E-isomer (c)Cis- isomer (d)None of these

76 Which substrate shows S_N1 mechanism:
a) 1-chloro-2-cyclohexene (b)1-chloro-3-cyclohexene
(c) Both a & b (d)None of the above

77 E1 and E2 are the representation of the ----------
a) α-elimination (b) ɣ-elimination
(d) β-elimination (d) Both a & b

78 1,1,1-trifloro-2,2-difloroethane is reacted in el. mination with ---------- mechanism
a) E1 (b) E2 (c) E1CB (d) None of the above

ANSWERS

1.	d	2.	b	3.	a	4.	b	5.	a
6.	c	7.	a	8.	c	9.	b	10.	b
11.	a	12.	b	13.	c	14.	b	15.	c
16.	a	17.	b	18.	d	19.	c	20.	b
21.	b	22.	c	23.	d	24.	d	25.	a
26.	d.	27.	d	28.	a.	29.	c.	30.	a.
31.	d.	32.	d.	33.	b.	34.	b.	35.	a.
36.	c.	37.	b.	38.	b.	39.	c.	40.	d.
41.	d.	42.	d.	43.	d.	44.	a.	45.	a.
46.	c.	47.	c.	48.	d.	49.	d.	50.	a.
51.	b.	52.	d.	53.	a.	54.	c.	55.	d.
56.	b.	57.	c.	58.	b.	59.	c.	60.	a.
61.	a.	62.	d.	63.	b.	64.	d.	65.	a.
66.	b	67.	a	68.	a	69.	d	70.	c
71.	d	72.	c	73.	d	74.	d	75.	a
76.	a	77.	c	78.	c				

26. ALIPHATIC HYDROCARBONS

Hydrocarbons: These are organic compounds of carbon and hydrogen. Hydrocarbons can be aliphatic or aromatic.

Aliphatic hydrocarbons:can be classified into saturated and unsaturated hydrocarbons.

Saturated hydrocarbons: alkanes are the example of saturated hydrocarbon. They have a general formula C_nH_{2n+2}.

Unsaturated hydrocarbons: alkenes and alkynes are unsaturated hydrocarbons Alkenes have a general formula C_nH_{2n} and alkynes are represented by general formula C_nH_{2n-2}. Alkenes are also called olefins and oily products are form from lower alkenes.

Homologues: This compounds differ by a $-CH_2$ group from each other. This series is called as homologous series.

Functional group: An atom or group of atoms responsible for the physical and chemical properties of a compound is also known as functional group.

Alkanes are also called paraffins. prepared By using following methods alkenes can be prepared.

(a) Sabatier and Sendern's Reaction Catalytic hydrogenation

It is the addition of H_2 to double/ triple bond in the presence of Ni at 200.

$$\underset{\text{Alkene}}{CH_3-CH=CH_2} + H_2 \xrightarrow[200^\circ C]{Ni} \underset{\text{Alkane}}{R-CH_2-CH_3}$$

$$\underset{\text{Alkyne}}{CH_3\equiv C} + H_2 \xrightarrow[200-300^\circ C]{Ni} \underset{\text{Alkane}}{CH_3-CH_2-CH_3}$$

(b) Reduction of alkyl halides

With nascent hydrogen the reduction of alkyl halides is carried out.

$$CH_3I + 2H \longrightarrow CH_4 + HI$$

The reactivity order of alkyl halides is as follows.

Alkyl iodides > Alkyl bromides > Alkyl chlorides > Alkyl fluorides.

The reduction of primary alkyl halides is easier than secondary and that of secondary than tertiary.

(c) Hydrolysis of Carbides

From aluminum or beryllium carbide by addition of water methane can also be obtained.

$$Al_4C_3 + 12H_2O \longrightarrow 3CH_4 + 4Al(OH)_3$$

$$Be_2C + 4H_2O \longrightarrow CH_4 + 2Be(OH)_2$$

(d) Grignard Reagent

$$C_2H_5MgBr + HOH \longrightarrow CH_4 + Mg\begin{matrix}OH\\Br\end{matrix}$$

(e) Wurtz Reaction

$$2CH_3I + 2Na \xrightarrow{ether} CH_3-CH_3 + 2NaI$$

(f) Frankland Reaction

In this method Zn is used instead of Na used in Wurtz reaction.

$$2CH_3I + Zn \longrightarrow CH_3-CH_3 + ZnI_2$$

(g) Decarboxylation

In presence of soda lime (NaOH + CaO) Sodium salts of fatty acids can undergo decarboxylation.

$$C_2H_5COONa + NaOH \xrightarrow{CaO} C_2H_6 + Na_2CO_3$$

(h) Kolbe's Synthesis

Under high current density using platinum electrodes Sodium or potassium salt of carboxylic acid is electrolyzed to yield alkane.

$$2RCOO\overset{-}{\underset{+}{K}} + 2H_2O \longrightarrow 2R + 2CO_2 + H_2 + KOH$$

Kolbe's synthesis can be used for generation of methane

(i) Wolf Kishner's Reduction

In presence of sodium exthoside or any other alkaline it is a reduction of aldehydes or ketones . Catalyst with hydrozone at 150 —200°C.

$$C_2H_5CHO + H_2N \cdot NH_2 \xrightarrow{-H_2O} C_2H_5CHN \cdot NH_2$$

$$CH_3CH_2CH_3 + N_2 \quad EtONa$$

(j) Clemmensen's Reduction

Reduction of aldehydes or ketones (more easily reduced) with Zn — Hg and concentrated hydrochloric acid.

$$CH_3COCH_3 + 4H \longrightarrow CH_3CH_2CH_3 + H_2O$$

(k) Heating with Excess conc. HI

In presence of red P at 150 — 100°C under presence aldehydes, ketones, alcohols, and fatty acids heated with excess of conc. HI to yield alkanes.

$$CH_3OH + 2HI \xrightarrow[150°C]{P} CH_3 + H_2O + I_2$$

$$HCHO + 4HI \xrightarrow[150°C]{P} CH_3 + H_2O + 2I_2$$

$$CH_3COCH_3 + 4HI \xrightarrow[150°C]{P} CH_3CH_2CH_3 + H_2O + 2I_2$$

$$CH_3COOH + 6HI \xrightarrow[200°C]{P} CH_3CH_3 + 2H_2O + 3I_2$$

Properties of Alkanes

Alkanes are insoluble in water and it is lighter than water . In non-polar solvents like ether, benzene, hexane etc alkenes are soluble. Normal alkanes having even number of C-aton and it can showed slightly higher melting point than the next odd C-atom containing homologue and this is due to the close packing of molecules.

Chemical Properties

(a) Halogenation

In presence of sunlight halogenations can takes place. Chlorine does not show any reaction with metane in dark.

$$CH_4 + Br_2 \xrightarrow[light]{U.V} CH_3Br + HBr$$

Reactivity order

F > Cl > Br > I

Tertiary C > Secondary C > Primary C > methane

(b) Sulphonation

Alkanes reacts with oleum at 400°.

$$CH_3CH_2CH_3 + H_2SO_4 \longrightarrow CH_3CHCH_2 \cdot SO_3H + H_2O$$

Reactivity order

3° H > 2° H > 1° H

(c) Nitration

It is carried out by heating vapours of alkane and nitric acid at 400 ° 500°C.

$$CH_4 + HO—NO_2 \xrightarrow{400—500°C} CH_3NO_2 + H_2O$$

Reactivity order

3° H > 2° H > 1° H

During nitration reaction higher alkane undergoes cleavage to yield a mixture of nitrated products.

(d) Oxidation

In presence of sufficient oxygen/air alkanes burn smooth to CO_2 and H_2O.

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$$

In absence of sufficient oxygen/air alkanes form CO and carbon black.

$$2CH_4 + 3O_2 \longrightarrow 2CO + 4H_2O$$

$$CH_4 + O_2 \longrightarrow C + 2H_2O$$

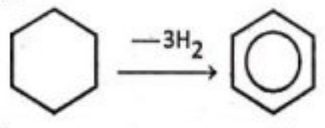
$$(CH_3)_3CH + [O] \xrightarrow{KMnO_4} (CH_3)_3COH$$

In the presence of oxidizing agents Tertiary alkanes easily oxidized to alcohols while other are resistant.

$$CH_4 + [O] \xrightarrow[200°C \text{ at } 100 \text{ atm}]{\text{Cu-tube}} H_2C{=}O \quad \text{formaldehyde}$$

Oxidation of straight chain alkanes is more easier than branched chain alkanes .

(e) Aromatisation



(f) Isomerisation

$$\underset{\text{n-pentane}}{CH_3(CH_2)_3CH_3} \xrightarrow[HCl]{AlCl_3} \underset{\text{Iso-pentane}}{CH_3—\overset{\overset{CH_3}{|}}{CH}—CH_2—CH_3}$$

(l) Cracking

Branched chain alkanes can be easily cracked in comparison to straight chain alkanes.

(j) Alkylation

Alkylation of branched chain alkanes are easier than straight chain alkanes.

Liquefied petroleum gas (LPG) used for domestic and industrial purposes is mixture of n-butane and isobuane, containing some fraction of propane.

ALKENES

Preparation

(a) Dehydration of Alcohols

$$CH_3CH_2OH \xrightarrow[170°C]{\text{Conc. } H_2SO_4} CH_2{=}CH_2 + H_2O$$

In the dehydration of alcohol phosphoric acid alumina or phosphorous pentaoxide may also be used as dehydrating agents.

Saytzeff's Rule

The hydrogen atoms will be removed from that carbon which have lesser number of hydrogen atoms .

$$CH_3CH_2\underset{\underset{OH}{|}}{CH}CH_3 \xrightarrow[Heat]{Al_2O_3} \underset{\text{(Major product)}}{CH_3CH{=}CHCH_3} + \underset{\text{(Minor product)}}{CH_3CH_2CH{=}CH_2}$$

(b) Partial Reduction of Alkynes

It is done in the presence of Lindlar's catalyst (Pd poisoned by $BaSO_4$ and quinine).

$$CH_3CH_2{-}C{\equiv}CH + H_2 \xrightarrow[Quinoline]{Pd{-}BaSO_4} CH_3CH_2CH{=}CH$$

(c) Kolbe's Synthesis

$$\underset{\underset{CH_2COONa}{|}}{\overset{CH_2COONa}{|}} \xrightarrow{\text{Electrolysis}} \xrightarrow{\text{Decarboxylation}} \underset{CH_2}{\overset{CH_2}{||}} + 2CO_2$$

(d) Dehydrohalogenation

Dehydrohalogenation of alkyl halides with alcoholic KOH olecfins can be prepared.

$$CH_3CH_2CH_2I \xrightarrow{\text{Alcohalic}} CH_3CH{=}CH_2 + KI + H_2O$$

(e) Dehalogenation of Vicinal Dihalides

In the presence of Zn dust, suspended in ethanol dehalogenation of vicinal dihalides.

$$\underset{\underset{Br}{|}}{\overset{Br}{|}}{CH_3CH_2CH_2} + Zn \xrightarrow[Heat]{Alcohol} CH_3CH_2{-}CH_2 + ZnBr_2$$

(f) Cracking

$$CH_3CH_2CH_3 \xrightarrow{600°} CH_3CH{=}CH_2 + CH_2{=}CH_2 + CH_4$$

Properties

These are water insoluble, polar solvent soluble, burn in air with luminous flame and explosive in oxygen or air. The branching in chains lower the boiling point with each carbon atom added to chain the boiling point rises 20 — 30°C. The trans -isomer has low boiling point in comparison to cis- isomer because cis isomer has higher polarity and due to poor symmetry melting points of cis-isomers are low.

Chemical Reactions of Alkenes

(A) Substitution Reactions

The substitution undergoes free radical reaction and this reactions occur at high temperature.

$$CH_2{=}CHCH_3 + Br_2 \xrightarrow{600°C} CH_2{=}CHCH_2Br + HBr$$

(B) Polymerization

$$nCH_2{=}CH_2 \longrightarrow (CH_2{-}CH_2)n{-}$$

(C) Isomerisation

Isomerisation occurs due migration of — CH_3 groups or shifting of double bond towards centre of the carbon chain. In isomerisation catalysts are $AlCl_3$ (500 — 700°C) or $Al_2(SO_4)_3$ (200 — 300°C).

Alkene can also undergo dimersiation.

(D) Addition Reactions

(a) Catalytic Hydrogenation

$$CH_2{=}CH_2 + H_2 \xrightarrow{Ni} CH_3{-}CH_3$$

(b) Halogenation

$$CH_2{=}CH_2 + Br_2 \longrightarrow BrCH_2{-}CH_2Br$$

Reactivity Order

F > Cl > Br > I

From the above reaction The detection of double in substance is carried. Br solution in CCl_4 is red, while colourless vicinal dihalide is formed, if double is present.

(c) Hydrogen Halides Addition

$$CH_2{=}CH{-}CH_3 + HBr \longrightarrow CH_3{-}\underset{\underset{Br}{|}}{CH}{-}CH_3$$

Reactivity Order

HI > HBr > HCl > HE

Markownikoff's Rule

The carbon atom which have the lesser number of hydrogen atoms halogen will attack to that carbon atom.

In peroxides Anti Markownikoff's rule is followed.

(d) Addition of Hypohalaus Acid

Markownikoff's rule is followed.

$$CH_3CH=CH_2 + HOCl \longrightarrow CH_3\underset{Cl}{CH}-\underset{OH}{CH_2}$$

(e) Addition of H_2SO_4

$$CH_2=CH_2=H_2SO_4 \longrightarrow CH_3CH_2-O-SO_3H$$

(f) Hydroboration

$$3CH_2=CH_2 + BH_3 \longrightarrow (CH_3CH_3)_3\,B$$

(g) Oxidation

Different oxidation products are formed under different conditions.

$$CH_2=CH_2 + H_2O + O \xrightarrow{\text{Cold } KMnO_4} \underset{OH}{CH_2}-\underset{OH}{CH_2}$$

$$CH_2=CH_2 + [O] \xrightarrow{\text{Hot } KMnO_4} CH_3-COOH + CO_2 + H_2O$$

$$2CH_2=CH-CH_3 + O_2 \xrightarrow{\text{Ag at } 300^\circ C} \underset{O}{2CH-CH}-CH_3$$

$$CH_3-CH_2-CH=CH_2 \xrightarrow{CuO} CH_2=CH-CH_2CHO + H_2O$$

$$CH_3-CH=CH-CH_3 + CH_3COOOH \longrightarrow CH_3-\underset{O}{CH-CH}-CH_3$$

$$CH_3-CH=CH_2 + H_2O_2 \longrightarrow CH_3-\underset{O}{CH-CH_2} + H_2O_2$$

$$CH_3CH=CHCH_3 + O_3 \xrightarrow[Zn]{H_2O} 2CH_3CHO + ZnO + CO_2$$

$$CH_2=CH_2 + 3O_2 \xrightarrow{\text{Heat}} 2H_2O + 2CO_2$$

(h) Carbonization

$$CH_2=CH_2 + CO + H_2 \xrightarrow[170^\circ C,200\text{ atm}]{HCO(CO)_4}$$

$$CH_3CH_2CHO \xrightarrow[Ni]{H_2} CH_3CH_2CH_2OH$$

(i) Addition of nitrosyl chloride or bromide

$$CH_2=CH_2 + NOBr \longrightarrow \underset{Br}{CH}-\underset{NO}{CH_2}$$

Alkenenes are isomeric with cycloalkanes or cycloparaffins. Ethylene is produced by disintegration of cells in fruit ripening processes. It is also used as artificial ripening agent. Ethylene produces anesthesia on inhalation.

Detection and Location of Double Bond

(i) By Bromine Water Test

The red color of bromine in CCl_4 disappears if a compound has a double bond.

(ii) By Backer's Reagent Test

The purple color of 1% alkaline $KMnO_4$ solution converted into brown color.

By ozonolysis the double bond location can be identified and oxidation with hot conc. $KMnO_4$. And at double bond the splitting of compound can also be occurred and from that identification of products double bond position can be located.

(i) Oxidation with Hot Conc. $KMnO_4$

$$CH_3CH_2\overset{CH_3}{\underset{|}{C}}=\overset{H}{\underset{|}{C}}-CH_3 \xrightarrow[\text{Hot } KMnO_4]{[O]} \underset{\text{Ketone}}{CH_3CH_2\overset{CH_3}{\underset{|}{C}}=O} + \underset{\text{Carboyclic acid}}{CH_3COOH}$$

(ii) Ozonolysis

$$CH_3CH=\overset{CH_3}{\underset{|}{C}}-CH_3 \xrightarrow[(ii)\,H_2O/Zn]{(i)\,O_2} \underset{\text{Aldehyde}}{CH_3CHO} + \underset{\text{Ketone}}{CH_3-\overset{O}{\overset{||}{C}}-CH_3}$$

In conjugated dienes 1,2 adduct is formed as major product at lower temperatures and 1,4 adult a major product at higher temperature.

$$CH_2=CH-CH=CH_2 + HBr \longrightarrow$$

$$\underset{\text{(1,2-Adduct)}}{CH_2=CH-\overset{Br}{\underset{|}{CH}}-CH_3} + \underset{\text{(1,4-Adduct)}}{CH_3-CH=\overset{Br}{\underset{|}{C}}HCH_2}$$

Dienes undergo polymerization in the presence of peroxide.

$$\underset{\text{1,3-Butadiene}}{CH_2=CH-CH=CH_2} \xrightarrow{\text{Peroxide}}$$

$$\underset{\text{Polybatadiene}}{(-CH_2-CH=CH-CH_2-)_n}$$

Alkynes

Alkynes contain at least one carbon-carbon triple bond and are isomeric with dienes.

Due to overlapping of two sp hybrid orbitals a σ-bond is formed and the π-bond is formed due to overlapping of two 2p orbitals from the two adjacent carbon atoms.

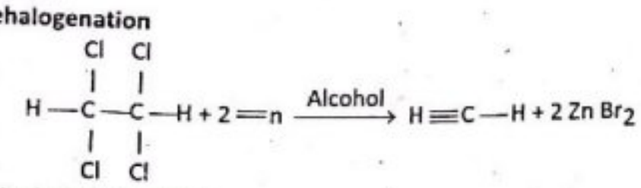
The hydrogen attached to triple bond is acidic in nature.

Acidity Order:

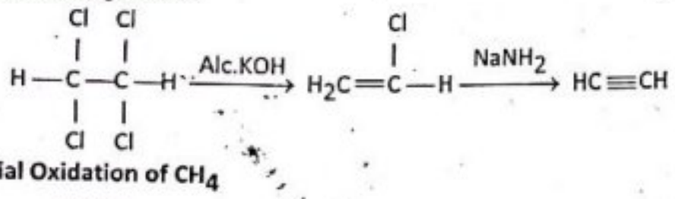
Alkyne > Alkene > Alkane

Preparation

(a) Dehalogenation



(b) Dehydrohalogenation



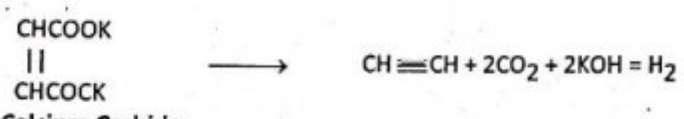
(c) Partial Oxidation of CH_4

$$6CH_4 + O_2 \xrightarrow{1500°C} 2C_2H_2 + 2CO + 10H_2$$

(d) Synthesis

$$2C + H_2 \xrightarrow{\text{Elecronic arc}} C_2H_2$$

(e) Kolbe's Electrolysis



(f) From Calcium Carbide

$$CaC_2 + 2H_2O \longrightarrow HC \equiv CH + Ca(OH)_2$$

(g) From Iodoform

$$2CH_2I + 6Ag \longrightarrow CH \equiv CH + 6AgI$$

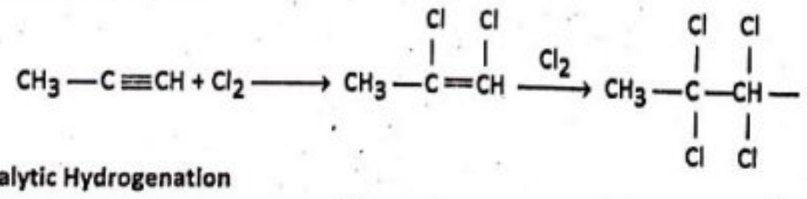
(h) From alkylation of Acetylides

$$HC \equiv CNa + C_2H_5Br \longrightarrow HC \equiv C - C_2H_5 + NaBr$$

Properties

Chemical Properties

(a) Addition of Halogens



(b) Catalytic Hydrogenation

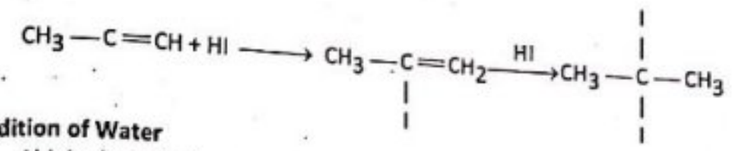
$$CH \equiv CH + H_2 \xrightarrow{Ni} CH_2 = CH_2 \xrightarrow[Ni]{H_2} CH_3 - CH_3$$

Lindlar catalyst is used to stop reaction at alkene stage.

$$CH \equiv CH + H_2 \xrightarrow[\text{Quinoline}]{Pd\text{-}BaSO_2} H_2C = CH_2$$

(c) Addition of Hydrogen Halides

According Markownikoff's rule the addition of hydrogen can occured. Anti Markownikoff's addition takes place in the presence of peroxide.



(d) Addition of Water

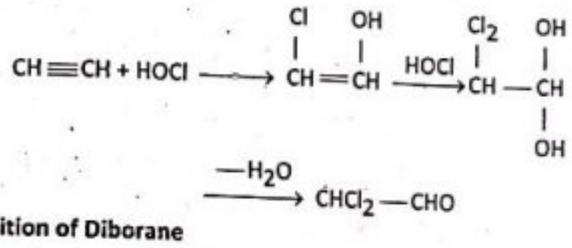
Aldehydes or ketones are the products of reaction.

$$CH \equiv CH + H_2O \xrightarrow[H_2SO_4]{HgSO_4} CH_2 = CHOH \longrightarrow CH_3CHO$$

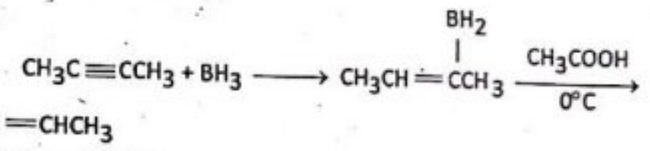
(e) Addition of HCN

$$CH \equiv CH + HCN \xrightarrow{Ba(CN)_2} CH_2 = CHCN$$

(f) Addition of Halous Acid



(g) Addition of Diborane



$CH_3CH = CHCH_3$

(h) Addition of H_2SO_4

$$CH \equiv CH + 2H_2SO_4 \longrightarrow CH_3 - CH(HSO_4)_2$$

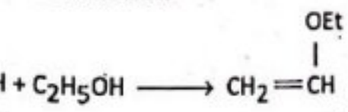
(i) Addition of Carboxylic Acids

$$CH \equiv CH + CH_3COOH \xrightarrow[200°C]{CH_3COOZn} \underset{\text{Vinyl acetate}}{CH_2 = CHOOCH_3}$$

(j) Addition of Carbonmonoxide

$$HC \equiv CH + CO + H_2O \xrightarrow{Ni(CO)_4} CH_2 = CH \cdot COOH$$

(k) Addition of Alcohols



Catalyst:

Mercuric salts, KOH, BF_3 etc.

(I) Oxidation

On oxidation usually cleavage occurs at the site of triple bond.

$$CH_3C\equiv CCH_3 \xrightarrow[2[O]]{KMnO_4} CH_3CO-COCH_3 \xrightarrow{[O]} 2CH_3COOH$$

$$CH_3C\equiv CH + O_3 \xrightarrow{H_2O} CH_3COOH + HCOOH$$

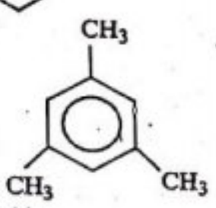
The triple bond present in alkynes is more stable towards oxidation in comparison to alkenes.

$$2CH\equiv CH + 5O_2 \longrightarrow 4CO_2 + 2H_2O$$

Polymerization

$$3CH\equiv CH \xrightarrow[\text{Red hot glass tube}]{500^\circ C}$$

$$3CH_3C\equiv CH \xrightarrow[\text{Red hot glass tube}]{500^\circ C}$$



$$CH\equiv CH \xrightarrow[\text{and ammonium chloride in dil.HCl}]{\text{Cuprous chloride}} CH_2=CH-C\equiv CH$$

Vinyl autylene

Curious chloride

Dil.HCl 160°C

$$(-CH_2-\underset{\text{Cl}}{\underset{|}{C}}=CH-CH_2-)_n \xleftarrow{\text{Polymerization}} CH_2=\underset{\text{Cl}}{\underset{|}{C}}-CH=CH_2$$

Neoprene (Synthetic ruber)

Chloroprene

Acetylene is acidic in nature but weaker acid than phenol and ethyl alcohol. The π-bond of ethylene is more stronger than π-bond in acetylene. Alkenes are more reactive then alkynes. If a compound contain both double and triple bonds the addition to double bond is more preferable.

IDENTIFICATION OF ALKANES, ALKANES AND ALKYNES

Test	Alkanes	Alkenes	Alkynes
Alkaline $KMnO_4$	No reaction	Decolorization and formation of glycols.	Decolorization and formation of carboxylic acids.
Br-Water	No reaction	Decolorization	Decolorization
Ammonical Cu_2Cl_2	No reaction	No reaction	Red ppt. of cuprous acetylide
Tollen's Reagent Test (Ammonical silver nitrate)	No reaction	No reaction	White ppt. of silver acetylide

MULTIPLE CHOICE QUESTIONS

1. Which one is Chloroform
   (a) CH_2Cl_2 (b) CH_3Cl
   (c) $CHCl_3$ (d) CCl_4
2. Vinylacetylene combines with HCl to form
   (a) Polyacetylene (b) Benzene
   (c) Chloroprene (d) Divinyl acetylene
3. Which is used for artificial ripening of fruit?
   (a) Ethane (b) Ethene
   (c) Ethyne (d) Methane
4. Preparation of vegetable ghee involves
   (a) Halogenation (b) Hydroxylation
   (c) Hydrogenation (d) Hydration
5. Which is methyl cyanide
   (a) CH_3NH_2 (b) CH_3NO_2
   (c) CH_3CN (d) $CH_2 = CH - CN$
6. The functional group contained in the compound CH2=CH2 is a(n)
   (a) Ester (b) Ketone
   (c) Alkene (d) Alcohol
7. An alkane with 7 carbon atoms contains _____ hydrogen atoms.
   (a) 16 (b) 14
   (c) 18 (d) 20
8. Marsh gas mainly contains
   (a) C_2H_2 (b) CH_4
   (c) H_2S (d) CO
9. Which of the following will decolourise alkaline $KmnO_4$ solution?
   (a) C_3H_8 (b) CH4
   (c) CCl_4 (d) C_2H_4
10. Bayer's reagent is
    (a) Alkaline permanganate solution (b) Acidified permanganate solution
    (c) Neutral permanganate solution (d) Aqueous bromine solution
11. The rate of rection of ————with halogen is fastest?
    (a) F (b) Cl
    (c) Br (d) I
12. According to the increasing order of boiling points arrange following
    (a) Isopentane < n-pentane < neopentane
    (b) n-pentane < neopentane < Isopentane
    (c) neopentane < Isopentane < n-pentane
    (d) neopentane < Isopentane > n-pentane
13. Which of the following reaction the alkanes mainly undergo ————?
    (a) Polymerization (b) Addition
    (c) Elimination (d) Substitution
14. which of following mechanism Substitution could follow?
    (a) Electrophilic (b) Free radical
    (c) Nucleophilic (d) All

15. With bromine gas which of the following compound will react most readily?
(a) $CH_3CH_2CH_2CH_3$ (b) $CH_3CH=CHCH_3$
(c) $CH_3C\equiv CH$ (d) $CH_3CH_2CH_3$

16. Diesel Cetane number is determined by comparing it with?
(a) Hexadecane (b) Octane
(c) Iso pentane (d) Decane

17. For detection of reaction Baeyer's reagent is used ?
(a) Unsaturation (b) Oxidation process
(c) Reduction Process (d) Carbohydrate

18. With 1-pentene HCl react to?
(a) 1-chloropentane (b) 2-chloropentane
(c) 3-chloropentane (d) 1,2-chloropentane

19. which has highest strain among the following compound
(a) Cyclohexane (b) Cyclopentane
(c) Cyclobutane (d) Cyclopropane

20. Alkanes containing a methyl group on main chain at 2nd carbon are called
(a) Iso-alkane (b) Normal-alkane
(c) Neo-alkane (d) Branched-alkane

21. When one hydrogen atom of alkane is removed then it is called
(a) Alkene (b) Alkyl
(c) Aldehyde (d) Saturated hydrocarbon

22. Alkanes are also known as
(a) Saturated hydrocarbon (b) Unsaturated hydrocarbon
(c) Paraffins (d) Both a & c

23. Sabatier Senderns reaction involve _____ in presence of Ni
(a) Alkene and H_2 (b) Alkene and O_2
(c) Alkene and N_2 (d) Alkyne and Cl_2

24. Hydrogenolysis results in the formation of
(a) Alkane (b) Alkene
(c) Alkyne (d) Aldehyde

25. Clemmensens reduction infolves the reduction of
(a) Ketone (b) Aldehyde
(c) Alkane (d) all of above

26. Soda lime is a mixture of
(a) CaO and KOH (b) CaO and NaOH
(c) NaOH and Na2O (d) Na2O and KOH

27. Removal of CO2 is called
(a) Carboxylation (b) Decarboxylation
(c) Esterification (d) Hydroxylation

28. Molozonide is unstable and changes into ozonide on
(a) Reduction (b) Oxidation
(c) Hydrolysis (d) Rearrangement

29. Due to presence of double bond alkenes are
(a) Unsaturated (b) Saturated
(c) Polar (d) Non-polar

30. R-Mg-Br is called
(a) Grignard reagent (b) Metallic alkyl halide
(c) Both a & b (d) Alkyl

31. Upto _____ C atoms alkanes are gases
(a) 2 (b) 3
(c) 4 (d) 6

32. Which of the following is the most reactive
(a) Ethane (b) Ethyne
(c) Ethene (d) Benzene

33. Introduction of nitro group in a molecule is called
(a) Nitration (b) Halogenation
(c) Sulphonation (d) Amination

34. Order of ease of halogenation in alkane is
(a) $I_2>Cl_2>Br_2>F_2$ (b) $F_2>Cl_2>I_2>Br_2$
(c) $F_2>Cl_2>Br_2>I_2$ (d) $Cl_2>F_2>Br_2>I_2$

35. General formula of alkyne is
(a) C_nH_{2n+2} (b) C_nH_{2n-2}
(c) C_nH_{2n} (d) C_nH_{2n+2}

36. Removal of halogen and hydrogen atom is
(a) Halogenation (b) Dehalogenation
(c) Dehydrohalogenation (d) Hydrohalogenation

37. The gas used in manufacturing of urea fertilizer
(a) C_2H_6 (b) C_2H_4
(c) C_2H_2 (d) CH_4

38. Alkenes are produced from dehalogenation of
(a) Dihalo alkane (b) Trihalo alkane
(c) Vicinal dihalo alkane (d) Vicinal trihalo alkane

39. Reactivity due to pi-electrons is present in
(a) Alkane (b) Alkene
(c) Alkyne (d) Both b & c

40. Raney nickel is prepared from _____ by treating with caustic soda
(a) Ni-Cu alloy (b) Ni-Fe alloy
(c) Ni-Al alloy (d) Ni-Mg alloy

41 Organic compounds containing carbon chains are referred as
(a) Aliphatic compounds (b) Aromatic compounds
(c) Alkalinic compound (d) Allylic

42. The aliphatic hydrocarbons have a main source
(a) Grains (b) Wood
(c) Waste products (d) Petroleum

43. By using the following method the petroleum products are separated into various fractions
(a) Fractional distillation (c) Distillation
(c) Solvent extraction (d) Isomerization

44. The hydrocarbon that composed of fewer carbon atoms rise up the column In fractional distillation in the form of a ———?
(a) Gas (b) Supercritical liquid

(c) Liquid (d) Solid

45. What is the name of organic compound shown?

(a) Butane (b) Cyclobutane

(c) Diethane (d) 1,2-dimethyl butane

46. Following reaction is also called :

$$\underset{\text{Alkyne}}{CH_3 \equiv C} + H_2 \xrightarrow[200-300^\circ C]{Ni} \underset{\text{Alkane}}{CH_3-CH_2-CH_3}$$

(a) Frankland Reaction (b) Wurtz Reaction

(c) Wolf Kishner's Reduction (d) Sabatier and Sendern's Reaction

47. For preparing alkanes in this method Zn is used instead of Na ?

(a) Frankland Reaction (b) Wurtz Reaction

(c) Wolf Kishner's Reduction (d) Sabatier and Sendern's Reaction

48. In Wolf Kishner's Reduction. What is intermediate product?

$$C_2H_5CHO + H_2N \cdot NH_2 \xrightarrow{-H_2O} CH_3CH_2CH_3 + N_2 \quad EtONa$$

(a) $C_2H_5CHN \cdot NH_2$ (b) $C_2H_5CHN_2$

(c) $C_2H_5CHONNH_2$ (d) $C_2H_5CHNH_2$

49. The statements of Saytzeff's Rule?

(a) The loss of hydrogen atoms result from that carbon which have lesser number of hydrogen atoms.

(b) The loss of hydrogen atoms result from that carbon which have greater number of hydrogen atoms.

(c) The loss of hydrogen atoms result from any carbon that have hydrogen atoms.

(d) There is no loss of hydrogen atoms from any carbon atom having double bond.

50. On decarboxulation Isobutyric acid gives following?

(a) Ethane (b) Butane

(c) Propane (d) Isobutane

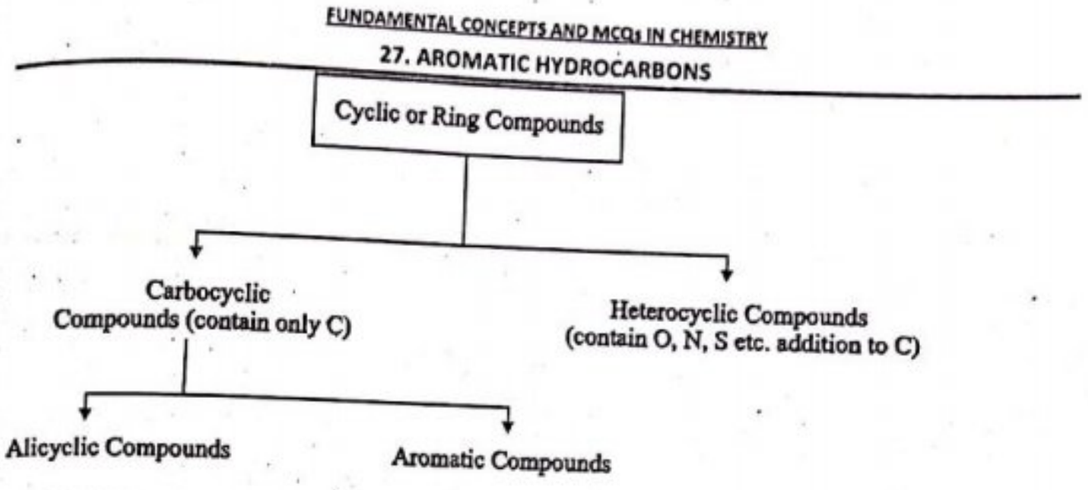
51 Haloform reaction is used to prepare

a) CCl_4 (b)$CHCl_3$ (c)Halides (d)Halogens

ANSWERS

1. c	2. c	3. b	4. c	5. c	6. c	7. a	8. B
9. d	10. a	11. a	12. c	13. d	14. d	15. c	16.a 17.
a 18.	b 19.	d 20.	a 21.	b 22.	c 23. a	24.a 25.	a
26. b	27. b	28. b	29. a	30. a	31. c	32.c 33. a	34.
c 35.	b 36.	c 37.	d 38.	c 39. b	40.c 41.	a 42.	d
43. a	44. a	45. b	46. d	47. a 48.a	49. a	50. c	51
b							

27. AROMATIC HYDROCARBONS



In 1825, M. Faraday first time isolate the benzene from destructive distillation of Coal. Benzene and its alkylated derivatives of its are liquids. The compounds which contain more than one aromatic ring are solids. With a characteristic sooty flame aromatic hydrocarbons are burn and large amount of carbon is produced on burning them. These compounds contain a high carbon to hydrogen ration and little oxygen. There is 1:1 carbon to hydrogen ration in benzene. With basic permanganate and Br_2/CCl_4 aromatic hydrocarbon give negative test. In conc. H_2SO_4 (class I) aromatic hydrocarbons are insoluble, however the more activated ones are soluble in H_2SO_4 but not H_3PO_4 (class N_2). All aromatic hydrocarbons dissolve in fuming H_2SO_4, react with azoxybenzene in the presence of $AlCl_3$ as a catalyst to give a colored diazo complex and also react with $CHCl_3/AlCl_3$ to produce the highly colored triarylcarbonium ion in solution.

Preparation of Benzene

(i) From distillation of Light Oil.

(ii) Berthelot's Synthesis (1820)

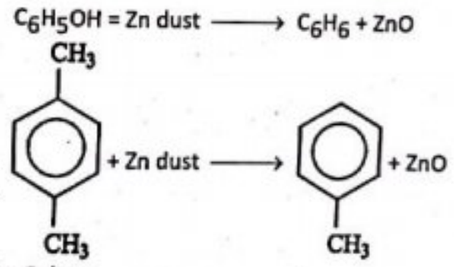
$$3HC \equiv CH \longrightarrow C_6H_6$$

(iii) From aromatic Acids

$$C_6H_5COOH \xrightarrow{NaOH} C_6H_6COONa \longrightarrow C_6H_6 + Na_2CO_3$$

(iv) From Phenol

$$C_6H_5OH = Zn\ dust \longrightarrow C_6H_6 + ZnO$$



(v) From diazonim Salts

$$C_6H_5N_2Cl \xrightarrow{C_6H_5OH} C_6H_6 + N_2 + HCl + CH_3CHO$$

$$C_6H_5N_2Cl + 2H \xrightarrow{SnCl_2/NaOH\ excess} C_6H_6 + N_2 + HCl$$

(vi) Hydrolysis

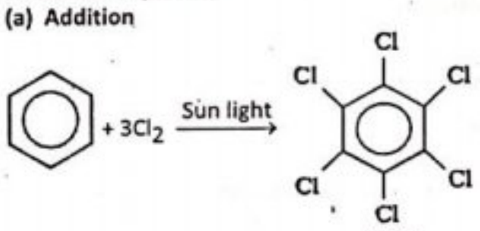
$$C_6H_5—SO_3H \xrightarrow[Super\ heated\ steam]{Conc.HCl} C_6H_6 + H_2SO_4$$

Properties

Benzene is a colorless , volatile and inflammable liquid. With 32% ethanol Benzene forms an azotrophe (b.p.68°C) .

Chemical Properties

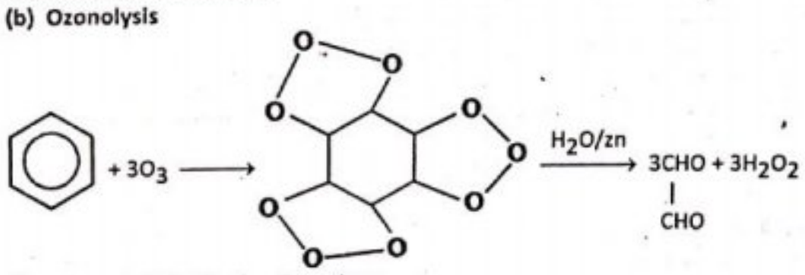
(a) Addition



BHC

Benzene hexachloride (BHC) is also known as gammaxene under the trade name lindane very well known as insecticide.

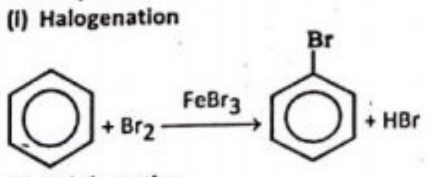
(b) Ozonolysis



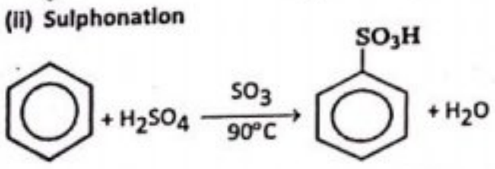
(c) Aromatic Substitution Reactions

Benzene undergo substitution reactions in preference to addition reactions. Benzene does not give unsaturation tests such as does not decolorize Br_2 water or 1% alkaline $KMnO_4$ solution. Halogenation, nitrations, sulphonation, Friedel craft alkyaltion and acylation are the example of electrophilic substitution reactions.

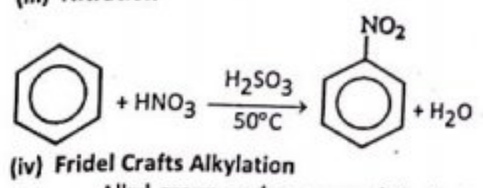
(I) Halogenation



(ii) Sulphonation

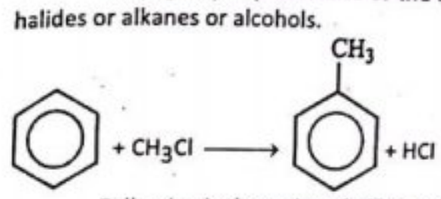


(iii) Nitration



(iv) Fridel Crafts Alkylation

Alkyl group replaces one of the hydrogens of the benzene ring when it is treated with alkyl halides or alkanes or alcohols.



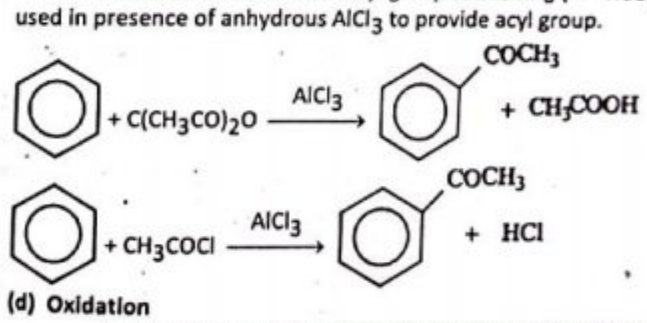
Following is the order of efficiency of various alkylation catalysis.

$$AlBr_3 > AlCl_3 > FeCl_3 > BF_3 > TiCl_3 > ZnCl_2$$

In addition acid catalyst such as conc. H_2SO_4 or phosphoric acid etc. can also be employed but they are less effective.

(v) Fridel Craft Acylation

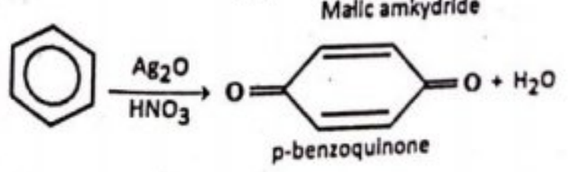
It is the substitution of acyl group to the ring (—RCO). Acid chlorides or acid anhydrides are used in presence of anhydrous $AlCl_3$ to provide acyl group.



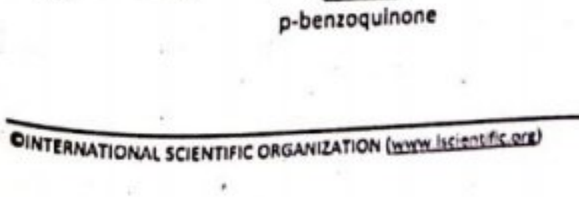
(d) Oxidation

Benzene does not show oxidation reaction with mild oxidizing agents such as $KMnO_4$, K_2Cr_2O etc.

Under high frastic condition decomposition of benzene occurs to CO and H_2O.

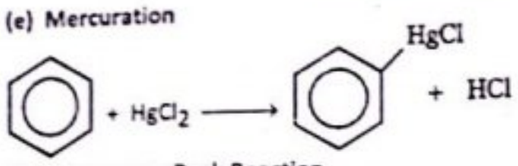


Malic amkydride

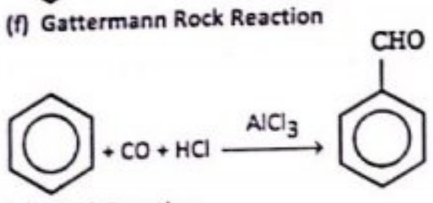


p-benzoquinone

(e) Mercuration

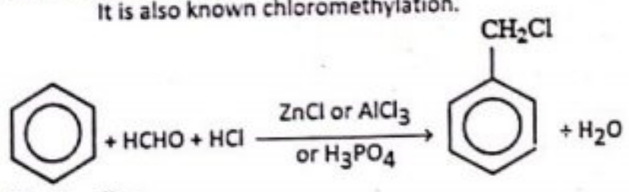


(f) Gattermann Rock Reaction

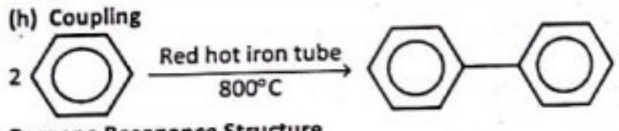


(g) Black Reaction

It is also known chloromethylation.



(h) Coupling



Benzene Resonance Structure

Benzene resonance energy is 35 K Cals. Kekul was first to propose satisfactory benzene structure in 1865. The bond angle in all C — C — C and C — C — H atoms are 120°. These 12 sigma and 3 π bonds in benzene. Among sigma bonds there are six C — C sigma bonds (sp^2 — sp^2) and six C — H sigma bonds (sp^2 — s)

Huckel's Rule

No. of π-$\bar{e}$s in aromatic ring = 4n + 2

where

n = No. of benzene rings

Any compound which obey Hucke's rule is aromatic compound

⇒ Benzene ring is activated by O- and P-directors and deactivated by meta directors.

O – and P– Directing Groups

—OH, NH_2, Cl, Br, I, CH_3, C_2H_5, OR, NHR, NHR_2, RBr etc.

Meta Directing Groups

COOR, COR, CHO, COOH, CN, NO_2, HSO_3 etc.

Alkyl Benzenes

Preparation

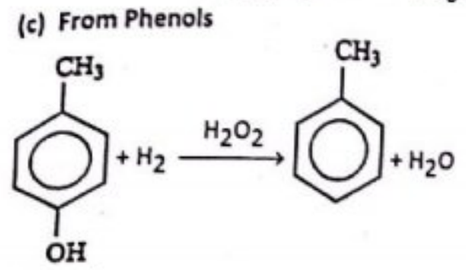
(a) Wurtz Fitting Reaction

$$C_6H_5Cl + CH_3Cl + 2Na \xrightarrow{\text{Ether}} C_6H_5CH_3 + 2NaCl$$

(b) From Grignard Reagent

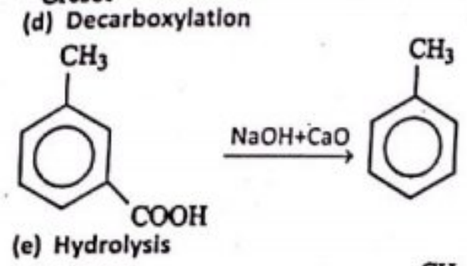
$$C_6H_5MgBr \xrightarrow{RBr} C_6H_5R + MgBr_2$$

(c) From Phenols

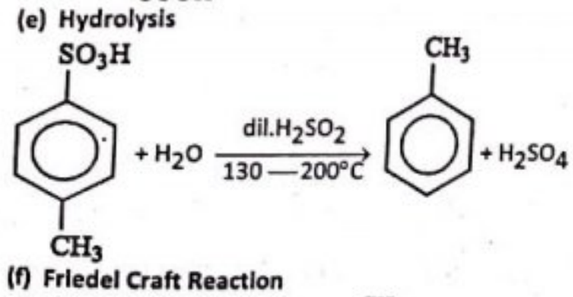


Cresol

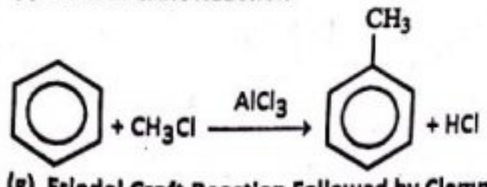
(d) Decarboxylation



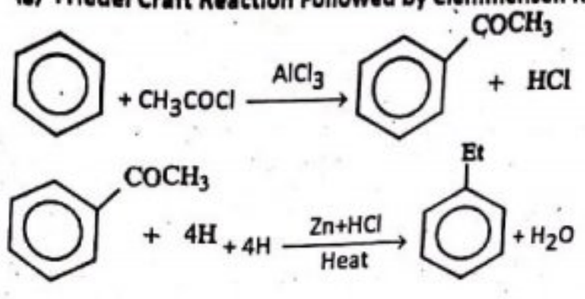
(e) Hydrolysis



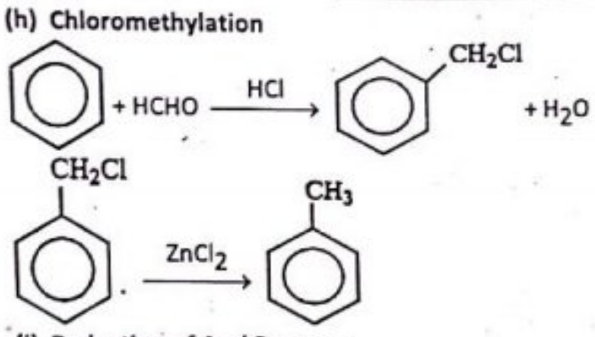
(f) Friedel Craft Reaction



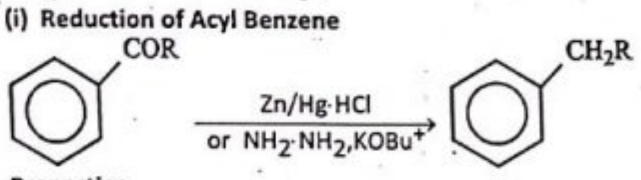
(g) Friedel Craft Reaction Followed by Clemmensen Reduction



(h) Chloromethylation

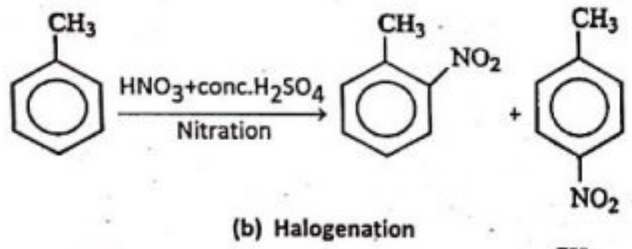


(i) Reduction of Acyl Benzene

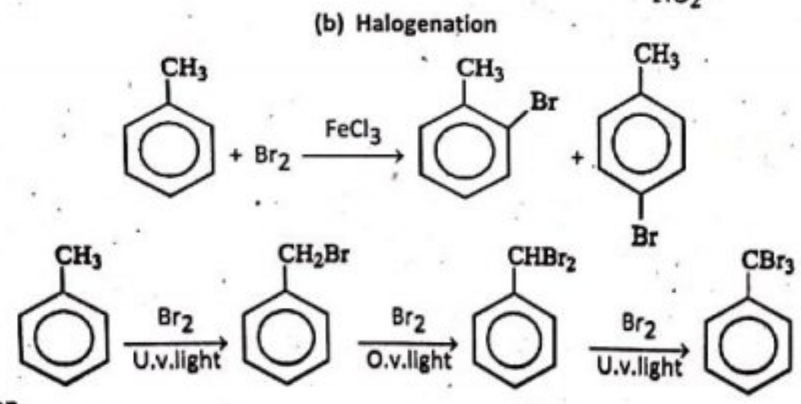


Properties

(a) Nitration

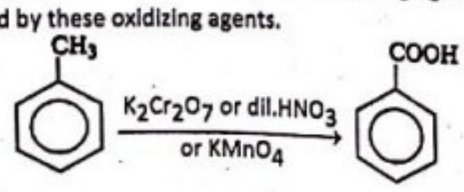


(b) Halogenation

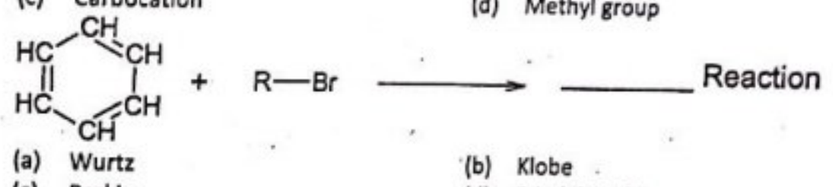
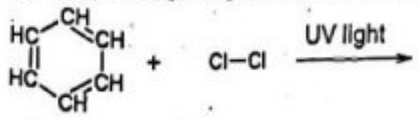
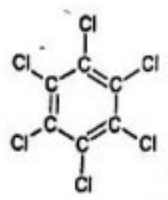
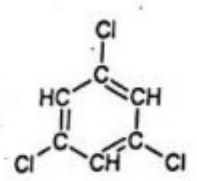


(c) Oxidation

Benzene derivative rings are not affected by mild oxidizing agents such as $KMnO_4$, $K_2Cr_2O_7$ etc. but side chain is affected by these oxidizing agents.



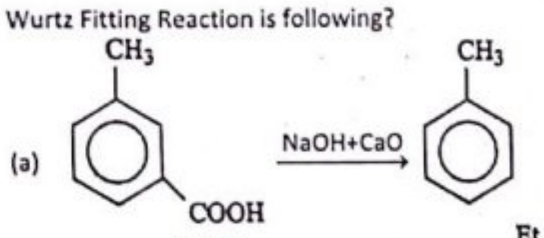
MULTIPLE CHOICE QUESTIONS

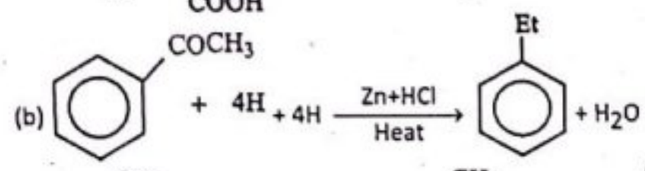
1. _____ is used as insecticide.
   (a) Benzene hexachloride (b) Toluene
   (c) Chlorobenzene (d) Monochloro benzene
2. The molecular formula of toluene is
   (a) C_7H_7 (b) C_8H_8
   (c) C_8H_7 (d) C_7H_8
3. Which catalyst converts benzene into maleic anhydride?
   (a) $AlCl_3$ (b) $ZnCl_2$
   (c) V_2O_5 (d) Ag_2O
4. Phenanthrene has _____ fused rings.
   (a) 2 (b) 3
   (c) 4 (d) 5
5. Aromatic hydrocarbons give negative test with
   (a) Br_2/CCl_4 (b) CCl_4
   (c) permanganate (d) both a & c
6. In Friedel Craft reaction electrophile is?
   (a) Carbanion (b) Carbon radical
   (c) Carbocation (d) Methyl group
7. 
   (a) Wurtz (b) Klobe
   (c) Perkin (d) Friedel Crafts
8. Gammaxene is the name of _____
   (a) Benzenehexachloride (b) Toluene
   (c) Chlorobenzene (d) Monochlorobenzne
9. Correct order for the calatlysis efficiency of catalysts is:
   (a) $AlBr_3 > AlCl_3 > FeCl_3 > BF_3 > TlCl_3 > ZnCl_2$
   (b) $TlCl_3 > AlBr_3 > AlCl_3 > FeCl_3 > BF_3 > ZnCl_2$
   (c) $AlBr_3 > AlCl_3 > BF_3 > TlCl_3 > ZnCl_2 > FeCl_3$
   (d) $AlBr_3 > FeCl_3 > BF_3 > AlCl_3 > TlCl_3 > ZnCl_2$
10. 
    (a) 
    (b) 

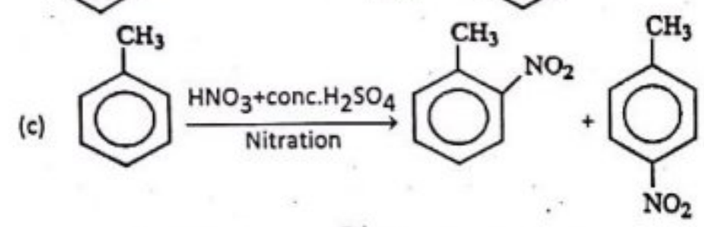
(c)

(d)

11. Wurtz Fitting Reaction is following?

(a) 

(b) 

(c) 

(d) $C_6H_5Cl + CH_3Cl + 2Na \xrightarrow{Ether} C_6H_5CH_3 + 2NaCl$

12. Mixture of catalysts $Cr_2O_3 + Al_2O_3 + SiO_2$ at 500°C is used to prepare benzene from ——
(a) N-hexane (b) acetylene
(c) sodium benzoate (d) benzene sulphonic acid

13. Which of following oxidizing agent for the oxidation of benzene?
(a) $KMnO_4$ (b) $K_2Cr_2O_7$
(c) Dil. HNO_3 (d) None of these

14. Which catalyst is employed for the benzene preparation from acetylene at 70°C?
(a) Raney nickel (b) Organo nickel
(c) Ni 250 – 300°C (d) $Cr_2O_3 + Al_2O_3 + SiO_2$

15. Resonance energy of benzene is ———— K Cals.
(a) 53 (b) 37
(c) 55 (d) 35

16. In Friedel Craft reaction, AlCl3 is used to give?
(a) Weak nucleophile (b) Weak electrophile
(c) Strong electrophile (d) Strong nucleophile

17. Benzene ring is activated by?
(a) Ortho directors (b) Ortho and para directors
(c) Ortho and meta directors (d) Meta directors

18. Oxidation of benzoic acid with acidified $KMnO_4$ or $K_2Cr_2O_7$ produces?
(a) n-propyl benzene (b) tolunene
(c) ethyl benzene (d) All

19. Which is a meta directing?
(a) C_2H_5 (b) NHR_2
(c) COOH (d) RBr

20. Which one is the molecular formula of benzal chloride?
(a) $C_6H_5CH_2Cl$ (b) $C_6H_5CH{=}CHCl$
(c) $C_6H_5CHCl_2$ (d) None

21. Ortho and para directing group is?
(a) COOR (b) COR
(c) CHO (d) I

22. Benzenetrizonide hydrolysis yields three moles of?
(a) Glyoxal (b) Gluoxime
(c) Glycol (d) Benzaldehyde

23. Organic Compounds are most likely to?
(a) Not burn in air (b) Contain covalent bonds
(c) Soluble in water (d) High melting points

24. Benzene ozonlysis produces?
(a) Vicinal diol (b) Glycol
(c) Glyoxal (d) Both b & c

25. The propane combustion products are?
(a) $3CO_2 + 4H_2O$ (b) $3CO_2 + 4H_2O$
(c) $3CO + 4H_2O$ (d) $2CO_2 + 4H_2O$

26. Which compound readily undergoes sulphonation?
(a) Toluene (b) Nitrobenzene
(c) Chlorobenzene (d) Benzene

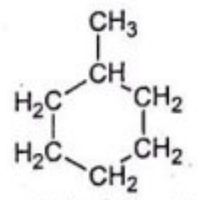
27. Which of the following is the structural isomer of C_5H_{12}?
(a) Any of following
(b) 2,2-dimethylpropane and pentane
(c) 2-methylbutane and 2,2-dimethylpropane
(d) pentane and 2-methylbutane

28. Benzene preparation from acetylene can be regarded as ————
(a) dehydration (b) polymerization
(c) condensation (d) oxidation

29. Which of the following is the Select structural isomer pair ?
(a) 2-methylpentane and 2,3-dimethylbutane
(b) 2-methylpropane and propane
(c) Propane and butane
(d) 2-methylbutane and butane

30. Nitronium ion is ————
(a) NO (b) NO_3 (c) NO^{2+} (d) NO^{2-}

31. The following compound has IUPAC name



(a) methylhexane (b) 1-methylcyclohexane
(c) 1-methylcyclohexane (d) methylcyclohexane

32. Benzene does not undergo ————
(a) addition reaction (b) substitution reaction
(c) polymerization reaction (d) oxidation reaction

33. 2,4-dimethylpentane has molecular formula?
(a) C_7H_{14} (b) C_7H_{16}
(c) C_7H_{12} (d) C_5H_{10}

34. Acetophenone is a ————
(a) ether (b) aldehyde
(c) ketone (d) ester

35. Anthracene has ————fused rings.
(a) 2 (b) 3
(c) 4 (d) 5

36. Fused cyclic aromatic compound is ————
(a) naphthalene (b) biphenyl
(c) biphenyl amine (d) diphenyl methane

37. Toluene chlorination in the sunlight gives?
(a) chlorobenzene (b) o-chlorotoluene
(c) p-chlorotoluene (d) benzyl chloride

38. Direct nitration ————is not possible.
(a) Toluene (b) Phenol
(c) Benzoic acid (d) Aniline

39. Which pair has both ortho and para directing groups
(a) OH, RCO (b) NR_3, CN
(c) $N(CH_3)_2$, NH_2 (d) OCH_3, CHO

40. In Etard reaction ———— Chromyl chloride is used.
(a) Neutralizing agent (b) Solvation add
(c) Catalyst (d) Oxidizing agent

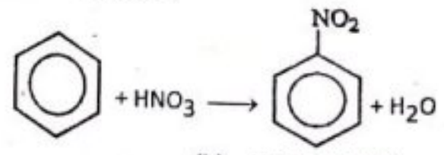
41 For the following reaction what is the catalyst?

$C_6H_5N_2Cl + 2H \longrightarrow C_6H_6 + N_2 + HCl$

(a) $SnCl_2$/NaOH excess (b) $SnCl_2$/KOH excess
(c) $ZnCl_2$/NaOH excess (d) $SnCl_2$

42. The benzene molecuole contains
(a) delocalized pi electrons (b) three double bonds
(c) two double bonds (d) one double bond

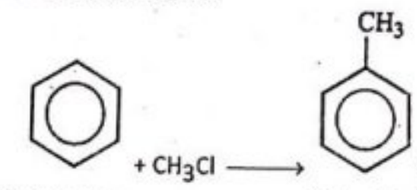
43. For the following reaction what is catalyst?



(a) H_2SO_3 at 50ºC (b) H_2SO_4 at 50ºC
(c) HCl at 50ºC (d) H_2SO_3 at 150ºC

44. Following are the monosubstitued aromatic compounds except,
(a) phenol (b)xylene
(c) toluene (d) benzoic acid

45. Following reaction is also called as?



(a) Friedel Craft Acylation (b) Friedel Craft Akylation
(c) Black's reaction (d) None of these

46. The shape of benzene molecule is?
(a) planar (b)pyramidal
(c) hexagonal (d) plane hexagonal

47. Benzene has ————sigma and ————pi bonds, respectively?
(a) 6, 6 (b) 6, 3
(c) 12, 3 (d) 9, 4

48. The resonance energy of benzene is?
(a) 250.5 Cal/mol (b)250.5kJ/mol
(c) 150.5 kJ/mol (d)150.5 Cal/mol

49. For the preparation _____ Gattermann Rock Reaction is used?
(a) Benzene (b) Formaldehyde
(c) Benzoic acid (d) Benzaldehyde

50. Chlorobenzene nitration gives?
(a) o – chloronitrobenzene (b) p – chloronitrobenzene
(c) m – chloronitrobenzene (d) a & b

51 Common reactions of benzene and its derivatives are
a) Electrophilic addition reactions
b) Electrophilic substitution reactions
c) Nucleophilic addition reactions
d) None of these

52 The most strained cycloalkane is
(a) Cyclobutane (b)Cyclopropane
(b) (c)Cyclohexane (d)Cyclopentane

ANSWERS

1.a	2.d	3. c	4. b	5. d	6. c	7. d	8.a
9.a	10.a	11. d	12. a	13. d	14. b	15. D	16.c
17.b	18.d	19. c	20. c	21. d	22. a	23. b	24.c
25.b	26.a	27. a	28. b	29. a	30. c	31. D	32.c
33. b	34.c	35. a	36. a	37. d	38. d	39. c	40.d
41.a	42.a	43. a	44. b	45. d	46. d	47. c	48.c
49.d	50. d	51.b	52. b				

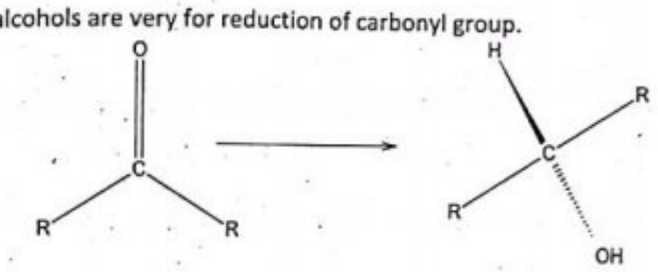
28. ALCOHOLS, DIOLS AND TRIOLS

Alcohol is an organic compound that contains hydroxyl (-OH) functional groups and they contain one or more hydroxyl groups (—OH). The compounds are not alcohol in which —OH group is directly attached to benzene ring they are known as phenols. Aryl substituted alcohols are also called as aromatic alcohols e.g. $C_6H_5CH_2OH$, benzyl alcohol. Depending upon number of hydroxyl groups present in the compound alcohols may be classified as mono-,di-, tri- or polyhydric alcohols.

Monohydric Alcohols

Methyl alcohol is known as carbinol, ethyl alcohol is also called grain alcohol and methanol is known as wood spirit. From wood methanol is a byproduct in the production of charcoal. In all organic synthesis laboratories Methanol, ethanol, and isopropyl alcohol are present.

For example, alcohols are very for reduction of carbonyl group.



Preparation

(a) Hydration of Alkenes

$$CH_2{=}CH_2 + H_2SO_4 \longrightarrow CH_3CH_2OSO_3H$$
$$H_2O$$
$$CH_3CH_2OH + H_2SO_4$$
$$CH_2{=}CH_2 + H_2O \xrightarrow[300°C]{\text{Catalyst}} CH_3CH_2OH$$

(b) Hydrobonation

$$CH_2{=}CH_2 \xrightarrow[(ii)\ H_2O_2]{(i)\ BH_3} CH_3CH_2OH$$

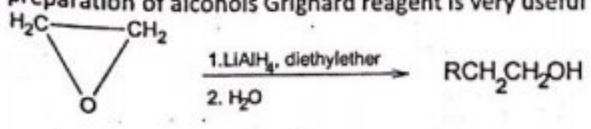
(c) Reduction

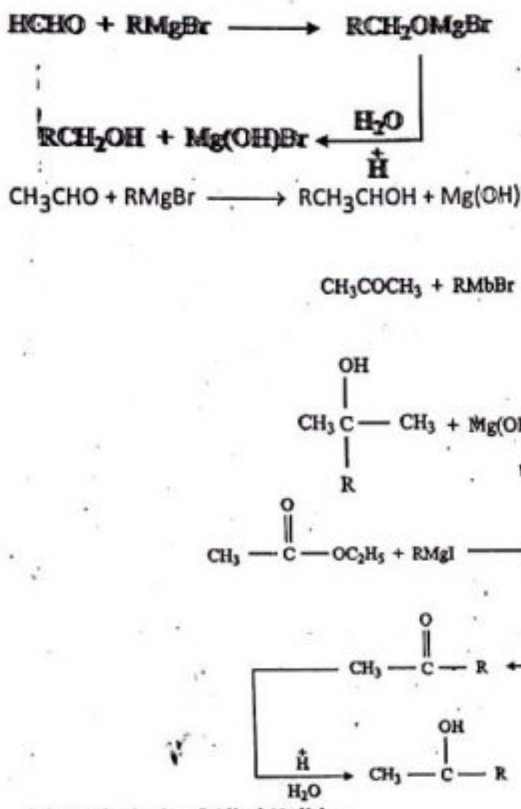
Hydrogenation of the carbon–oxygen double bond by Na Aldehydes, ketones, fatty acids and their ester can be reduced to alcohols .Hg and water, Rancy Ni and hydrogen, Na or K in alcohol or LiAlH4 etc. ketones yield secondary alcohols and aldehyde yield primary alcohol. LiAlH4 must beused in solvents such as anhydrous diethyl ether or tetrahydrofuran as it reacts violently with water and alcohols.

$$CH_3CHO + 2H \longrightarrow CH_3CH_2OH$$

(d) From Grignard Reagent

For preparation of alcohols Grignard reagent is very useful





(e) Hydrolysis of Alkyl Halides

$CH_3CH_2Br + KOH \longrightarrow CH_3CH_2OH + KBr$

(f) From Oxo Process

During this process aldehyde is produced which is reduced to alcohol.

(g) From Primary Amines

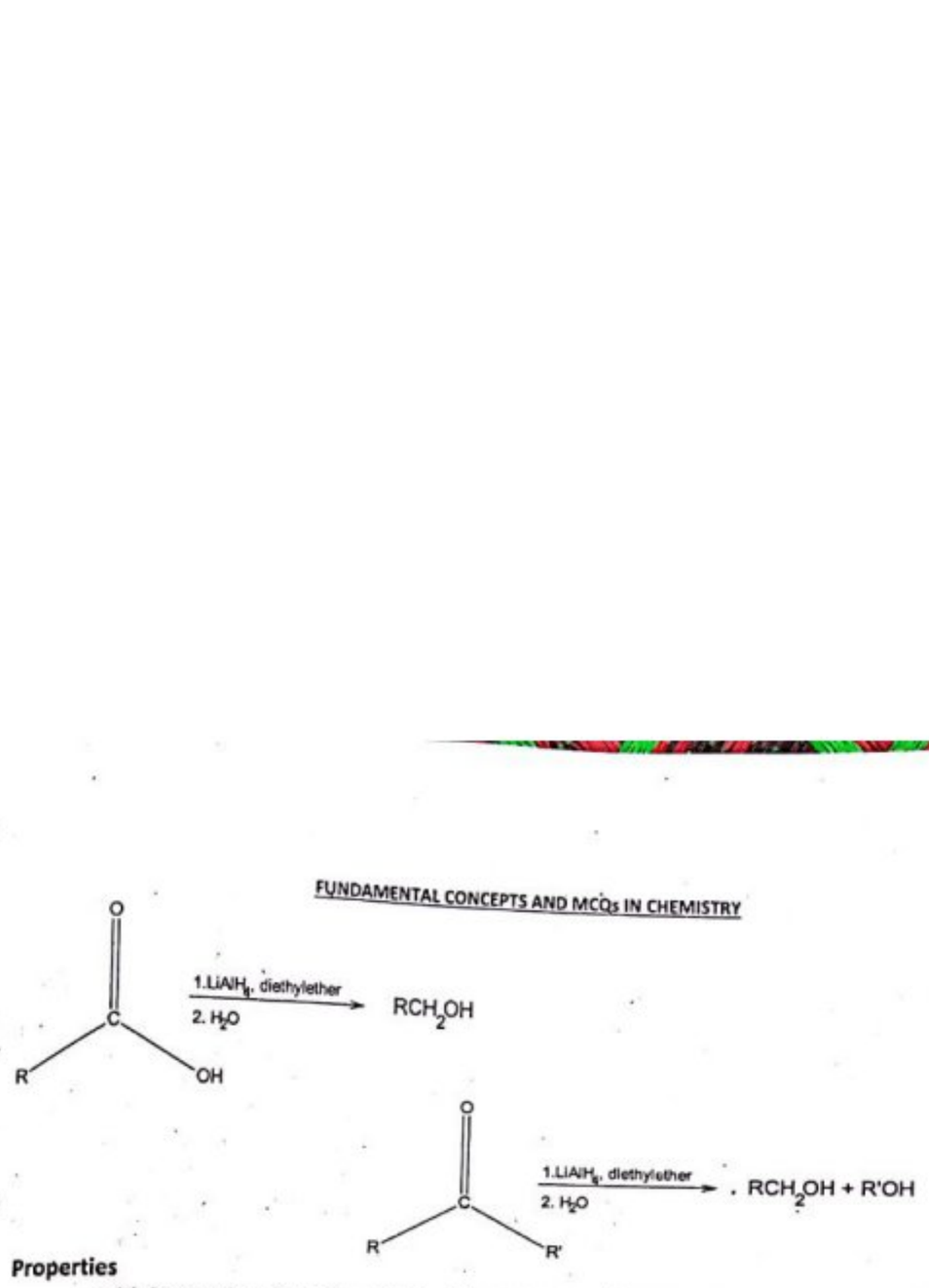
$CH_3CH_2NH_2 + HNO_2 \longrightarrow CH_3CH_2OH + N_2 + H_2O$

(h) From Fermentation

$C_6H_{12}O_6 + \text{Yeast} \xrightarrow[30°C]{\text{Zymase}} 2C_2H_5OH + 2CO_2$

(i) From Carboxylic acids and esters

Carboxylic acids are exceedingly difficult to reduce. In presence of a very powerful reducing agent their reduction is possible.



Properties

with inorganic salts such as $CuSO_4.5H_2O$ Alcohols form loose inorganic compounds. Alcohols are neutral to litmus but they show weak acidic character due to ionization of $\overset{\delta-}{O}—\overset{\delta-}{H}$ bond.

Acidic Character: Pri – alcohols > Sec – alcohols > ter – alcohols

Formation of alkoxide ion:

Pri – alcohols > Sec – alcohols > ter – alcohols

Break of alkoxide ion: Pri – alcohols < Sec – alcohols < ter – alcohols

Chemical Properties

Reaction Industry O —H Bond Cleavage

(i) Acidic Nature

$2CH_3CH_2OH + 2Na \longrightarrow 2CH_3CH_2ONa + H_2$

(ii) Reaction with Grignard Reagent

$CH_3OH + CH_3MgBr \longrightarrow CH_4 + Mg(OCH_3)Br$

(iii) Oxidation

$$CH_3CH_2CH_2OH \xrightarrow{O} CH_3CH_2CHO \xrightarrow{O} CH_3CH_2COOH$$

$$CH_3\underset{OH}{\underset{|}{C}}HCH_3 \xrightarrow{O} CH_3\overset{O}{\overset{||}{C}}CH_3$$

Tertiary alcohols react only under drastic conditions to yield carboxylic acid with lesser number of C-atoms.

$$R_3COH \xrightarrow{[O]} RCOOH + CO_2 + H_2O$$

(iv) Reaction with Acid Halides or Acetic Anhydride

$C_2H_5OH + CH_3COCl \longrightarrow CH_3COOC_2H_5 + HCl$

$C_2H_5OH + (CH_3CO)_2O \longrightarrow CH_3COOC_2H_5 + CH_3COOH$

Reaction Involving Cleavage of C —OH Bond

(i) Reaction with Inorganic Acids

$ROH + H_2SO_4 \longrightarrow ROSO_2H + H_2O$

(ii) Reactions with Thionyl Chloride

$CH_3CH_2OH + SOCl_2 \longrightarrow CH_3CH_2Cl + SO_2 + HCl$

(iii) Reaction with Halogen

$$CH_3CH_2OH + Cl_{2(dry)} \longrightarrow CH_3CHO + 2HCl$$

$$CH_3CHO + 3Cl_2 \longrightarrow CCl_3CHO + 3HCl$$

(iv) Reaction with Ammonia

$$CH_3OH + NH_3 \xrightarrow[360°C]{Al_2O_3} CH_3NH_2 + H_2O$$

$$2CH_3OH + NH_3 \xrightarrow[360°C]{Al_2O_3} (CH_3)_2NH + 2H_2O$$

$$3CH_3OH + NH_3 \xrightarrow[360°C]{Al_2O_3} (CH_3)_3N + 3H_2O$$

(v) Reduction

$$CH_3CH_2OH + H_2 \xrightarrow[400°C]{V_2O_5/I_2O_3} CH_3CH_3 + H_2O$$

(vi) Reaction with Halogen Acids

$$C_2H_5OH + HCl \longrightarrow C_2H_5Cl + H_2O$$

(vii) Reaction with Phosphorous Halides

$$CH_3CH_2OH + PCl_5 \longrightarrow CH_3CH_2Cl + POCl_3 + HCl$$

Reaction Involving both Hydroxyl and Alkyl Groups

(i) Dehydration

$$C_2H_5OH + H_2SO_4 \xrightarrow{100°C} C_2H_5OSO_3H + H_2O$$

$$C_2H_5OH + H_2SO_4 \xrightarrow{165-170°C} C_2H_5OSO_3H + H_2O$$

$$CH_2{=}CH_2 + H_2SO_4 \longleftarrow$$

$$C_2H_5OH + H_2SO_3 \xrightarrow{140°C} C_2H_5OSO_3H + H_2O$$

(ii) Dehydrogenation

$$CH_3CH_2OH \xrightarrow[300°C]{Cu} CH_3CHO$$

$$CH_3{-}\underset{\displaystyle OH}{\underset{|}{CH}}{-}CH_3 \xrightarrow[300°C]{Cu} CH_3COCH_3 + H_2O$$

$$(CH_3)_3COH \xrightarrow[300°C]{Cu} (CH_3)_2{-}CH{=}CH_2 + H_2O$$

This method can be used to distinct primary, secondary and tertiary alcohols.

Identification of Primary, Secondary and Tertiary Alcohols

(i) Lucas Reagent (Conc. HCl + anhydrous $ZnCl_2$)

Tertiary alcohol reacts immediately, secondary alcohol react in five minute and primary alcohol do not react at room temperature.

(ii) Oxidation Behaviors

Primary alcohols $\xrightarrow{[O]}$ Aldehydes $\xrightarrow{[O]}$		Carboxylic acids
Secondary alcohols $\xrightarrow{[O]}$ Ketones $\xrightarrow[\text{degradation}]{\text{Oxidative}}$		Mixture of carboxylic acid with lesser number of carbon atoms.
Tertiary alcohols $\xrightarrow[\text{agent}]{\text{Acidic Oxidizing}}$		Ketones and carboxylic acids (Lesser no of C-atoms)

(iii) Dehydrogenation

Described above.

(iv) Victor Meyer's Method

Primary Alcohols

$$RCH_2OH \xrightarrow{P+I_2} RCH_2I \xrightarrow{HgNO_2} PCH_2NO_3 \xrightarrow{HNO_2}$$

$$RCNO_2 \xrightarrow{NaOH} \text{Red color.}$$
$$\|$$
$$NOH$$

Secondary Alcohols

$$RCHOHR \xrightarrow{P+I_2} RCHIR \xrightarrow{AgNO_2} RCHNO_2R \xrightarrow{HNO_2}$$

$$R_2C{-}NO_2 \xrightarrow{NaOH} \text{Blue color}$$
$$|$$
$$N{=}O$$

Tertiary Alcohols

$$R_3COH \xrightarrow{P+I_2} R_3CI \xrightarrow{AgNO_2} R_3CNO_2 \xrightarrow{HNO_2}$$

$$\text{No action} \xrightarrow{NaOH} \text{Colorless}$$

(v) Esterification

The esterification rates of primary, secondary and tertiary alcohols are 45.7%, 5.4% and 1.4%, respectively with acetic.

Methylated Spirit: Ethanol, methanol (10%), pyridine (0.4) and light caotchoucine.

Rectified Spirit: 95.5% alcohol, 4.5% water.

Absolute Alcohol: Containing no water

Manufacture of Ethyl Alcohol

(a) From Molasses

Molasses is a liquor remained after crystallization of sugar.

$$C_{12}H_{12}O_{11} + H_2O \xrightarrow{\text{Invertase}} \underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{Fructose}}{C_6H_{12}O_6}$$

$$C_6H_{12}O_6 \xrightarrow{\text{Zymase}} 2C_2H_5OH + 2CO_2$$

Absolute alcohol can be obtained by distilling rectified spirit with quick line or magnesium ethoxide.

(b) From Starch

$$(C_6H_{10}O_5)_{11} + nH_2O \xrightarrow{\text{Diastase}} \underset{\text{Maltase}}{nC_{12}H_{22}O_{11}}$$

$$C_{12}H_{22}O_{11} + H_2O \xrightarrow{\text{Maltase}} \underset{\text{Glucose}}{2C_6H_{12}O_6}$$

$$C_6H_{12}O_6 \xrightarrow{\text{Zymase}} 2C_2H_5OH + 2CO_2$$

Dihydric Alcohols

They have —OH groups on two different carbon atoms and are called as glycol or diol. Glycol name is given due to their sweet taste.

Preparation

(i) From Ethylene Bromide

$$BrCH_2CH_2Br + Na_2CO_3 + H_2O \longrightarrow \overset{OH}{\underset{|}{CH_2}}-\overset{OH}{\underset{|}{CH_2}} + 2NaBr + CO_2$$

(ii) From Ethylene

Glycols can be prepared by passing ethylene in cold from Baeyer's reagent (dilute alkaline $KMnO_4$ soln).

$$CH_2{=}{=}CH_2 + [O] + H_2O \longrightarrow \underset{\underset{OH}{|}}{CH_2}-CH_2OH$$

(iii) $BrCH_2CH_2Br + 2NaOOCH_3 \longrightarrow \underset{\underset{CH_2OOCCH_3}{|}}{CH_2OOCCH_3}$

$$HOCH_2-CH_2OH \xleftarrow{NaOH,\text{Hydrolysis}}$$

Properties

Ethyl glycol is colorless, syrupy liquid (b.p.197°C).

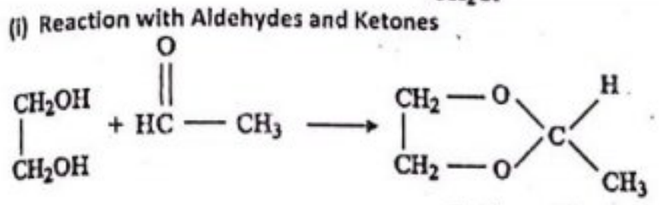
(i) Reaction with Acids

$$\underset{\underset{CH_2OH}{|}}{CH_2OH} + CH_3COOH \xrightarrow{H_2SO_4} \underset{\underset{CH_2OH}{|}}{CH_2OOCH_3} + CH_3COOH$$

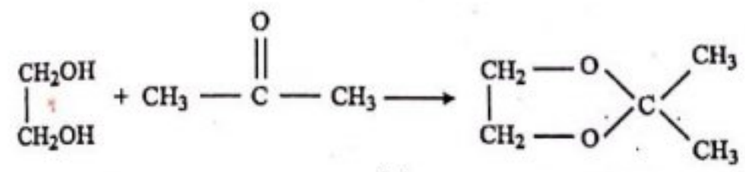
$$\underset{\underset{CH_2OOCCH3}{|}}{CH_2OOCCH_3} \xleftarrow{H_2SO_4}$$

$$\underset{\underset{CH_2OH}{|}}{CH_2OH} + HCl \xrightarrow[160°C]{} \underset{\underset{CH_2OH}{|}}{CH_2Cl} + HCl \xrightarrow{200°C} \underset{\underset{CH_2Cl}{|}}{CH_2Cl}$$

(i) Reaction with Aldehydes and Ketones



Cyclic acetal



Cyclic ketal

(ii) Reaction with Sodium

$$HOCH_2-CH_2OH + Na \xrightarrow{50°C} \underset{\underset{CH_2OH}{|}}{CH_2ONa} \xrightarrow{Na} \underset{\underset{CH_2ONa}{|}}{CH_2ONa}$$

(iii) Dehydration

Different products are formed under different condition.

$$CH_2OH-CH_2OH \xrightarrow[\text{Phosphoric acid}]{ZnCl_2} CH_2{=}{=}CHOH$$

Vinyl alcohol

Rearrange

CH_3COH

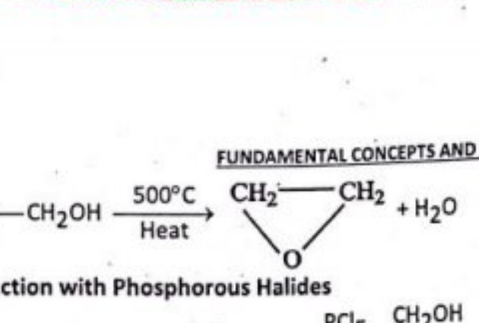
$$2CH_2OHCH_2OH \xrightarrow[\text{or conc.}H_2SO_4]{\text{Phosphoric acid}} \text{O}(CH_2-CH_2)_2\text{O} + 2H_2O$$

(iv) Reaction with Phosphorous Halides

(v) Oxidation

The products produced independent on nature of oxidizing agent.

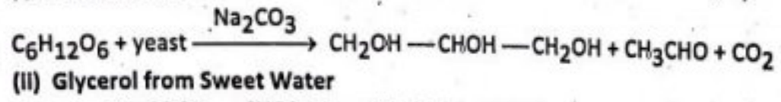
(vi) Acetylation



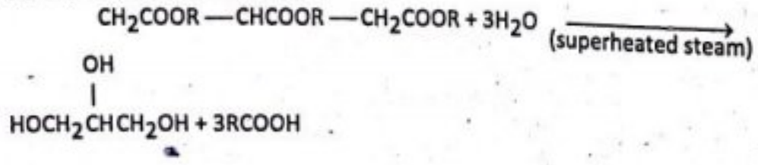
Trihydric Alcohols

Preparation

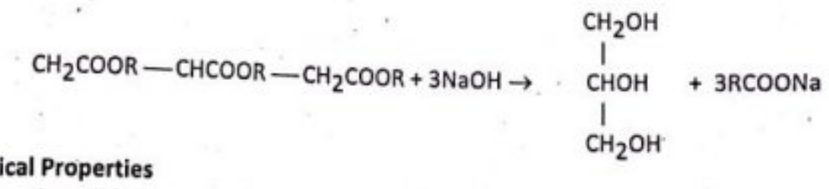
(i) Fermentation



(ii) Glycerol from Sweet Water

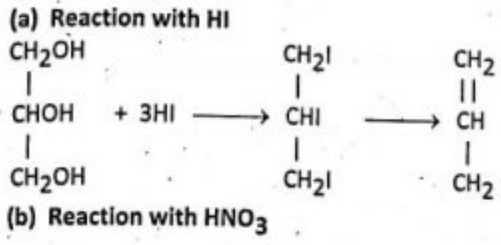


(iii) From Fats and Oils

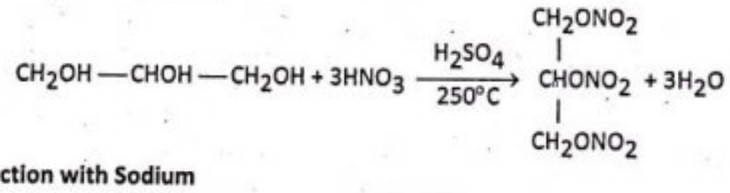


Chemical Properties

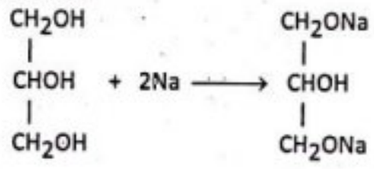
(a) Reaction with HI



(b) Reaction with HNO_3

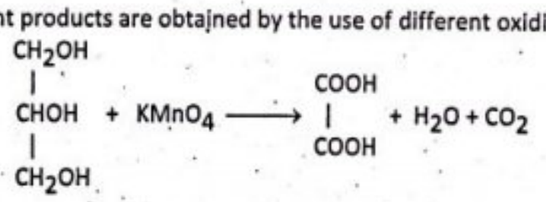


(c) Reaction with Sodium

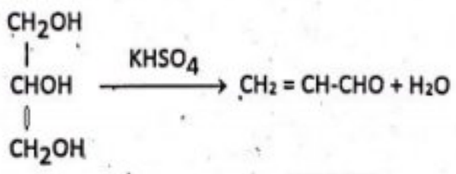


(d) Oxidation

Different products are obtained by the use of different oxidizing agents.

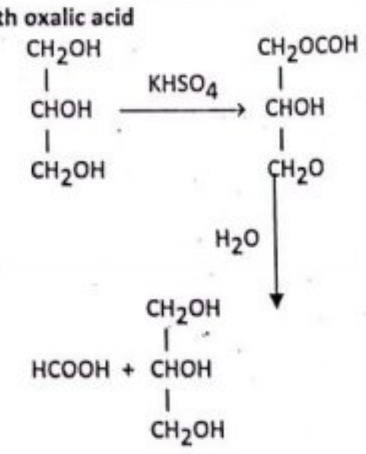


(e) Dehydration



Acerolein

(f) Reaction with oxalic acid



MULTIPLE CHOICE QUESTIONS

1 Ethanol can be converted into ethanoic acid by
(a) Hydrogenation (b) Hydration
(c) Oxidation (d) Fermentation

2. Methyl alcohol is not used
(a) As a solvent (b) As an antifreezing agent
(c) As a substitute for petrol (d) For denaturing of ethyl alcohol

3. Methanol can be obtained from
(a) water gas (b) destructive distillation of wood
(c) methane (d) all

4 An alcohol which can be prepared by fermentation is
(a) CH3OH (b) C3H7OH
(c) CH3 - CH2 - OH (d) C6H5OH

5. Phenol was isolated by Runge from
(a) vegetable oil (b) coaltar
(c) wood (d) none of these

6. Which one of the following compound does not have - OH group
(a) ethylene glycol (b) glycerol
(c) picric acid (d) ethyl acetate

7. The hydrogenation of phenol in the presence of Ni and heat gives
(a) cyclohexane (b) n - hexane
(c) 1 - hexanol (d) cyclohexanol

8 Ethanol and methanol can be distinguished by a
(a) Iodoform test (b) Lucas test
(c) Benedicts test (d) Tollens test

9. Which one of the following alcohol has greater boiling point
(a) ethanol (b) ethylene glaycol
(c) glycerol (d) methanol

10 The distinguish among primary, secondary and tertiary alcohols, one would use the following experimental method.
a) Sandmeyer reaction\
b) Witting reaction
c) Ninhydrin test
d) Lucas test

11 Aromatic hydrocarbons can be characterized by
a) Friedel Crafts testb) Formalin test
c) Both A&B d) None of these

12 In *t*-butyl alcohol, the tertiary carbon is bonded to:
a) Three carbon atoms
b) Three hydrogen atoms
c) One hydrogen atoms
d) No hydrogen atoms

13. Dehydration of 2-butanol produces 2-butene as a major product according to?
(a) Saytzeff rule (b) Peroxide effect
(c) Markownikoff's rule (d) Anti Markownikoff's rule

14. Acetamide produce on reaction with $LiAlH_4$?
(a) Methanol (b) Ethanol
(c) Iso propyl alcohol (d) Formic acid
(e) Butanol

15. A distinction among primary, secondary and tertiary alcohol can be carried out using?
(a) Black's reaction (b) Cannizzaro's reaction
(c) Wurtz reaction (d) Williamson's synthesis
(e) Frankland reaction

16. What is the functional group that distinguishes alcohols?
a) carboxyl c) hydroxy
b) carbonyl d) amide

17. Which statement about both glycerol (1,2,3-propanetriol) and ethanol is true?
a) They both contain 3 carbons in the skeleton.
b) They both are tertiary alcohols.
c) The both take part in hydrogen bonding
d) Glycerol is a triol while ethanol is a diol.

18. Which of the following compounds is correctly classified as a tertiary alcohol?
a) 3-methyl-1-butanol b) 2-methyl-1-butanol
c) 3-methyl-2-butanol d) 2-methyl-2-butanol

19. Which of the following would be made from an alcohol by a dehydration reaction?
a) alkyne b) alkene
c) alkane d) alkyl halide

20. When phenol dissolves in water, it functions as
a) a weak base b) a weak acid
c) an oxidizing agent d) a reducing agent

21. Oxidation of a thiol produces a
a) salt b) aldehyde
c) ketone d) Disulfide

22. What is the correct order of reactivity of alcohols in the following reaction?

R—OH + HCl ——2→ ZnCl R—Cl + H2O

a) 1° > 2° > 3° b) 1° < 2° > 3°

c) 3° > 2° > 1° d) 3° > 1° > 2°

23. Phenol is less acidic than _____.

a) ethanol b) o-nitrophenol

c) o-methylphenol d) o-methoxyphenol

24. Which of the following reagents can be used to oxidise primary alcohols to aldehydes?

a) CrO3 in anhydrous medium.

b) KMnO4 in acidic medium.

c) Pyridinium chlorochromate.

d) Heat in the presence of Cu at 573K.

25. Phenol can be distinguished from ethanol by the reactions with _____.

a) Br2/water b) Na

c) Neutral FeCl3 d) all the above

26. Catalytic dehydrogenation of primary alcohol gives a

a) ketone b) aldehyde

c) secondary alcohol d) ester

27. Denatured alcohol is

a) Rectified spirit + methanol + naphtha b) Undistilled ethanol

c) Reactified spirit d) Ethanol + Methanol

28. Methanol cannot be dried with anhydrous $CaCl_2$ because

a) Cacl2 dissolve in it

b) it is not good dehydrating agent

c) it forms a solid $CaCl_2$. $4CH_3OH$

29. The compound on dehydration gives a ketone. The original compound is

a) tertiary alcohol b) secondry alcohol

c) primary alcohol d) carboxylic acid

30. Which one of the following is termed as benzul alcohol?

(a) C6H5OH (b) C6H5CH(OH)2

(c) C6H5CH2OH (d) C6H5COOH

31. Which one of the following is also known as lactic acid?

(a) 3-Hydroxy propanoic acid (b) 2-Hydroxy propanoic acid

(c) 2-hydroxy butanoic acid (d) 3-hydroxy butanoic acid

32. Which one of the following is also known as tartaric acid?

(a) 2 3-dihydroxy butance 1 4 -dioic acid

(b) 2 3 -dihydroxy butanedioic acid

(c) 2 3 -dihydroxy butanioc acid

(d) 2 2 -dihydroxy butanoic acid

33. Water gas heated at 450?C and 200 atm pressure in the presence of ZnO+Cr2O3 will produce

(a) methanal (b) methanol

(c) carbonic acid (d) methane

34. The residue obtained after the crystallization of sugar from concentrated sugar cane juice is called

(a) Mother liquor (b) Filterate

(c) Extract (d) Molasses

35. The formula of starch is

(a) $C_{12}H_{22}O_{11}$ (b) $C_6H_{10}O_5$

(c) $(C_6H_{10}O_5)n$ (d) $C_6H_{12}O_6$

36. The process of fermentation of starch involve many enzymes the sequence of enzymes used are

(a) Diastase-maltase-zymase (b) Zymase-maltase-diastase

(c) Maltase-diastase-zymase (d) Diastase-zymase-maltase

37. The rectified spirit contains

(a) 12% alcohol (b) 90% alcohol

(c) 95% alcohol (d) 100% alcohol

38 K2Cr2O7/H2SO4 generate

(a) Oxygen (b) Hydrogen

(c) Nascent oxygen[O] (d) Nascent hydrogen[H]

39. The oxidation of isopropyl alcohol will yield

(a) propane (b) Propanol

(c) Propanone (d) Propanoic acid

40 Which compound is also known by the name of carbolic acid?

(a) C_2H_2OH (b) H_2CO_3

(c) C_6H_5OH (d) H_3PO_3

41. The composed of Lucas Reagent?

(a) Conc. HCl + $ZnCl_2$ (b) Conc. HNO_3 + anhydrous $ZnCl_2$

(c) Conc. HCl + anhydrous $ZnCl_2$ (d) Dil. HCl + anhydrous $ZnCl_2$

42. Secondary alcohols $\xrightarrow{[O]}$ Ketones $\xrightarrow[\text{degradation}]{\text{Oxidative}}$ ——?

(a) Carboxylic acids

(b) Mixture of carboxylic acid with large number of carbon atoms

(c) Ketones and carboxylic acids (Lesser no of C-atoms)

(d) Mixture of carboxylic acid with lesser number of carbon atoms

43. In fusel oil which is a major component ?

(a) Ethanol (b) Methanol

(c) Butanol (d) Isoamyl alochol

44. Which of the following is rubbing alochol?

(a) $(CH_3)_2CHOH$ (b) $(CH_3)_3COH$

(c) C_2H_5OH (d) $CH_3CH_2CH_2OH$

45. In alcohols nucleophilicity increases with?

(a) Increase with number of electro-repelling R groups

(b) Decrease with number of electro-repelling R groups

(c) No effect of number of electro-repelling R groups

(d) Alcohols do not have any nucleophilicity

46. In conversion of ROH to RX what is correct decreasing order of effectiveness of hydrogen halide acids

(a) HI < HBr < HCl << HF (b) HF < HCl < HI < HBr

(c) HI > HBr < HCl >> HF (d) HI > HBr > HCl >> HF

47. The reactivity order of alcohol towards halogen halides is as follows?

(a) 3º > 2º > 1º > MeOH (b) 3º < 2º > 1º > MeOH

(c) 3º < 2º < 1º > MeOH (d) 3º < 2º < 1º < MeOH

48. –OH is ———— leaving group.
(a) Powerful (b) Weak
(c) Mild (d) Strong

49. Which of the following is Jones reagent?
(a) Conc. HCl + $ZnCl_2$
(b) Conc. HNO_3 + anhydrous $ZnCl_2$
(c) $KMNO_4$
(d) Chromic acid in aqueous acetone

50. For the removal of trace of water from ethanol Which is most suitable?
(a) Na (b) Mg
(c) Distillation (d) C

51. Isopropyl alcohol on oxidation gives?
(a) Ether (b) Acetone
(c) Ethylene (d) Acetylene

52. Spirit contains ———— % alcohol by weight.
(a) 12.5 (b) 25
(c) 50 (d) 75

ANSWERS

1. c	2. c	3. d	4. c	5. b	6. d	7. d	8. a
9. c	10. d	11. b	12. a	13. a	14. b	15. d	16. c
17. c	18. d	19. b	20. b	21. d	22. c	23. b	24. a, c, d
25. a, c		26. b	27. a	28. c	29. b	30. c	31. b
32. a		33. b	34. d	35. c	36. a	37. c	38. c
39. c	40. c	41. c	42. d	43. d	44. a	45. a	46. d
47. a	48. b	49. d	50. b	51. b	52. c		

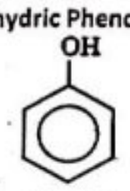
29. PHENOLS

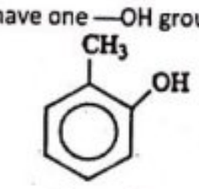
Phenols have general formula ArOH. Ar is phenyl, substituted phenyl and some other aryl group e.g. naphthyl. In phenols hydroxyl group directly attached to a benzene ring. Phenols are resemble with alcohols in some extend due to presence of –OH group. Phenols and alcohols both can be converted to esters and ether. However, phenols have different chemical and physical properties than alcohols. The simplest phenols are solids and liquids having low meltig points. Phenols are less soluble in water and readily soluble in organic solvents while most of its derivatives are insoluble in water. Phenols are fairly acidic compounds.

Classification of Phenols:

(a) Monohydric Phenols

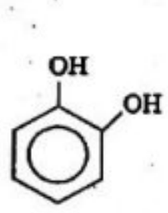
Monohydric Phenols have one —OH group directly attached to the benzene ring.e.g.

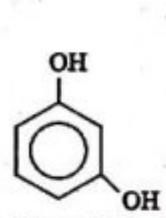

Phenol


O-cresol

(b) Dihydric Phenols

Dihydric Phenols two hydroxyl groups attached to benzene ring.

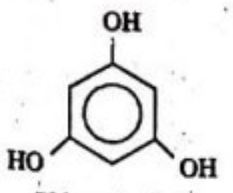

Catechol

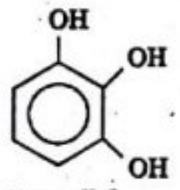

Resorcinol

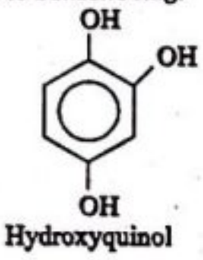

Quinol

(c) Trihydric Phenols

In trihydric phenols three hydroxyl groups are attached to benzene ring.


Phloroglucinol


Pyrogallol


Hydroxyquinol

⇒ Plants and animals contain phenols.

Preparation of phenols

(a) From diazonium salts

$$C_6H_5N_2Cl + H_2O \xrightarrow[\text{Heat}]{\overset{+}{H}} C_6H_5OH + N_2 + HCl$$

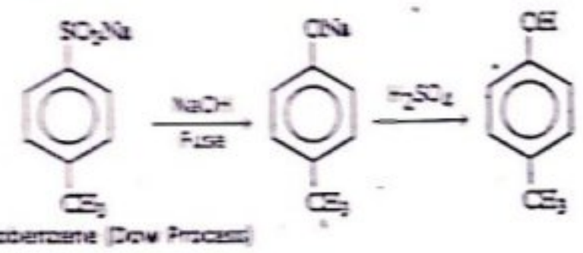
(b) Decarboxylation of phenolic acid

$$C_6H_4(OH)(COOH) + NaOH(CaO) \longrightarrow Na_2CO_3 + C_6H_5OH$$

(c) From Grignard Reagent

$$C_6H_5MgBr \xrightarrow{[O]} C_6H_5OMgBr \xrightarrow[HCl]{H_2O} C_6H_5-OH + Mg(OH)Br$$

(d) From Aromatic sulphonic acids



(e) From chlorobenzene (Dow Process)

$$C_6H_5Cl + 2NaOH \longrightarrow C_6H_5ONa + NaCl + H_2O$$

$$C_6H_5ONa + HCl \longrightarrow C_6H_5OH + NaCl$$

Properties

Phenols have less solubility in water and have higher boiling point as compared to the corresponding alcohols. The monohydric phenols are more toxic while di-and trihydric phenols are comparatively less toxic.

Why phenols are more acidic than alcohols?

Phenols have more acidic properties than alcohols because in phenols phenoxide ion is generated by the removal of H^+ ion. This H^+ ion make phenols more stable than alkoxide ion of corresponding alcohol. Phenoxide ion has greater stability due to the delocalization of negative charge in the ring. Therefore it has more stable conjugate base of the phenol (phenoxide ion) and more acidic towards that species. Electron withdrawing group (e.g. $-NO_2$) increases the acidity of phenols while acidity decrease by electron donating groups (e.g. $-CH_3$).

Acidity Order

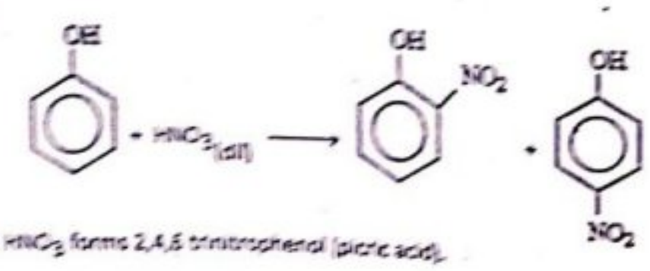
$$ROH < HOH < C_6H_5OH < H_2CO_3 < RCO_2H$$

Chemical Reactions

(A) Reactions of Benzene Ring

Hydroxyl group is highly activating and directs the new coming group to ortho and para positions.

(a) Nitration



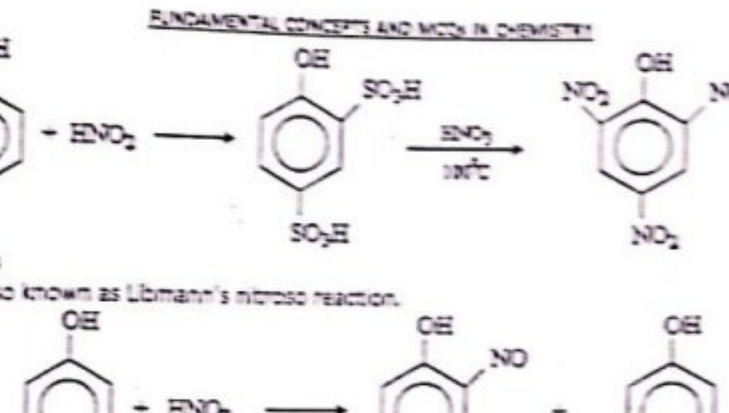
Conc. HNO_3 forms 2,4,6 trinitrophenol (picric acid).

(b) Nitrosation

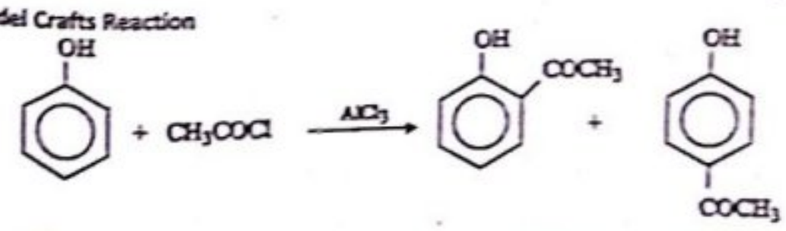
It is also known as Libmann's nitroso reaction.

(c) Sulphonation

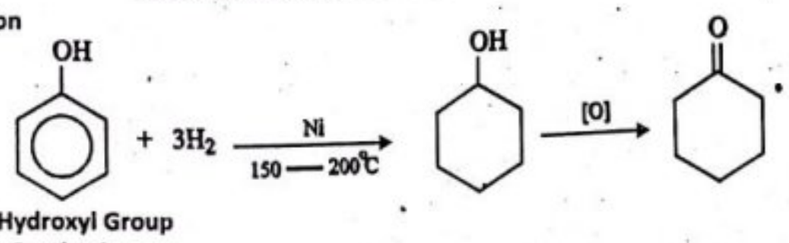
(d) Halogenation



(e) Fridel Crafts Reaction

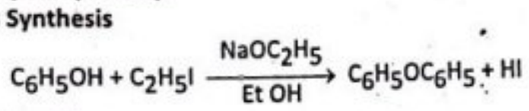


(f) Hydrogenation

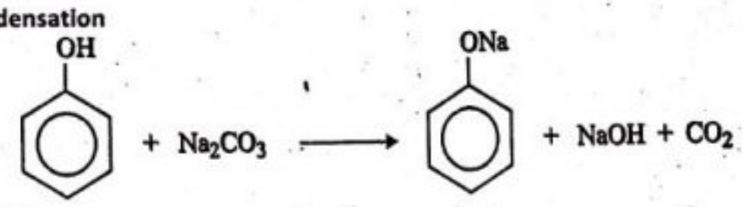


(B) Reaction of Hydroxyl Group

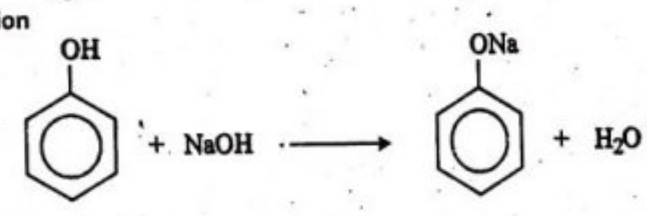
(a) Williamson's Synthesis



(b) Claisen Condensation

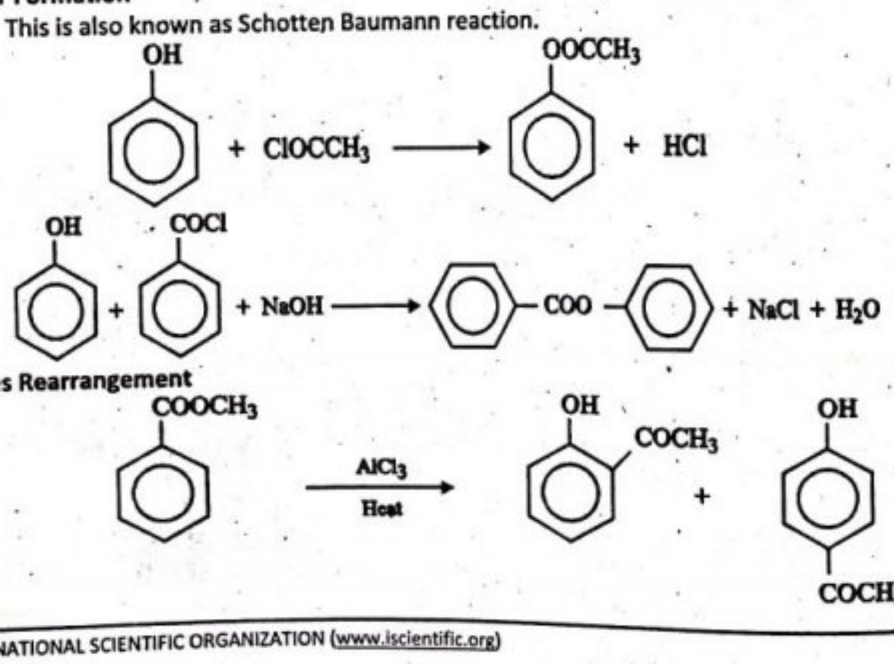


(c) Salt Formation



(d) Ester Formation

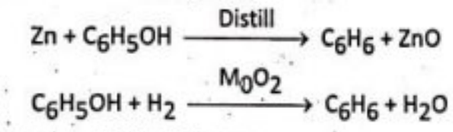
This is also known as Schotten Baumann reaction.



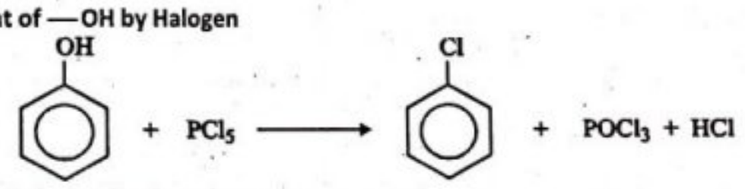
(e) Fries Rearrangement

(f) Ether Formation

(g) Replacement of —OH Group by H

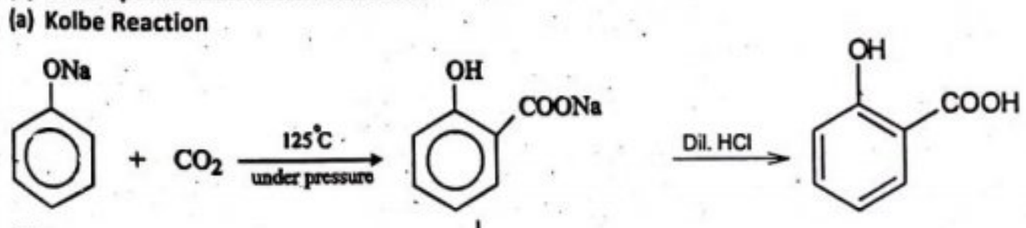


(h) Replacement of —OH by Halogen

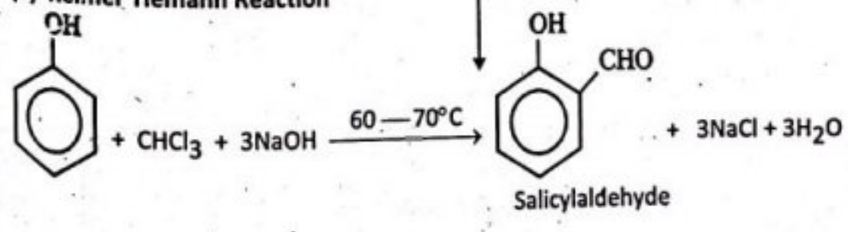


(C) Electrophilic Substitution Reactions

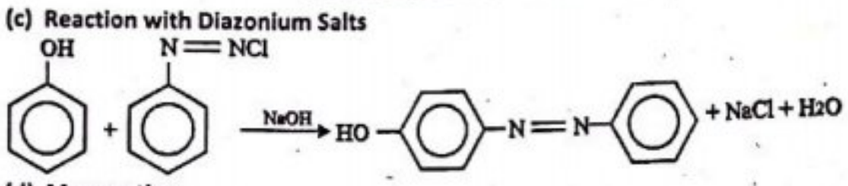
(a) Kolbe Reaction



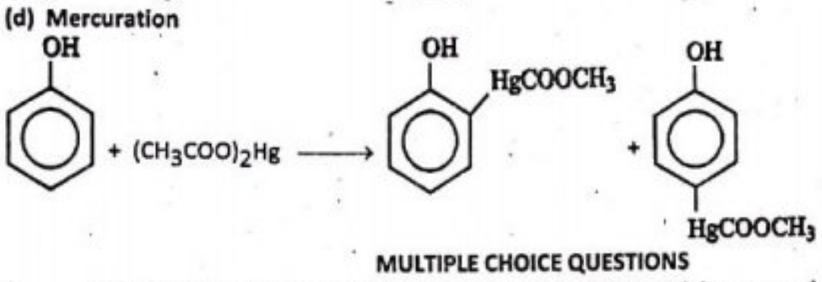
(b) Reimer Tiemann Reaction



(c) Reaction with Diazonium Salts



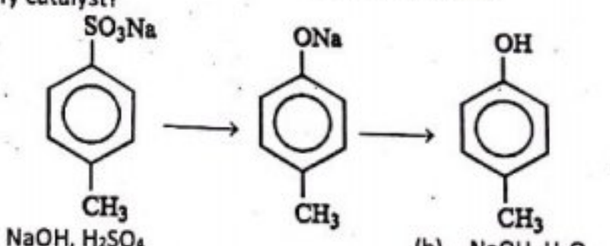
(d) Mercuration



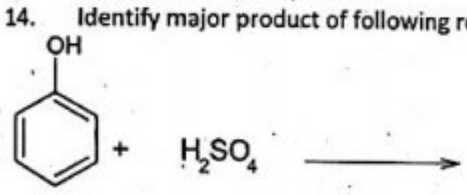
MULTIPLE CHOICE QUESTIONS

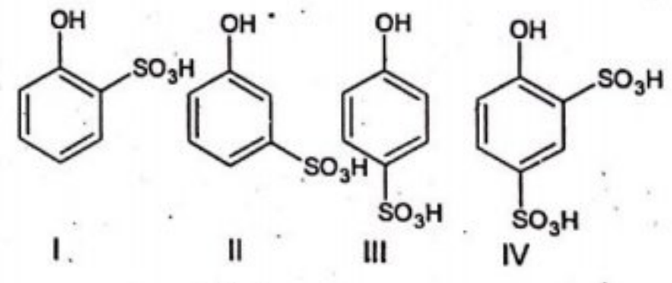
1. Which of the following reagents may be used to distinguish between phenol and benzoic acid?
   (a) Neutral $FeCl_3$ (b) Aqueous naOH
   (c) Tollen's reagent (d) Molisch reagent
2. The conversion of m-nitrophenol to resorcinol involves respectively
   (a) Diazotization, reduction and hydrolysis
   (b) Hydrolysis, diazotization and reduction
   (c) Reduction, diazotization and hydrolysis
   (d) Hydrolysis, reduction and diazotization
3. Which compound is also known by the name of carbolic acid?
   (a) C_2H_2OH (b) H_2CO_3
   (c) C_6H_5OH (d) H_3PO_3
4. The given dissociation constant (Ka) value 1.3x10-10 is of
   (a) Alcohol (b) Acetic acid
   (c) Water (d) Phenol
5. Heating phenol with Zn will yield
   (a) Benzene (b) Benzoic acid
   (c) Phenoxide (d) Cyclohexane
6. Treating phenol with formaldehyde in the presence of dilute base forms Bakelite. The process involved is
   (a) Oxidation (b) Elimination
   (c) Condensation polymerization (d) Additional polymertization
7. Phenol was isolated by Runge from
   (a) Vegetable oil (b) Coaltar
   (c) Wood (d) None of these
8. The hydrogenation of phenol in the presence of Ni and heat gives
   (a) Cyclohexane (b) n-Hexane
   (c) 1-Hexanol (d) Cyclohexanol
9. Phenol is readily soluble in
   (a) Water (b) Organic solvents
   (c) Inorganic solvents (d) All of these

10. o-Nitrophenol is
    (a) Volatile (b) Steam volatile
    (c) Non-volatile (d) Non of these
11. Identify catalyst?



    (a) $NaOH, H_2SO_4$ (b) $NaOH, H_2O$
    (c) Na_2CO_3, H_2SO_4 (d) Na_2CO_3, H_2O
12. In Dow process reactants are?
    (a) Phenol and sodium hydroxide
    (b) Chlorobenzene and sodium hydroxide
    (c) Toulene and sodium hydroxide
    (d) Aromatic sulphonic acids and sodium hydroxide
13. Which of following phenols are known to be more toxic?
    (a) Trihydric phenols (b) Dihydric phenols
    (c) Monohydric phenols (d) All have same toxicity
14. Identify major product of following reaction at elevated temperature?





    (a) I (b) II
    (c) III (d) IV
15. What is catalyst in Williamson synthesis?
    (a) Ni/EtOH (b) NaOEt/Acetone
    (c) Cu/EtOH (d) NaOEt/EtOH
16. Phenol undergoes ionization to become more stable by reacting with
    (a) Negative ions (b) Positive ions
    (c) Both a and b (d) Neutral atoms

17 Phenol is stronger acid than water and itself is
(a) Weakly acidic (b) Weakly basic
(c) Alkali (d) Strong acid

18. Melting point of phenol is
(a) 55°C (b) 43°C
(c) 25°C (d) 15°C

19. Melting point of phenol is relatively high for an aryl compound because of the
(a) Hydrogen bonding (b) Ionic bonding
(c) Covalent bonding (d) All of them

20. Phenol is
(a) Solid (b) Crystalline solid
(c) Gas (d) Liquid

21. Dow's method is used to prepared
(a) Ether (b) Ethanol
(c) Phenol (d) Methanol

22. Picric acid forms when phenol react with
(a) Hydrogen (b) Nitric acid
(c) Formaldehyde (d) Sulphuric acid

23. Phenols are derivative of
(a) Alkanes (b) Alkenes
(c) Alkynes (d) Benzene

24. 2, 4, 6 tribromophenol forms when phenol directly react with
(a) Nitric acid (b) Formaldehyde
(c) Bromine (d) Hydrogen

25. Phenol is derivative and has resemblance in structure to
(a) Oxides of lithium (b) Oxides of magnesium
(c) Water (d) Oxides of aluminium

26. Phenols was discovered by
(a) Henderson (b) Runge
(c) Hofmann (d) Bakelite

27. When phenol is treated with conc. H_2SO_4 at 373 K, the major product is
(a) o-Hydroxy benzene sulphonic acid
(b)..p-Hydroxy benzene sulphonic acid
(c) A mixture of o- and p-hydroxy benzene sulphonic acid
(d) m-Hydroxy benzene sulphonic acid

28. Comparing, Phenol reacts readily then benzene, so it is a
(a) Nucleophiles (b) Electrophile
(c) Protophile (d) Both A and B

29. Reaction of Phenol with alkali results in a
(a) Salt (b) Water
(c) Gas (d) Both A and B

30. Phenol dissolves well in
(a) Alkalis (b) Acids
(c) Bases (d) Water

31. Bromine reacts with phenol and decolorize orange color and turns it to
(a) White precipitate (b) Pink precipitate

(c) Blue precipitate (d) Black precipitate

32. Phenols can act as antioxidant because...
(a) They are acidic. (b) They undergo electrophilic substitution.
(c) They are free radical scavengers. (d) They are easily oxidised.

33. Amongst the following phenols which is most acidic
(a) Picric acid (b) 2-Nitrophenol
(c) 2, 4-Dinitrophenol (d) m-Nitrophenol

34. Phenol gives anisole on reaction with
(a) Sodium ethoxide (b) Sodium methoxide
(c) Diazomethane in the presence of HF (d) Methanol

35. Phenol can be converted to o-hydroxybenzaldehyde by
(a) Kolbe's (b) Reimer-Tiemann-reaction
(c) Wurtz reaction (d) Sandmeyer's reaction

36. Phenol can be distinguished from ethanol by the following reagents except
(a) Sodium (b) $NaOH/I_2$
(c) Neutral $FeCl_3$ (d) Br_2/H_2O

37. Phenol is heated with a solution of mixture of KBr and $KBrO_3$. The major product obtained i above reaction is:
(a) 2, 4, 6-Tribromophenol (b) 2-Bromophenol
(c) 3-Bromophenol (d) 4-Bromophenol

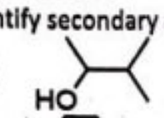
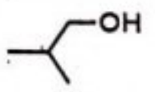
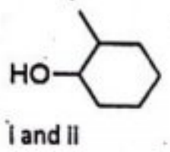
38. The correct order of acid strength of the following compounds is
A. Phenol B. p-Cresol C. m-Nitrophenol D. p-Nitrophenol
(a) A>B>D>C (b) C>B>A>D
(c) D>C>A>B (d) B>D>A>C

39. The correct order of decreasing acidity of nitrophenols will be
(a) m-Nitrophenol > p-Nitrophenol > o-Nitrophenol
(b) o-Nitrophenol > m-Nitrophenol > p-Nitrophenol
(c) p-Nitrophenol > m-Nitrophenol > o-Nitrophenol
(d) p-Nitrophenol > o-Nitrophenol > m-Nitrophenol

40. When phenol is treated with CHCl3 and NaOH, the product formed is:
(a) Salicylic acid (b) Salicylaldehyde
(c) Benzaldehyde (d) Benzoic acid

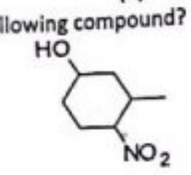
41. Phenols are far more ———— than alcohols.
(a) Acidic (b) Basic
(c) Neutral (d) Less acidic

42. Phenols with an electron withdrawing substituent are more ————.
(a) Acidic (b) Basic
(c) Neutral (d) Less acidic

43. Identify secondary alcohol among following?
(i) 
(ii) 
(iii) 
(iv) 
(a) I only (b) I and II

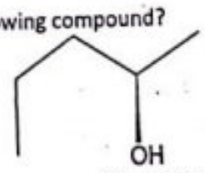
(c) i and iv (d) iii only

44. What is the IUPAC name of the following compound?



(a) 3-hydroxy-5-nitrotoluene
(b) 3-methyl-4-nitrophenol
(c) 4-hydroxy-2-methylnitrobenzene
(d) 4-nitro-3-methylphenol

45. What is the IUPAC name of the following compound?



(a) (S)-4-methyl-2-pentanol (b) (S)-2-methyl-4-pentanol
(c) (R)-2-methyl-4-pentanol (d) (R)-4-methyl-2-pentanol

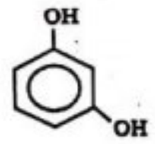
46. Select strongest acid among following?
(a) Propanol (b) Methanol
(c) Water (d) Phenol

47. Select strongest acid among following?
(a) p-aminophenol (b) p-nitrophenol
(c) Phenol (d) p-methyl phenol

48. What is aromatic alcohol?
(a) A six member carbon containing alternating single and double bond
(b) –OH group attached to benzene ring
(c) Highly flammable
(d) Toxic

49. What is result of reacting phenol with a metal?
(a) Production of hydrogen gas (b) No reaction
(c) The chlorination of phenol (d) a and c

50. Following compound is?



(a) Catechol (b) Quinol
(c) Resorcinol (d) Eugnol

ANSWERS

1.a	2.c	3.c	4.d	5.a	6.c	7.b	8.d
9.b	10.b	11.a	12.b	13.c	14.c	15.d	16.a
17.a	18.b	19.a	20.b	21.c	22.b	23.d	24.c
25.c	26.b	27.b	28.b	29.d	30.a	31.a	32.c
33.a	34.c	35.b	36.a	37.a	38.c	39.d	40.b
41.a	42.a	43.c	44.b	45.d	46.d	47.b	48.b
49.a	50.c						

30. ORGANIC HALOGENS

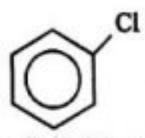
Organic Halogens

Aliphatic Halides or Alkyl Halides

e.g. CH_2Cl
Methylene chloride

Aromatic Halides or Aryl Halides

e.g. Benzyl chloride



Some other examples of commonly known alkyl halides are
CH_2Cl_2 Difluorodichloro methane (Freon)

$CHCl=CCl_2$ 1, 1, 2-trichloroethylene (Westrosol)

Preparation

(a) From Alcohols

The alcohols are most important compounds from which alkyl halides are mostly prepared because the alcohols are found in variety of shapes and sizes. The alkanes need direct halogenation while it is difficult to form alkyl halides by such type of halogenation of alkanes.

$$R{-}OH \xrightarrow{HX \text{ or } PX_3} R{-}X \longrightarrow \begin{cases} \text{Substitution products} \\ \text{Elimination Products} \\ \text{Organometallic compounds} \end{cases}$$

(b) From Halogen Acids

$$CH_3{-}CH_2{-}CH{=}CH_2 \xrightarrow{HBr} CH_3CH_2\underset{\displaystyle Br}{\underset{|}{C}}H{-}CH_3$$

(Markownikoff's Products)

$$CH_3{-}CH_2{-}CH{=}CH_2 + HBr \xrightarrow{Peroxide} CH_3CH_2CH_2CH_2Br$$

(Anti Markownikoff's Product)

$$CH_3CH_2CH_2OH + HBr \longrightarrow CH_3CH_2CH_2Br + H_2O$$

$$CH_3CH_2CH_2OH + HCl \xrightarrow{ZnCl_2} CH_3CH_2CH_2Cl$$

(c) Halogenation

$$CH_4 + Cl_2 \xrightarrow{U.V.Light} CH_3Cl + HCl$$

(d) From Phosphorous Halides

$$C_3H_7OH + PCl_5 \longrightarrow C_3H_7Cl + HCl + POCl_3$$

(e) Hunbsdiecker's Method

$$RCOOAg + Cl_2 \longrightarrow RCl + AgCl + CO_2$$

(f) Halogen Exchange Reaction

$$CH_3Br + NaI \xrightarrow{Acetone} CH_3I + NaBr$$

Properties

Alkenes that have same carbon number as Haloalkanes have very low boiling points while Haloalkanes have high boiling points. As the atomic weight of halogens compounds decrease the boiling point of that compound also decreases therefore the fluoride has the lowest boiling point as compared to other halogens. They are insoluble in water while soluble in organic solvents. The alkyl halides are denser than water. These compounds are usually bounded through dipole-dipole forces or Van der Waal forces and they are unable to form bond through hydrogen.

Boiling Points

$$RI > RBr > RCl > RF$$

Alkyl fluorides are poisonous and lighter than water.

(a) Nucleophilic substitution

$$RX = \underset{\xleftarrow{SN^2 \text{ increases}}}{\xrightarrow{SN^1 \text{ increases}}} H_3CX \quad 1^\circ \quad 2^\circ \quad 3^\circ$$

(i) Substitution nucleophilic unimolecular (SN^1) Reaction

The SN1 reactions are involved one molecule so it called as unimolecular. Its rate determing step involves that molecules and it follow first order of kinetics. The rate determing step controls the rate of stepwise reaction. Carbonation is formed as an intermediate in this reaction. Tertiary halides undergo SN^1 reaction.

$$\bar{O}H + CH_3{-}\underset{\displaystyle CH_3}{\underset{|}{\overset{\displaystyle CH_3}{\overset{|}{C}}}}{-}Br \longrightarrow CH_3{-}\underset{\displaystyle CH_3}{\underset{|}{\overset{\displaystyle CH_3}{\overset{|}{C}}}}{-}OH$$

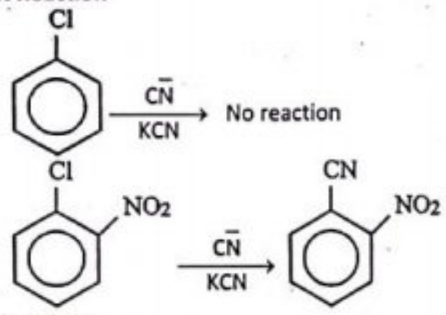
(ii) Substitution nucleophilic bimolecular (SN^2) Reaction

The SN2 reaction used two molecules in its rate determing step so it is called bimolecular and has second order of kinetics. An SN^2 reaction proceeds with complete stereochemical inversion. Steric factors play important role in determining rates of SN^2 reactions.

∴ Secondary alkyl halides undergo either SN^1 or SN^2 reaction.

Polar solvents favor SN^1 mechanism due to polar transition state whereas solvents. The presence of low concentrations and weak nucleophile such as H_2O, ROH etc. in reaction medium favor SN^1 mechanism. High concentrations and strong nucleophile such as $\bar{O}H$, $\bar{O}R$ etc. favor SN^2 mechanism.

(b) Displacement Reaction



(c) Elimination Reactions

$$CH_3CH_2CH_2Br + \text{Alc. KOH} \longrightarrow CH_3CH{=}CH_2 + KBr + H_2O$$

$$CH_3CH_2CH_2Br + KOC_2H_5 \longrightarrow CH_3CH_2CH_2{-}O{-}C_2H_5 + KBr$$

Tertiary alkyl halides undergo E_1 elimination mechanism by primary and secondary alkyl halides.

$$CH_3\underset{\displaystyle Br}{\underset{|}{C}}HCH_2CH_3 \longrightarrow \underset{\text{(Minor Product)}}{CH_2{=}CHCH_2CH_3} + \underset{\text{(Major Product)}}{CH_3CH{=}CHCH_3}$$

(d) Reduction Reactions

Alkyl halides are reduced to corresponding alkanes by Ni, Zn/HCl, and LiAlH4 in ether and red phosphorous.

$$CH_3CH_2CH_2Br + H_2 \xrightarrow{Ni} CH_3CH_3CH_3 + HBr$$

(e) Wurtz Reaction

$$2CH_3CH_2Br + 2Na \xrightarrow[ether]{dry} CH_3CH_2CH_2CH_3 + 2NaBr$$

(f) Grignard Reagent

$$CH_3I + Mg \xrightarrow{Ether} CH_3MgI$$

$$CH_3CH_2CH_2Br + 2Li \xrightarrow{Ether} CH_3CH_2CH_2Li + LiBr$$

$$4C_2H_5Cl + 4Pb/Na \xrightarrow[(Alloy)]{} (C_2H_5)4Pb + 4NaCl$$

(g) Fridel Crafts Reaction

$$CH_3CHI + C_6H_6 \xrightarrow{AlCl_3} C_6H_5CH_2CH_3 + HI$$

(h) Effect of Heat

$$CH_3\underset{\displaystyle Br}{\underset{|}{C}}HCH_3 \xrightarrow[300°C]{Above} CH_3CH{=}CHCH_3$$

(i) Halogenation

$$CH_3Cl + Cl_2 \xrightarrow[light]{U.v.} CH_2Cl_2 \xrightarrow{Cl_2} CHCl_3 \xrightarrow{Cl_2} CCl_4$$

(j) Rearrangement

$$CH_3CH_2CH_2Br \xrightarrow[300°C]{AlCl_3} CH_3\underset{\displaystyle Br}{\underset{|}{C}}HCH_3$$

Substitution Reactions

(a) Reaction with Ag_2O

$$2C_2H_5Br + Ag_2O \longrightarrow C_2H_5OC_2H_5 + 2AgBr$$

(b) Reaction with Cyanides

$$CH_3Br + NaCN \xrightarrow[Heat]{EtOH} CH_3CN + NaBr$$

$$CH_3Cl + AgCN \longrightarrow CH_3CN + AgCl$$

(c) Reaction with Nitrites

$$CH_3I + AgNO_2 \longrightarrow CH_3NO_2 + AgI$$

$$CH_3I + NaNO_2 \longrightarrow CH_3NO_2 + NaI$$

(d) Reaction with Carboxylic Acids Salts

$$CH_3COOAg + CH_3I \longrightarrow CH_3COOCH_3 + AgI$$

$$CH_3COONa + CH_3Br \longrightarrow CH_3COOCH_3 + NaBr$$

(e) Reaction with Ammonia

A mixture of amines is formed in reaction

$$CH_3CH_2Br + NH_3 \longrightarrow CH_3CH_2NH_2 + HBr$$

$$CH_3CH_2NH + CH_3CH_2Br \longrightarrow (CH_3CH_2)_2NH + HBr$$

$$(CH_3CH_2)_2NH + CH_3CH_2Br \longrightarrow (CH_3CH_2)_3N + HBr$$

$$(CH_3CH_2)_3N + CH_3CH_2Br \longrightarrow (CH_3CH_2)_4 + HBr$$

(f) Reaction with Sodium Alkoxide

It is also known as Williamson's synthesis.

$$CH_3CH_2Br + NaOCH_2CH_3 \longrightarrow (CH_3CH_2)_2O + NaBr$$

(g) Reaction with Potassium or Silver Oxide

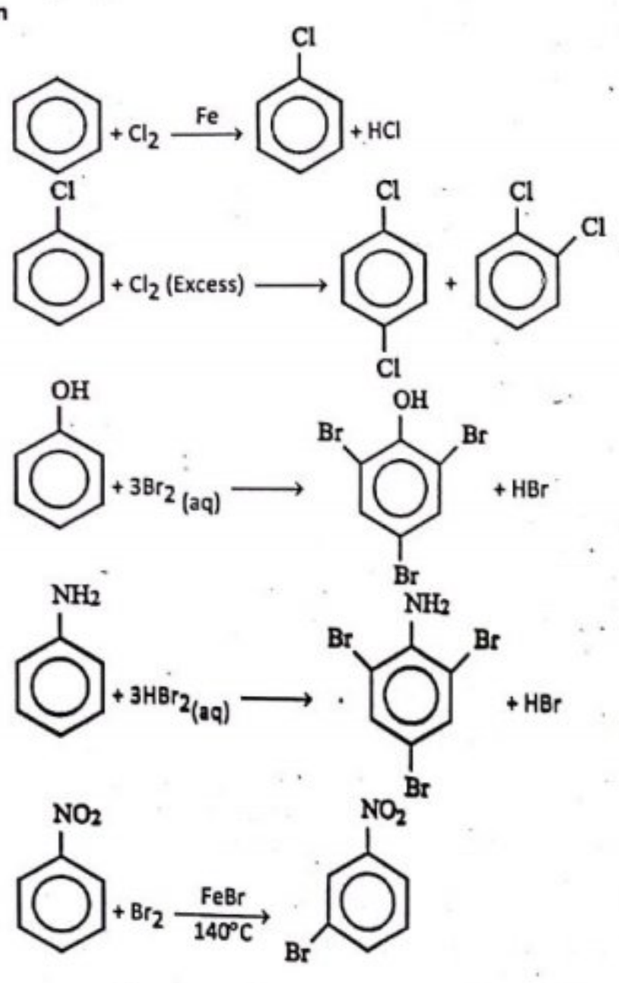
$$CH_3Cl + KOH \xrightarrow[Heat]{H_2O} CH_3OH + KCl$$

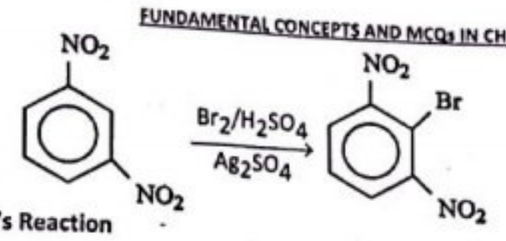
$$CH_3Br + AgOH \longrightarrow CH_3OH + AgBr$$

ARYL HALIDES

Preparation

(a) Halogenation





(b) Sandmeyer's Reaction

$$C_6H_5N_2Cl + CuCl \longrightarrow C_6H_5 + N_2 + CuCl_2$$

$$C_6H_5Cl + CuCl$$

(c) From Phenols

$$C_6H_5OH + PCl_5 \longrightarrow C_6H_5Cl + POCl_3 + HCl$$

(d) By Action of HOBr

$$C_6H_6 + HOBr \longrightarrow C_6H_5Br + H_2O$$

Properties

Aryl halides are heavier than water while alkyl halides are lighter than water. The difference in melting points of aryl halides is much wider than their boiling points.

Chemical Properties

(a) Halogen Substitution Reaction

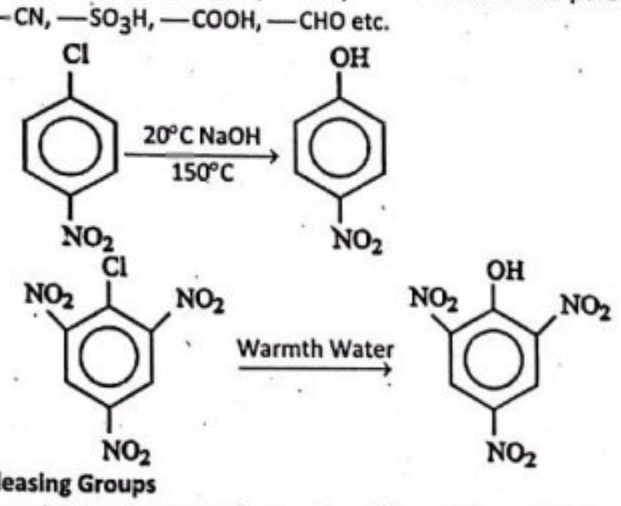
Reactions occur only under drastic conditions.

$$C_6H_5Cl + NaOH \xrightarrow{300°C/200\ atm} C_6H_5ONa + HCl$$

$$C_6H_5Cl + NH_3 \xrightarrow[cuprous\ chloride]{200°C/60\ atm} C_6H_5NH_2 + HCl$$

(b) Electron Withdrawing Groups

They activate the halogen group when present at ortho and para positions. Examples are —COR, —NO_2, —CN, —SO_3H, —COOH, —CHO etc.



(c) Electron Releasing Groups

Electron releasing groups such as —R, —OR, —NH_2, —OH etc. deactivate nuclear halogens towards nucleophilic substitution reactions.

(d) Reduction

$$C_6H_5Cl \xrightarrow{LiAlH_4} C_6H_6 + HCl$$

(e) Wurtz Fitting Reactions

The reaction that occur in the presence of only aryl halides is termed as a Wurtz reaction whereas reaction that used alkyl halides is termed as Fitting reaction.

(f) Grignard Reagent

$$C_6H_5Br + Mg \xrightarrow{Ether} C_6H_5MgBr$$

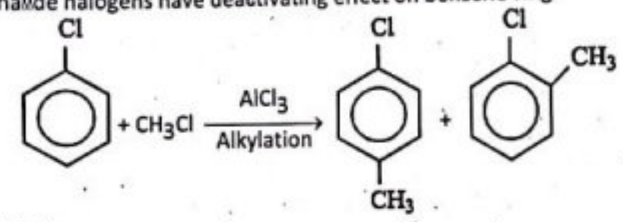
(g) Ulmann Reaction

$$2C_6H_5I + 2Cu \xrightarrow{Heat} C_6H_5 - C_6H_5 + I_2$$

Aryl bromides and chlorides give this reaction only in the presence of e withdrawing group at ortho and para positions. Aryl fluorides don't undergo Ulmann reaction.

(h) Reaction of Benzene Ring

In aryl halide halogens have deactivating effect on benzene ring.



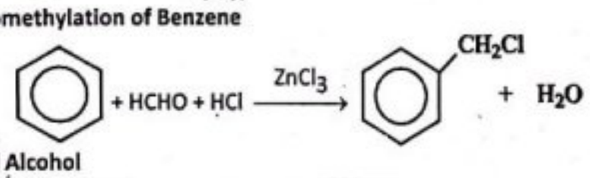
ARYL ALKYL HALIDES

Preparation

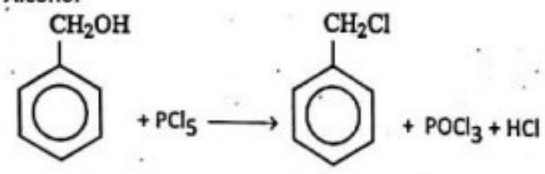
(a) From Toluene

$$C_6H_5-CH_3 + Cl_2\ (dry) \xrightarrow{h\nu} C_6H_5CH_2Cl + HCl$$

(b) From Chloromethylation of Benzene



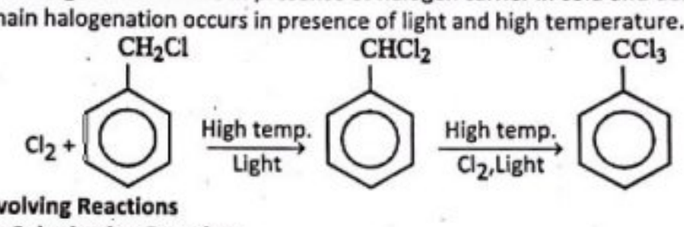
(c) From Benzyl Alcohol



Properties

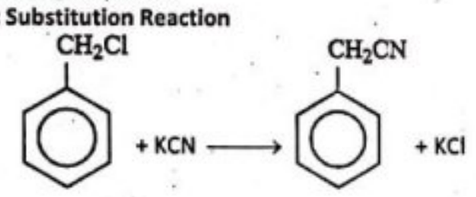
(a) Reactions of Benzene Ring

Nuclear halogenation occurs in presence of halogen carrier in cold and dark.
Side chain halogenation occurs in presence of light and high temperature.

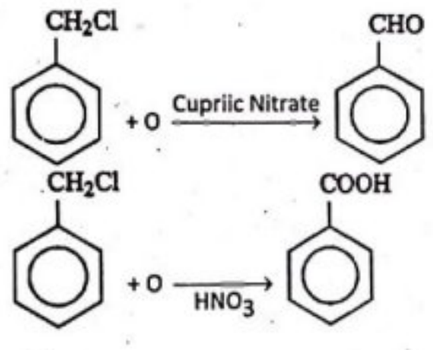


(b) Halogen Involving Reactions

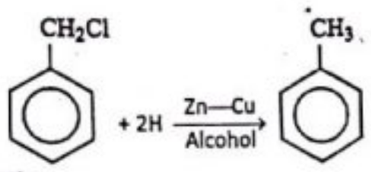
(i) Nucleophilic Substitution Reaction



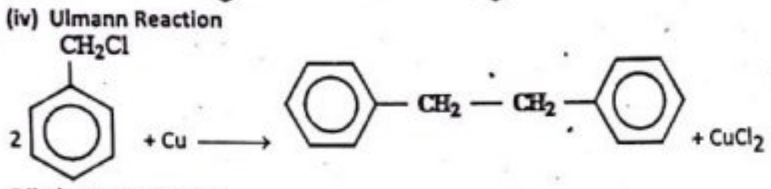
(ii) Oxidation



(iii) Reduction



(iv) Ulmann Reaction

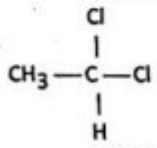


Dihalogen Derivative

Dihalogen derivatives are of three types.

(a) Gem Dihalides

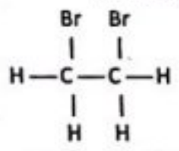
Two halogen atoms attached to some carbon.



Dichloroethane (Ethylidene dichloride).

(b) Vicinal Dihalides

Two halogen atoms attached to adjacent carbon atoms.



1,2-Dibromoethane (Ethylene dibromide)

(c) d-w Halides

Two halogen atoms attached to terminal carbon atoms of chain.

$Cl—CH_2—CH_2—CH_2—Cl$

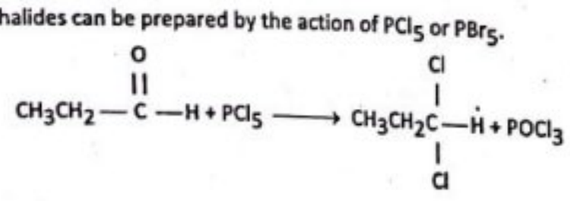
Trimethylene dichloride

Properties

(a) Gem-dihalides

(i) From Aldehydes and Ketones

Gem-dihalides can be prepared by the action of PCl_5 or PBr_5.



(ii) By addition of Halogen Acids to Alkynes

$HC \equiv CH + 2HBr \longrightarrow CH_3CHBr_2$

(b) Vicinal Dihalides

(i) By addition of Halogens to Alkenes

$CH_2 = CH_2 + Cl_2 \longrightarrow CH_2Cl—CH_2Cl$

(ii) By the action of PCl_5 on Glycols

(c) d,w-Dihalides

$CH_2—CH—CH_2Br + HBr \longrightarrow BrCH_2CH_2CH_2Br$

Properties

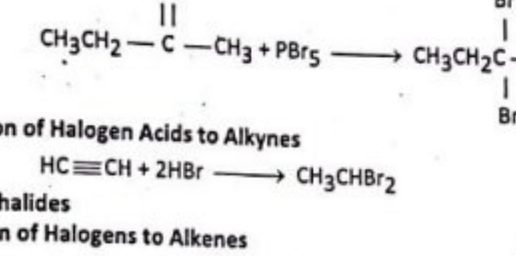
Gem dihalides are less reactive than alkyl halide whereas reactivity of vicinal and dihalides is of same reactivity as alkyl halides.

Chemical Properties

(i) Dehydrohalogenation

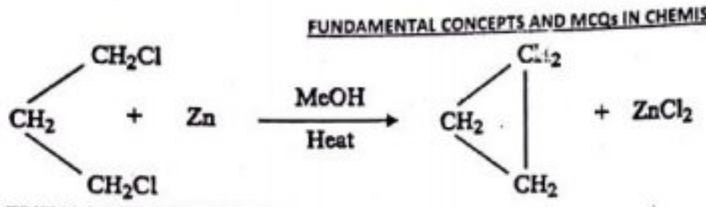
$CH_3CHCl_2 + 2KOH\ (alc.) \xrightarrow[Heat]{Ethanol} HC \equiv CH + 2KCl + 2H_2O$

(ii) Hydrolysis



(iii) Dehalogenation

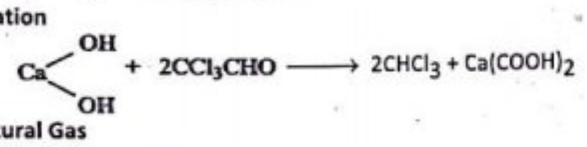
$Cl—CH_2—CH_2—Cl + 2n \xrightarrow[Heat]{MeOH} CH_2 = CH_2 + ZnCl_2$



TRIHALOGEN DERIVATIVES

Trihalogen derivatives of alkenes are called as haloforms. e.g. chloroform ($CHCl_3$).

Preparation

(i) 

(ii) Natural Gas

$$CH_4 + Cl_2 \xrightarrow{400^\circ} CH_3Cl + CH_2Cl_2 + CHCl_3 + CCl_4$$

(iii) From Chloral Hydrate

$$CCl_3CH(OH)_2 + 2NaOH \longrightarrow CHCl_3 + HCOONa + H_2O$$

(iv) Haloform Reaction

$$CH_3\,C\,CH_3 + 3NaOCl \longrightarrow CH_3\,C\,CCl_3 + 3NaOH$$

Properties

(i) Decomposition

The most toxic and poisonous phosgene gas is prepared when the decomposition of chloroform occur

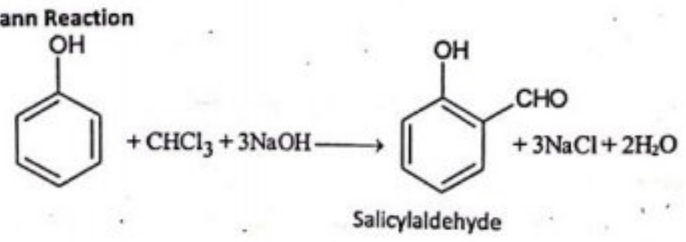
$$2CHCl_3 + O_2 \longrightarrow 2COCl_2 + 2HCl$$

To avoid decomposition of chloroform to phosgene, 0.1%, ethyl alcohol is added. The purity of chloroform is tested by using $AgNO_3$. If chloroform is decomposed it will produce precipitate with $AgNO_3$.

(ii) Reduction

$$CHCl_3 + 2H \xrightarrow[\text{Ethanol}]{Zn/HCl} CH_2Cl_2 + 2HCl$$

(iii) Reimer Tiemann Reaction



Salicylaldehyde

(iv) Chlorination

$$CHCl_3 + Cl_2 \xrightarrow{\text{Sun light}} CCl_4 + HCl$$

(v) Carbylamine Reaction

$$C_6H_5NH_2 + CHCl_3 + 3KOH \longrightarrow C_6H_5NC + 3KCl + 3H_2O$$

(vi) Heating with Silver Powder

$$2CHCl_3 + 6Ag \longrightarrow HC{\equiv}CH + 6AgCl$$

(vii) Nitration

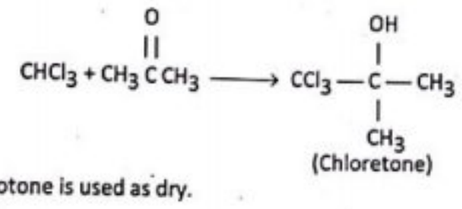
Chloroform on reaction with nitric acid from nitrochlorform or chloropicrin (tear gas).

$$CHCl_3 + HONO_2 \longrightarrow Cl_3CNO_2 + H_2O$$

(viii) Hydrolysis

$$CHCl_3 + 3KOH \longrightarrow CH(OH)_3 \xrightarrow{-H_2O} HCOOH$$

(ix) Reaction with Acetone



(Chloretone)

Cholorotone is used as dry.

(x) Anaesthetic

Chloroform mixed with 30% ether is used as anaesthetic. Pure chloroform affects the heart.

TETRA-HALOGEN DERIVATIVES

Preparation

$$CH_4 + 4Cl_2 \xrightarrow{250-400^\circ C} CCl_4 + HCl$$

$$CS_2 + 3Cl_2 \xrightarrow{AlCl_3} CCl_4 + S_2Cl_2$$

Properties

(i) Reaction with HF

$$CCl_4 + 2HF \xrightarrow{SbCl_5} CCl_2F_2 + 2HCl$$

CCl_2F_2 (Dichlorodiflouromethane) is commonly known as Freon-12 and it is usually used as a propellant and refrigerant.

(ii) Reduction

$$CCl_4 + 2H \xrightarrow{Fe/H_2O} CHCl_3 + HCl$$

(iii) Reaction with Steam

$$CCl_4 + H_2O \xrightarrow{500^\circ C} \underset{\text{Phosgene}}{COCl_2} + 2HCl$$

(iv) Hydrolysis

$$CCl_4 + 4KOH \longrightarrow CO_2 + 2H_2O + 4KCl$$

CCl_4 is used as a fire extinguish having physene as a trade name.

Note

Westrosol ($CHCl{=}CCl_2$)

Dry cleaner, solvent for fats, oils, waxes, rubber and other substances.

Westron ($CHCl_2—CHCl_2$)

It is more stable than Westrosol and is used as solvent for fats, oils, waxes, rubber and other substances.

Teflon ($CF_2—CF_2$)

Used as insulator and lubricant.

Freon (CF_2Cl_2)

Used of refrigerant and propellant.

Vinyl Chloride ($CH_2=CHCl$)

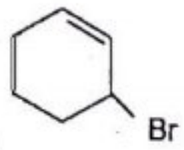
It is less reactive than ethylene.

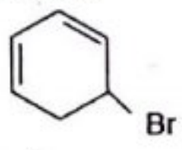
MULTIPLE CHOICE QUESTIONS

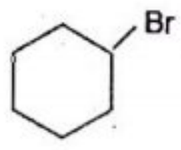
1. Isobutyl magnesium bromide with dry ether and absolute alcohol gives
   (a) $(CH_3)_2CHCH_2OH$ and CH_3CH_2MgBr
   (b) $(CH_3)_2CHCH_2CH_2CH_3$ and Mg(OH) Br
   (c) $(CH_3)_3CH$ and $CHCH_2OMgBr$
   (d) $(CH_3)_3CH$, $H_2C=CH_2$ and Mg(OH)Br
2. Which of the following will give a yellow precipitate with I_2/NaOH?
   (a) HCHO (b) $CH_3COOCOCH_3$
   (c) CH_3CONH_2 (d) $CH_3CH(OH)CH_2CH_3$
3. Alkyl halides react with dialkyl copper reagents to give
   (a) Alkenes (b) Alkyl Copper Halides
   (c) Alkanes (d) Alkenyl Halides
4. Tertiary alkyl halides are practically inert to substitution by SN2 mechanism because of
   (a) Insolubility (b) Instability
   (c) Inductive Effect (d) Steric Hindrance
5. Feron used as refrigerant is
   (a) $F_2C=CF_2$ (b) CH_2F_2
   (c) CCl_2F_2 (d) CF
6. In the chemical reaction, the compounds (A) and (B) are respectively

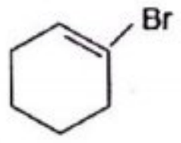
$$CH_3CH_2NH_2 + CHCl_3 + 3KOH \rightarrow (A) + (B) + 3H_2O$$

   (a) C_2H_5NC and 3KCl
   (b) C_2H_5CN and 3KCl
   (c) $CH_3CH_2CONH_2$ and 3KCl
   (d) C_2H_5NC and K_2CO_3
7. Ethyl chloride on reduction with LiAlH4 gives compound 'X' as an important product. 'X' on chlorination with one mole of Cl_2 in the presence of light at ordinary temperature gives 'Y'. What is 'Y'?
   (a) C_2H_5OH (b) C_2H_5Cl
   (c) C_2H_6 (d) C_2H_4
8. CCl4 is used as fire extinguisher because
   (a) Of its covalent bond
   (b) Of its low boiling point
   (c) Of its high melting point
   (d) It give incombustible vapour
9. Which of following is fast debrominated?

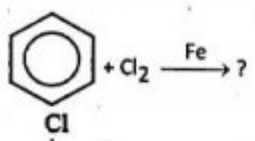
(a) 

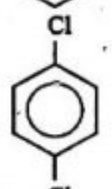
(b) 

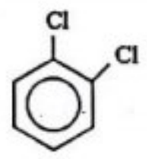
(c) 

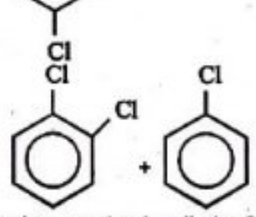
(d) 

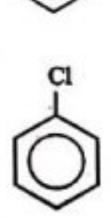
10. Among the halogens, the one which is oxidized by nitric acid is
    (a) Iodine (b) Chlorine
    (c) Bromine (d) Fluorine

11. 

(a) 

(b) 

(c) 

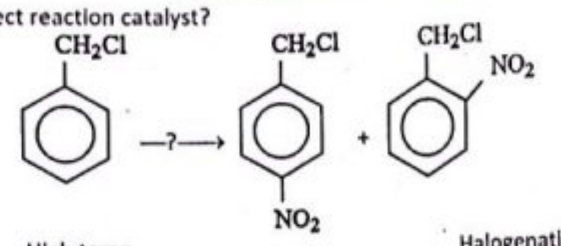
(d) 

12. Following reaction is called as?

$$C_6H_5N_2Cl + CuCl \longrightarrow C_6H_5 + N_2 + CuCl_2$$
$$C_6H_5Cl + CuCl \longleftarrow$$

    (a) Carbyl amine reaction (b) Hunbsdiecker's Method
    (c) Williamson's synthesis (d) Sandmeyer's Reaction
13. ———— activate the halogen group when present at ortho and para positions.
    (a) —OR (b) —COR
    (c) —OH (d) —R
14. Aryl fluorides don't undergo————.
    (a) Carbyl amine reaction (b) Wurtz reaction
    (c) Hydrolysis (d) Ulmann Reaction

15. Select reaction catalyst?

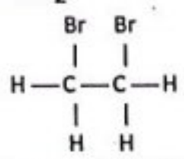
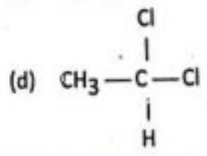


(a) $\xrightarrow[Cl_2,Light]{High\ temp.}$ (b) $\xrightarrow[Fe]{Halogenation}$

(c) $\xrightarrow[Nitration]{NHO_3+H_2SO_4}$ (d) $\xrightarrow{ZnCl_3}$

16. Which of following is gem dihalide?

(a) $CuCl_2$ (b) $BrCH_2CH_2CH_2Br$

(c)  (d) 

17. CH_3Cl on reaction with KCN followed by hydrolysis yields

(a) CH_3CN (b) CH_3COOH

(c) HCOOH (d) CH_3COOK

18. Deposition of Pb in ———— can be prevented using 1,2-dibromoethane.

(a) Metal working lathe machines (b) Electric heaters

(c) Petrol engines (d) Water pipes

19. Preparation of alkyl halides in laboratory is least preferred by:

(a) Direct halogenations of alkanes

(b) Addition of hydrogen halides to alkenes

(c) Treatment of alcohols

(d) Halide exchange

20. Which of following is not the utilization of CH_3Br?

(a) Insecticide (b) Disinfectant

(c) Pesticide

(d) As disinfectant for young fruit trees

21. Organic compounds which contains halogens is

(a) PVC (b) polyvinyl chloride

(c) poly chloro ethene (d) all of them

22. Which of the following would not be a reasonable nucleophile in a SN2 reaction?

(b) NH (b) NC^-

(c) H_2O (d) HO^-

23. Which of the following halides will react most rapidly in a SN2 reaction?

(a) CH_3F (b) CH_3Cl

(c) CH_3Br (d) CH_3I

24. Chlorobenzene is prepared commercially by

(a) Dow's process (b) Deacon's process

(c) Raschig process (d) Etard's process

25. Aryl halides are less reactive towards nucleophilic substitution reaction as compared to alkyl halides due to

(a) The formation of less stable carbonium ion

(b) Resonance stabilization

(c) Longer–carbon–halogen bond

(d) Both (1) and (2)

26. Which of the following factors does not favour SN1 mechanism?

(a) Strong nucleophile (b) Polar solvent

(c) Low concentration of nucleophile (d) alkyl halide

27. Which of the following is the correct order of decreasing reactivity towards nucleophilic substitution?

(a) Vinyl chloride > Allyl chloride > Propyl chloride

(b) Propyl chloride > Vinyl chloride > Allyl chloride

(c) Alyl chloride > Vinyl chloride > Propyl chloride

(d) Allyl chloride > Propyl chloride > Vinyl chloride

28. The organic chloro compound, which shows complete stereochemical inversion during a SN2 reaction, is

(a) CH_3Cl (b) $(C_2H_5)_2CHCl$

(c) $(CH_3)_3CCl$ (d) $(CH_3)_2CHCl$

29. $CH_3–CH_2–Br$ on treatment with LiAlH4 gives ethane gas while $(CH_3)_3C–Br$ on same treatment gives H_2 gas because

(a) The former is SN_2 and later is E_2 reaction

(b) The former is E_2 and later is SN_2 reaction

(c) The former is SN_1 and later is E_2reaction

(d) The former is E_2 and later is SN_2 reaction

30. Which one of the following statements is wrong?

(a) Lower alkyl halides are either colourless gases or volatile liquids

(b) Alkyl halides are highly soluble in water

(c) Alkyl halides burn easily with green edged flame

(d) The higher alkyl halides are colourless solids

31. The compound (C) is in this reaction

$$CH_3OH \xrightarrow{PI_3} (A) \xrightarrow{KCN} (B) \xrightarrow{Hydrolysis} (C)$$

(a) CH_3OH (b) HCOOH

(c) CH_3CHO (d) CH_3COOH

32. Which will be obtained by boiling CH_2Cl_2 with caustic soda?

(a) Sodium oxalate (b) Sodium acetate

(b) Sodium formate (d) Ethyl alcohol

33. A mixture of 1-chlorobutane and 2-chlorobutane when treated with alcoholic KOH, gives

(a) 1-butene (b) 2-butene

(c) Isobutylene (d) A mixture of 1-butene and 2-butene

34. Which of the following processes does not occur during formation of CHCl3 from ethyl alcohol and bleaching powder?

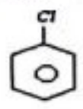
(a) Oxidation (b) Chlorination

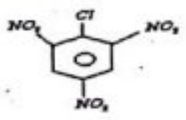
(b) Hydrolysis (d) Reduction

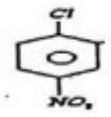
35. In which of the following compounds, carbon exhibits a valency of 4 but oxidation state-2?
(a) HCHO (b) CH_3Cl
(c) CH_2Cl_2 (d) $CHCl_3$

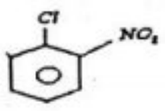
36. The antiseptic action of CHI_3 is due to
(a) Iodoform itself
(b) Liberation of free iodine
(c) Partially due to iodine and partially due to CHI_3 itself
(d) None of the above

37. Which of the following compound undergoes replacement of Cl by OH by merely warming with aq NaOH

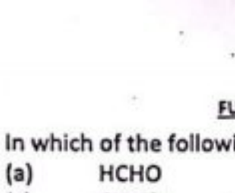
(a) 

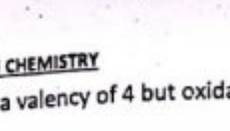
(b) 

(c) 

(d) 

38. Which of the following will be the least reactive towards nucleophilic substitution?
(a) C_2H_5Cl (b)

(c) 

(d) 

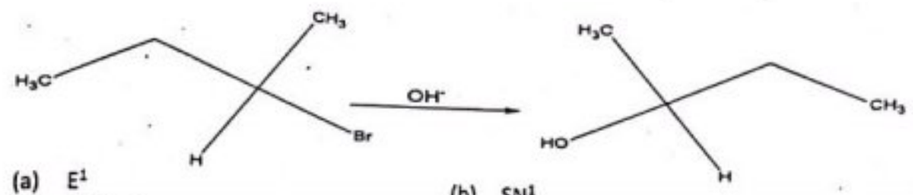
39. The reaction given below is known as
$C_6H_5I + 2Na + ICH_3 \rightarrow C_6H_5\text{-}CH_3 + 2NaI$
(a) Wurtz reaction (b) Fiting reaction
(c) Wurtz-Fiting reaction (d) Ullmann reaction

40. Chlorobenzene on heating with aqueous NH_3 under pressure in the presence of cuprous chloride gives
(a) Benzamide (b) Nitrobenzene
(c) Aniline (d) Chloroaminobenzene

41. Magensium is reacted with _____ to prepare Grignard reagent.
(a) Ethyl amine (b) Diethyl ether
(c) Methyl amine (d) Ethyl iodide

42. Following compound does not give Iodoform test?
(a) Acetophenone (b) Ethanal
(c) Ethanol (d) Benzophenone

43. The reaction described is?



(a) E^1 (b) SN^1
(c) SN^2 (d) E^2

44. Aryl halides are less reactive than alkyl halides towards electrophile due to?
(a) High boiling points (b) Low boiling points
(c) Resonance (d) Stability of carbonium ions

45. On reduction with Zn and HCl, chloroform gives?
(a) Choloropicrin (b) Formic acid
(c) Cholorotone (d) Methylene dichloride

46. $CHCl_3$ + Alcoholic KOH $\longrightarrow$ Primary aromatic amine
The reaction given above is known as?
(a) Carbyl amine reaction (b) Wurtz reaction
(c) Hydrolysis (d) . Reduction

47. Select correct reactivity order of halide ions?
(a) F > Cl > Br > I (b) I > Cl > Br > F
(c) F > Br > Cl > I (d) I > Br > Cl > F

48. _____is used to coat non-sticking pots?
(a) Teflon (b) Propylene
(c) Styrene (d) Isomyristrate

49. Identify following reaction?
$RCOOAg + Cl_2 \longrightarrow RCl + AgCl + CO_2$
(a) SN^1 Reaction (b) SN^2 Reaction
(c) Wurtz Reaction (d) Hunbsdiecker's Method

50. Reaction of ethyl bromide with sodium alkoxide is called as_____.
(a) Carbyl amine reaction (b) Hunbsdiecker's Method
(c) Williamson's synthesis (d) Wurtz Reaction

Answers

1. c	2. d	3. c	4. d	5. c	6. a
7. b	8. d	9. b	10. a	11. d	12. d
13. b	14. d	15. c	16. d	17. b	18. c
19. a	20. E	21. d	22. d	23. c	24. c
25. a	26. a	27. d	28. a	29. a	30.b
31. d	32. b	33. d	34. d	35. b	36.b
37. b	38. d	39. c	40. c	41. d	42. d
43. c	44. c	45. d	46. a	47. d	48.d
49. c	50. c				

31. CARBOXYLIC ACIDS

These are compounds containing —COOH group.

Monocarboxylic Acids

These contain only —COOH group. Carboxylic acids are functional isomers of esters.

Preparation

(a) Oxidation

$$CH_3CH_2OH \xrightarrow{[O]} CH_3COOH$$

The oxidizing agents are $KMnO_4$, dilute HNO_3 and $K_2Cr_2O_7 + H_2SO_4$.

(b) Hydrolysis

$$CH_3COOC_2H_5 + NaOH \xrightarrow{Heat}$$

$$CH_3COONa + C_2H_5OHCH_3COONa + HCl \longrightarrow CH_3COOH + NaCl$$

$$CH_3CH_2CN \xrightarrow{Conc.H_2SO_4} CH_3CH_2COOH$$

(c) From Grignard Reagents

$$CH_3CH_2CH_2MgBr + CO_2 \longrightarrow CH_3CH_2CH_2COOMgBr$$

$$CH_3CH_2CH_2COOMgBr \xrightarrow[H]{H_2O} CH_3CH_2COOH + Mg(OH)Br$$

(d) From Dicarboxylic Acids

$$COOH—CH_2—COOH \xrightarrow{Heat} CH_3COOH + CO_2$$

Malonic acid

$$COOH—COOH \xrightarrow{Heat} HCOOH + CO_2$$

(e) From Acid Amides

$$CH_3CONH_2 + HNO_2 \longrightarrow CH_3COOH + N_2 + H_2O$$

(f) From Sodium Alkoxide

$$C_2H_5ONa + CO \xrightarrow{160°C} C_2H_5COONa$$

$$C_2H_5COONa \xrightarrow{HCl} C_2H_5COOH + NaCl$$

(g) Catalytic Oxidation of Long Chain Alkanes

$$RCH_3 + 2O_2 \xrightarrow[\text{potassium stearate } 180°C]{\text{Manganous and}} RCOOH + CO_2$$

(I) From Reduction

$$CH_3CH{=}CHCH_2COOH + 2H \longrightarrow CH_3CH_2CH_2CH_2COOH$$

(j) Koch Reaction

$$CH_2{=}CH_2 + CO + H_2O \xrightarrow[400°C]{H_3PO_4} CH_3CH_2COOH$$

Properties

First four members of carboxylic acids series are water soluble. Even number of carbon atoms containing carboxylic acids have higher melting points a, compared to odd C-atoms acids. The carboxylic acids do not show some reactions of carbonyl group. pKa value is decreases with increase in acidic strength.

Acidity Order

$HCOOH > CH_3COOH > CH_3CH_2COOH > CH_3(CH_2)_nCOOH$

$Cl_2CHCOOH > HCOOH > C_6H_5COOH > CH_3COOH > NH_2CH_2COOH$

Acidity is decrease in the presence of Electron donating groups, and vice versa.

Chemical Properties

(A) Reactions due to Replaceable Hydrogen

Salt Formation

$$CH_3COOH + NaOH \longrightarrow CH_3COONa + H_2O$$

$$CH_3COOH + Zn \longrightarrow (CH_3COO)_2Zn + H_2$$

(B) Reactions of Hydroxyl Group

(a) Formation of Acid Halides

$$CH_3COOH + PCl_5 \longrightarrow CH_3COCl + POCl_3 + HCl$$

(b) Formation of Anhydrides

$$2CH_3COH \xrightarrow{P_2O_5} CH_3—\overset{O}{\overset{\|}{C}}—O—\overset{O}{\overset{\|}{C}}—CH_3 + H_2O$$

(c) Formation of Nitrites

$$CH_3COOH + CO(NH_2)_2 \longrightarrow CH_3CONH_2$$

$$CH_3CONH_2 \xrightarrow[\text{Heat}]{P_2O_5} CH_3CN + H_2O$$

(d) Ester Formation

$$CH_3COOH + HOC_2H_5 \longrightarrow CH_3COOC_2H_5 + H_2O$$

(e) Amide Formation

$$CH_3COOH + NH_3 \longrightarrow CH_3COONH_4 \longrightarrow CH_3CONH_2 + H_2O$$

(C) Reactions of Carbonyl Group

$$R—COOH \xrightarrow[Ether]{LiAlH_4/NaBH_4} RCH_2OH$$

$$CH_3COOH + 3H_2 \xrightarrow[200—250°C]{Red\ P/HI} CH_3—CH_2 + 2H_2O$$

(D) Reactions of Carboxylic Acid

(a) Decarboxylation

$$CH_3COONa + NaOH \xrightarrow{CaO} CH_4 + Na_2CO_3$$

(b) Aldehyde Formation

$$(CH_3COO)_2\,Ca + (HCOO)_2\,Ca \longrightarrow 2CH_3CHO + 2CaCO_3$$

(c) Ketone Formation

$$(CH_3COO)_2\,Ca \longrightarrow CH_3COCH_3 + CaCO_3$$

(d) Hunsdiecker Reaction

$$2CH_3COOAg + Cl_2 \longrightarrow 2CH_3Cl + 2CO_2 + 2AgCl$$

(e) Schmidt Reaction

$$NaH_3 + H_2SO_4 \longrightarrow HN_3$$

$$CH_3COOH + HN_3 \longrightarrow CH_3NH_2 + CO_2 + N_2$$

(E) Reaction duet to Alkyl Group

(a) Hell-Volhard-Zelinsky Reaction

$$CH_3CH_2CH_2COOH + Cl_2 \xrightarrow{P} CH_3CH_2\underset{Cl}{\underset{|}{C}}HCOOH + HCl$$

$$CH_3CH_2\underset{Cl}{\underset{|}{C}}HCOOH + Cl_2 \xrightarrow{P} CH_3CH_2\underset{Cl}{\underset{|}{C}}COOH$$

Formic acid does not undergo halogenation due to absence of d-carbon atom.

(b) Oxidation

$$CH_3\overset{\beta}{C}H_2\overset{\alpha}{C}H_2COOH + [O] \xrightarrow{H_2O_2} CH_3\underset{OH}{\underset{|}{C}}HCH_2COOH$$

β-hydroxy butyric acid

Reaction of Formic Acid

In addition to above reactions, formic acid gives following reactions.

(a) Reaction with conc. H_2SO_4

$$HCOOH \xrightarrow{Conc.H_2SO_4} CO + H_2O$$

(b) Action of Heat

$$HCOOH \xrightarrow{160^\circ C} CO_2 + H_2$$

(c) Reducing Agent

Formic acid like aldehydes but unlike other carboxylic acids reduces Tollen's reagent, Fehling solution, mercuric chloride and potassium permanganate.

$$HCOOH + Ag_2O \longrightarrow CO_2 + H_2O + 2Ag \text{ (Silver mirror)}$$

$$HCOOH + 2CuO \longrightarrow CO_2 + H_2O + Cu_2O \text{ (Reddish brown ppt.)}$$

$$HCOOH + 2HgCl_2 \longrightarrow CO_2 + 2HCl + Hg_2Cl_2 \text{ (White)}$$

$$2HCOOH + Hg_2Cl_2 \longrightarrow 2CO_2 + HCl + 2Hg \text{ (Black)}$$

$$2KMnO_4 + 3H_2SO_4 + 5HCOOH \longrightarrow K_2SO_4 + 2MnSO_4 + 5CO_2 + 8H_2O$$

(d) Heating of Sodium Salt with Sodalime

$$HCOONa + NaOH \xrightarrow{CaO} H_2 + Na_2CO_3$$

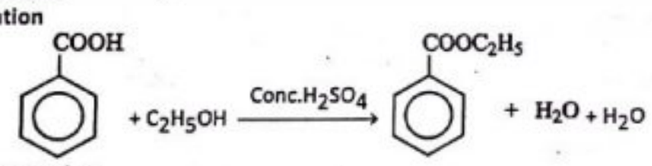
(e) Heating of Sodium Format

$$2HCOONa \xrightarrow{300^\circ C} \underset{COONa}{\underset{|}{COONa}} + H_2$$

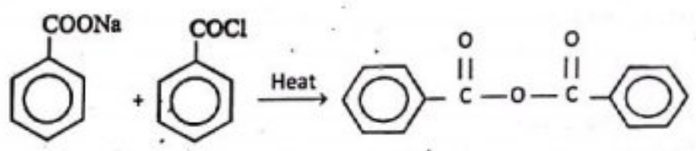
$$\underset{COONa}{\underset{|}{COONa}} + 2HCl \longrightarrow \underset{COOH}{\underset{|}{COOH}} + 2NaCl$$

Chemical Preparation

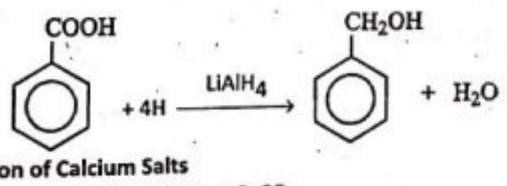
(a) Ester Formation



(b) Anhydride Formation



(c) Reduction



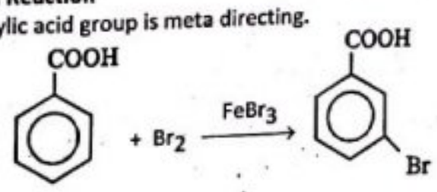
(d) Dry Distillation of Calcium Salts

$$Ca(COOC_6H_5)_2 \longrightarrow C_6H_5COC_6H_5 + CaCO_3$$

$$Ca(COOC_6H_5)_2 + Ca(HCOO)_2 \longrightarrow 2C_6H_5CHO + 2CaCO_3$$

(e) Substitution Reaction

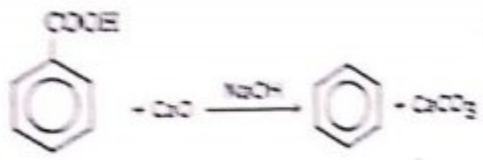
Carboxylic acid group is meta directing.



(f) Formation of Amides

$$C_2H_5COOH + NH_3 \longrightarrow C_2H_5COONH_4 \xrightarrow{\text{Heat}} C_2H_5CONH_2 + H_2O$$

(g) Reaction with Sodalime



Acid Derivatives

The reactivity order of group attached to carbonyl carbon is as following.

Acid chloride > Acid anhydride > Acid ester > Acid amide

Acid Chloride

Preparation

(a) From Anhydrous Fatty Acids

By heating anhydrous fatty acid with PCl_5, PCl_3, $SOCl_2$, SO_2Cl_2 etc.

$$2CH_3COOH + SO_2Cl_2 \longrightarrow 2CH_3COCl + H_2SO_4$$

$$CH_3COOH + SOCl_2 \longrightarrow CH_3COCl + SO_2 + HCl$$

(b) Industrial Scale Preparation

By distilling of anhydrous fatty acids sodium salts with PCl_3, $POCl_3$, $SOCl_2$, SO_2Cl_2, etc.

$$3CH_3COONa + PCl_3 \longrightarrow 3CH_3COCl + Na_3PO_3$$

$$CH_3CHO + CCl_4 \xrightarrow{\text{Benzoyl peroxide}} CH_3COCl + CCl_3$$

Properties

Acid chlorides are more reactive than alkyl chlorides due to polarization of carbonyl group.

Chemical Properties

(a) Hydrolysis

$$CH_3COCl + H_2O \longrightarrow CH_3COOH + HCl$$

(b) Ammonolysis

$$CH_3COCl + NH_3 \longrightarrow CH_3CONH_2 + HCl$$

(c) Reaction with Amines

$$CH_3COCl + 2CH_3NH_2 \longrightarrow CH_3CONHCH_3 + CH_3NH_2^+ + Cl^-$$

$$CH_3COCl + 2(CH_3)_2NH \longrightarrow CH_3CON(CH_3)_2 + (CH_3)_2NH_2^+ + Cl^-$$

$$CH_3COCl + NaCOOCH_3 \longrightarrow CH_3COOCOCH_3 + NaCl$$

(d) Alcoholysis

$$CH_3COCl + C_2H_5OH \longrightarrow CH_3COOC_2H_5$$

(e) Friedel Craft Reaction

(f) Reaction with Ether

$$C_2H_5COCl + C_2H_5OC_2H_5 \longrightarrow C_2H_5COOC_2H_5 + C_2H_5Cl$$

(g) Reduction

$$CH_3COCl + H_2 \longrightarrow CH_3CHO + HCl$$

$$CH_3COCl + 4H \xrightarrow[\text{Ether}]{LiAlH_4} CH_3CH_2OH + HCl$$

(h) Reaction with Grignard Reagent

$$CH_3COCl + CH_3MgCl \longrightarrow CH_3COCH_3 + MgCl_2$$

(i) Reaction with Urea, Hydrazine and Hydroxyl Amine

$$CH_3COCl + H_2NNH_2 \longrightarrow \underset{\text{Acetyl hydrazine}}{CH_3CONHNH_2} + HCl$$

$$CH_3COCl + NH_2CONH_2 \longrightarrow \underset{\text{Acetyl urea}}{CH_3CONHCONH_2} + Cl$$

$$CH_3COCl + H_2NOH \longrightarrow \underset{\text{Acetyl hydroxylamine}}{CH_3CONHOH} + HCl$$

(j) Reaction with Hydrazoic Acid

$$CH_3COCl + HN_3 \longrightarrow CH_3CON_3 + HCl$$

Acid Anhydride

Preparation

(i) $CH_3COONa + ClCOCH_3 \longrightarrow CH_3CO—OCOCH_3 + NaCl$

(ii) $CH_3COOH + ClCOCH_3 \xrightarrow{\text{Pyridine}} CH_3COOCOCH_3 + HCl$

(iii) $CH_3COOH \longrightarrow CH_2=C=O + H_2O$

$CH_3COCH_3 \longrightarrow CH_2=C=O + CH_4$

Ketene

$CH_2=C=O + CH_3COOH \longrightarrow CH_3COOCOCH_3$

(iv) $8CH_3COONa + SO_2 + 2Cl_2 \longrightarrow 4(CH_3CO)_2O + Na_2SO_4 + 6NaCl$

Properties

It is a colorless liquid with boiling point of 140°C.

Esters

$$CH_3COOH + HOC_2H_5 \longrightarrow CH_3COOC_2H_5 + H_2O$$

Acid Amides

Preparation

(a) From Ammonium Salts of Carboxylic Acids

$$CH_3COONH_4 \xrightleftharpoons{\text{Heat}} CH_3CONH_2 + H_2O$$

(b) From Carboxylic Acids

$$CH_3COOH + NH_2\overset{\overset{O}{\|}}{C}NH_2 \xrightarrow{\text{Heat}} CH_3CONH_2 + CO_2 + NH_4$$

(c) From Alkyl Cyanides

$$CH_3CN + H_2O \longrightarrow CH_3CONH_2$$

(d) From Ammonolysis of Acid Derivatives

$$(CH_3CO)_2O + 2NH_3 \longrightarrow CH_3CONH_2 + CH_3COONH_4$$

$$CH_3COCl + 2NH_3 \longrightarrow CH_3CONH_2 + NH_4Cl$$

$$CH_3COOC_2H_5 + NH_3 \longrightarrow CH_3CONH_2 + C_2H_5OH$$

Properties

Formamide is available in liquid phase, where as all others amides are white, odourless, crystalline solid. The melting points of amides are higher than those acids due to intermolecular hydrogen bonding. Amides are amphoteric.

Chemical Properties

(a) Reduction

$$CH_3CONH_2 + 4H \xrightarrow[C_2H_5—OH]{Na} CH_3CH_2NH_2 + H_2O$$

(b) Dehydration

$$CH_3CONH_2 \xrightarrow{P_2O_5} CH_3CN + H_2O$$

(c) Hoffman Bromide Reaction

$$CH_3CONH_2 + Br_2 + 4KOH \xrightarrow[\text{(alcoholic)}]{} CH_3NH_2 + 2KBr + K_2CO_3 + 2H_2O$$

(d) Action of HNO_2

$$CH_3CONH_2 + HNO_2 \longrightarrow CH_3COOH + N_2 + H_2O$$

Urea

Urea was synthesized for the first time in laboratory by Wholer (1828) by evaporating ammonium cyanate solution which was prepared by evaporating a solution containing ammonium sulfate and potassium cyanate.

$$2KCNO + (NH_4)_2SO_4 \xrightarrow{\text{Heat}} 2NH_4CNO + K_2SO_4$$

$$NH_4CNO \xrightarrow[\text{Rearrangement}]{\text{Molecular}} NH_2—\overset{\overset{O}{\|}}{C}—NH_2$$

In urine, urea is present as $NH_2CONH_2 \cdot HNO_3$.

Properties

(a) Laboratory Scale Preparation

$$C_2H_5O—\overset{\overset{O}{\|}}{C}—OC_2H_5 + 2NH_3 \longrightarrow NH_2—\overset{\overset{O}{\|}}{C}—NH_2 + 2EtOH$$

$$COCl_2 + 2NH_3 \longrightarrow NH_2\overset{\overset{O}{\|}}{C}NH_2 + 2HCl$$

$$COCl + 2NH_3 \longrightarrow NH_2CONH_2 + 2HCl$$

(b) Industrial Scale Preparation

(i) $CaC_2 + N_2 \xrightarrow{150°C} CaNCN \xrightarrow{H_2SO_4} NH_2CN \xrightarrow{H_2O} NH_2CONH_2$

(ii) $NH_3 + CO_2 \longrightarrow O=C(NH_2)(OH) + NH_3$

$$H_2O + NH_2\overset{\overset{O}{\|}}{C}NH_2 \rightleftharpoons O=C(NH_2)(ONH_4)$$

Properties

Urea is an odourless, white and crystalline solid with melting point of 132°C. It is soluble in water and alcohol but in ether it is insoluble.

Chemical Properties

(a) Hydrolysis

$$NH_2CONH_2 + H_2O \longrightarrow 2NH_3 + H_2CO_3 \longrightarrow H_2O + CO_2$$

(b) Reaction with Hydrazine

$$NH_2CONH_2 + H_2N—NH_2 \longrightarrow \underset{\text{Semicarbazide}}{NH_2CONHNH_2} + NH_3$$

Semicarbazide is a half hydrazide and half amide.

(c) Action of HNO_2

$$NH_2ONH_2 + HN_2O \longrightarrow 2NH_3 + 2H_2O + H_2CO_3$$

$$H_2O + CO_2$$

(d) Reaction with Ethanol

$$NH_2CONH_2 + C_2H_5OH \longrightarrow NH_2COOC_2H_5 + NH_3$$

e) Acetylation

$$NH_2CONH_2 + CH_3COCl \longrightarrow NH_2CONHCOCH_3 + HCl$$

$$2C_2H_5OH \xrightarrow[250^oC]{Al_2O_3} C_2H_5OC_2H_5 + H_2O$$

MULTIPLE CHOICE QUESTIONS

1. Tamarinds contain major quantities of following acid?
   (a) Citric acid (b) Tartaric acid
   (c) Acetic acid (d) Butyric acid
2. Sour milk contains which acid?
   (a) Citric acid (b) Tartaric acid
   (c) Acetic acid (d) Butyric acid
3. What is the common name of ethanoic acid ?
   (a) Acetic acid (b) Ethanic acid
   (c) Formic acid (d) Propionic acid
4. Benzoic acid is a?
   (a) Strong acid (b) Weak base
   (c) Salt (d) Weak acid
5. Artificial fruity smell and flavors of food are due to?
   (a) Alcohols (b) Aldehydes
   (c) Ketones (d) Esters
6. ———— (IUPAC name) is product of butyric acid and ethanol.
   (a) Ehyl butyrate (b) Methyl pentanoate
   (c) Butyl ethanoate (d) Ethyl butanoate
7. Amine acts as ———— in distilled water.
   (a) Strong acid (b) Weak base
   (c) Salt (d) Neutral
8. Nicotine, caffeine, and morphine are?
   (a) Alcohols (b) Aldehydes
   (c) Amides (d) Carboxylic acids
9. Semicarbazide is a half ———— and half ————.
   (a) Alcohols, acid (b) hydrazide, amide
   (c) Ketones, hydrazide (d) Carboxylic acid, amide
10. Malonic acid on continuous heating for long time produce?
    (a) Acetic acid (b) Ethanoic acid
    (c) Propanoic acid (d) Formic acid

11. Even number of carbon atoms containing carboxylic acids have ———— melting points in comparison to odd C-atoms acids.
    (a) Higher (b) Lower
    (c) Exactly same (d) Somewhat same
12. Select correct acidity order.
    (a) $HCOOH > C_6H_5COOH > CH_3COOH > NH_2CH_2COOH > Cl_2CHCOOH$
    (b) $Cl_2CHCOOH < HCOOH < C_6H_5COOH < CH_3COOH < NH_2CH_2COOH$
    (c) $Cl_2CHCOOH > HCOOH < C_6H_5COOH > CH_3COOH > NH_2CH_2COOH$
    (d) $Cl_2CHCOOH > HCOOH > C_6H_5COOH > CH_3COOH > NH_2CH_2COOH$
13. Select correct acidity order.
    (a) $HCOOH < CH_3COOH < CH_3CH_2COOH < CH_3(CH_2)_nCOOH$
    (b) $HCOOH > CH_3COOH > CH_3CH_2COOH > CH_3(CH_2)_nCOOH$
    (c) $CH_3COOH > CH_3CH_2COOH > CH_3(CH_2)_nCOOH > HCOOH$
    (d) $HCOOH < CH_3COOH < CH_3CH_2COOH > CH_3(CH_2)_nCOOH$
14. ———— does not undergo halogenation.
    (a) Acetic acid (b) Ethanoic acid
    (c) Propanoic acid (d) Formic acid
15. ———— is only carboxylic acid that reduces Tollen's reagent, Fehling solution, mercuric chloride and potassium permanganate.
    (a) Acetic acid (b) Ethanoic acid
    (c) Propanoic acid (d) Formic acid
16. Formamide is a.
    (a) Solid (b) Gas
    (c) Liquid (d) Semi solid
17. Amides are ———— in character.
    (a) Acidic (b) Basic
    (c) Amphoteric (d) Weak acid
18. In urine, urea is present as.
    (a) $NH_2CONH_2 \cdot NH_2CONH_2$ (b) $NH_2CONH_2 \cdot HNO_3$
    (c) NH_2CONH_2 (d) $NH_2CONH_2 \cdot H_2O$
19. Give name of a cyclic compound that gives an equimolar amount of $HOOCCH_2CH_2COOH$ on oxidative cleavage?
    (a) Cylcobutene (b) Cyclobutane
    (c) Cyclopropene (d) Cyclopropane
20. ———— acid is present in red ants.
    (a) Formic acid (b) Ethanoic acid
    (c) Propanoic acid (d) Malic acid
21. ———— give white precipitate with $HgCl_2$.
    (a) Acetic acid (b) Ethanoic acid
    (c) Propanoic acid (d) Formic acid
22. Baking powder contains which acid?
    (a) Acetic acid (b) Lactic acid
    (c) Propanoic acid (d) Tartaric acid

23. Urine is acidic in nature due to presence of?
(a) Acetic acid (b) Urea
(c) HCl (d) NaH_2PO_4

24. Which of the following is basic?
(a) CH_3CH_2OH (b) H_2O_2
(C) $HOCH_2CH_2OH$ (d) CH_3COOH

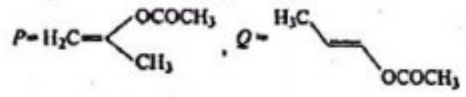
25. Acetamide is treated separately with the following reagents. Which one of these would give methyl amine?
(a) PCl_5 (b) $NaOH + Br_2$
(c) Sodalime (d) Hot conc. H_2SO_4

26. Hydrogenation of benzyoyl chloride in the presence of Pd on $BaSO_4$ gives.
(a) Benzyl alcohol (b) Benzaldehyde
(c) Benzoic acid (d) Phenol

27. When propionic acid is treated with aqueous sodium bicarbonate, CO_2 is liberated. The C of CO_2 comes from?
(a) Methyl group (b) Carboxylic acid group
(c) Methylene group (d) Bicarbonate group

28. Benzoyl chloride is prepared from benzoic acid by.
(a) Cl_2, *hv* (b) SO_2Cl_2
(c) $SOCl_2$ (d) Cl_2,H_2O

29. The product of acid hydrolysis of *P* and *Q* can be distinguished by.



(a) Lucas reagent (b) 2,4-DNP
(c) Fehling's solution (d) $NaHSO_3$

30. An enantiomerically pure acid is treated racemic mixture of an alcohol having one chiral carbon. The ester formed will be?
(a) Optically active mixture (b) Pure enantiomer
(c) *Meso* compound (d) Racemic mixture

31. Benzamide on treatment with $POCl_2$ gives.
(a) Aniline (b) Benzonitrile
(c) Chlorobenzene (d) Benzyl amine

32. When benzene sulphonic acid and *p*-nitrophenol are treated with $NaHCO_3$, the gases released respectively, are.
(a) SO_2, NO_2 (b) SO_2, NO
(c) SO_2, CO_2 (d) CO_2, CO_2

33. When - COOH is attached directly to the benzene ring the acid is called:
(a) Aliphatic (b) Alicyclic
(c) Carboxylic (d) Aromatic

34. The common name of propane 1 3-dioic is.
(a) Oxalic acid (b) Aromatic acid
(c) Malonic acid (d) Fumaric acid

35. The common thing in phthalic acid and oxalic acid is that both are.
(a) Aromatic (b) Dicarboxylic
(c) Hydrocarbons (d) Strong acids

36. The irritation caused by red ants bite is due to?
(a) Lactic acid (b) Formic acid
(c) Uric acid (d) Acetic acid

37. The acid which is used as ink remover is.
(a) Oxalic acid (b) Succinic acid
(c) Adipic acid (d) Acetic acid

38. Which of the following is the strongest acid?
(a) Water (b) Formic acid
(c) Acetic acid (d) Propanoic acid

39. Synthetic rubber is prepared by.?
(a) Acetic acid (b) Formic acid
(c) Carbonic acid (d) Benzoic acid

40. Acidic amino acids have.
(a) 2 amino groups and 1 carboxylic group
(b) 1 amino and 1 carboxylic groups
(c) 2 carboxylic groups and 1 amino group
(d) 2 amino and 2 carboxylic groups

41. In the formation of Zwitter ions proton goes from?
(a) Carboxyl to amino group (b) Amino to carboxyl group
(c) Amino group only (d) Carboxyl group only

42. The term internal salt refers to?
(a)Acidic character of amino acids (b)Basic character of amino acids
(c)Dipolar character of amino acids (d) Non-polar structure of amino acids

43. The organic acid that does not has COOH group is?
(a) phthalic acid (b) carbolic acid
(c) Maleic acid (d) Succinic acid

44. Which one of the following acids is present in lemon juice?
(a) Citric acid (b) Benzoic acid
(c) Tartaric acid (d) Oxalic acid

45. The test which is used for the identification of amino-acids is.
(a) Ninhydrin test (b) Molisch test
(c) Biuretic test (d) Benedict test

46. Which one of following amino acid is neither acidic nor a basic in nature?
(a) Lysine (b) Histidine
(c) Proline (d) Glutamic acid

47. Carboxylic acid reacts with ammonia to form ammonium salts which on heating produces?
(a) CO_2 (b) Alkane
(c) Ester (d) Acid amide

48. Glycine is the name of an amino acid because of?
(a) Sweet taste (b) Bitter taste
(c) Shining appearance (d) Green colour

49. The complete reduction carboxylic acid results in the formation of.
(a) Alkyne (b) Alkene

(c) Alkane (d) Alcohol

50. The organic acid that can be made from ethanol is.
(a) Acetic acid (b) Formic acid
(c) Butanoic acid (d) Citric acid

51. Picric acid is.
(a) monocarboxylc acid (b) dicarboxylic acid
(c) dicarboxylic acid (d) none of these

52. The formula of palmitic acid.
(a) $C_{15}H_{31}COOH$ (b) $C_{13}H_{27}COOH$
(c) $C_{17}H_{33}COOH$ (d) $C_{17}H_{35}COOH$

53. Essential amino acids are?
(a) 5 (b) 10
(c) 15 (d) 20

54. The aliphatic monocarboxylic acids are obtained by the hydrolysis of.
(a) proteins and oild (b) fats and proteins
(c) fats and oils (d) all above

55. Which of the following is not a fatty acid?
(a) Propanoic acid (b) Acetic acid
(c) Phthalic acid (d) Butanoic acid

56. An acid with unpleasant smell.
(a) formic acid (b) acetic acid
(c) propionic acid (d) butyric acid

57. The basic hydrolysis of ethyl acetate produces?
(a) Ethanol (b) acetic acid
(c) ethanol and acetic acid (d) ethanol and sodium acetate

58. Carboxylic acid on reduction with HI / phosphorous yields.
(a) alkane (b) alcohols
(c) aldehydes (d) ketones

59. Which of the following is not an ester?
(a) amyl acetate (b) sodium butyrate
(c) isobutyle formate (d) octyl acetate

60. The reaction of carboxylic acids with alcohols in presence of cone. H_2SO_4 is called?
(a) Esterification (b) Neutralization
(c) Hydrolysis (d) Saponification

61. Which of the following has orange flavor?
(a) Isobutyl formate (b) octyl acetate
(c) ethyl butyrate (d) amyl lactate

62. Which of the following is not an amino acids?
(a) glumatic acid (b) lactic acid
(c) aspartic acids (d) Glycine

63. Among of the following which amino acids is present in cheese?
(a) lysine (b) alanine
(c) tyrosine (d) proline

64. amino succinic acid is also called——

(a) Lysine (b) aspartic acid
(c) Alanine (d) glutamic acid

65. Which of the following is an unsaturated?
(a) malonic acid (b) oxalic acid
(c) succinic acid (d) maleic acid

ANSWERS

1.	b	2.	d	3.	a	4.	d	5.	d
6.	d	7.	b	8.	c	9.	b	10.	d
11.	a	12.	d	13.	b	14.	d	15.	d
16.	c	17.	c	18.	b	19.	a	20.	a
21.	d	22.	e	23.	d	24.	a	25.	b
26.	b.	27.	d	28.	c.	29.	c.	30.	d.
31.	b.	32.	d.	33,	d.	34.	c.	35.	b.
36.	b.	37.	a.	38.	b.	39.	a.	40.	c.
41.	a.	42.	c.	43.	b.	44.	a.	45.	a.
46.	c.	47.	d.	48.	a.	49.	c.	50.	a.
51.	d.	52.	a.	53.	b.	54.	c.	55.	c.
56.	d.	57.	d.	58.	a.	59.	b.	60.	a.
61.	b.	62.	b.	63.	c.	64.	b.	65.	d.

32. ALDEHYDES AND KETONES

Aldehydes and ketones have carboxyl $\left(\rangle C = O\right)$ functional group. In aldehdye oxygen atom is attached to primary carbon atom whereas in ketones it is attached to secondary carbon atom. According to IUPAC aldehydes are known as alkenals and ketones are called as alkanones.

Preparation

These can be synthesizeda in the laboratory from alkenes, alkynes, arenes, and alcohols by reactions given following.

(a) Dehydrogenation

$$RCH_2OH \xrightarrow[300^\circ C]{Cu} RCHO + H_2O$$

$$CH_3CHOHCH_3 \xrightarrow[300^\circ C]{Cu} CH_3\overset{O}{\overset{\|}{C}}CH_3 + H_2O$$

(b) Oxidation

$$CH_3-\overset{OH}{\overset{|}{C}}H-CH_3 + CH_3-\overset{O}{\overset{\|}{C}}-CH_3 \xrightarrow{[(CH_3)_3CO]_3Al} CH_3-\overset{O}{\overset{\|}{C}}-CH_3 + CH_3CHOHCH_3$$

The reaction 'b' (oxidation) is also known as Oppenauer oxidation.

$$CH_3CH_2CH_2OH + [O] \xrightarrow[H_2SO_4]{K_2Cr_2O_7} CH_3CH_2CHO + H_2O$$

$$CH_3\overset{OH}{\overset{|}{C}}H-CH_3 + [O] \xrightarrow[H_2SO_4]{K_2Cr_2O_7} CH_3-\overset{O}{\overset{\|}{C}}-CH_3 + H_2O$$

(c) From Acids

$$Ca(CH_3COO)_2 \xrightarrow{Heat} CH_3-\overset{O}{\overset{\|}{C}}-CH_3 + CaCO_3$$

$$2CH_3COOH \xrightarrow[300^\circ C]{MnO} CH_3-\overset{O}{\overset{\|}{C}}-CH_3 + CO_2 + H_2O$$

$$HCOOH + CH_3COOH \xrightarrow[300^\circ C]{MnO} CH_3CHO + CO_2 + H_2O$$

$$(RCOO)_2Ca \xrightarrow{Pyrolysis} R\overset{O}{\overset{\|}{C}}R' + R\overset{O}{\overset{\|}{C}}R = R'\overset{O}{\overset{\|}{C}}R' + (R'COO)_2Ca$$

(d) Oxo Process

$$CH_2=CH_2 + CO + H_2 \xrightarrow{Co(CO)_4} CH_3CH_2CHO$$

$$2CH_3-CH=CH_2 + 2CO + 2H_2 \xrightarrow{Co(CO)_4} CH_3CH_2CHO + CH_3\underset{CH_3}{\underset{|}{C}}HCHO$$

(e) Hydrolysis of Gem-dihalides

$$CH_3CHBr_2 \xrightarrow[200^\circ C]{aq\ NaOH} CH_3CHO$$

(f) Rosenmund Reduction

$$CH_3COCl + H_2 \xrightarrow{Pd/BaSO_4} CH_3CHO + HCl$$

(g) Wacker Method

$$CH_2=CH_2 + PdCl_2 + H_2O \longrightarrow CH_3CHO + Pd + 2HCl$$

$$CH_3CH=CH_2 + PdCl_2 + H_2O \longrightarrow CH_3-\overset{O}{\overset{\|}{C}}-CH_3 + Pd + 2HCl$$

(h) Oxidation of Glycols

$$CH_2(OH)-CH_2(OH) + Pb(OOCCH_3)_4 \xrightarrow{CH_3COOH} 2HCHO + 2CH_3COOH + Pb(OOCCH_3)_2$$

(i) Stephen Reduction

This method is only specific for the synthesis of alcohols. Ketones cannot be prepared by using Stephen reduction.

Properties

Aldehydes and ketones have higher boiling points than alkenes due to more polarity and the dipole-dipole interactions But in the presence of hydrogen bonding alcohols have higher boiling points than these carbonyl compounds. Aldehydes and ketones are water soluble as they can form hydrogen bonds with the protons of OH groups.

1. Reduction

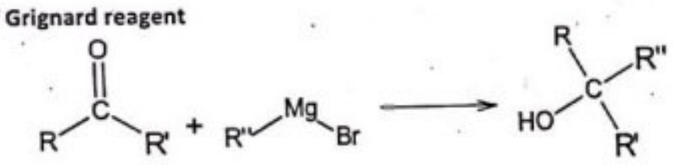
In Wolff–Kishner reduction, heating is carried out with hydrazine and alcoholic KOH to produce hydrocarbon. In Clemmensen reduction zinc amalgam and conc. HCl are catalyst.

Aldehyde or Ketone → Hydrocarbon

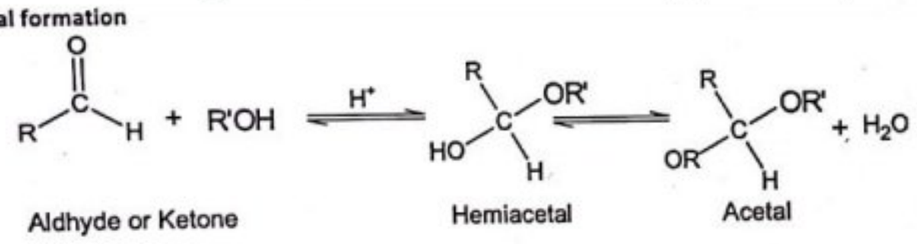
Aldehydes and ketones can be reduced to primary alcohols and secondary alcohols using catalytic hydrogenation over a metal catalyst and reduction with sodium borohydride or lithium aluminum hydride.

Aldehyde or Ketone — Alcohol

2. Addition of Grignard reagent

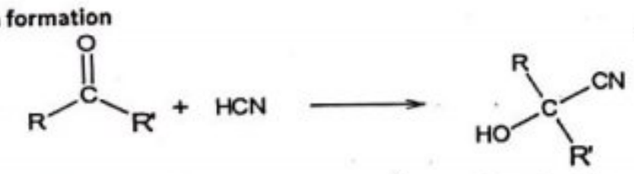


3. Acetal formation



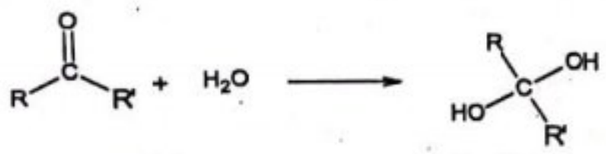
Aldhyde or Ketone — Hemiacetal — Acetal

4. Cyanohydrin formation

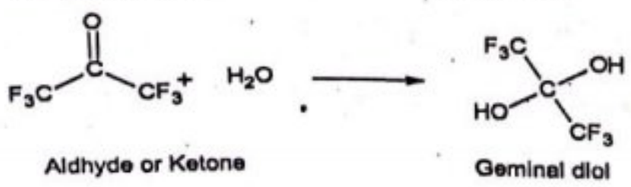


Aldhyde or Ketone — Cyanohydrin

5. Hydration

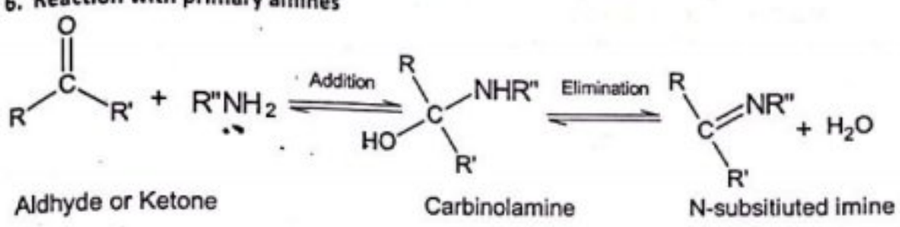


Aldhyde or Ketone — Geminal diol



Aldhyde or Ketone — Geminal diol

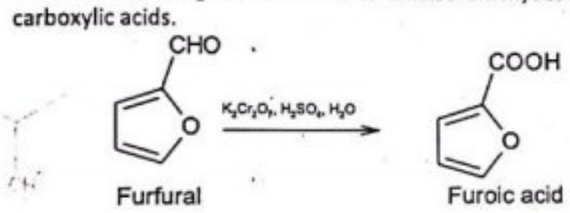
6. Reaction with primary amines



Aldhyde or Ketone — Carbinolamine — N-subsitiuted imine

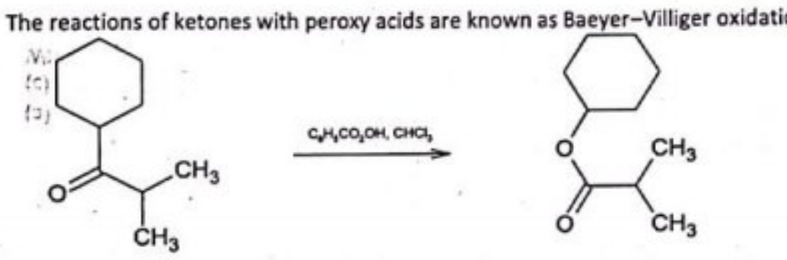
7. Oxidation of aldehydes and ketones

A number of reagents are used to oxidize aldehydes and these are readily oxidized to carboxylic acids.



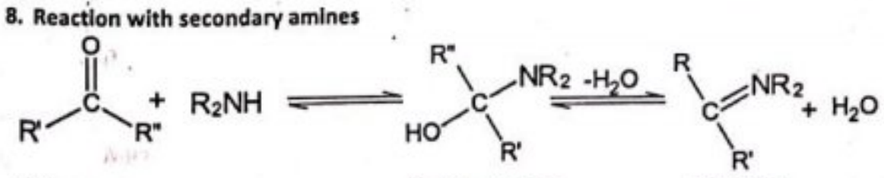
Furfural — Furoic acid

The reactions of ketones with peroxy acids are known as Baeyer–Villiger oxidations.



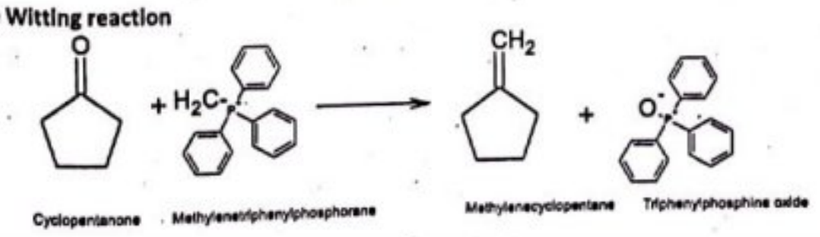
Cyclohexyl propryl ketone — Cyclohexyl propanate

8. Reaction with secondary amines



Aldhyde or Ketone — Carbinolamine — Enamine

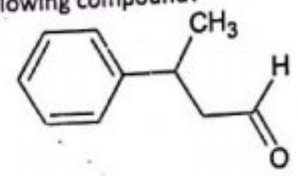
9. The Witting reaction



Cyclopentanone — Methylenetriphenylphosphorane — Methylenecyclopentane — Triphenylphosphine oxide

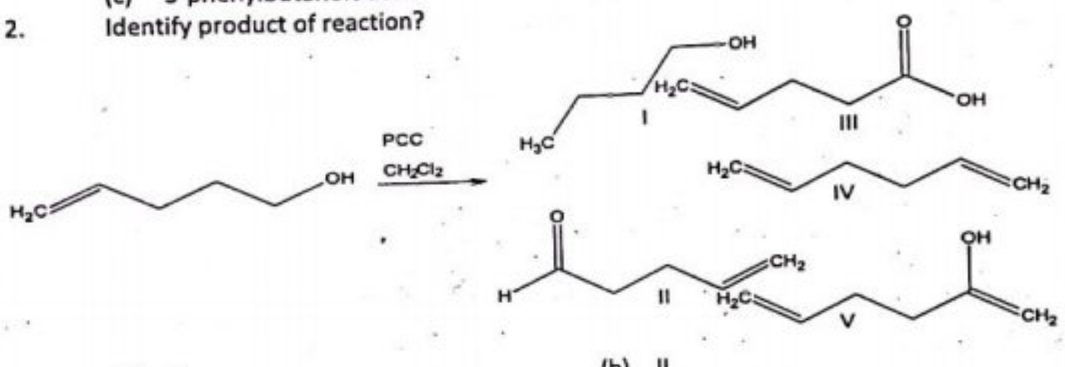
MULTIPLE CHOICE QUESTIONS

1. What is IUPAC name of following compound?



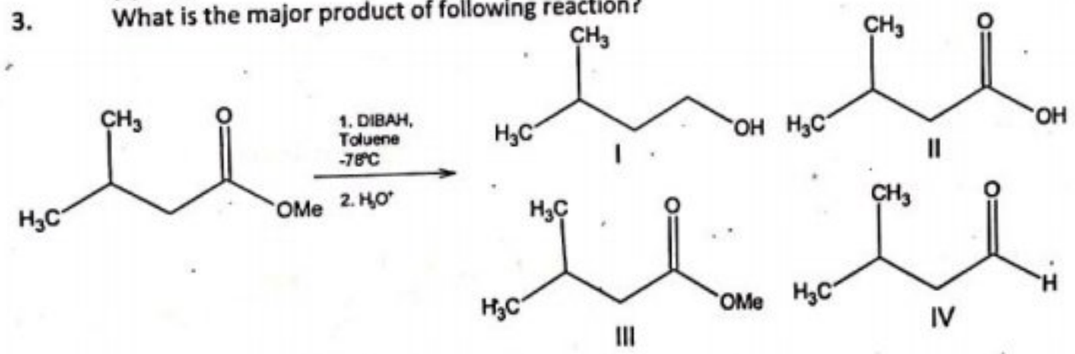
(a) 3-phenylbutanal
(b) 3-phenyl-1-butanone
(c) 3-phenylbutanoic acid
(d) 3-methyl-3-phenylpropanol

2. Identify product of reaction?



(a) I
(b) II
(c) III
(d) IV

3. What is the major product of following reaction?

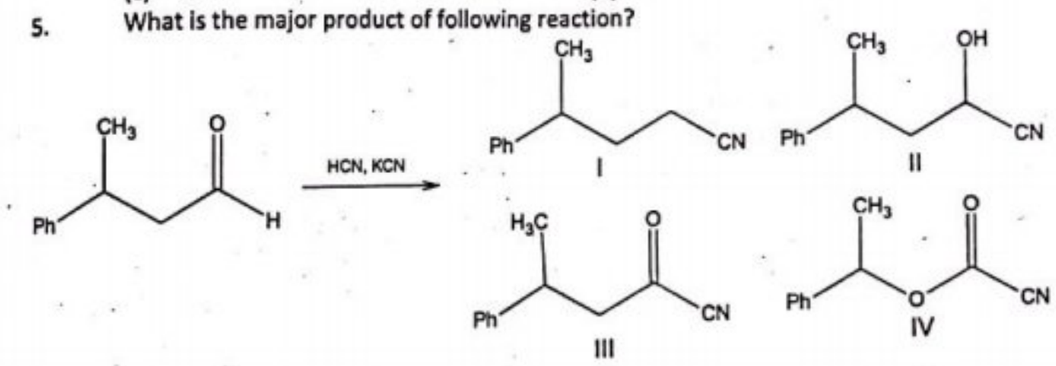


(a) I
(b) II
(c) III
(d) IV

4. What is the major product of following reaction?

(a) III
(b) I
(c) II
(d) IV

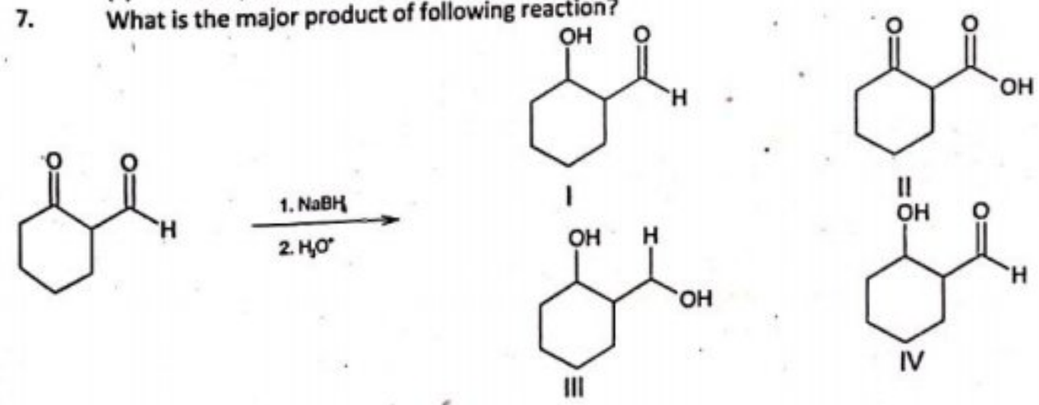
5. What is the major product of following reaction?



(a) III
(b) I
(c) II
(d) IV

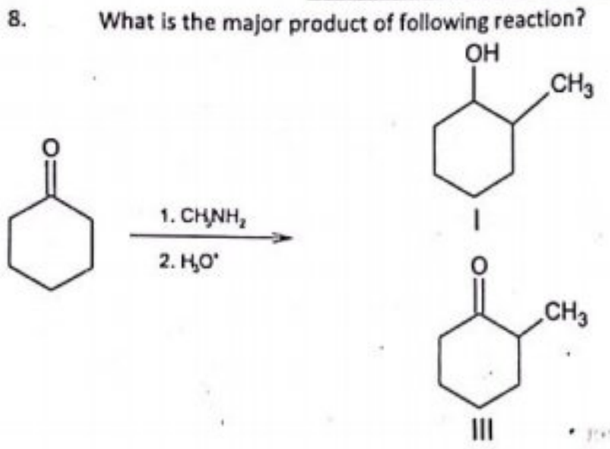
6. Ketone undergoes ———— reaction with HCN to form a cyanohydrin.
(a) Electrophilic addition
(b) Nucleophilic substitution
(c) Electrophilic substitution
(d) Nucleophilic addition

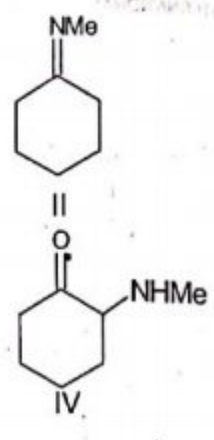
7. What is the major product of following reaction?



(a) III
(b) I
(c) II
(d) IV

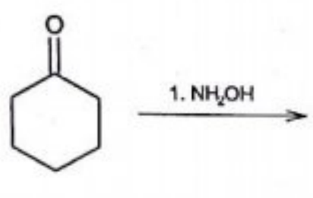
8. What is the major product of following reaction?

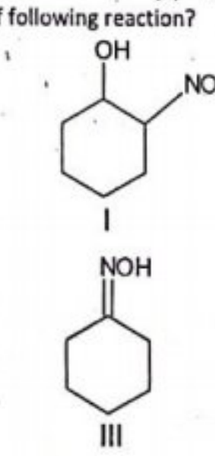


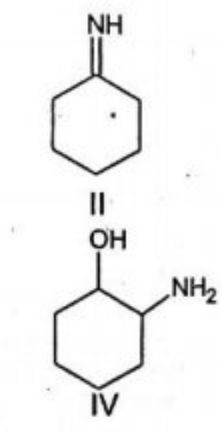


(a) III (b) I
(c) II (d) IV

9. What is the major product of following reaction?







(a) III (b) I
(c) II (d) IV

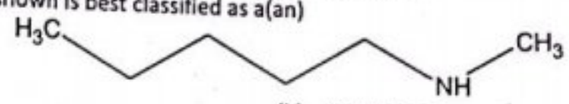
10. What is combinatorial chemistry?
(a) Synthesis of aldehydes and ketones.
(b) Synthesis of a large number of compounds at the same time, then testing them for a desired property.
(c) A combination of inorganic and organic chemistry.
(d) Mixing together random chemicals.

11. A Henry reaction an aliphatic nitro compound reacts with?
(a) Aldhyde (b) Carboxylic acid
(c) Ketone (d) Ether

12. In Robinson annulation a α,β-unsaturated ketone and a carbonyl group undergoes _____ prior to the aldol condensation.
(a) Michael reaction (b) Aldol reaction
(c) Nucleophilic conjugate addition (d) Organocatalysis

13. In the Guerbet reaction, an aldehyde, formed _____ from an alcohol, self-condenses to form the final product.
(a) Plant (b) In situ
(c) Reaction (d) Chemical

14. The compound shown is best classified as a(an)



(a) Enamine (b) Hydrazone
(c) Oxime (d) Imine

15. When a nucleophile encounters a ketone, the site of attack is
(a) Attacks terminal carbon
(b) The oxygen atom of the carbonyl
(c) Both the carbon and oxygen atoms, with equal probability
(d) The carbon atom of the carbonyl

16. Which of the following substance produce acetaldehyde on dry distillation?
(a) (CH3COO)2Ca (b) (HCOO)2Ca
(c) both (a) and (b) (d) none

17. Which of the following will have the highest boiling point?
(a) methanol (b) ethanol
(c) propanal (d) hexanone

18. Which of the following reaction is not shown by ketones?
(a) reaction with HCN
(b) reaction with NaHSO3
(c) reaction with 2 4 dinitrophenyl hydrazine
(d) reaction with Fehling solution

19. The carbon atom of carbonyl group is.
(a) sp hybridized (b) sp2 hybridized
(c) sp3 hybridized (d) dsp2 hybridized

20. Which of the following substances does not give iodoform test
(a) acetaldehyde (b) ethyl alcohol
(c) methyl alcohol (d) acetone

21. Formalin is _____ % solution of formaldehyde in water.
(a) 10% (b) 20%
(c) 40% (d) 60%

22. Which of the following aldehydes shows rapid reaction with sodium nitroprusside?
(a) formaldehyde (b) acetaldehyde
(c) benzaldehyde (d) acetone

23. Acetone reacts with HCN to form a cyanohydrin. It is an example of
(a) electronphilic addition (b) electrophilic substitution
(c) nucleophilic addition (d) nucleophilic substitution

24. Which of the following compounds will react with Tollens reagent?

(a) CH3-CHO (b) CH3-CH-CH3
(c) CH3-COOH (d) CH3-CO-CH2-CH3

25. Which of the following reactions may be associated with aldehyde and ketone?
(a) nucleophile addition (b) polymerization
(c) oxidation (d) all of the above

26. Cannizzaros reaction is not given by.
(a) formaldehyde (b) acetaldehyde
(c) benzaldehyde (d) trimethyl acetaldehyde

27. Which of the following reagents will react with both aldehydes and ketones?
(a) Grignard reagent (b) Tollens reagent
(c) Fehlings reagent (d) Benedicts reagent

28. Ketones are comparatively less reactive than aldehdye. It is due to
(a) alkyl groups are electron donating (b) steric hindrance
(c) both (a) and (b) (d) none

29. Which of the following do not give aldol condensation reactions?
(a) formaldehyde (b) acetaldehyde
(c) diemthyl ketone (d) propionaldehyde

30. Which of the following is not a use of formaldehyde?
(a) in silvery mirror (b) in making medicine urotropine
(c) in making throat lozenges (d) in making acetic acid

31. Formaldehyde and lactose are combined to produce throat lozenges named as.
(a) formamint (b) lactomint
(c) aldomint (d) formalactose

32. Which of the following is not a use of acetaldehyde?
(a) formation of phenolic resins (b) formation of mirror
(c) antiseptic inhalant (d) formation of throat lozenges

33. Formula of haloform is.
(a)HCOX (b)CX4 (c)CHX3 (d)CH3X

34. Formaldehyde condenses with phenol in the presence of dilute H2SO4 to yield.
(a) Nylon 66 (b) urotropine
(c) Aniline formaldehyde plastic (d) Bakelite

35. Formalin consists of mixture of formaldehyde methyl alcohol and water. Percentage of water in it is.
(a) 60% (b) 50%
(c) 52% (d) 8%

36. Which of the following will not give addition reaction with NaHSO3.
(a) HCHO (b) CH3CHO
(c) CH3-CH2-CHO (d) None of the above

37. On heating aldehydes with Fehlings solution we get a precipitate whose colour is.
(a) pink (b) black
(c) yellow (d) brick red

38. Which of the following compounds has the empirical formula CH2O and reacts with sodium hydroxide?
(a) carbonic acid (b) ethanol
(c) acetic acid (d) methanoic acid

39. Aldehyde and ketone have same general formula for homologous series.

(a) CnH2nO2n (b) CnH2n
(c) CnH2nO (d) CnH2nOn+1

40. Oxidation of primary alcohol gives.
(a) ketone (b) Aldehyde
(c) Alkene then – COOH (d) Ester

41. Ethanal is prepared industrially by air oxidation of ethylene using palladium chloride as catalyst and _____ as promoter.
(a) PdCl2 (b) Cu2Cl2
(c) CuCl2 (d) PbCl2

42. Ncleophilic addition reactions are catalysed.
(a) Acid (b) base
(c) Both a and b (d) None

43. Acetaldehyele cyanohydrin on acid hydrolysis yields.
(a) Tartaric acid (b) Propanoic acid
(c) Lactic acid (d) Valeric acid

44. Acetal on acid hydrolysis generates.
(a) Alcohol (b) Ketone
(c) Both a & b (d) None of the above

45. Which one exhibits aldol condensation.
(a) HCHO (b) C6H5CHO
(c) Cl3CCHO (d) CH3COCH3

46. For aldol condensation the conditions necessary?
(a) -C (b) -H
(c) Basic medium (d) All

47. Aldehydes are reduced to?
(a) P alcohol (b) S alcohol
(c) T alcohol (d) Not possible

48. Tetrahydroborate ion is the source of?
(a) proton (b) H+
(c) both a & b (d) H-

49. Which of the following is a symmetrical ketone?
(a) 3 – hexanone (b) acetone
(c) butanone (d) 2-pentanone

50. Dry distillation of calcium acetate results in the formation of?
(a) formaldehyde (b) acetaldehyde
(c) methane (d) acetone

ANSWERS

1.a	2.b	3.d	4.a	5.c	6.d	7.a	8.c	9.a	10.b
11.a	12.a	13.b	14.d	15.d	16.c	17.b	18.d	19.b	20.c
21.c	22.d	23.c	24.a	25.d	26.b	27.a	28.c	29.a	30.d
31.a	32.d	33.c	34.d	35.c	36.c	37.d	38.c	39.c	40.b
41.c	42.c	43.c	44.c	45.d	46.d	47.a	48.d	49.b	50.d

33. ETHERS AND ESTERS

Ethers: The general formula of ethers is R-O-R. The monovalent –OR is known as alkoxy group. e.g.
$-OCH_3$ (Methoxy) $-OC_2H_5$ (Ethoxy) $-OC_3H_7$ (n-Propoxy)

IUPAC names:

In IUPAC system ethers are known as alkoxy hydrocarbons. Larger alkyl group is taken as a parent name.

Functional isomerism and metamerism are common type of isomerism found in ethers.

Examples of functional isomerism:

CH_3OCH_3 (Dimethyl ethane) and C_2H_5OH (Ethyl alcohol)

Examples of metamerism:

$C_2H_5OC_2H_5$	$CH_3OC_3H_7$	$CH_3OCH(CH_3)_2$
Diethyl ether	Methyl n-propyl ether	Methyl isopropyl ether

Preparation:

(a) Dehydration of alcohols:

Dehydration of alcohols is carried out at 140 ºC

$$C_2H_5OH + H_2SO_4 \longrightarrow C_2H_5HSO_4 + H_2O$$

$$C_2H_5HSO_4 + C_2H_5OH \longrightarrow C_2H_5OC_2H_5 + H_2SO_4$$

$$2C_2H_5OH \xrightarrow[250°C]{Al_2O_3} C_2H_5OC_2H_5 + H_2O$$

(b) Williamson's Synthesis

$$C_2H_5ONa + C_2H_5I \longrightarrow C_2H_5OC_2H_5 + NaI$$

(c) From Grignard Reagent

$$CH_3OCH_2Cl + C_2H_5MgBr \longrightarrow CH_3OCH_2CH_2CH_3 + Mg(Br)Cl$$

(d) By Heating Alkyl Halide with Silver Oxide

$$2C_2H_5I + Ag_2O \longrightarrow C_2H_5OC_2H_5 + 2AgI$$

Properties

Ethers are inert or unreactive substances. They are basic in nature.

Reactions of Alkyl Groups

(a) Halogenation

$$CH_3CH_2OCH_2CH_3 + 2Cl_2 \xrightarrow{Dark} CH_3\underset{\displaystyle Cl}{\underset{|}{C}}HO\underset{\displaystyle Cl}{\underset{|}{C}}HCH_3$$

$$Cl_2 + CH_3CH_2OCH_2CH_3 \xrightarrow{Light} CCl_3CCl_2-O-CCl_2CCl_3$$

Peroxide Formation

$$CH_3CH_2OCH_2CH_3 \xrightarrow[Light]{O_2} CH_3\underset{\displaystyle OH}{\underset{|}{C}}HO\underset{\displaystyle OH}{\underset{|}{O}}CHCH_3$$

The detection of peroxide in ethers can be carried by shaking $FeSO_4$ solution with ether and then adding few drops of potassium thiocyanate solution. The appearance of red color indicates presence of peroxides in ethers. The peroxides oxidizes Fe^{2+} to Fe^{3+} ions in $FeSO_4$. Fe^{3+} gives red color with CNS^- ions.

Reactions of Etheral oxygen

(i) Formation of Oxonium Salts

$$C_2H_5OC_2H_5 + HCl \longrightarrow [(C_2H_5)_2OH]^+ + Cl^-$$

Reactions of C—O Linkage

(a) Hydrolysis

$$C_2H_5OC_2H_5 + H_2O \xrightarrow{H_2SO_4} 2C_2H_5OH$$

(b) Reaction with Conc. H_2SO_4

$$C_2H_5OC_2H_5 + H_2SO_4 \longrightarrow C_2H_5-HSO_4 + C_2H_5OH$$

$$C_2H_5OH + H_2SO_4 \longrightarrow C_2H_5HSO_4 + H_2O$$

(c) Reaction with PCl_5

$$C_2H_5O-OC_2H_5 + PCl_5 \longrightarrow 2C_2H_5Cl + POCl_3$$

$$C_3H_7OC_2H_5 + PCl_5 \longrightarrow C_3H_7Cl + C_2H_5Cl + POCl_3$$

(d) Cleavage by Acids

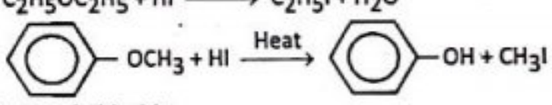
Order:

HI > HBr > HCl

$$C_2H_5OC_2H_5 + HI \xrightarrow{Cold} C_2H_5OH + C_2H_5I$$

$$CH_3OC_2H_5 + HI \xrightarrow{Cold} C_2H_5OH + CH_3I$$

$$C_2H_5OC_2H_5 + HI \xrightarrow{Heat} C_2H_5I + H_2O$$



(e) Reaction with Acetyl Chloride

$$C_2H_5OC_2H_5 + CH_3COCl \xrightarrow[Heat]{Anly.ZnCl_2} C_2H_5Cl + CH_3COOC_2H_5$$

$$C_2H_5OC_2H_5 + (CH_3CO_2)_2O \xrightarrow[Heat]{Anly.ZnCl_2} 2CH_3COOC_2H_5$$

(e) Combustion

$$C_2H_5OC_2H_5 + 6O_2 \longrightarrow 4CO_2 + 5H_2O$$

(f) Oxidation

$$CH_3CH_2OCH_2CH_3 \xrightarrow[-H_2O]{[O]} 2CH_3CHO \xrightarrow{[O]} CH_3COOH$$

(g) Dehydration

$$C_2H_5OC_2H_5 \xrightarrow[400°C]{Al_2O_3} 2CH_2=CH_2 + H_2O$$

Epoxides (Oxiranes)

(i) $H_2O + CH_2(O)CH_2 \xrightarrow{\overset{+}{H}} CH_2(OH)-CH_2(OH)$

(ii) $HBr + CH_2(O)CH_2 \longrightarrow CH_2(Br)-CH_2(OH)$

(iii) $C_2H_4\overset{-+}{O}Na + CH_2(O)CH_2 \longrightarrow C_2H_5OCH_2CH_2OH$

(iv) $HCN + CH_2(O)CH_2 \longrightarrow CNCH_2CH_2OH$

Organic Esters

Preparation

(a) Direct Esterification

$$CH_3COOH + HOC_2H_5 \overset{\overset{+}{H}}{\rightleftharpoons} CH_3COOC_2H_5 + H_2O$$

(b) From Acid Chlorides

$$CH_3COCl + C_2H_5OH \xrightarrow{\text{Pyridine}} CH_3COOC_2H_5 + HCl$$

(c) From Anhydrides

$$(CH_3CO)_2O + C_2H_5OH \xrightarrow{\text{Anhy } ZnCl_2} CH_3COOC_2H_5 + CH_3COCH$$

(d) From Salts of Carboxylic Acid

$$CH_3COOAg + C_2H_5I \xrightarrow{C_2H_5OH} CH_3COOC_2H_5 + AgI$$

(e) From Alkyl Cyanides

$$CH_3CN + C_2H_5OH + H_2O \xrightarrow{\overset{+}{H}} CH_3COOC_2H_5 + NH_3$$

(f) From Tischenko Reaction

$$CH_3CHO + CH_3CHO \longrightarrow CH_3COOC_2H_5$$

This reaction is based on Cannizzero's reaction.

(g) From Esterification of Carboxylic Acids

$$CH_3COOH_{(vapor)} + C_2H_5OH_{(vapor)} \xrightarrow[150-250^\circ C]{\text{Silica gel}} CH_3COOC_2H_5 + H_2O$$

(h) From Diazomethane

$$CH_3COOH + CH_2Na \xrightarrow{\text{Ether}} CH_3COOCH_3 + N_2$$

(i) Claisen Condensation

It is the condensation of an ester with aldehyde, ketone or ester by using sodium ethoxide to give β-keo ester.

$$2CH_3COOC_2H_5 \xrightarrow{C_2H_5-ONa} CH_3COCH_2CO_2C_2H_5 + EtOHC$$

MULTIPLE CHOICE QUESTIONS

1. The detection of peroxide in ethers can be carried by shaking _____ solution with ether and then adding few drops of _____ solution.
   (a) $FeCl_2$, potassium thiocyanate (b) $FeCl_3$, potassium thiocyanate
   (c) $FeSO_4$, potassium thiocyanate (d) $FeCl_2$, potassium cyanate
2. Select correct order of effectiveness for cleavage of etheral bond?
   (a) HI < HBr < HCl < HF (b) HI > HBr > HCl > HF
   (c) HI > HBr < HCl > HF (d) HI < HBr > HCl > HF
3. In Claisen condensation, an ester reacts with aldehyde, ketone or ester by using sodium ethoxide to give _____.
   (a) α-keo ester (b) α, β-keo ester
   (c) δ-keo ester (d) β-keo ester
4. Tischenko Reaction is used to prepare _____ from aldyhde.
   (a) Ester (b) Ether
   (c) Carboxylic acid (d) Amine
5. Select correct product?

$$H_2O + CH_2(O)CH_2 \xrightarrow{\overset{+}{H}} ?$$

   (a) $C_2H_5OCH_2CH_2OH$ (b) $CH_3COOC_2H_5 + H_2O$
   (c) $CH_2(Br)-CH_2(OH)$ (d) $CH_2(OH)-CH_2(OH)$
6. Select correct product?

$$C_2H_5OC_2H_5 \xrightarrow[400^\circ C]{Al_2O_3} ?$$

   (a) $CH_2(OH)-CH_2(OH)$ (b) $CH_2=CH_2 + H_2O$
   (c) $C_2H_5OCH_2CH_2OH$ (d) $CH_3COOC_2H_5 + H_2O$
7. Select appropriate choice?

$$CH_3COCl + C_2H_5OH \xrightarrow{\text{Pyridine}} ?$$

   (a) $CH_2(OH)-CH_2(OH)$ (b) $CH_2=CH_2 + H_2O$
   (c) $C_2H_5OCH_2CH_2OH$ (d) $CH_3COOC_2H_5 + HCl$

8. Select appropriate choice?

$$CH_3COOH + HOC_2H_5 \overset{\overset{+}{H}}{\rightleftharpoons} ?$$

(a) $CH_2(OH)-CH_2(OH)$ (b) $CH_2=CH_2 + H_2O$

(c) $C_2H_5OCH_2CH_2OH$ (d) $CH_3COOC_2H_5 + H_2O$

9. How you can obtain required product?

$$? \xrightarrow{\text{Anhy } ZnCl_2} CH_3COOC_2H_5 + CH_3COCH$$

(a) $CH_3COOH + HOC_2H_5$ (b) $CH_3COCl + C_2H_5OH$

(c) $(CH_3CO)_2O + C_2H_5OH$ (d) $CH_3COOAg + C_2H_5I$

10. What is missing in the following reaction?

$$CH_3CH_2OCH_2CH_3 \xrightarrow[-H_2O]{[O]} ? \xrightarrow{[O]} CH_3COOH$$

(a) $2CH_3CHO$ (b) $2CH_2=CH_2$

(c) C_2H_5OH (d) $(CH_3CO)_2O$

11. Fe^{3+} gives ——— color with CNS^- ions.

(a) Yellow (b) Red

(c) Brown (d) Blue

12. The following reaction is known as?

$C_2H_5ONa + C_2H_5I \longrightarrow C_2H_5OC_2H_5 + NaI$

(a) Tischenko Reaction (b) Claisen Condensation

(c) Diels-Alder Reaction (d) Williamson's Synthesis

13. Which one of the following is termed as benzul alcohol?

(a) C_6H_5OH (b) $C_6H_5CH(OH)_2$

(c) $C_6H_5CH_2OH$ (d) C_6H_5COOH

14. Which one of the following is also known as lactic acid?

(a) 3-Hydroxy propanoic acid (b) 2-Hydroxy propanoic acid

(c) 2-hydroxy butanoic acid (d) 3-hydroxy butanoic acid

15. Which one of the following is also known as tartaric acid?

(a) 2 3-dihydroxy butance 1 4 -dioic acid

(b) 2 3 -dihydroxy butanedioic acid

(c) 2 3 -dihydroxy butanioc acid

(d) 2 2 -dihydroxy butanoic acid

16. Water gas heated at 450c and 200 atm pressure in the presence of $ZnO+Cr_2O_3$ will produce.

(a) methanol (b) methanol

(c) carbonic acid (d) methane

17. The residue obtained after the crystallization of sugar from concentrated sugar cane juice is called.

(a) Mother liquor (b) Filterate

(c) Extract (d) Molasses

18. The formula of starch is.

(a) $C_{12}H_{22}O_{11}$ (b) $C_6H_{10}O_5$

(c) $(C_6H_{10}O_5)n$ (d) $C_6H_{12}O_6$

19. The process of fermentation of starch involve many enzymes the sequence of enzymes used are.

(a) Diastase-maltase-zymase (b) Zymase-maltase-diastase

(c) Maltase-diastase-zymase (d) Diastase-zymase-maltase

20. The rectified spirit contains.

(a) 12% alcohol (b) 90% alcohol

(c) 95% alcohol (d) 100% alcohol

21. $K_2Cr_2O_7/H_2SO_4$ generate.

(a) Oxygen (b) Hydrogen

(c) Nascent oxygen[O] (d) Nascent hydrogen[H]

22. The oxidation of isopropyl alcohol will yield?

(a) propane (b) Propanol

(c) Propanone (d) Propanoic acid

23. Which alcohol will undergo elimination reaction to give alkene in the presence of acidic potassium dichromate?

(a) Primary alcohol (b) Secondary alcohol

(c) Tertiary alcohol (d) All of above

24. The distinction test for primary secondary and tertiary alcohol required to react each of them is.

(a) Cone. HCl and anhydrous $SOCl_2$

(b) Cone. HCl and anhydrous $CaCl_2$

(c) Cone. HCl and anhydrous PCl_2

(d) Cone. HCl and anhydrous $ZnCl_2$

25. Which compound is also known by the name of carbolic acid?

(a) C_2H_2OH (b) H_2CO_3

(c) C_6H_5OH (d) H_3PO_3

26. The given dissociation constant (Ka) value 1.3x10-10 is of?

(a) Alcohol (b) Acetic acid

(c) Water (d) Phenol

27. Heating phenol with Zn will yield?

(a) Benzene (b) Benzoic acid

(c) Phenoxide (d) Cyclohexane

28. When phenol is heated with concentrated nitric acid the product is.

(a) Picric acid (b) o-nitrophenol

(c) 1 3 5 -trinitro benzene (d) p-nitrophenol

29. Treating phenol with formaldehyde in the presence of dilute base forms Bakelite. The process involved is?

(a) oxidation (b) elimination

(c) condensation polymerization (d) additional polymertization

30. Which compound shows hydrogen bonding?

(a) C_2H_6 (b) C_2H_5Cl

(c) CH_3OCH_3 (d) C_2H_5O

31. Ethanol can be converted into ethanoic acid by?
(a) Hydrogenation (b) Hydration
(c) Oxidation (d) Fermentation

32. Methyl alcohol is not used.
(a) As a solvent (b) As an antifreezing agent
(c) As a substitute for petrol (d) For denaturing of ethyl alcohol

33. Methanol can be obtained from?
(a) water gas (b) destructive distillation of wood
(c) methane (d) all

34. An alcohol which can be prepared by fermentation is
(a) CH_3OH (b) C_3H_7OH
(c) CH_3-CH_2-OH (d) C_6H_5OH

35. Absolute alcohol is obtained when rectified spirit is treated with?
(a) $Ca(OH)_2$ (b) $CaCO_3$
(c) $CaCl_2$ (d) CaO

36. When alcohol reacts with phosphorous halides it geives.
(a) alkyl halides (b) alkyl amine
(c) alkanes (d) alkynes

37. Phenol was isolated by Runge from?
(a) vegetable oil (b) coaltar
(c) wood (d) none of these

38. Which one of the following compound does not have - OH group.
(a) ethylene glycol (b) glycerol
(c) picric acid (d) ethyl acetate

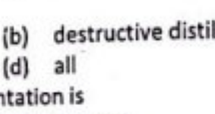
39. The hydrogenation of phenol in the presence of Ni and heat gives
(a) cyclohexane (b) n – hexane
(c) 1 – hexanol (d) cyclohexanol

40. Ethers show functional group isomerism with?
(a) aldehydes (b) ketones
(c) alcohols (d) carboxylic acid

41. Ethanol and methanol can be distinguished by a.
(a) Iodoform test (b) Lucas test
(c) Benedicts test (d) Tollens test

42. Which one of the following alcohol has greater boiling point?
(a) ethanol (b) ethylene glaycol
(c) glycerol (d) methanol

43. What is the name of the following compound?



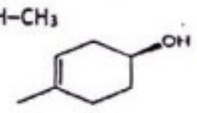
(a) Ethyl cyclohexyl ether
(b) Hexyl propyl ether
(c) 1-Ethoxycyclohexane
(d) Cyclohexyl propyl ether

44. Alcohols have higher boiling points than alkanes of comparable molecular weight because of?

(a) hydrogen bonding. (b) diaxial interactions.
(c) steric strain. (d) hyperconjugation

45. Which of the following has the highest boiling point?
(a) CH_3-O-CH_3 (b) CH_3-CH_2-OH
(c) $CH_3-CH_2-CH_3$ (d) $CH_2=CH-CH_3$

46. What is the correct name for the following compound?



(a) *R*)-1-methyl-1-cyclohexen-4-ol
(b) *S*)-1-methyl-2-cyclohexen-4-o
(c) (*R*)-4-methyl-4-cyclohexen-1-ol
(d) (*S*)-4-methyl-3-cyclohexen-1-ol

47. A chemist attempted unsuccessfully to form iodoethane from ethanol using NaI. Why did the reaction fail?
(a) I^- was not a good enough nucleophile.
(b) A secondary or tertiary alcohol was needed.
(c) ^-OH is a poor leaving group.
(d) Na^+ was a poor counterion

48. Which product is obtained when (*R*)-2-butanol is treated with *p*-toluenesulfonyl chloride?
(a) (*R*)-2-Butyl tosylate (b) (*S*)-2-Butyl tosylate
(c) *dl*-2-Butyl tosylate (d) *dl*-2-Butanol

49. What is the leaving group in an S_N2 displacement of an alkyl tosylate with sodium iodide?
(a) *p*-toluenesulfonic acid (b) toluenesulfonate anion
(c) sulfate anion (d) acetate anion

50. Which reagent would be best for the conversion of *tert*-butanol into *tert*-butyl bromide?
(a)PBr_3 (b)HBr (c)NaBr (d)Br_2, NaOH

ANSWERS

1.	c	2.	b	3.	d	4.	a	5.	d
6.	b	7.	d	8.	b	9.	c	10.	a
11.	b	12.	d	13.	c	14.	b	15.	a
16.	b	17.	d	18.	c	19.	a	20.	c
21.	c	22.	c	23.	c	24.	d	25.	c
26.	d.	27.	a	28.	a.	29.	a.	30.	d.
31.	c.	32.	c.	33,	d.	34.	c.	35.	d.
36.	a.	37.	b.	38.	d.	39.	d.	40.	c.
41.	a.	42.	c.	43.	d.	44.	a.	45.	b.
46.	d.	47.	c.	48.	a.	49.	b.	50.	b.

34. SPECTROSCOPY

Spectroscopy:

The interaction of electromagnetic radiation with matter/sample to obtain information about it is called spectroscopy.

Spectrum:

The information obtained about the sample under investigation is in the form of spectrum, a spectrum is a plot of intensity of light/energy detected versus wavelength, frequency or wavenumber. it can be used to get information about structure, geometry and interaction of molecules, atomic and molecular energy levels and nature of chemical bonds between atoms and molecules.

What is electromagnetic radiation?

The electromagnetic radiation is classified into cosmic rays, gamma rays, X-rays, ultra violet light, visible light, infrared, microwaves and radio waves. These have different wavelengths and act differently giving different types of information about the samples. The wavelength is increasing from cosmic rays to radio waves and their energy decreases in the opposite direction. There are different types of instruments used for spectroscopic analyses according to the type of spectroscopy used. Simply, in spectroscopy a light source is required which can be laser, ion source or radiation source, and a device to detect the changes in the light after interaction.

A reasonable change in energy occurs when matter absorbs radiation. The sample is destroyed when it absorbs the photon and the relationship between energy of photon frequency, wavelength and wavenumber is given bellow

$$E=hv=hc\lambda=hcv$$

When an atom moves from excited to ground state it emits energy and energy is absorbed when it moves from ground to excited state. This emission and absorption occur in form of discrete units of energy called quanta. When electromagnetic radiations interact with sample then the scattering (elastic or inelastic), reflection, diffraction and polarization can take place.

Type of spectroscopy	Wavelength Range λ[m]	Type of Quantum Transition
Gamma-ray emission	$0.05\text{-}15\times 10^{-9}$	Nuclear
X-Ray absorption, emission, fluorescence, and diffraction	$0.001\text{-}10\times 10^{-9}$	- Inner electron (e- of the K-, L-, or M-shell)
Ultraviolet visible absorption, emission, and fluorescence	$180\text{-}780\times 10^{-9}$	Bonding electrons (e- of the outer shells)
Infrared absorption and Raman scattering	$0.78\text{-}300\times 10^{-6}$	Rotation/vibration of molecules
Microwave absorption	$0.75\text{-}3.75\times 10^{-3}$	Rotation of molecules
Electron spin resonance	30×10^{-3}	Spin of electrons in a magnetic field
Nuclear magnetic resonance	0.6-10	Spin of nuclei in a magnetic field

Table: Spectroscopic methods based on electromagnetic radiation.

Different types of spectroscopy are available. In the following sections, well known types of spectroscopy are discussed:

UV/Visible spectroscopy:

In this technique the radiation associated with pi bonded electron transition (π-π^*) and (n- π^*) within a molecule in the region of 180-780 nm is studied. The bonding electrons absorb photon and make transition from ground state to one of many vibrational and rotational energy levels which result in the shift of various absorption lines.

Instrumentation

a) Photometers

For visible region some photometers are designed. Mostly have ranges that proceed from 180-200 nm in UV through Visible region to 800 nm. Very few cover a wide range from UV/VIS to 3000 nm. No doubt they are low cost, simple, portable and easy to handle but they have low versatility and are unable to generate whole spectra and may or may not have single or double reference beams.

b) Source

The better choice is to use a Deuterium lamp as a source. But commonly Tungsten/Halogen lamps are used.

c) Monochromator

Mostly diffraction gratings are used in UV/Visible instrument.

d) Detectors

Commonly photo diode detectors are used to measure the extinction in UV-VIS.

Qualitative applications

UV-VIS spectroscopy cannot absolutely identify the species but comparison of the spectral plot with the libraries of the data can be estimated by screening a substance.

The saturated organic compounds having hetero atoms such as O, N, S, Cl, Br, have nonbonding electrons which may excite after interaction with the radiation.

Chromophore: The unsaturated organic functional groups which can absorb in the ultraviolet or visible region are called chromophore. They can be isolated or conjugated groups and presence of pi-bonds in chromophores lead to the bathochromic effect (red-shift; absorbance at relatively longer wavelength).

Quantitative applications: In order to obtain linearity between energy and concentration, highly monochromatic radiation should be used and the influence of the solute should be negligible. In order to achieve reliable results, a reference standard is required.

Infrared Absorption Spectroscopy (IR): Any molecule possessing a dipole moment is IR-active. IR is not useful in determining quantitative measurements but is considered as a powerful tool for qualitative analysis because most of the molecular species absorb IR radiation with the exception of few homo-nuclear molecules such as O2, N2, Cl2, etc. do not have a net change in dipole moment. The technique provides good information of the functional groups present within a compound.

IR active vibrations: In a three atomic molecule (e.g. H_2O), the incident light causes the terminal atomic nuclei to vibrate around the centrally located atom. But only certain vibration leads to a net change the dipole. In IR- spectroscopy, the bending and asymmetrical stretching vibrations are relevant whereas the symmetrical stretching vibrations are not because of no net change in the dipole moment.

Asymmetrical Stretching Vibration: A change in the interatomic distance along the bond axis between the bonded atoms resulting in the shortening of the interatomic bond.

Bending vibration: This also called deformation and include a change in the angle between two bonds. These are of four types including scissoring, rocking, twisting, wagging.

IR is considered most useful technique for the identification of pure organic and inorganic compounds. Except chiral molecules in the crystalline state, each molecular species has a unique infrared absorption spectrum. The technique is less favorable for the quantitative analysis because of its narrow peaks that usually lead to deviations from Lambert-Beer's Law.

Instrumentation: A two-beam IR spectrometer utilizes a silicon-carbid or tungsten lamp that irradiates equally strong IR-beams through a sample compartment and a parallel aligned reference compartment. A photometer detects the differences in incoming radiation and sends it with the help of a monochromator, to the detector. A readout device ultimately displays the resultant spectra as a plot of wavenumbers versus transmittance. Fourier-Transform IR-spectrometers utilize are based on the Michelson interferometer.

Qualitative analysis: Relatively simple compounds give sharp peaks which are useful for the identification of the functional groups and a fingerprinting region (<1500 cm^{-1}). The identification of the functional groups in a molecule is usually not sufficient for the identification of a compound. It is common practice in the analysis of the IR spectral data to match the entire spectrum with an electronic library of different compounds.

Quantitative analysis: The peak-broadening takes place in the IR spectra due to the interaction of the rotational and stretching vibrations which does not allow the use of this technique for the absolute quantitative analysis of the compounds.

Raman spectroscopy:

Raman spectroscopy is based on a scattering phenomenon. Scattering results from interaction between the photons and molecules. The process is often described by use of a virtual electronic state, as shown in **Figure 12.1**. Most photons colliding with the molecules do not change their energy after collision. These collisions are called elastic collisions and the scattering in this case is known as Rayleigh scattering. Rayleigh scattering consists of photons which have the same energy as the incident photons. On the other hand, as a result of inelastic collision, collisions after which the incident photons change their energy, the incident photons deliver or receive a quantum of vibrational energy to the molecules. This interaction leads to Raman scattering. There are two types of Raman scattering. In Stokes scattering, the energy of the incident photons is decreased and the molecules initially occupying a lower vibrational energy state are promoted to higher vibrational energy states. In anti-Stokes scattering, the energy of the incident photons is increased and the molecules which were in a higher vibrational energy state end up in a lower vibrational energy state. These changes in the energy of the molecule occur due to the transition between one vibrational energy level to another. As molecules are generally in the ground vibrational state, Stokes Raman scattering most commonly occurs and is usually measured. The Raman shift of the photon energy is a measure of the energy of vibration of the molecule. A complex molecule will have many vibrational modes, and the intensity of the scattered radiation *versus* Raman shift constitutes a Raman spectrum which is distinctive for each individual substance. Therefore, the analysis of the Raman spectra can lead to the identification of a substance and can be used to study its structure.

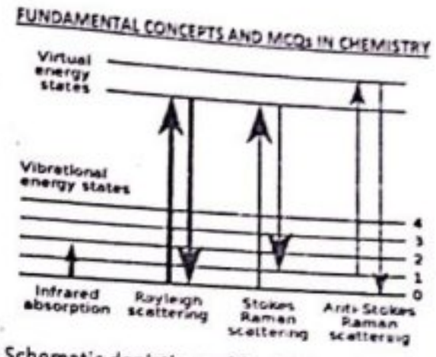


Figure The Schematic depictions of Rayleigh and Raman scattering.

Qualitative analysis: The measurement of the structural vibrations of nuclei and electrons alike, enables the Raman spectroscopy to be a powerful complementary tool to IR-spectroscopy. The IR-spectroscopy detects the molecules involving a net change in the dipole moment, whereas Raman spectroscopy on the basis of the polarizibility.

Quantitative analysis: Similar to IR-spectroscopy, the intensities of the Raman spectral features can be utilized for the quantitative analysis by comparing it to a series of standardized reference samples.

Nuclear Magnetic Resonance (NMR): Rotation of nuclei around their axis implies an angular momentum {p = h/(2×p)} of the nucleus and a magnetic momentum (m) of the circulating electrons. Nuclei with spin quantum number of zero (ms = 0) have no nuclear momentum and can't be observed by NMR. The isotopes with ms ³ ½ are NMR active (e.g. 1H, 13C, 15N, 19F, 31P, etc.). These nuclei with ms ³ ½ possess their spinning electrons possessing "μ", generate a tiny magnetic field on their own. These randomly oriented nuclei align themselves as a static external magnetic field (B0) is applied. Notably, a certain population of nuclei (N+, m = +½) will align themselves with the magnetic vector B0 while the remaining nuclei (N-, m = -½) against B0. The slight population excess in the lower level absorbs energy from the irradiating field. Transition between the two energy levels can occur when an additionally irradiated frequency (n), usually in the form of RF-signal (Radio Frequency) meets the energetic difference of the two energy states:

Transition from the lower (N-) to the upper energy level (N+) correspond to an absorption of energy, and those in the reverse direction to an emission of energy. Each transition is associated with a reversal of the spin orientation.

Chemical Shift: it is the frequency shift as a result of the shielding of the nuclei by the neighboring molecules, from the externally applied magnetic field leading to the reduction of the extent of external magnetic field experienced by the nuclei of sample. It is a lot more practicable to measure the frequency difference (Dn) between the resonance signals of the sample and that of a reference compound (in 1H- and 13C-NMR spectroscopy, tri-methyl-silane -TMS is used).

In reference to TSM, a compact molecule as 1-nitro-propane (CH3-CH2-CH2-NO2) generates three resonance bands in 1H-NMR. Usually the apical methyl-group (CH3, with e--pulling properties) will experience a less intense shift than the centered methylene group (CH2), while the outermost CH2-group (with e--pushing properties) will experience the largest shift.

Spin-Spin coupling: The coupling mechanism generates a characteristic multiplet pattern; for wxample, in ethyl-bromide (CH3-CH2-Br) in 1H-NMR, the methyl group (CH_3) with 3H-atoms is responsible for the quadruplet interference pattern (1:3:3:1) onto the neighboring methylene-group (CH_2), while the latter with only 2 H-atoms interacts with the former and leads to the splitting of the signal into a triplet pattern (1:2:1).

Instrumentation:

The external magnetic field aligns the nuclei along or against a magnetic field having the poles of the magnet in z-axis; a Radio frequency sweeping signal lifts the spinning electrons into an excited state; as the Radio frequency sweeping signal switched off, the excited nuclei (N+) spontaneously get back to the ground state by emitting a characteristic frequency (emission in x-axis), leading to the detection of the changes in the magnetic flux. The use of a pulsed RF-signals provides an interferogram rather than a continuos spectrum. Applying the mathematical operation of the Fourier transformation converts this time domain into the frequency domain (intensity vs. frequency shift). In order to improve the resolution, it is required to cool the sample to 77K with the help of liquid nitrogen; as this temperature causes all the nuclei to get back to a relaxed state which requires a higher induction energy to raise nuclei into the N+-state. In order to avoid the interference of the solute with the solvent, the solvent must be NMR-inactive; e.g in 1H NMR: deuterium (2H).

Qualitative analysis: By employing NMR spectroscopy, structural determination of the molecules as well as differentiation among different isomers is possible. The spin-spin coupling, e.g. a triplet vs. quartet (3:2) in 1H NMR spectroscopy leads to the determination of the number of protons involved in the coupling phenomenon.

Quantitative analysis: The amplitudes of singlets or multiplets are considered as direct quantitative indicators. The integration of these splitting patterns gives information about the number of protons or carbon-isotopes involved.

Mass Spectroscopy (MS):

This technique is based on the generation of gaseous ions, isotopes (charged species) from the analyte molecules under evacuated conditions, and their subsequent separation in electro-magnetic/-static field. The separation is achieved according to their mass-to-charge ratio (m/z); which is proportional to the extent of deflection of the externally applied field. The technique in combination with Gas Chromatography, Liquid Chromatography, and High Performance Liquid Chromatography is considered a powerful tool for the identification of the species.

Instrumentation: There are four building blocks which are required for the setup of an Mass Spectrometer:

1. The sample introduction system consists of a controlled release of analyte vapors from a reservoir. The samples are introduced into a high vacuum region, where the ion source, the mass analyzer, and the ion detector are present.
2. Ionization of the analyte can be done by employing a number of ways including electron ionization, chemical ionization and desorption ionization.
3. The ions generated are separated in a mass analyzer, most commonly used are magnetic sector, quadrupol mass filter, quadrupol ion trap, time of-flight, and ion-cyclotron resonance instruments.
4. The detection of ions is performed with an electron multiplier.

Qualitative analysis: Mass Spectrometry is not only the most sensitive technique for molecular analysis but also considered as a tool for the determination of molecular mass, molecular formula and structure elucidation of unknown compounds. The determination of the molecular mass is achieved by analyzing the isotope cluster at the highest m/z end in the spectrum which usually associated with the molecular ion mass. The assignment can be checked with the nearest fragment ions.

Quantitative analysis: Mass Spectrometry helps to characterize and develope reference methods, and in the quantification of macromolecules.

MULTIPLE CHOICE QUESTIONS

(1) Which region of electromagnetic spectrum is involved in electronic excitation?
(a) Ultraviolet (b) Visible

(c) Both of these (d) None of these

(2) Which of the following techniques is different from others as regards the basic principle?
(a) Ultraviolet spectroscopy (b) Visible spectroscopy
(c) Electronic spectroscopy (d) None of these

(3) In which region of the electromagnetic spectrum does oxygen absorb?
(a) 10-200nm (b) 200-400nm
(c) 400-800nm (d) None of these

(4) Which of the following electronic transition occurs when ethane is exposed to ultraviolet radiation?
(a) σ-σ* (b)π-π* (c)n-σ* (d)n- π*

(5) Which of the following electronic transition occurs when acetone is exposed to visible radiation?
(a)π-π* (b)n-σ* (c)n- π* (d)None of these

(6) Which of the following electronic transition cannot be studied by quartz ultraviolet spectroscopy?
(a)σ-σ* (b)π-π* (c)n-σ* (d)n- π*

(7) Which of the following electronic transition occurs when methanol is exposed to ultraviolet radiation?
(a)π-π* (b)n-σ* (c)n- π* (d)None of these

(8) Which of the following is an allowed transition?
(a)π-π* (b)n- π* (c)Both of these (d)None of these

(9) Which of the following is an forbidden transition?
(a)π-π* (b)n-σ* (c)n- π* (d)None of these

(10) Which of the following is used as a source of visible radiation?
(a)Tungsten filament lamp (b)Hydrogen discharge lamp
(c)Deuterium discharge lamp (d)All of these

(11) Which of the following solvents cannot be used for the UV/VIS spectral study of aldehydes?
(a)n-hexane (b)Cyclohexane (c)Ethanol (d)Acetronitrite

(12) What is the wavelength range of ordinary infrared region?
(a)0.8-2.5μm (b)2.5-16μm (c)16-1000μm (d)400-800nm

(13) The position of an infrared absorption band is commonly express by
(a)Wavelength (b)Wave number
(c)Both of these (d)None of these

(14) Which of the following modes of vibrations is different from the other?
(a)Stretching (b)Bending (c)Deformation (d)All of these

(15) Which of the following modes of vibrations is in-plane bending?
(a)Rocking (b)Twisting (c)Wagging (d)None of these

(16) What is the vibration degree of freedom of a molecule of methane?
(a)Five (b)Nine (c)Fifteen (d)None of these

(17) Which of the following bonds shows stretching absorption in the 3700-2500cm-1 region?
(a)C-C (b)C-O (c)C-N (d)None of these

(18) Which of the following bonds dose not shows stretching absorption in the 3700-2500cm-1 region?
(a)C-C (b)C-H (c)O-H (d)N-H

(19) Which of the following is not used as a source of IR radiation?
(a)Nernst filament (b)Tungsten filament
(c)Globar (d)None of these

(20) Which material is used for making the circular flat plates to hold the sample for IR study?
(a)Glass (b)Quartz (c)Rock salt (d)All of these

(21) In which form can a solid sample be studied by IR spectroscopy?
(a)As a mull (b)As a KBr disc
(c)As a solution (d)Any of these

(22) Which of the following can be used to prepare the mull of a solid sample for its IR stidy?
(a)Nujol (b)Hexachlorobutadiene
(c)Chlorofluorocarbon (d)All of these

(23) Which of the following is commonly used as a solvent for IR study?
(a)Water (b)Ethanol (c)Methanol (d)None of these

(24) Which of the following is not commonly used as a solvent for IR study?
(a)Ethanol (b)Chloroform
(c)Carbon tetrachloride (d)Carbon disulfide

(25) Where does the =C-H stretching absorption of an olefin appear in an infrared spectrum?
(a) At 3000cm-1 (b) Above 3000 cm-1
(c) Below 3000 cm-1 (d) In the 1650-1600 cm-1 region

(26) In infrared spectroscopy which frequency range is known as the fingerprint region?
(a) 1400 - 1200cm-1 (b) 400 - 900cm-1
(c) 900 - 600cm-1 (d) 600 - 250cm-1

(27) Which statement is FALSE about light sources?
(a)deuterium lamps are used for the UV
(b)Nernst glowers emit IR radiation
(c)tungsten filaments emit visible light
(d)All the above are wrong statements

(28) In UV-visible absorption Spectrophotometer, what does absorbance measure?
(a)The fraction of light of a particular wavelength absorbed by a sample
(b)The fraction of light of a particular wavelength transmitted by a sample
(c)The total amount of light energy absorbed by a sample
(d)The intensity of light that emerges from a sample

(29) The main advantage of fluorescence over UV-vis spectroscopy is
(a)Its sensitivity
(b)Its compatibility with separation techniques
(c)That emission spectra give fairy sharp peaks
(d)Its compatibility with most analytes

(30) Infrared spectroscopy provides valuable information about
a) Molecular weight.
b) Melting point.
c) Conjugation.
d) Functional groups

(31) A strong signal at 3400 cm–1 in an IR spectrum indicates the presence of a(n)
(a)Alcohol (b)Amine (c)Carbonyl (d)Alkane

(32) Which of the following bonds would be expected to have the highest frequency stretch?
(a)Carbon–carbon single bond (b)Carbon–carbon double bond
(c)Carbon–carbon triple bond (d)Carbon–bromine single bond

(33) Which of the following bonds would be expected to have the lowest frequency stretch?
(a)C–Cl (b)C–I (c)C–Br (d)C–F

(34) Why is the oxygen-hydrogen absorption of CH_3OH such a broad band in the infrared?
(a)Rotational energy levels broaden the absorption,
(b)Hyperconjugation resonance broadens the absorption.
(c)Resonance broadens the absorption.
(d)Hydrogen bonding broadens the absorption.

(35) Infrared radiations have wavelength
(a)Lower than microwave (b)Higher than X- Rays
(c)Both A & B (d)None of these

(36) In UV-Visible spectroscopy, if an auxochrome shifts the position of absorption to longer wavelength there will be
(a)Hyperchromic effect (b)Hypochromic effect
(c)Bathochromic shift (d)Hypsochromic shift

(37) In UV-Visible spectroscopy, if an auxochrome shifts the position of absorption to shorter wavelength there will be
(a)Hypochromic effect (b)Hyperchromic effect
(c)Bathochromic shift (d)Hypsochromic shift

(38) Homodienic components .....than hetrodienic system
(a)Equally shift the position of absorption to longer wavelength
(b)Shifts the position of absorption less to the longer wavelength
(c)Shifts the position of absorption more to the longer wavelength
(d)None of these

(39) Which one is forbidden transition
(a)n-π^* (b)π-π^* (c)n-σ^* (d)σ-σ^*

(40) In ^{1}H-NMR circulating pi-electrons of benzene add to
(a)Deshielding effect (b)Shielding effect
(c)Both of these (c)None of these

(41) In H-NMR high electron density in acetylene adds to
(a)Shielding effect (b)Deshielding effect
(c)Both of these (d)None of these

(42) In evaluating chemical shift value, the nucleus that is deshieled will have
(a)Higher chemical shift value (b)Lower chemical shift value
(c)May have lower or higher value (d)None of these

(43) Woodward Fieser rules are applied for
(a)Allenes (b)Cyclic Hydrocarbons
(c)α, β, Unsaturated carbonyl and polyene non conjugated
(d)Non conjugated polymer

(44) Homoannular diene has λ_{max} value.Woodward Fieser rules are applied for
(a)214 (b)217 (c)234 (d)None of them

(45) Which statement represents Auxochrome
(a)–OH, Ph- (b)Ethene & Ethyne
(c)-OH, -NH_2, -OR (d)All of the above

(46) Which part of spectrophotometer is used to convert electromagnetic radation in to monochromatic radiation
(a)Monochromator (b)Deuterium lamp
(c)Detector (d)None of the above

(47) Which statement is true for bathochromic sh ft.
(a)A shift to a higher energy (b)A shift to a lower higher energy
(c)An increase in intensity (d)A decrease in intensity

(48) Which statement is true for hypochromic effect.
(a)A decrease in intensity (b)An increase in intensity
(c)A shift to a lower higher energy (d)A shift to a higher energy

(49) Scissoring, rocking, wagging are the vibration
(a)Stretching vibration (b)Symmetrical vibration
(c)Both a & b (d)Bending vibration

(50) Aromatics have diagonistic peaks in the ----------region of IR spectra
(a)1200-1000 cm-1 (b)1700-1500 cm-1
(c)900-700 cm-1 (d)None of the above

(51) Carbonyl shows absorption peaks in IR spectra
(a)2300-2100 cm-1 (b)1200-1000cm-1
(c)Both a& b (d)1900-1600cm-1

Answers

1.	c	2.	d	3.	a	4.	a	5.	d
6.	a	7.	a	8.	a	9.	b	10.	a
11.	c	12.	b	13.	c	14.	a	15.	b
16.	b	17.	d	18.	a	19.	b	20.	c
21.	d	22.	d	23.	d	24.	a	25.	b
26.	b.	27.	d	28.	b.	29.	a.	30.	d.
31.	b.	32.	d.	33,	b.	34.	d.	35.	c.
36.	c.	37.	d.	38.	c.	39.	a.	40.	a.
41.	a.	42.	a.	43.	c.	44.	d.	45.	c.
46.	a.	47.	b.	48.	a.	49.	d.	50.	c.
51.	d								

PART IV: APPLIED CHEMISTRY

Applied chemistry is the branch of science which deals with the study of composition, structure and properties of matter. Applied chemistry also deals with principles and laws that govern the changes in matter. It is also called pure chemistry. In Applied chemistry, involves mostly, one's aim is to seek more answers to questions and to enlarge the pool of information. It acts as a bridge between chemistry and chemical engineering i.e. large scale-process industries. In which, not only the study about basic principles of chemistry, but also involves the study of apparatus used in industrial work and analytical instruments used in industrial work for the benefit of mankind. In Applied Chemistry, many chemical fields are involved, working on several materials including metal compounds, organic and inorganic compounds, proteins, polymers etc., doing basic researches and their applications in various fields. Different branches of applied chemistry are analytical chemistry, industrial chemistry, biochemistry, geochemistry, petrochemistry, radiochemistry, biotechnology and medicinal or pharmaceutical chemistry. Applied chemistry helps to determine the composition of the given sample of material by using different analytical techniques. It also involves in the manufacturing of various chemical substances like salts, acids, construction materials like cement, glass, plastic as well. Study of metabolic pathways, molecular, cellular and chemical activities of living organisms are also related to applied chemistry. Moreover it also deals with the composition of soils and rocks. Applied chemistry also has its role in the transformation of crude oil (petroleum) and natural gas into useful products and raw materials which can later use for different purposes. It also involves the use of radioactive materials to study the pathways and mechanisms of chemical reactions occurring in living organism. Principles of applied chemistry involve the designing, synthesizing and developing new pharmaceutical drugs for curing different diseases.

Multiple Choice Questions

01. Separation of ————is done by chromatography.
(a) Solution (b) Atoms
(c) Mixtures (d) Molecules

02. In chromatography, pattern on the paper is called
(a) Chroma (b) Chroming
(c) Chromatograph (d) Chromatogram

03. Components with small value of K show affinity for
(a) Stationary phase (b) Mobile phase
(c) No phase (d) Solution

04. Chromatography may refer to the
(a) Mass of a component (b) Testing of additives
(c) Testing of alkalinity (d) Testing of acidity

05. Chromatography is useful especially for
(a) Food (b) Drugs
(c) Salt solutions (d) Both (a & b)

06. Technique used to separate insoluble particles from liquids is called (a) Crystallization
(b) Chromatography
(c) Solvent extraction (d) Filtration

07. Reliable and safe method of drying crystals is by using
(a) Filter paper (b) Open air
(c) Vacuum desiccator (d) Oven

08. A substance showing high vapor pressure at its melting point will show (a) Decomposition (b) Crystallization (c) Condensation (d) Sublimation

09. Distributive law controls the process of
(a) Solvent extraction (b) Crystallization
(c) Filtration (d) Sublimation

10. Rf values differ with the different mixture of components due to
(a) Used combination of solvents
(b) Distributive law
(c) Solvent polarity
(d) Their different distributive coefficients in solvent

11. The process of crystallization involves the use of $CaCl_2$ and PCl_5 as
(a) Drying agent (b) Oxidizing agent
(c) Reducing agent (d) Coloring agent

12. Which is not sublime material from following?
(a) Ammonium chloride (b) Potash alum
(c) Benzoic acid (d) Iodine

13. Element act as an inert electrode is
(a) Cu (b) Ag
(c) Pt (d) All

14. Stronger oxidizing agent has greater
(a) Reduction potential (b) Oxidation potential
(c) Redox potential (d) EMF of cell

15. Current flows in an electrolytic cell from
(a) Cathode to anode in outer cell
(b) Anode to cathode outside the cell
(c) Cathode to anode outside the cell
(d) Anode to cathode inside cell

16. In a galvanic cell
(a) Chemical energy converted to electricity
(b) Electrical energy converted into chemical energy
(c) Electrical energy converted into heat
(d) Chemical energy converted into heat

17. Voltaic cell produced electricity due to
(a) Reduction (b) Oxidation
(c) Bothe (a & b) (d) Neutralization

18. Electricity carries ———— in electrolytic cell.
(a) Spontaneous reaction (b) Non-spontaneous reaction
(c) Neutralization (d) None

19. To measure standard electrode potential Zn is dipped in
(a) 1 M ZnO solution (b) 1.5 M $ZnSO_4$ solution
(c) 1 M $ZnSO_4$ solution (d) 0.1 M $ZnSO_4$ solution

20. ———— are transfers by salt bridge.
(a) Ions (b) Electrons
(c) Current (d) Anion

21. H2 gas is filled at pressure of ———— in SHE.
(a) 750 mm of Hg (b) 760 mm of Hg
(c) 780 mm of Hg (d) 800 mm of Hg

22. Lead accumulators are referred as
(a) Primary cell (b) Secondary cell
(c) Voltaic cell (d) Bothe (b & c)

23. Hydrolysis of fat or oil with ———— is called saponification.
(a) Acid (b) Alkali
(c) Enzyme & acid (d) Enzyme & alkali

24. Rate of reaction catalyzed by enzyme is directly proportional to the concentration of
(a) Enzyme (b) Substrate
(c) Enzyme & product (d) Enzyme & substrate

25. Molten urea is cooled by air in the tower called
(a) Condensation (b) Prilling
(c) Evaporation (d) Crystallization

26. One of the following is not useful fertilizer for paddy rice
(a) Urea (b) Ammonium sulphate
(c) Ammonium nitrate (d) DAP

27. Which of the following fertilizer is useful for tobacco and potato crop?
(a) KCl (b) $KMnO_4$
(c) KNO_3 (d) K_2SO_4

28. ———— includes in calcareous material.
(a) Chalk (b) Lime stone
(c) Marble (d) All

29. Nutrients which are required by the plant in large amount for its normal growth are called
(a) Micronutrients (b) Macronutrients
(c) Nitrogenous fertilizers (d) Phosphorus fertilizers

30. Which one of the following is the organic fertilizer?
(a) Ammonium nitrate (b) Ammonium sulphate
(c) Manure (d) All

31. Mixture of ———— is called cement.
(a) Clay & clinker (b) Lime stone & gypsum
(c) Limestone & clay (d) Clay, limestone, gypsum

32. Cement has the greatest percentage of
(a) Lime (CaO) (b) Alumina Al_2O_3
(c) Magnesia (MgO) (d) Silica SiO_2

33. Raw cement material contains limestone and clay in the composition of
(a) 75% lime stone, 25% clay (b) 15% lime stone, 55% clay
(c) 25% lime stone, 75% clay (d) 55% lime stone, 15% clay

34. Cottrell precipitator is based on the principle of
(a) Peptisation
(b) Le-Chatelier's principle
(c) Scattering of light
(d) Neutralization of charge on colloidal particles

35. Which one of the following factors is responsible for the color of sky?

(a) Absorption of light by atmospheric gases
(b) Wavelength of scattered light
(c) Transmission of light
(d) All of these

36. Adsorption of gas on a solid depends on
(a) Temperature of gas (b) Nature of gas
(c) Pressure of gas (d) All of these

37. A substance which————is called emulsifier.
(a) Homogenizes the emulsion
(b) Coagulates the emulsion
(c) Stabilizes the emulsion
(d) Accelerates the dispersion of liquid in liquid

38. Which of following gas readily adsorbed by activated charcoal?
(a) N_2 (b) SO_2
(c) O_2 (d) H_2

39. Potash alum helps in water purification by
(a) Sulphate part combines with dirt and remove it
(b) Forming Si complex with clay particles
(c) Coagulating the mud particles
(d) Making mud water soluble

40. Dissolution of sulphur (S_8) results in the formation of
(a) Associated colloid (b) Micelle
(c) Macromolecular colloid (d) Multimolecular colloid

41. ————is a colloidal solution of Fog.
(a) Gas in liquid (b) Liquid in gas
(c) Solid in gas (d) Gas in gas

42. Reactions in the presence of zeolite catalyst depend on
(a) Pores (b) Apertures
(c) Size of cavity (d) All of these

43. Which of the colloidal property is independent of the charge of the colloidal particles?
(a) Coagulation (b) Electrophoresis
(c) Tyndall effect (d) Electro-osmosis

44. Which of the following instrument used to measure the absorbance of a colored compound in solution?
(a) Colorimeter (b) Chlorimeter
(c) Calorimeter (d) Coulometer

45. Which one of the following do not absorb in UV/VIS range?
(a) Aspirin (b) Paracetamol
(c) Phenobarbitone (d) Chloral hydrate

46. Which of the following technique is useful in identifying and quantifying known impurity in drug substance?
(a) NMR (b) HPLC
(c) MS (d) IR

47. Modern method of isotopes separation is

(a) X ray (b) Laser separation
(c) Ionization (d) Chromatography

48. Isotopes in solid state can be determined by using ————mass spectrometer.
(a) Alison's (b) Dempester's
(c) Bohr's (d) Aston's

49. Instrument used to collect ions is called
(a) Electrometer (b) Ionizer
(c) Spectrometer (d) None

50. Each metal produced ————X-rays.
(a) Same (b) Characteristic
(c) Distorted (d) None

51. Urea contains _____ percentage of nitrogen (N).
(a) 40% (b) 20%
(c) 46.60% (d) 30%

52. Separation of metal from ore is
(a) Cyclone separation (b) Floatation process
(c) Metallurgy (d) Magnetic separation

53. _____ is potassic fertilizers
(a) $KMnO_4$ (b) NH_4NO_3
(c) KNO (d) None

54. Which one is better cleaning agent
(a) Detergents (b) Soap
(c) both (d) None

55. Wear clothes are made up of
(a) Nylon fibers (b) Terylene fibers
(c) Wool fiber (d) Cotton mixed with nylon

56. _____ Is thermosetting plastic
(a) Polyethylene (b) Bakelite
(c) Polystyrene (d) Polyethyne

57. Formula of white lead is
(a) $PbCO_3$ (b) $Pb(OH)_2$
(c) $Pb(OH)_2\ 2PbCO_3$ (d) Pb_3O_4

58. ————Is used for the manufacturing of Vitamin C
(a) Electrolysis (b) Carbon reduction
(c) Haber process (d) Reichstein process

59. PVC is formed at
(a) 80°C (b) 20°C
(c) 50°C (d) 100°C

60. _____ is the raw material for the production of urea
(a) Ammonia and carbon dioxide (b) Oxygen and carbon dioxide
(c) Ammonia and Phosphate (d) Ammonia and oxygen

61. Petrol boils at
(a) 35-70°C (b) 170-120°C
(c) 270°C (d) Below 20°C

62. _____ is volatile organic compound
(a) Benzene (b) Carbon tetrachloride
(c) Chloroform (d) Both (a & b)

63. Which of the following fertilizers are derived from animals and plants?
(a) Synthetic fertilizers (b) Artificial fertilizers
(c) Natural fertilizers (d) Both (a & c)

64. Mineral fertilizers contain
(a) N, P, K (b) N, K
(c) C, H & N (d) C, H & O

65. Naturally occurring polymer is
(a) Proteins (b) Polyethene
(c) PVC (d) Propylene

66. ____ is NOT natural polymer
(a) Wool (b) Nylon
(c) Silk (d) Leather

67. _____ is monomer of PVC
(a) Glycol (b) Propylene
(c) Vinyl chloride (d) Succinic acid

68. Plastics are
(a) Acids (b) Solvents
(c) Synthetic polymer (d) Salts

69. Paint is consists of
(a) Binder (b) Thinner or solvents
(c) Pigments (d) All

70. Which type of glass is not manufactured in Pakistan?
(a) Pyrex glass (b) Flint glass
(c) Lime glass (d) Soda glass

71. _____ is a mineral based industry
(a) Tea (b) Petrochemical
(c) Coffee (d) Sugar

72. Bauxite used as a raw material in
(a) Jute industry (b) Steel industry
(c) Cement industry (d) Aluminium smelting industry

73. Silica used as a raw material
(a) Steel industry (b) Cement industry
(c) Coal industry (d) Almunium industry

74. Conversion of mineral into oxides is
(a) Roasting (b) Smelting
(c) Reigning (d) Bessemerization

75. Polymer is large molecule which is made up of
(a) Monomer (b) Metamers
(c) Dimer (d) All

76. Smelting is
(a) Oxidation of metals (b) Oxidation of minerals
(c) Melting of metals (d) Reduction of metal oxides

77. _____ is used to obtain nylon by heating

(a) Vinyl chloride
(b) Epichlorohydrin
(c) Acrylic acid
(d) Adipic acid with hexamethylene diamine

78. The heavy engineering industry is
(a) Heavy machinery (b) Glass
(c) Heavy electricals (d) Iron and Steel

79. Industry is the important factor for
(a) Federal development (b) Provisional development
(c) National development (d) Central development

80. In Pakistan, industry is divided into ____ categories
(a) 3 (b) 5
(c) 4 (d) 2

81. Formula of Gypsum
(a) $CaSO_4.7H_2O$ (b) $MgSO_4$
(c) $MgSO_4.3H_2O$ (d) $CaSO_4.2H_2O$

82. pH of soil is _____, which is maintained by fertilizers
(a) From 6-8 (b) Below 3
(c) From 7-8 (d) 5

83. Formula of plaster of Paris
(a) $2CaSO_4.3H_2O$ (b) $MgSO_4$
(c) $2CaSO_4.H_2O$ (d) $2MgSO_4.H_2O$

84. Ammonium nitrate, Ammonium sulphate and urea are example of
(a) Nitrogenous fertilizer (b) Phosphatic fertilizer
(c) Potassic fertilizer (d) None

85. By fusion of silicate, an amorphous product is produced called
(a) Plastic (b) Glass
(c) Rayon (d) None

86. _____ is not a natural polymer
(a) Silk (b) Leather
(c) Nylon (d) Wool

87. _____ is used to softened the material
(a) Carburising (b) Normalizing
(c) Anealing (d) Tempering

88. Study of mineral is called
(a) Histology (b) Ore
(c) Minerology (d) None

89. _____ is a solid material from which metal is extracted
(a) Ore (b) Metal
(c) Mineral (d) None

90. Polymer formation by
(a) Coordination reaction between monomers
(b) Hydrolsis of monomer
(c) Condensation reaction between monomers
(d) None

91. Nylon is a

(a) Polyamides (b) Peptides
(c) Amides (d) None

92. Plastic of recycle bottle is made up of
(a) Terylene (b) Caprolactam
(c) Nylon (d) None

93. α Iron of crystal structure has
(a) Face centered cubic (b) Body centered cubic
(c) Simple cubic (d) None

94. The arrangement of ions in crystal lattice is
(a) Two dimension (b) One dimension
(c) Three dimension (d) Both (b & c)

95. Position of atom in crystal is indicated by
(a) Lattice points (b) Lattice circles
(c) Lattice lines (d) Lattice arrangements

96. Crystal lattice is also called
(a) Lattice line (b) Lattice array
(c) Space lattice (d) None

97. Barium sulphate forms
(a) Rhombic crystals (b) Cubic crystal
(c) Monoclinic crystal (d) Hexagonal crystal

98. Hardness of water is estimated by
(a) Clark's method (b) Soap titration
(c) EDTA method (d) Both (a & c)

99. Cement is a
(a) Separator (b) Acid
(c) Binder (d) None

100. More than one type of unsaturated polymer combines to form
(a) Terpolymer (b) Co-polymer
(c) Polytone (d) All

Answers

01	C	35	B	69	D
02	D	36	D	70	A
03	A	37	C	71	B
04	B	38	B	72	D
05	D	39	C	73	B
06	D	40	D	74	A
07	C	41	B	75	A
08	D	42	D	76	D
09	A	43	C	77	D
10	D	44	A	78	A
11	A	45	D	79	A
12	B	46	B	80	A
13	C	47	B	81	D
14	A	48	B	82	C
15	B	49	B	83	C
16	A	50	B	84	A
17	C	51	C	85	B
18	B	52	C	86	C
19	C	53	C	87	C
20	A	54	A	88	C
21	B	55	B	89	A
22	D	56	B	90	C
23	B	57	C	91	A
24	B	58	D	92	A
25	B	59	A	93	B
26	C	60	A	94	C
27	C	61	A	95	A
28	D	62	A	96	C
29	B	63	C	97	A
30	C	64	A	98	A
31	D	65	A	99	C
32	A	66	B	100	B
33	A	67	C		
34	D	68	C		

PART V: ENVIRONMENTAL CHEMISTRY

The term environment means "surrounding". It consists of following components that are; atmosphere, hydrosphere, lithosphere and biosphere. Environmental chemistry is the scientific study of the chemical and biochemical processes that occur in nature. It is different from green chemistry, which seeks to reduce potential pollution at its source. It can be defined as the study of the sources, reactions, transport, effects, and fates of chemical species in the air, soil, and water environments; and the effect of human activity and biological activity on these.

It gives information about the chemical processes occurring in the environment which are impacted by humankind's activities. These impacts may be felt on a local scale, through the presence of urban air pollutants or toxic substances arising from a chemical waste site, or on a global scale, through depletion of stratospheric ozone or global warming. It involves the first understanding about the working of the uncontaminated environment that which chemicals in what concentrations are present naturally, and with what effects. Without this it would be impossible to accurately study the effects humans have on the environment through the release of chemicals.

Environmental pollution can be defined as the addition of undesirable material to environment either due to human activities or due to some natural phenomenon which adversely affect the quality of air and hence, affects the life on earth. Air pollution, soil pollution, water pollution, noise pollution, radioactive pollution and thermal pollution all these are types of environmental pollution. Atmospheric pollution is generally studied as troposphere pollution or stratospheric pollution. Troposphere pollution occurs due to presence of undesirable solid or gaseous particles in the air. The major gaseous pollutants are oxides of sulphides, hydrocarbons, ozone and other oxidants while particulate pollutants includes; dust, mist, fumes, smoke, smog etc. By increase in concentration of gases like CO_2, methane and chlorofluorocarbons (CFCs) the temperature of earth surface is increasing day by day hence causing global warming and also green-house effect. Acid rain is caused by oxides of sulphur and nitrogen and is harmful for trees, plants, animals, human beings and for aquatic life.

In order to control environmental pollution non-biodegradable materials (plastic, glass, metal scraps etc.) sent for recycling while biodegradable wastes should be deposited in landfills. Environmental chemistry can be applied to treat wastes, to reduce and prevent the impacts of discharges in to the environment. Environmental Chemistry provides data input for risk assessment and treatability studies and determines the required level of environmental quality or control needed in a system.

Multiple Choice Questions

1. Which one is not considered as heavy industry?
   (a) Paper (b) Fertilizer
   (c) Iron (d) None
2. Per acre requirement of land for macronutrients is
   (a) 5-200 kg (b) 200-400 kg
   (c) 40-200 kg (d) 20-200 kg
3. Which element is used for purification of water in swimming pools?
   (a) Sodium (b) Chlorine
   (c) Phosphorous (d) Potassium
4. Out of total water on earth percentage of salt water is
   (a) 30% (b) 40%
   (c) 97.5% (d) 50%

5. Water shows maximum density at
   (a) 10°C (b) 4°C
   (c) 5°C (d) 12°C
6. Quality of water is measured by following factors
   (a) BOD (b) BO
   (c) COD (d) All of these
7. Minerals which are causes of hard water formation are
   (a) Ca, Mg (b) Al, Mg
   (c) Al, Ca (d) None
8. Water dissolves which thing during thunderstorms
   (a) HCl (b) Clouds
   (c) Dust particles (d) Nitric acid
9. Which gas is not considered as air pollutant?
   (a) CO (b) CO_2
   (c) NO (d) SO_2
10. A chlorine free radical can destroy how many molecules
    (a) 100,000 (b) 50,000
    (c) 20,000 (d) 10,000
11. Coagulant used for water purification is
    (a) Nickel sulphate (b) Alum
    (c) Copper sulphate (d) Barium sulphate
12. How many times recycling of newspaper can be done?
    (a) 2 (b) 5
    (c) 3 (d) 4
13. For water purity minimum value of DO should be
    (a) 1ppm (b) 2ppm
    (c) 3ppm (d) 4ppm
14. Which one of the following gases is produced in landfill?
    (a) Hydrogen sulphide (b) Chlorine
    (c) Oxygen (d) Hydrochloric acid gas
15. More polluted water is indicated by which value of COD
    (a) Low value (b) Higher value
    (c) Both of these (d) None of these
16. Which one of these is used for disinfecting water to avoid formation of toxic compounds with chlorine?
    (a) KMnO4 (b) Chloramines
    (c) Alum (d) O_3
17. Waste water is polluted by leather tanneries due to the salt of
    (a) Lead (b) Copper
    (c) Chromium (VI) (d) None
18. Which components of paint are used for forming films?
    (a) Thinners (b) Pigments
    (c) Drier (d) Resins
19. In presence of which one of these chlorination of water is considered harmful?
    (a) Dissolved oxygen (b) Ammonia
    (c) Carbon dioxide (d) None

20. Bulk of hydrosphere content is formed by
(a) Glaciers & icecaps (b) Oceans
(c) Fresh water lakes (d) All of above.

21. In tropical region ozone causes
(a) Aggravates asthma (b) Damages to eyes
(c) Chest discomfort (d) All of these

22. Surface and ground water is polluted by following human activities
(a) Septic tanks (b) Pesticides
(c) Petroleum production (d) All of these

23. Suspended solid waste which is removed by coagulation from raw water is
(a) 60% (b) 70%
(c) 80% (d) 90%

24. Significant depletion of ozone occurs every year during
(a) Sep-Nov (b) Aug-Nov
(c) Dec-Jan (d) Nov-Dec

25. Bacterial action produces mainly
(a) NO_2 (b) N_2O_3
(c) NOx (d) NO

26. Which one is largest recycled item?
(a) Newspaper (b) Plastic
(c) Glass (d) Aluminum

27. A class of carcinogenic compounds known as dioxins is significantly produced from
(a) Leachate (b) Incineration
(c) Landfills (d) Effluents

28. At which temperature (°C) organic compounds are completely burnt during incineration
(a) 650-700 (b) 800-850
(c) 950-300 (d) 850-900

29. In which year phenomenon of acid rain got importance?
(a) 1960s (b) 1950s
(c) 1930s (d) 1940s

30. In mid of seventeenth century Augus Smith discovered
(a) Acid (b) Base
(c) Fertilizer (d) Acid rain

31. Which pollutant of automobiles produces mental diseases?
(a) Nitrogen oxide (b) Lead
(c) Mercury (d) Nitrogen oxide

32. In certain seasons increased asthmatic attacks are due to
(a) Eating seasonal vegetables (b) Low temperature
(c) Inhalation of seasonal pollens (d) Wet and dry environment

33. DDT is
(a) Fungicide (b) Herbicide
(c) Insecticide (d) All of these

34. In stratosphere ozone extends up to
(a) 0-15 (b) 15-40
(c) 10-15 (d) 15-25

35. Which one of the following dissolves more rapidly in blood hemoglobin than oxygen?
(a) Ozone (b) Sulphur dioxide
(c) Carbon monoxide (d) Nitrous oxide

36. Main aim of recycling is
(a) Conserve energy (b) Conserve sources
(c) Conserve raw material (d) All of these

37. Which one of following is more toxic?
(a) Ag (b) Hg
(c) Fe (d) C

38. Which one of the following is produced during a reaction caused by ultraviolet radiations of sun?
(a) Fluorides (b) Sulphur dioxide
(c) Carbon monoxide (d) Ozone

39. Which one of following is reason of destruction of Shahi Qilla?
(a) Flood in Ravi
(b) Air pollutants from Lahore chemical industries
(c) Temperature mediated spoilage of marble
(d) All of above

40. Term pollution is used for
(a) Removal of top oil
(b) Release of undesirable/toxic materials in environment
(c) Conservation of energy
(d) All of above

41. B.O.D of drained sewage is
(a) More than that of water (b) Less than that of water
(c) Equal to that of water (d) None of these

42. Which one of these is cause of water pollution?
(a) Aeroplanes (b) Automobiles exhaust
(c) Smoke/Fly ash (d) 24D and pesticides

43. Which pollutant is biodegradable?
(a) Plastic (b) Sewage
(c) Asbestos (d) Mercury

44. Which one of these cancers is produced due to ultraviolet radiations?
(a) Skin cancer (b) Mouth cancer
(c) Lung cancer (d) Liver cancer

45. Which one of these is used for measurement of soil salinity?
(a) Conductivity meter (b) Photometer
(c) Protometer (d) Potometer

46. Photochemical pollution is related to pollution in
(a) Air (b) Water
(c) Soil (d) All of above

47. During burning of fossil fuels which one of the following green house gas is produced?
(a) Nitrogen (b) Methane
(c) Hydrogen (d) Carbon dioxide

48. Rise in sea level is caused by which environmental problem?
(a) Acid rain (b) Cutting down trees in rain forests

(c) Damage to ozone layer (d) Global warming

49. Total volume of water on earth is
(a) 2 billion Km^3 (b) 1.386 billion Km^3
(c) 4 billion Km^3 (d) 1 billion Km^3

50. Lead is pollutant of air
(a) Air pollutant (b) Soil pollutant
(c) Radioactive pollutant (d) Noise pollutant

51. On global scale major cause of SO_2 is?
(a) Volcanoes (b) Electric sparks
(c) Combustion (d) All

52. Which one of the following is a macronutrient?
(a) Boron (b) Iron
(c) Copper (d) Carbon

53. Hypochlorous acid reacts with the dissolved ammonia to produce
(a) NH_2Cl (b) $NHCl_2$
(c) NCl_2 (d) All

54. The elements which are required for healthy growth of plants are
(a) N P K (b) N K C
(c) N S P (d) N Ca P

55. Which one of the following is not a secondary pollutant?
(a) Ozone (b) Carbonic acid
(c) Sulphuric acid (d) Carbon dioxide

56. In atmosphere residence time of methane is
(a) 3 -7 days (b) 2-3 days
(c) 3-7 years (d) 2-3 years

57. In acid rain following acid may be present
(a) H_2SO_4 (b) HNO_3
(c) HCl (d) Both (a & b)

58. In photochemical smog yellow color is due to the presence of
(a) Dinitrogen oxide (b) Nitrogen dioxide
(c) Chlorine gas (d) Chlorine dioxide

59. Following one is not a condition for the formation of smog
(a) Sufficient NO (b) Sunlight
(c) Less movement of air (d) Winds

60. In which temperature range incineration of municipal waste is carried out?
(a) 250-500°C (b) 500-900°C
(c) 950-1300°C (d) 900-1000°C

61. There is more thickness of ozone layer in _____layer of atmosphere
(a) Troposphere (b) Stratosphere
(c) Mesosphere (d) Photosphere

62. Which one of the following is not a primary pollutant?
(a) SO_3 (b) CO
(c) NO (d) H_2SO_4

63. The air pollutant which is more dangerous for ozone layer is?
(a) CFC (b) CO_2
(c) CO (d) Oxides of nitrogen

64. The main cause of the acid rain is
(a) CO (b) NO_2
(c) Both (a & b) (d) CO_2

65. Which of the following statement is not true?
(a) The amount of ozone layer is greater in the region close to equator
(b) Ozone act as filter for UV radiations
(c) CFCs plays effective role in removing O_3 in the stratosphere
(d) None

66. Smog is the combination of
(a) Smog and fog (b) Rain and fog
(c) Acid rain and smoke (d) All

67. Gills of fishes are clogs by which of the following?
(a) Aluminum (b) Chlorine
(c) Sulphur (d) Lead

68. Polluted rain water has following pH
(a) Between 5 and 7 (b) Less than 5
(c) More than 5 (d) 8

69. Water is often treated with chlorine to
(a) Increase oxygen content (b) Kill germs
(c) Remove hardness (d) Remove suspended particles

70. Ozone layer is depleted due to
(a) Oxides of nitrogen (b) Oxides of carbon
(c) Oxides of sulphur (d) None

71. Diameter of typical thunderstorm is
(a) 50 miles (b) 15 miles
(c) 60 miles (d) 25 miles

72. Carbon monoxide prevents transport of oxygen in body due to
(a) Combining with oxygen to form CO_2
(b) Destruction hemoglobin
(c) Preventing reaction between oxygen and hemoglobin
(d) Forming stable compound with hemoglobin

73. Pollutants have adverse effect over
(a) Biosphere (b) Ecosystem
(c) Both (a & b) (d) Hydrosphere

74. Which of the following is dissolved by water during thunderstorms?
(a) Dust particles (b) HCl
(c) Nitric acid (d) Clouds

75. By which water scum is formed with soap?
(a) Hard water (b) Soft water
(c) Distilled water (d) Undistilled water

76. Out of total water available on earth percentage of fresh water is
(a) 1% (b) 2.5%
(c) 4% (d) 3%

77. Amount of water available for human use is
(a) 0.30% (b) 0.2%
(c) 40% (d) 50%

78. Typical thunderstorm lasts for an average of
(a) 30 minutes (b) 60 minutes
(c) 40 minutes (d) 50 minutes

79. The gases which are responsible for green house effect are
(a) CO_2 (b) CH_4
(c) Both (a & b) (d) None

80. BOD stands for
(a) Biological oxygen demand (b) Biochemical oxygen demand
(c) Both (a & b) (d) None

81. The great historical monument Tajmahal can be damaged by
(a) Green house effect (b) Global warming
(c) Acid rain (d) None

82. In which region of atmosphere human beings live along with other organisms?
(a) Troposphere (b) Mesosphere
(c) Stratosphere (d) Photosphere

83. Harmful radiations emitted from sun are
(a) UV (b) X rays
(c) IR (d) None

84. Troposphere pollution is caused by
(a) Gaseous air pollutants (b) Particulate pollutants
(c) Both (a & b) (d) None

85. PAN (a component of photochemical smog) cause
(a) Eye irritation (b) Throat irritation
(c) Breathing problems (d) All

86. The study of chemical and biochemical processes occurring in nature is called
(a) Applied Chemistry (b) Environmental Chemistry
(c) Organic Chemistry (d) All

87. Minute living organisms dispersed in atmosphere are
(a) Viable particulates pollutants (b) Non viable particulate pollutants
(c) None (d) All

88. Non viable particulates are formed by
(a) Smoke (b) Dust
(c) Fumes (d) All

89. The major causes of water pollution are
(a) Pathogens (b) Organic wastes
(c) All (d) Chemical pollutants

90. Soil pollution is caused by
(a) Pesticides (b) Herbicides
(c) Both (a& b) (d) None

91. Global warming may results in
(a) Melting of glaciers (b) Eutrophication
(c) Increased BOD (d) Both (a & b)

92. Addition of phosphate containing fertilizers in water bodies causes
(a) Increase in algal growth (b) Increases in fish population
(c) None (d) All

93. Which one of the following gas is produced by respiratory function of plants and animals?
(a) CO (b) CO_2
(c) NO_2 (d) None

94. If BOD level of water in reservoir is less than 5ppm it would be
(a) Highly pure (b) Highly polluted
(c) Less pure (d) none

95. Biodegradable pollutants are decomposed by
(a) Viruses (b) Bacteria
(c) Algae (d) None

96. Sources of dissolved oxygen (DO) in water are
(a) Photosynthesis (b) Natural aeration
(c) Mechanical aeration (d) All

97. Which one of the following is not a component of photochemical smog?
(a) NO_2 (b) O_3
(c) SO_2 (d) All

98. Which one of the following is not correct?
(a) O_3 is not responsible for green house effect
(b) O_3 can oxidize SO_2 to SO_3
(c) Both (a & b)
(d) None

99. _____ extends above troposphere upto50 km above sea level
(a) Mesosphere (b) photosphere
(c) Stratosphere (d) None

100. _____ is the lowest region of atmosphere around 10km
(a) Troposphere (b) Mesosphere
(c) Both (a & b) (d) None

ANSWERS

01	D	35	C	69	B
02	A	36	D	70	A
03	B	37	B	71	B
04	C	38	D	72	D
05	B	39	B	73	B
06	D	40	B	74	C
07	A	41	A	75	A
08	D	42	D	76	B
09	B	43	B	77	B
10	A	44	A	78	A
11	B	45	A	79	C
12	B	46	A	80	B
13	D	47	B	81	C
14	A	48	D	82	A
15	B	49	B	83	A
16	A	50	A	84	C
17	C	51	A	85	A
18	D	52	D	86	B
19	B	53	D	87	A
20	B	54	A	88	D
21	D	55	D	89	C
22	D	56	C	90	C
23	C	57	D	91	D
24	A	58	B	92	A
25	D	59	D	93	B
26	A	60	D	94	B
27	B	61	B	95	B
28	C	62	D	96	D
29	B	63	A	97	C
30	D	64	B	98	A
31	B	65	A	99	C
32	C	66	A	100	A
33	C	67	A		
34	B	68	A		

PART VI - GENERAL CHEMISTRY

1. Important biological molecules functional groups contain
   (a) Oxygen and/or nitrogen and are acidic
   (b) Oxygen and a phosphate
   (c) Nitrogen and a phosphate
   (d) Oxygen and/or nitrogen and are polar
2. Natural buffers in living systems has acid/base pairs?
   (a) H_2CO_3/HCO_3^- (b) $H_2PO_4^-/HPO_4^{2-}$
   (c) Histidine$^+$/histidine (d) All of these
3. Alanine, tyrosine, and lysine all are present in
   (a) DNA (b) Strong base
   (c) Phospholipid (d) Protein
4. Hydrophilic interactions and hydrogen bonds are types of
   (a) Weak chemical bonds that hold together the atoms within a molecule
   (b) Strong chemical bonds that hold together the atoms within a molecule
   (c) Weak chemical bonds that link together separate molecules
   (d) Strong chemical bonds that link together separate molecules
5. Fats accompany high energy than simple sugars due to presence of
   (a) Carbon atoms (b) hydrogen atoms
   (c) Covalent bonds (d) hydrogen bonds
6. Polar solvent has affinity to dissolve?
   (a) Gasoline (heptanes& octanes) (b) Methane
   (c) Argon (d) sodium chloride
7. Oxygen, Carbon and Nitrogen
   (a) Can all form covalent bonds with other elements
   (b) Contain protons and neutrons in their atomic nuclei
   (c) Are common elements in the molecules that make up living organisms
   (d) All of the above
8. Microtubules, actin filaments and motor proteins all are present in
   (a) The mechanism of photosynthesis that occurs in chloroplasts
   (b) The rough ER (endoplasmic reticulum) in prokaryotic cells
   (c) The cytoskeleton of eukaryotic cells
   (d) the process that moves small molecules across cell membranes
9. _____ is a porous, double phospholipid bilayer structure
   (a) the nuclear envelope (b) the plasma membrane
   (c) the mitochondrion (d) the cytoskeleton
10. First line of defense for an organism against attack by an invader is usually
    (a) To flee or hide (b) its body wall
    (c) a specific immune response (d) a nonspecific immune response
11. Fluid mosaic model of cell membranes proposes that
    (a) the most common type of molecules in the membrane are proteins
    (b) Basic membrane structure results from how the proteins interact with water
    (c) The membrane is a highly mobile mixture of phospholipids and proteins
    (d) The unique properties of cell types are determined by their phospholipids
12. The peptide bond in proteins is
    (a) Only found between proline residues

(b) Usually cis unless proline is the next amino acid
(c) Usually trans unless proline is the next amino acid
(d) is planar because of steric hinderance

13. Mitochondria has?
(a) Cytochrome oxidase
(b) Succinate dehydrogenase
(c) Dihydrolipoyl dehydrogenase
(d) All of these

14. Carrier proteins
(a) Transport only one substance
(b) Transport more than one substance
(c) Exchange one substance to another
(d) Perform all of these functions

15. A lipid bilayer permits freely the mobility of
(a) Urea (b) Fructose
(c) Glucose (d) Potassium

16. _____ is known as the power house of the cell.
(a) Nucleus (b) Cell membrane
(c) Mitochondria (d) Lysosomes

17. Digestive enzymes of cellular compounds are confined in
(a) Lysosomes (b) Ribosomes
(c) Peroxisomes (d) Polysomes

18. Eukaryotic organelles e.g. mitochondria and chloroplasts has highly folded membranes that
(a) increase the surface area where key chemical processes can occur
(b) help the cell against physical damage
(c) make it possible to package large amounts of DNA within the cell
(d) assist with cell movement

19. Large amounts of ATP is synthesized from sugars in the presence of
(a) Lysosome (b) Vesicles
(c) Mitochondria (d) Plasma membrane

20. Diseases are caused by?
(a) Pathogens (b) T cells
(c) Lymphocytes (d) Macrophages

21. Palmitate has 16 carbon atoms having
(a) 2 double bonds (b) 3 double bonds
(c) One double bond (d) None of these

22. For human nutrition the lowest energy value lipid is
(a) olive oil (b) Olestra
(c) Margarine (d) Cardiolipih

23. Metabolism of fructose is done by
(a) fructose 1-phosphate pathway
(b) fructose 6-phosphate pathway
(c) glyceraldehyde 3-phosphate pathway
(d) both (a) and (b)

24. Human stomach cannot digest
(a) Starch (b) complex carbohydrates

(c) denatured proteins (d) Cellulose

25. Electron microscope instead of light microscope is necessary to observe?
(a) Animal (b) Bacterial
(c) Protist (d) All of these

26. ΔH°_{a} for atomization of hydrogen is
(a) 199 kj/mole (b) 218 kj/mole
(c) 250 kj/mole (d) 299 kj/mole

27. NaOH and HCl neutralization evolve heat
(a) -40.4kj/mole (b) -50.5 kj/mole
(c) -55.5 kj/mole (d) -57.4 kj/mole

28. Standard enthalpy of combustion of ethanol is
(a) -100 kj/mole (b) -1250 kj/mole
(c) -1368 kj/mole (d) -1500 kj/mole

29. Equilibrium can exist at the reaction completed
(a) 50% (b) < 50%
(c) > 50% (d) any of above

30. Moles of a substance per litre is known as
(a) Molar concentration (b) active weight
(c) composition (d) concentration

31. Rate of forward and backward reaction becomes equal at state
(a) Homogenous (b) equilibrium
(c) heterogeneous (d) static

32. Products and reactants are present in sufficient amount in reaction mixture when kc is
(a) Neither very large nor very small (b) very small
(c) very large (d) infinity

33. Concentration is taken in
(a) mol. Ml (b) mol/liter
(c) g equivalent liter (d) g. Lit-1

34. When both forward and backward reaction proceeds at equal rate it is
(a) State of equilibrium (b) dynamic equilibrium
(c) chemical equilibrium (d) static equilibrium

35. An example of _____ equilibrium is when evaporation rate becomes equal to rate of condensation
(a) Dynamic (b) chemical
(c) static (d) physical

36. Dynamic equilibrium means the molar concentration of the reactants and products
(a) Becomes constant (b) Becomes infinitely
(c) Decreases (d) increases

37. According to law of mass action rate of reaction is proportional to the product of active masses of
(a) Product (b) reactant
(c) concentration (d) catalyst

38. When reactant and product are in same phase equilibrium is
(a) Dynamic (b) heterogeneous
(c) homogenous (d) static

39. Equilibrium involving different phases of reactants and products is
(a) Dynamic (b) heterogeneous
(c) homogenous (d) static

40. Multiple phases of reactant and products means a phase
(a) Homogenous (b) heterogamous
(c) dynamic (d) static

41. A heterogeneous equilibrium means reactant and products arein
(a) Gaseous phase (b) liquid phase
(c) solid phase (d) more than one phase

42. When a system loses some energy ΔE Carries a
(a) Negative sign (b) Positive sign
(c) Neutral sign (d) No sign

43. Along with the average energy of reactants additional energy required for successful reaction is called
(a) Enthalpy function (b) Heat of reaction
(c) effective energy (d) activation energy

44. A substance that alters the rate of reaction without itself being used is called
(a) Catalyst (b) electrolyte
(c) acid (d) poison

45. A catalyst alters
(a) The direction of a reaction (b) The rate of a reaction
(c) The concentration of a reaction (d) The molecularity of a reaction

46. Rate constant K_c
(a) Does not change with the increase of temperature
(b) Change with the change of temperature
(c) does not change with the decrease in temperature
(d) None of these

47. Law of mass action states that rate of reaction is directly proportional to the
(a) Size of the container (b) Molar conc. of reactants
(c) nature of reactants (d) All of the above

48. Liquid and its vapors acquire _____ at constant temperature
(a) Constant equilibrium (b) static equilibrium
(c) dynamic equilibrium (d) none of these

49. If concentration of compound is taken in molar units then the equilibrium constant is
(a) K_l (b) K_{lp}
(c) K_{sf} (d) K_l

50. Conventionally product concentration is taken in
(a) numerator (b) denominator
(c) both of these (d) fractions

51. Which of the following has lowest heat of hydration?
(a) Li^+ (b) Na^+
(c) K^+ (d) Mg^{2+}

52. How much energy is absorbed during dissolution of one mole of NaCl
(a) 2.008 KJ/mol (b) 1.008 KJ/mol
(c) 4.008 KJ/mol (d) 3.008 KJ/mol

53. NaCl is used because of its _____ property in freezing the ice cream
(a) Constitutive property (b) Additive property
(c) Colligative property (d) Roault's law

54. _____ has the same oxidation number in all of its known compounds?
(a) Beryllium (b) Chlorine
(c) Bromine (d) Nitrogen

55. In K_2MnO_4, oxidation number of Mn is
(a) +7 (b) +6
(c) +5 (d) +4

56. Which statement is correct about standard hydrogen electrode?
(a) 1.0M HCl solution is used
(b) H_2 gas at 1 atm pressure is present
(c) Platinum electrode is used
(d) All of the above

57. Electrolysis is a process which utilizes
(a) Chemical energy (b) Electrical energy
(c) Heat energy (d) Biochemical energy

58. Standard hydrogen electrode has an arbitrarily fixed potential
(a) 0.00 volt (b) 1.00 volt
(c) 0.10 volt (d) 2.00 volts

59. The oxidation number of chromium in $K_2Cr_2O_7$ is
(a) 14 (b) 12
(c) 6 (d) 7

60. What is correct about electrolysis of molten NaCl
(a) Oxidation takes place at cathode (b) Cl_2 gas is produced at anode
(c) Reduction occurs at anode (d) H_2 gas is produced at cathode

61. Oxidation state of oxygen in OF_2 is
(a) 0 (b) +1
(c) -2 (d) +2

62. In superoxides, the oxygen has oxidation number
(a) 0 (b) +1
(c) -1/2 (d) -1

63. An electrochemical cell which produces electricity with a redox reaction is called a
(a) Voltaic cell (b) Standard cell
(c) Reversible cell (d) Electrolytic cell

64. A non-spontaneous redox reaction takes place as a result of electricity in
(a) Voltaic cell (b) Denial cell
(c) Dry cell (d) Electrolytic cell

65. Oxidation state of sulfur in SO_3^{2-}?
(a) -4 (b) -2
(c) +2 (d) +4

66. In lead storage batteries the cathode is made of
(a) Pb (b) Pb coated with PbO_2
(c) $PbSO_4$ (d) Mixture of Pb and PbO_2

67. Which reaction takes place at cathode during electrolysis?
(a) Oxidation (b) Reduction
(c) Both (d) None

68. In electrolysis of aqueous solution of NaCl which ion is discharged at anode
(a) Cl^- (b) OH^-
(c) Na^+ (d) H^+

69. What is true of following for the given reaction?

$$CrO_4^{2-} + 14H^+ + 6Cl^- \rightarrow 2Cr^{3+} + 3Cl_2 + 7H_2O$$

(a) Chromium is oxidized (b) Cl^- is reduced to Cl_2
(c) Cl^- is oxidized to Cl_2 (d) H^+ is reduced to H_2

70. on the basis of obtained standard deviation values, same set of samples analyzed with different methods can be compared using ———— ?
(a) Q test (b) F test
(c) T test (d) Regression coefficient

71. Detection limit is a concentration that gives a signal equals to ———— times to the standard deviation of the blank.
(a) 2 (b) 4
(c) 3 (d) 5

72. An analytical method is classified as meso when concentration of the analyte is
(a) 10-100 mg (b) >100 mg
(c) > 10 mg (d) 1-10 mg

73. How many significant figures are in answer of 47 – 47. 213.
(a) 1 (b) 2
(c) 5 (d) 3

74. How many significant figures are in 0.00080670000.
(a) 8 (b) 2
(c) 5 (d) 3

75. In atomic absorption spectrophotometer the flame used is
(a) air-coal gas (b) air-propane
(c) air-acetylene (d) oxyacetylene

76. All are Argillaceous material irrespective of the
(a) Vlay (b) marine shells
(c) Slate (d) blast furnace slag

77. Cement can be synthesized by
(a) dry process (b) wet process
(c) both (d) None

78. Phosphorus is helpful in the growth of
(a) root (b) Leave
(c) stem (d) Seed

79. Rotary kiln comprises of zones
(a) 4 (b) 3
(c) 2 (d) 5

80. Nutrients that are required in small amount for the growth of plants are
(a) nitrogenous fertilizers (b) Micronutrients
(c) phosphorus fertilizer (d) all of the above

81. Urea can be most suitably synthesized by the raw material
(a) CH_4, N_2 and CO_2 (b) H_2, N_2 and CO
(c) H_2, CO_2 and H_2O (d) H_2O, N_2 and H_2

82. Urea is a fertilizer
(a) Synthetic
(b) Natural fertilizer
(c) provides micronutrients to the plants
(d) Inorganic water soluble compound

83. Percentage of nitrogen in urea is
(a) 36 (b) 46
(c) 56 (d) 66

84. Both nitrogen and phosphorus can be provided by the fertilizer
(a) urea (b) calcium superphosphate
(c) diammonium phosphate (d) potassium nitrate

85. Potassium functions in the plant to
(a) form starch sugar and fibrous material
(b) ripen the seeds and fruits
(c) increase the resistance against disease
(d) all the above statements are correct

86. Clinker is the
(a) roasted calcareous material
(b) roasted argillaceous material
(c) roasted calcareous and argillaceous material
(d) roasted gypsum

87. Cement contains highest percentage of
(a) CaO (b) SiO_2
(c) Al_2O_3 (d) MgO

88. Raw material of cement does not contain
(a) lime stone (b) Gypsum
(c) KNO_3 (d) Iron oxide

89. Manufacturing of cement process the correct sequence is
(a) crushing heating mixing grinding
(b) crushing mixing heating grinding and mixing
(c) crushing grinding mixing heating
(d) mixing heating grinding crushing

90. Correct percentage of clay and lime stone for cement preparation is
(a) 75% lime stone and 25% clay (b) 25% lime stone and 75% clay
(c) 15% lime stone and 55% clay (d) 55% lime stone and 15% clay

91. Country that has largest installed capacity of spindles is
(a)Japan (b)Philippines (c)China (d)India

92. Pure water can be obtained from sea water through the process of
(a) centrifugation (b) separating funnel
(c) fractional distillation (d) simple distillation

93. Bauxite is used as a raw material by the industry
(a) Aluminium Smelting (b) Steel

(c) Jute (d) Cement

94. Silica as a raw material is used by the industry
(a) Steel (b) Cement
(c) Coal (d) Aluminium

95. Which gas is not water soluble
(a) ammonia (b) carbon dioxide
(c) hydrogen (d)oxygen

96. Main source of thermal pollution is
(a) Sun heats up the lakes and ponds
(b) Hot water from factories drains into rivers and ponds
(c) Hot oil drains into rivers and lakes
(d) None of these

97. steel is marketed by public sector plants via
(a) TISCO (b) Tata Steel
(c) SAIL (d) GAIL

98. For the treatment of industrial effluents, mechanical mean used is
(a) sedimentation (b) rainwater harvesting
(c) recycling of waste water (d) biologically

99. The highest temperature of decomposition zone in cement manufacturing is
(a) 600°C (b) 800°C
(c) 1000°C (d) 1200°C

100. Reedy plant from which the word paper is derived is
(a) Rose (b) Sun flower
(c) Papyrus (d) Water Hyacinth

101. $n \rightarrow \sigma^*$ transition can happen in
(a) Saturated Alkyl halides (b) Alcohols
(c) Aldehydes (d) All of these

102. In flame photometry, the temperature of flame is determined depending upon
(a) Excitation energy of the element
(b) How it is combined in the sample
(c) The sensitivity required
(d) Presence of other elements

103. Which of the following processes may occur in flame?
(a) translational, vibrational and rotational motions
(b) excitation
(c) ionization
(d) All

104. Which of the following are involved in electronic transitions in organic molecules?
(a) σ – electrons (b) n – electrons
(c) π – electrons (d) All

105. Which of the following are separated with perfusion chromatography?
(a) Polar compounds (b) Macromolecules
(c) Micro molecules (d) Non polar compounds

106. Which of the following chromatographic techniques sometimes uses detector based on radio activity?
(a) GC (b)SEC (c)TLC (d)HPLC

107. In HPLC silica gel is used in the form of
(a) Aquagel (b) Xerogel
(c) Hydrogel (d) Biogel

108. Which of the following adsorbents is used for separation of xanthophyll and carotenoids?
(a) Silica gel (b) Alumina
(c) Starch (d) Calcium carbonate

109. Example of the micro wave active molecule is
(a) HCl (b) CO
(c) $CHCl_3$ (d) CH_3Cl

110. Which of the following when attached with benzene ring produces auxochromic effect?
(a) $-CH_3$ (b) – Cl
(c) – Br (d) All

111. Which device is used to prevent the back flow during pumping in chromatography?
(a) Check valve (b) Pressure
(c) Diffusion (d) Gas flow

112. Two partially immiscible liquids form a single phase at a temperature which is known as
(a) Transition temperature (b) Absolute temperature
(c) Consulate temperature (d) Room temperature

113. At what conditions the molar volume of CO_2 is maximum?
(a) STP (b) 127°C & 1 atm
(c) 0°C and 1 atm (d) 273°C and 1atm

114. All gases liquefy before reaching at
(a) 373 K (b) 273 K
(c) -473 K (d) 0 K

115. Select the correct relationship
(a) 1mm Hg = 1 torr = 1 atm (b) 1mm Hg = 760 torr = 1 atm
(c) 760 mm Hg = 760 torr = 1 atm (d) 760 mm Hg = 1 torr = 1atm

116. Acetone and chloroform mix with each other because of
(a) Intermolecular hydrogen bonding
(b) Dipole-dipole interaction
(c) Instantaneous dipole
(d) All of the above

117. Which of the following solid substances is considered as pseudo solid?
(a) NaCl (b) Glass
(c) CaF_2 (d) All

118. Antifreeze in the automobile is an important application of
(a) Constitutive property (b) Additive property
(c) Colligative property (d) Chemicals

119. What is the order of reaction of photosynthesis?
(a) 0 (b) 1
(c) 2 (d) Fractional order

120. What information is obtained from collision theory?
(a) Rate of reaction (b) order of reaction
(c) Molecularity of reaction (d) All of these

121. The reaction of hydrolysis of ethyl-acetate (ester) is a
(a) 1st order (b) 2nd order
(c) 3rd order (d) 0 order

122. If the rate constant (k) is in $mol^{-1}\ dm^3\ s^{-1}$, the order of reaction will be
(a) 1 (b) 2
(c) 3 (d) 0

123. Mn^{2+} ions formed during oxidation with $KMnO_4$ and acid which act as catalyst. This is an example of
(a) Chemo-catalyst (b) Auto-catalysis
(c) Inhibitor (d) Poisoning of catalysts

124. Instantaneous rate of reaction at the beginning is always ———— than average rate
(a) Small (b) Smaller
(c) Higher (d) Medium

125. What is the order of a reaction with Rate = K $[N_2O_5]$?
(a) First order (b) Pseudo first order
(c) Second order (d) Third order

126. Main component of solution is
(a) Solvent (b) Solute
(c) Solvent as well as solute (d) Solid particles

127. At given temperature if maximum amount of solute is present in a solvent, it gives
(a) Saturated solution (b) Unsaturated solution
(c) Supersaturated solution (d) Impure solution

128. Percentage composition may have possible relations
(a) Four (b) Five
(c) Three (d) One

129. The oxidation number in elemental states is always
(a) Positive (b) Negative
(c) Zero (d) Non-zero

130. K^+ has oxidation number
(a) +1 (b) +2
(c) +3 (d) -2

131. Ca^{2+} shows oxidation number
(a) +1 (b) +2
(c) +3 (d) -2

132. Except metal Hydrides, hydrogen shows oxidation state
(a) 0 (b) +1
(c) -1 (d) -2

133. In metal hydrides, oxidation state of hydrogen is
(a) 0 (b) +1
(c) -1 (d) ½

134. Oxygen except peroxides and super oxides shows oxidation state of
(a) -1 (b) -2
(c) +2 (d) -1/2

135. In peroxides oxygen shows oxidation number
(a) -1 (b) -2

(c) +2

136. Oxidation state of oxygen in super oxides is
(a) -1 (d) -1/2
(c) +2 (b) -2

137. The oxidation number of oxygen in CF_2
(a) -1 (d) -1/2
(c) +2 (b) -2

138. The oxidation number of each element of group VII-A in binary compounds is
(a) -1 (d) -1/2
(c) +2 (b) -2

139. Group IA elements shows oxidation state
(a) -1 (d) 0
(c) +1 (b) -2

140. Group IIA elements shows oxidation state of
(a) -1 (d) +2
(c) +2 (b) -2

141. Group IIIA elements shows oxidation state of
(a) -1 (d) +4
(c) +2 (b) -2

142. In a neutral compound total sum of all the oxidation states is always
(a) Zero (b) One
(c) Two (d) Three

143. Chromium shows oxidation number in sodium dichromate
(a) +4 (b) +6
(c) +5 (d) +8

144. Noble gases show oxidation number
(a) +1 (b) 0
(c) -1 (d) -2

145. Chromium has oxidation number in $K_2Cr_2O_7$
(a) +4 (b) +6
(c) +5 (d) +8

146. Sulpher in SO_2 has oxidation number
(a) -4 (b) +6
(c) +4 (d) +2

147. Iron in $K_3Fe(CN)_6$ shows oxidation state
(a) +2 (b) +3
(c) +4 (d) +1

148. 12% alcohol means $12cm^3$ of alcohol dissolved in _____ of solution
(a) $90\ cm^3$ (b) $100\ cm^3$
(c) $110\ cm^3$ (d) $112cm^3$

149. If a solution is 10^{-7} M, it would be
(a) Neutral solution (b) Acidic solution
(c) Basic solution (d) slightly acidic

150. 1 litre of solution having one mole of solute is
(a) 1 molar (b) 1molal

(c) 1 Normal (d) None of the above

151. $CaCO_3$ has the percentage composition
(a) Ca 1%, C1%, O_2 3% (b) Ca 40%, C 12%, O_2 48%
(c) Ca 12%, C 40%, O_2 48% (d) Ca 48%, C 12%, O_2 40%

152. A solution having hydrogen ion concentration of 5.5×10^{-3} M will have the pH
(a) 2.26 (b) 3.40
(c) 3.75 (d) 2.76

153. Technique that can be used to separate aniline from a mixture is
(a) Fractional crystallization (b) Fractional distillation
(c) Vacuum distillation (d) Steam distillation

154. Which units of solution are independent of temperature
(a) Molarity (b) Normality
(c) Formality (d) Molality

155. If a solution is made by mixing 20 ml of N/2 H_2SO_4, 5ml of N-HCl, and 30ml of N/3 HNO_3 in one litre, resulting normality will be
(a) N/5 (b) N/10
(c) N/20 (d) N/40

156. In NH_4OH silver halide that is least soluble
(a) AgBr (b) AgF
(c) AgCl (d) AgI

157. A salt gives yellow precipitates by passing H_2S gas through its acidified solution that is soluble in ammonium sulphide, the radical present is
(a) As^{3+} (b) Sb^{3+}
(c) Cd^{2+} (d) Cu^{2+}

158. In qualitative analysis of Fe, during precipitation NH_4Cl is added before NH_4OH to
(a) Decrease concentration of OH^- ions
(b) Prevent interference by phosphate ions
(c) Increase concentration of Cl^- ions
(d) Increase concentration of NH_4^+ ions

159. When HCl is added to stannous sulphide solution made with yellow ammonium sulphide, the precipitates formed are
(a) SnS (b) SnS_2
(c) Sn_2S_2 (d) $(NH_4)_2SnS_2$

160. Which one of the following can be used instead of NH_4Cl for the precipitation of the third group radicals
(a) Ammonium nitrate (b) Ammonium sulphate
(c) Ammonium oxalate (d) Sodium chloride

161. Before tha analysis of III group radicals the conc. Nitric acid is added to
(a) Oxidise any remaining H_2S
(b) Form nitrate which gives granular ppt.
(c) Convert ferrous into ferric ions
(d) Increase ionization of NH_4OH

162. When KI is heated by mixing with conc. H_2SO_4, specie formed is
(a) HI (b) I_2

(c) HIO_3 (d) KIO_3

163. IV^{th} group of basic radicals is analyzed in the presence of H_2S by adding
(a) HCl (b) NaOH
(c) NH_4Cl (d) NH_4Cl and NH_4OH

164. If flame test of a salt generates brick red color, it indicates
(a) Na (b) K
(c) Sr (d) Ca

165. C_5H_{12} generates 1 signal in the proton NMR while 2 signals are generated in C-13 NMR, compound is
(a) pentane.
(b) 2-methylbutane.
(c) 2,2-dimethylpropane.
(d) Cannot tell without more information.

166. How many ml of 1M H_2SO_4 solution can be neutralize by using 10 milliliters of 1M NaOH solution?
(a) 2.5 ml (b) 5.0 ml
(c) 10 ml (d) 20 ml

167. Molal solution means one mole of solute dissolved in
(a) 1000 gm of the solvent (b) One litre of the solvent
(c) One litre of the solution (d) 22.4 litre of the solution

168. 0.1 M solution is basic by
(a) Ammonium acetate (b) Ammonium chloride
(c) Ammonium sulphate (d) Sodium acetate

169. Heat changes in a chemical are studied in the branch of chemistry is
(a) Thermochemistry (b) Electrochemistry
(c) Photochemistry (d) Thermodynamics

170. In Joules calorie is equivalent
(a) 0.418 J (b) 41.84 J
(c) 4.184 J (d) 418.45 J

171. Energy of a state function is
(a) Highest (b) Lowest
(c) Intermediate (d) Have any amount of energy

172. System always tends to be stable by attaining a state of
(a) Lowest energy (b) Same as before
(c) Higher energy (d) Reverse to original energy

173. If heat is transferred from the system to the surrounding process is called
(a) Endothermic (b) Exothermic
(c) Fast reaction (d) Emitter

174. Heat is released in reaction is
(a) Exothermic (b) Endothermic
(c) None of these (d) Both of these

175. If heat change is negative, reaction is said to be
(a) Reversible (b) At equilibrium
(c) Exothermic (d) Endothermic

176. AgCl in water has the solubility product
(a) 1.8×10^{-10} (b) 9.8×10^{-6}

(c) 1.2×10^{-10} (d) None of the above

177. To make Saturated solution of NaCl in water at 0°C we needs
(a) 37.5 g of NaCl in 100g of H_2O (b) 37.5 g of NaCl in 1000 g of H_2O
(c) 375 g of NaCl in 100 g of H_2O (d) 37.5 g of NaCl in 10 g of H_2O

178. The solubility of $Ce_2(SO_4)_3$ shows straight line in graph
(a) Below 40°C (b) Below 30°C
(c) from 40°C onwards (d) From 60°C onwards

179. $CuSO_4$ in water at 0C shows the solubility of
(a) 14.3 g/100g (b) 14.3 g/10g
(c) 39.0g/100g (d) 48.2g/100g

180. At 100 C $CuSO_4$ in water shows solubility of
(a) 60.5g/100g (b) 65.5 g/100g
(c) 75.5 g/100g (d) 80.9g/100g

181. Not a colligative property?
(a) Density (b) depression of freezing pint
(c) Elevation of boiling point (d) Osmotic pressure

182. Hydrates are obtained by crystallizing compounds from there
(a) Aqueous solution (b) original solution
(c) saturated solution (d) Dilute solution

183. Heat is evolved in which of the following process most likely?
(a) Dissociation (b) Sublimation
(c) Hydration (d) Ionization

184. Molal boiling point constant K_b is the ratio of the elevation in boiling point to
(a) Molarity (b) Molality
(c) Mole fraction of solvent (d) mole fraction of solute

185. The average rate of reaction between two intervals is to reaction rate at any moment
(a) Equal (b) Not equal
(c) Balanced (d) Higher

186. Mathematically rate of reaction is
(a) dc/dt (b) dt/dc
(c) d(c) Dt (d) $(d(c)^2/(dt)^2$

187. By increasing the concentration of reactants
(a) Increases the number of collisions directly
(b) Has no effect on the number of collisions
(c) Has inverse effect on the number of collisions
(d) Decrease the number of collisions

188. For a reaction, A → B, Rate of reaction = -dx/dt means the concentration of the reacting specie
(a) Increasing (b) decreasing
(c) Not changing (d) Reaction is not possible

189. Units for Concentration of a solution are
(a) Mol/litre (b) $mol^{-1}/litre^{-1}$
(c) $mol^{-1}l$ (d) mol l

190. The rate of reaction has units
(a) Mol $l^{-1}s^{-1}$ (b) $Mol^{-1}l^{-1}s^{-1}$
(c) Mol l S^{-1} (d) Mol l s

191. If concentration change for a reaction is zero, the rate of reaction will be
(a) 1 (b) 0
(c) depends on time (d) Impossible to predict

192. By increase the initial concentration of reactant reaction rate may
(a) Increase (b) Decrease
(c) Does not effect at all (d) All above

193. In reaction $2H_2+2NO \rightarrow 2H_2O+N_2$ doubling or tripling the concentration of NO, rate increases
(a) Four times & nine times (b) Five times & ten times
(c) Three times & six times (d) Two times & three times

194. Temperature increase causer the increase in the reaction rate of
(a) Exothermic reaction (b) Endothermic reaction
(c) Increase a little (d) Decrease rapidly

195. Increase in temperature causes the rate of reaction to
(a) Increase greatly (b) Does not increase
(c) Increase a little (d) decrease rapidly

196. Correct units of reaction rate are?
(a) mol/dm^3 (b) Mol/s
(c) Mol/dm^3s (d) S

197. By increasing concentration, the rate of reaction
(a) Increases (b) Decreases
(c) Remains same (d) Not effected at all

198. Units for the rate of gaseous reaction are expressed as
(a) Grams/s (b) Atomic s^{-1}
(c) Mol $l^{-1}s^{-1}$ (d) Atmospheric sec^{-1}

199. Reaction rate
(a) Increases as reaction proceeds
(b) Decreases as reaction proceeds
(c) Remains the same as reaction proceeds
(d) May decreases or increases

200. A 10 °C increase in temperatures doubles the rate of reaction due to
(a) Decreases activation energy of reaction
(b) Decrease the number of collisions between reactions
(c) Increase in the activation energy of reactants
(d) Increase in the number of effective collisions

201. Nuclear spin can be observed
(a) in all Nuclei (b) in most Nuclei
(c) only in g,g Nuclei (d) in C nuclei only

202. When subjected to a strong magnetic field
(a) one measures an IR spectrum
(b) the swaying of an atom becomes larger
(c) the nuclear spins orient themselves
(d) C atoms orient only

203. A solute of red color will
(a) absorbs red light (b) absorbs green light
(c) emits green light (d) Absorb orange light

204. Extinction coefficient is
(a) a constant of a substance (b) a universal constant
(c) equal to one (d) equal to 0

205. If concentration of substance is doubled
(a) the wave length of the absorption is different
(b) the extinction coefficient is twice as large
(c) the extinction is twice as large
(d) 4 times large

206. Infrared radiations are
(a) waves of warmth
(b) possessing more energy than UV waves
(c) red
(d) Cool waves

207. In IR spectrum, the units of entity taken on the abscissa are
(a) meter (b) centimeter
(c) per centimeter (d) per meter

208. Aqua-regia is formed by mixing
(a) 1part conc. HCl and 3 parts conc. HNO_3
(b) 2part conc. HCl and 1 part conc. HNO_3
(c) 2parts conc. HCl and 1 part conc. HNO_3
(d) 3parts conc. HCl and 2 parts conc. HNO_2

209. Why HCl is preferred over HNO_3 to make solutions in inorganic salt analysis?
(a) Nitrates are not decomposed to sulphides
(b) Nitric acid contains nitrogen
(c) Hydrochloric acid is not an oxidizing agent
(d) Chlorides are easily converted to sulphides

210. The units taken on abscissa in an NMR spectrum are
(a) δ (b) Hertz
(c) ppm (d) nm

211. Largest chemical shift signal appeared in a ^{13}C NMR spectrum is due to
(a) C=O groups (b) CH_3 groups
(c) aromatic C-Nuclei (d) All have same value

212. In NMR spectrum, a triplet means
(a) a triple linear signals (b) three signals
(c) three spectrums (d) Due to doublet in vicinity

213. In a ^1H NMR at a neighboring C atom a CH_2 group generates
(a) doublet (b) triplet
(c) quadruplet (d) pentate

214. In aromatic C nucleus, a hydrogen signal is expected at
(a) 2 ppm (b) 4 ppm
(c) 7 ppm (d) 9 ppm

215. ^{13}C NMR spectrum
(a) a triplet is evidence of a CH_3 group presence
(b) the signals are between 0 and 10 ppm
(c) every C atom generates a signal
(d) every H atom generates a signal

216. In mass spectrometry
(a) the analyzed substance remains intact
(b) large quantities of the substance are required
(c) the analyzed substance is ionized
(d) All

217. In qualitative analysis Al^{3+}, Cr^{3+} and Fe^{3+} are kept in same group because their
(a) Carbonates are insoluble in ammonia
(b) Hydroxides are insoluble in ammonia
(c) Sulphides are soluble in acids
(d) Electronic charge is the same

218. Mass spectrometery provides the information about
(a) the color of a substance
(b) the molecular mass of a substance
(c) the reactivity of a substance
(d) Physical properties

219. Function of magnet in mass spectrometer is to work as
(a) recorder for the NMR spectrum
(b) accelerator for the ions
(c) deflector for the ions
(d) protector for the ions

220. Approximate weight of an element having specific heat 0.16, will be
(a) 16 (b) 40
(c) 30 (d) 64

221. Most deshielded protons are present in
(a) CH_3Cl (b) CH_3I
(c) CH_3Br (d) CH_4

222. Most deshielded methyl protons are present in
(a) tetramethylsilane (b) methyl fluoride
(c) methanol (d) methylamine

223. Splitting pattern of methylene protons in propane is
(a) triplet (b) quartet
(c) doublet (d) septet

224. Methylene protons shows signal for of butane
(a) doublet (b) triplet
(c) quartet (d) quintet

225. Amount of O_2 liberated when 10 ml 20 vol solution of H_2O_2 is heated
(a) 20 ml (b) 30 ml
(c) 200 ml (d) 400 ml

226. At upper consulate temperature of 49.1°C Methanol cyclohexane system show percentage
(a) 21% (b) 23%
(c) 27% (d) 29%

227. Phenol water system homogenizes as
(a) 30% Phenol, 70% water (b) 35% phenol, 65% water
(c) 34% phenol, 66 % H_2O (d) 40% Phenol, 60 % H_2O

228. Single layer of water aniline system appears at
(a) 120°C (b) 134°C

(c) 165°C (d) 167°C

229. Consulate temperature of Methanol cyclohexane system is
(a) 35.1°C (b) 41.3°C
(c) 49.1°C (d) 51.4°C

230. Raoult's law depicts that the lowering of V.P is
(a) Inversely proportional to mole fraction of solute
(b) Directly proportional to mole fraction of solute
(c) Inversely proportional to absolute T
(d) Directly proportional to absolute T

231. Relative lowering of vapor pressure is
(a) Independent of T
(b) depends upon the concentration of solute
(c) Is constant when equimolar proportion of different solutes are dissolved in the same mass
(d) all of the above

232. Substance having chemically attached water molecules is called
(a) Crystal (b) Hydrate
(c) Solvate (d) None of these

233. If CH_3COONa is hydrolyzed the solution produced will be
(a) Acidic (b) Basic
(c) neutral (d) None of these

234. At a given temperature the amount of solute dissolved in 100 g of solvent is known as
(a) Solubility Product (b) Solubility
(c) Molarity (d) Normality

235. If Cl^- ions are added to saturated solution of KCl, solubility of KCl will
(a) Decrease (b) Increases
(c) Remains the same (d) Not effect at all

236. The substance that does not dissolve in sufficient amount is known as
(a) Sparingly soluble (b) Miscible
(c) Remains same (d) Not effect at all

237. At freezing point temperature, solid and liquid phases of given substance have the
(a) different vapor pressure (b) Same vapor pressure
(c) Absolute vapor P (d) none of these

238. Elevation of boiling point of a substance
(a) Can be studied by Beckmann method
(b) Can be studied by Landberger,s method
(c) cannot be studied by Landbergers method
(d) None of these

239. Following is the colligative property
(a) lowering of vapor pressure (b) elevation of boiling point
(c) Depression of freezing point (d) All of the above

240. Colligative properties are dependent on
(a) The number of solute ions (b) The number of solvent ions
(c) Both A &B (d) Might A not B

241. When the solvent is containing dissolved nonvolatile solute particles is
(a) Vapor pressure is decreased

(b) Vapor pressure is elevated
(c) vapor pressure is neither decreased nor increased
(d) Vapor pressure is either decrees or increase

242. Greater the concentration of solute
(a) The higher will be boiling point
(b) The lower will be boiling point
(c) The boiling point is not affected
(d) no change in vapor pressure

243. There is 1g CO_3^{-1}present in 1000g aq solution of $CaCO_3$. The concentration of solution is
(a) 1000 ppm (b) 100 ppm
(c) 10 ppm (d) 10, 000 ppm

244. For the preparation of 250 Cm^3 of 0.1 M solution how much NaOH is required?
(a) 1g (b) 10 g
(c) 2g (d) 6g

245. 2%NaOH solution has molality nearly
(a) 0.5 (b) 0.05
(c) 0.25 (d) 2.05

246. In a 500 cm^3 of 3M solution the number of moles of solute are
(a) 1 (b) 1.5
(c) 3 (d) 4

247. If 8g of NaOH dissolved in 500 cm^3 of solution the molarity will be?
(a) 0.2M (b) 0.04M
(c) 0.4M (d) 0.8M

248. Molarity of a solution has units
(a) moles/Kg (b) g/dm^3
(c) dm^3/mol (d) Mol/dm^3

249. The mole fraction is expressed in units
(a) mol/dm^3 (b) Moles/kg
(c) g/dm^3 (d) None

250. Mole fraction of oxygen in 7g nitrogen and 8g oxygen mixture is
(a) 1 (b) 0.1
(c) 0.5 (d) 0.2

251. Electrolysis of KNO_3(aq) generates
(a) K and N (b) K and N_2
(c) N_2 and O_2 (d) K and O

252. NaOH electrolysis gives
(a) H is collected at anode (b) Is collected at anode
(c) H_2 at anode (d) O_2 at anode

253. In down cell product is obtained by electrolysis of
(a) Aqeous solution of NaCl
(b) Fused sodium chloride
(c) Aqueous solution & fused NaCl at some time
(d) Either (a) or (b)

254. Caustic soda is prepared industrially from
(a) Concentrated solution of NaCl
(b) Any solution of NaCl

(c) Dilute solution of NaCl
(d) Fused NaCl

255. Magnesium metal is obtained in electrolytic cell by
(a) Concentrated aqueous solution of its chloride
(b) Dilute aqueous solution of its chloride
(c) Its fused chloride
(d) Any solution

256. Aluminum is obtained in electrolysis process from
(a) Fused Bauxite
(b) In the presence of catalyst
(c) In the presence of fused cryolite
(d) All of the above

257. Cell that produces electricity is called
(a) Dry cell (b) Unit cell
(c) Voltaic cell (d) Battery cell

258. Cathode attracts
(a) Cations (b) Anions
(c) Hydroxyl ions (d) Oxide ions

259. Anode attracts
(a) Anions (b) Cations
(c) Electrodes (d) Neutral in nature

260. Reducing agent is itself
(a) Oxidized (b) Ionized
(c) Reduced (d) Neutralized

261. Addition of oxygen or removal of hydrogen is called
(a) Oxidation reaction (b) Reduction reaction
(c) Half cell reaction (d) Over cell reaction

262. Oxidation takes place at
(a) Anode (b) Cathode
(c) Electrode (d) Ion solution

263. Electrons are received at
(a) Anode (b) Cathode
(c) Electrode (d) wall of cell

264. Electrons are lost in
(a) Oxidation (b) Reduction
(c) Electrolysis (d) Vallancy

265. $CaCO_3 \rightarrow CaO + CO_2$ here calcium under goes.
(a) Oxidation (b) Reduction
(c) No change in oxidation state (d) Both oxidation and Reduction

266. Emf generated by voltaic cell is called
(a) Oxidation potential (b) Cell potential
(c) Redox potential (d) None of above

267. Electromotive force is measured in
(a) Volts (b) Joule
(c) Coulomb (d) Ohm

268. Electrolyte can conduct electricity
(a) In the form of solution (b) In fused state
(c) In any form (d) Either (a) or (b)

269. SHE arbitrarily taken as
(a) 0.0 volt (b) (b) 1.0 volt
(c) 0.10 volt (d) 1.20 volt

270. Metal can replace other in a reaction if it has place in series
(a) Below (b) Above
(c) Between (d) Anywhere in

271. Lead accumulator battery has cathode made of
(a) Pb (b) PbO_2
(c) PbO_3 (d) CuO

272. The single cell of lead accumulator generates
(a) 2 V (b) 2.5 V
(c) 4 V (d) 8 V

273. Alkaline battery cell generates
(a) 1 volt (b) 1.5 volt
(c) 2 volt (d) 5 volt

274. Solute particles are surrounded by solvent molecules in
(a) Hydrolysis (b) Hydration
(c) Solvation (d) Dissolution

275. Solution having higher amount of salt dissolved is
(a) Saturated solution (b) Buffer solution
(c) Concentrated solution (d) Unsaturated solution

276. The enthalpy change for the reaction of an acid and base is called
$NaOH + HCl \rightarrow NaCl + H_2O$
(a) Heat of reaction (b) Heat of formation
(c) Heat of neutralization (d) Heat of combustion

277. In a spontaneously endothermic reaction the temperature of the surrounding
(a) Remains constant (b) Increases
(c) Decreases (d) Remain unchanged

278. The enthalpy of any element in its standard state is
(a) 1 kJ mol^{-1} (b) Zero
(c) 298 kJ mol^{-1} (d) Always +ve

279. The unit of enthalpy is
(a) Joule (b) Coulomb
(c) Volt (d) Kg m^{-1} s^{-1}

280. Total kinetic energy of molecules is due to sum of its
(a) Translational motion (b) Rotational motion
(c) Vibrational motion (d) All

281. Which property of gas is state function?
(a) Enthalpy (b) Entropy
(c) Pressure (d) All of these

282. Which of the following is and endothermic process?
(a) Condensation of steam (b) Freezing of water
(c) Electrolysis of water (d) All

283. In a bomb calorimeter the reaction is carried out at ———
(a) Constant volume (b) Constant pressure
(c) Constant pressure (d) a, b and c condition

284. Solubility of $Ca(OH)_2$ is exothermic and will increase
(a) At high temperature (b) At low temperature
(c) Temperature independent (d) None

285. Ionization constant K_a for acetic acid at 25°C is
(a) 1.85×10^{-5} (b) 1.85×10^{-10}
(c) 1.85×10^{-15} (d) 1.85×10^{-20}

286. The rate of reaction ——— as reaction proceeds.
(a) Increases (b) Decreases
(c) Remains same (d) May decrease or increase

287. What is the pH of pure water?
(a) 6.2 (b) 7
(c) 14 (d) 0

288. Human blood has a pH value of
(a) 7.0 (b) 7.35
(c) 7.85 (d) 6.65

289. 0.001N NaOH aqueous solution has pH
(a) 11 (b) 3
(c) 8 (d) 12

290. The dissociation constant for water at 25°C is
(a) 1×10^{-7} (b) 1×10^{-14}
(c) 1×10^{-19} (d) 7×10^{-14}

291. If H^+ ions concentration is 1×10^{-7} its pH will be
(a) Acid (b) Basic
(c) Neutral (d) Zero

292. Crystalline solids containing water are called
(a) Hydrates (b) Hydrides
(c) Hydrolyzed (d) All above

293. Azeotropic mixtures can be separated by
(a) Simple distillation (b) Fractional distillation
(c) Vacuum distillation (d) All

294. The molality of solution containing 10g of NaOH/Kg solution is
(a) 0.25m (b) 0.5m
(c) 1.0m (d) 2.0m

295. Hydrolysis of potassium acetate produces
(a) Acidic solution (b) Basic solution
(c) Neutral solution (d) None of these

296. One molal solution contains
(a) 1 dm^3 of solvent (b) 1 dm^3 of solution
(c) 1000 g of solvent (d) 22.4 dm^3 of solution

297. In a solution the sum of mole of fractions of all components is always equal to
(a) Zero (b) One
(c) Two (d) 100

298. Two miscible liquids obey Raoult's law if
(a) $\Delta H = 0$
(b) $\Delta V = 0$
(c) Both ΔH and ΔV are zero
(d) Neither ΔV nor ΔH should be zero

299. Which of the following compounds has highest freezing point?
(a) 1 mole NaCl (b) 1 mole KCl
(c) 1 mole $CaCl_2$ (d) 1 mole Urea

300. 10% aqueous solution of glucose freezes at
(a) 0°C (b) < 0°C
(c) > 0°C (d) Suspension

301. Paschen, Bracket and P-fund series of emission spectra of atomic hydrogen lie in
(a) Infrared region (b) X-ray region
(c) Ultraviolet region (d) Microwave region

302. According to Aufbau's principle which one of the following orbitals should be filled first?
(a) 3d (b) 4f
(c) 5d (d) 4s

303. X-rays are attracted towards
(a) Anode (b) Cathode
(c) Both (a & b) (d) All

304. Which of the following rays are used in television picture tube?
(a) Positive rays tube (b) Discharge tube
(c) X-rays tube (d) Millikan tube

305. Which of the following quantum numbers determines the shape of an orbital?
(a) Spin (b) Azimuthal
(c) Magnetic (d) Principal

306. Which of the following atomic orbitals has highest energy?
(a) 2s (b) 1s
(c) 3s (d) 4d

307. Which quantum number will be different for the two electrons present in an s-orbital?
(a) Principle quantum number (b) Azimuthal quantum number
(c) Magnetic quantum number (d) Spin quantum number

308. In nitrogen with electronic configuration $1s^2, 2s^2, 2p^3$ the number of unpaired electrons is
(a) 0 (b) 1
(c) 3 (d) 5

309. Principle, azimuthal and magnetic quantum numbers are respectively related to
(a) Size, shape and orientation (b) Shape, orientation and size
(c) Size, orientation and shape (d) Shape, size and orientation

310. Dalton's law of partial pressure is not obeyed by
(a) N_2 and O_2 (b) H_2 and O_2
(c) NH_3 and HCl (d) H_2 and He

311. Is comparison to H_2 the diffusion rate of a gas having 72 molar mass will be
(a) 1/6 times (b) 1.4 times
(c) 6 times (d) same

312. If a gas at 273 K and 76 cm Hg has a density of 1.98 g dm^{-3} it could be
(a) CH_4 (b) C_2H_6

(c) CO2 (d) X_e

313. Liquefaction of an ideal gas is not possible because
(a) It has critical temperature above 0°C
(b) Molecules have small size
(c) Molecules have extra-large size
(d) Negligible operative force

314. Density of a gas is usually expressed in
(a) Kg m^{-3} (b) Kg dm^{-3}
(c) g dm^{-3} (d) g cm^{-3}

315. The SI units for Van der Waal constant "a" is
(a) atom dm^3mol^{-2} (b) atom dm^6mol^{-2}
(c) Nm^4 mol^{-2} (d) Nm mol^{-1}

316. The Chromatography in which the mobile phase is a gas is called?
(a) Absorption (b) Partition
(c) Gas (d) Ion exchange

317. In paper chromatography if the paper is dipped in a pool at the bottom of the container it is is called?
(a) Liquid solid chromatography
(b) Liquid gas chromatography
(c) Descending paper chromatography
(d) Ascending paper chromatography

318. In paper chromatography retardation factor (Rf) value cannot be more than
(a) 0 (b) 0.1
(c) 1 (d) 0.5

319. Gas chromatography can only be used for mixtures which are
(a) Volatile or thermally unstable
(b) Volatile or thermally stable
(c) Non-volatile or thermally stable
(d) Non-volatile or thermally unstable

320. The term "chromatography" came from "chroma" and "graphy" which mean
(a) Color writing (b) Colorless
(c) Color forming (d) Color spreading

321. Which of the following gases has lowest density at STP?
(a) N_2 (b) CO
(c) Ne (d) NH_3

322. Kinetic molecular theory of gases was given by
(a) Bernoulli (b) Clausius
(c) Maxwell & Boltzmann (d) All

323. The cooling process based on Joule-Thomson effect is
(a) Exothermic (b) Endothermic
(c) Both (d) None

324. Plasma is the forth state of visible matter which constitutes universe nearly
(a) 50% (b) 25%
(c) 75% (d) 99%

325. Which of the following compounds absorb radiation appreciably below 200 nm?
(a) $CH_2 = CH_2$ (b) CH_2COCH_3

(c) $CH_2 = CH - CH = CH_2$ (d) Both (a & b)

326. Inner membrane of the mitochondrion is embedded by
(a) the enzymes of the tricarboxylic acid cycle (Krebs' cycle)
(b) the components of the electron transport chain
(c) glycogen molecules
(d) triacylglycerol molecules

327. Breakdown of Liver glycogen is triggered by
(a) Insulin (b) glucagon
(c) adrenaline (d) both (b) and (c)

328. Complete oxidation of one gram of carbohydrates yields energy
(a) 4 kJ (b) 8 kJ
(c) 16 kJ (d) 24 Kj

329. Experimentally Nucleic acids can be analyzed by studying
(a) molecular weight (b) absorption of visible light
(c) absorption of UV light (d) none of these

330. Thymidine
(a) can participate in hydrophobic interactions due to its methyl group
(b) is replaced by uracil in RNA
(c) normally forms two hydrogen bonds with adenosine
(d) all of the above

331. RNA and DNA contains sugars respectively
(a) deoxyribose, ribose (b) ribose, deoxyribose
(c) ribose, phosphate (d) ribose, uracil

332. Nucleoside is a purine or pyrimidine base is
(a) covalently bonded to a sugar (b) ionically bonded to a sugar
(c) hydrogen bonded to a sugar (d) none of the above

333. Fragments that will move fast in gel electrophoresis are
(a) Large fragments (b) Small fragments
(c) Large genome (d) None of these

334. Cholestrol is the precursor of
(a) steroid hormones (b) vitamin A
(c) bile salts (d) both (a) and (c)

335. In the regulation of fatty acid synthesis the key enzyme is
(a) acetyl CoA carboxylase (b) AMP activated proteinkinase
(c) protein phosphatase (d) none of these

336. In Arachidonate 20 carbon atoms are found with
(a) 3 double bonds (b) 2 double bonds
(c) 4 double bonds (d) 8 double bonds

337. Triacylglycerols are
(a) soluble in water
(b) Insoluble in water
(c) soluble in water at elevated temperature
(d) partially soluble in water

338. Animals are unable to convert fatty acids into glucose since
(a) acetyl CoA cannot be converted to pyruvate
(b) absence of malate synthase

(c) absence of dehydrogenase
(d) absence of a-ketoglutarate dehydrogenase

339. Fatty acid breakdown in eukaryotes takes place in
(a) mitochondrial matrix (b) Cytosol
(c) cell membrane (d) endoplasmic reticulum

340. Phospholipid accompany
(a) hydrophilic heads and hydrophobic tails
(b) long water-soluble carbon chains
(c) positively charged functional groups
(d) both (b) and (c)

341. Fatty acids is broken down in eukaryotic cells in
(a) mitochondrial matrix (b) cell membrane
(c) Cytosol (d) endoplasmic reticulum

342. Fertility of soil can be enhanced by
(a) Rotation of the crops
(b) Adding lime to the acid salts
(c) Adding manure and growing legumes
(d) All

343. Which statement is not correct about the nitrogen importance?
(a) It enhances plant growth
(b) It is involved in the synthesis of protein and nucleic acids
(c) It accelerates fruits and flowers growth
(d) It is involved in the chlorophyll synthesis

344. The single nutrient that provides NPK fertilizer is
(a) Straight (b) Compound
(c) both a and b (d) none of the above

345. Which of following is a macronutrient
(a) Cu (b) Cl
(c) H (d) Zn

346. When urea is added to the soil, reaction takes place is
(a) Endothermic (b) exothermic
(c) both a and b (d) no heat energy is involved

347. For ammonia synthesis most suitable catalyst is
(a) Pt
(b) $ZnO + Cr_2O_3$
(c) Fe in fused mixture of $Al_2O_3 + SiO_2 + MgO$
(d) All of the above

348. Molten urea is cooled by counter air flow in the tower by the process known as
(a) Prilling (b) Evaporation
(c) Condensation (d) Crystallization

349. paddy rice are not suitable fields for fertilizer that is
(a) Urea (b) DAP
(c) Ammonium sulphate (d) NH_4NO_3

350. Calcareous material among the following is
(a) lime stone (b) marble
(c) Chalk (d) All

351. Na_2CO_3 has Enthalpy of solution
(a) -102 kj/mole (b) -19.3 kj/mole
(c) -25.0 kj/mole (d) -29.0 kj/mole

352. Bomb calorimeter measures heat of reaction at
(a) Constant volume (b) constant pressure
(c) both of them (d) None of them

353. A calorimeter measures
(a) Heat of reaction (b) Heat of combustion
(c) Heat of formation (d) Heat of vaporization

354. Hess's law cannot be used to measure
(a) Heat of combustion (b) enthalpy charge
(c) heat of dissolution (d) internal energy

355. Hess's law is just as the
(a) Law of transformation (b) Law of heat exchange
(c) Law of heat summation (d) Law of constant composition

356. Reaction that never stops and move in both directions is
(a) Reversible reaction (b) Irreversible reaction
(c) Equilibrium reaction (d) none of the above

357. $PCl_5 \rightarrow PCl_3 + Cl_2$ here dissociation of phosphorus pentachloride is
(a) Reversible reaction (b) irreversible reaction
(c) incomplete reaction (d) Uni directional

358. As the reaction proceeds the rate of reaction
(a) Decreases (b) increases
(c) remains constant (d) decreases as well increases

359. Bidirectional reaction is also known as
(a) Reversible reaction (b) exothermic reaction
(c) endothermic react (d) Irreversible reaction

360. Reversible reactions proceed in
(a) Forward direction (b) Backward direction
(c) both directions (d) none of the direction

361. Reaction which continues only in one direction up to completion is
(a) Equilibrium reaction (b) reversible reaction
(c) irreversible (d) bidirectional

362. When equilibrium is established the concentration of reactants and products becomes
(a) Constant (b) different
(c) zero (d) same

363. Equilibrium can be expressed most accurately by saying that
(a) Temperature of opposing reactions is equal
(b) Rates of opposing reactions becomes equal
(c) Opposing reactions ceases
(d) Come of reactants is products are equal

364. Heat energy change at constant temperature and constant pressure is known as
(a) Enthalpy change (b) heat of sublimation
(c) bond energy (d) internal energy changes

365. Relationship between the entities, H, P, ∈ & V is
(a) ∈=H+PV (b) ∈=H-P
(c) H=∈+PV (d) H=∈-Pv

366. Symbol by which standard heat of formation is expressed
(a) ΔH_f (b) ΔH_f^0
(c) ΔH (d) Δ∈

367. Taking standard heat of formation, the it is considered that heat contests of all the participating elements is
(a) Zero (b) positive
(c) negative (d) normal

368. Temperature at which standard enthalpies are taken is
(a) 273 k (b) 373k
(c) 298 k (d) 290 k

369. Enthalpy of a system is represents its
(a) Heat content (b) energy state
(c) reaction rate (d) activation energy

370. ΔH° is measured at the temperature
(a) 0C (b) 25C
(c) 100C (d) 150C

371. The enthalpy change for the reaction of CO and O to form CO_2 has ΔH
(a) -110.53 KJ/mol (b) -282.98 KJ/mole
(c) 393.15 Kj/mole (d) 110.53 KJ/mole

372. Heat of formation is positive for
(a) NH_3 (b) CO_2
(c) NO (d) H_2O

373. Positive values for enthalpy change are for the process of
(a) Neutralization (b) Sublimation
(c) Atomization (d) All of the above

374. $\Delta H°_f$ MgO formation is
(a) -500 kj/mole (b) -550 kj/mole
(c) -692 kj/mole (d) -750 kj/mole

375. $\Delta H°_f$ for CO_2 is
(a) -300.4 kj/mole (b) -393.7 kj/mole
(c) -432.4 kj/mole (d) -473.9 kj /mole

376. Useful method for rate determination for reactions which involves volume changes is
(a) Spectrometry (b) Conductometry
(c) Dilatometric method (d) Refractometric method

377. Consider a reaction A → B showing Rate = d[b]/d[t] means
(a) Concentration of reacting is increasing
(b) Concentration of product is increasing
(c) No product can be made about concentration of reactants or products
(d) Reaction will not taken place

378. To maintain the pH of blood 7.4 what ratio between H_2CO_3 and $NaHCO_3$ is required
(a) 1 : 10 (b) 1 : 20
(c) 1 : 25 (d) 1 : 30

379. Opposite to the osmosis is?
(a) Diffusion (b) Effusion
(c) Effusion (d) Coagulation

380. Solutions are of type
(a) Isotonic solution (b) Hypotonic solutions
(c) Hypertonic solution (d) All of these

381. Carrier protein can
(a) Transport only one substance
(b) Transport more than one substance
(c) Exchange one substance to another
(d) Perform all of these functions

382. Monosaccharides has the general formula
(a) $C_nH_{2n}O_n$ (b) $C_{2n}H_2O_n$
(c) $C_nH_2O_{2n}$ (d) $C_nH_{2n}O_{2n}$

383. Polysaccharides has the general formula
(a) $(C_6H_{10}O_5)_n$ (b) $(C_6H_{12}O_5)_n$
(c) $(C_6H_{10}O_6)_n$ (d) $(C_6H_{10}O_6)_n$

384. _____ is aldose sugar
(a) Glycerose (b) Ribulose
(c) Erythrulose (d) Dihydoxyacetone

385. Milk lacks the?
(a) Vitamin C (b) Vitamin A
(c) Vitamin B2 (d) Vitamin K

386. Milk lacks the?
(a) Phosphorus (b) Sodium
(c) Iron (d) Potassium

387. HDL is synthesized and secreted by?
(a) Pancreas (b) Liver
(c) Kidney (d) Muscle

388. Membrane lipid bilayer performs following processes rapidly except
(a) Flexing of fatty acyl chains
(b) Lateral diffusion of phospholipids
(c) Transbilayer diffusion of phopholipids
(d) Rotation of phospholipids around their long axes

389. In the cell the heaviest particulate component is?
(a) Nucleus (b) Mitochondria
(c) Cytoplasm (d) Golgi apparatus

390. In the cytoplasm the largest particulate component is?
(a) Lysosomes (b) Mitochondria
(c) Golgi apparatus (d) Endoplasmic reticulum

391. Through membrane the exchange of material takes place
(a) Only by diffusion (b) Only by active transport
(c) Only by pinocytosis (d) All of these

392. Lipid bilayer membrane has phospholipid?
(a) Choline phosphoglycerides (b) Ethanolamine phosphoglycerides
(c) Inositol phosphoglycerides (d) Serine phosphoglycerides

393. All the following processes occur rapidly in the membrane lipid bilayer except
(a) Flexing of fatty acyl chains
(b) Lateral diffusion of phospholipids
(c) Trans bilayer diffusion of phospholipids
(d) Rotation of phospholipids around their long axes

394. In intestinal lumen the surface tension between aqueous medium and fat droplets is suppressed by
(a) Bile Salts (b) Bile acids
(c) Conc. H_2SO_4 (d) Acetic acid

395. Naturally occurring amino acids possesses compounds?
(a) Guanidinium ion (b) Indole
(c) Imidazole (d) All of these

396. The pH of a solution is dependent on
(a) concentration of salt
(b) relative concentration of acids and bases
(c) dielectric constant of the medium
(d) environmental effect

397. Molecular reactions
(a) are the reactions of the functional groups
(b) are independent of the functional groups
(c) require an enzyme in all cases
(d) all of the above

398. Example of pentose sugar is
(a) Dihydroxyacetone (b) Ribulose
(c) Erythrose (d) Glucose

399. Sugar of DNA is
(a) Xylose (b) Ribose
(c) Deoxyribose (d) Ribulose

400. Sugar of RNA is
(a) Ribose (b) Deoxyribose
(c) Ribulose (d) Erythrose

401. Which of following type of column has the greater efficiency and resolution?
(a) Packed (b) Non-packed
(c) Capillary (d) Steel

402. "Brock Mann Activity Scale" is used chromatography for the characterization of
(a) Mobile phase (b) Stationery phase
(c) Gradient elution (d) Isocratic elution

403. In thin layer chromatography (TLC) which compound will come at the top of the plate?
(a) Polar (b) High boiling point
(c) Low boiling point (d) Non-polar

404. The composition of soap is the sodium or potassium salts of
(a) Essential oils (b) Fatty acids
(c) Alcohols (d) Carboxylic acids

405. Commercial glasses are consisting of?
(a) soda (b) silica
(c) lime (d) all

406. Determinate errors are may also be called as
(a) Random (b) Non random
(c) Systematic (d) b & c

407. In a chromatogram, there is ———— on x-axis?
(a) Retention time (b) Peak splitting
(c) Column efficiency (d) Detector Response

408. Which of following is type of adsorption chromatography?
(a) Paper (b) TLC
(c) GSC (d) None

409. Which of the following cannot be recycled?
(a) Plastic wear bottles (b) Cartoons
(c) Glass containers (d) All can be recycled

410. The branch of science which deals with study of composition of matter is called
(a) Chemistry (b)Physics (c) Biology (d) All

411. Mottling of teeth is caused by?
(a) Cl excess (b) F excess
(c) F deficiency (d) Br presence

412. Biodiesel produce from algae is ———— generation fuel?
(a) 1st (b) 2nd
(c) 3rd (d) 4th

413. The main advantage of the mass spectrometer detection in GC over the FID is?
(a) Sensitivity
(b) Identification through compound library
(c) Linear range
(d) Dynamic range

414. ———— lamp is useful for variable UV wavelengths in HPL(c)
(a) Hydrogen (b) Deuterium
(c) Xenon (d) Tungsten

415. Retention factor, *k'*, describe
(a) Mobile phase velocity
(b) Distribution ration of analyte between two phases
(c) Stationery phase stability
(d) Migration rate of analyte through a chromatographic column

416. "Triple point" is present in?
(a) GC (b) GPC
(c) SCFE (d) TLC

417. On heating a mixture of NaCl potassium dichromate with conc. H_2SO_4, the compound formed is
(a) Chromic chloride (b) Chromyl chloride
(c) Chlorine dioxide (d) Chromic acid

418. In the ring test for nitrate, the brown color of the ring is due to the formation of
(a) Ferrous nitrite (b) Ferrous nitrate
(c) $FeSO_4$. NO (d) $FeSO_4$. NO_2

419. Which of the following compounds turns black with NH_4OH
(a) Lead chloride (b) Mercurous chloride
(c) Mercuric chloride (d) Calcium chloride

420. In which titration experiment phenolphthalein is not used as indicator
(a) Oxalic acid and $KMnO_4$ (b) KOH and H_2SO_4
(c) NaOH and acetic acid (d) $Ba(OH)_2$ and HCl

421. Phenolphthalein is a good indicator for titrating
(a) NaOH against oxalic acid (b) Ferrous sulphate against $KMnO_4$
(c) NaOH against H_2SO_4 (d) None of these

422. What will be the resulting solution if a 100 ml of 10N HCl is mixed with 175 ml of 20N NaOH?
(a) Acidic (b) Basic
(c) Neutral (d) None of these

423. What is the mass ratio of oxygen in Pb_3O_4 and PbO_2?
(a) 2 : 3 (b) 3 : 2
(c) 2 : 1 (d) 4 : 3

424. IR band at near $3000cm^{-1}$ is due to
(a) C-C swaying (b) C-H swaying
(c) C=O swaying (d) All

425. In IR spectra below $1500cm^{-1}$ is
(a) Area of C-H swaying (b) the area of C=O swaying
(c) Fingerprint area (d) Functional group region

426. 1 Molar phosphoric acid solution will have the normality?
(a) 0.5N (b) 1N
(c) 2N (d) 3N

427. The normality of a solution containing 4 g NaOH in 10 ml solution
(a) 10 N (b) 1.0 N
(c) 9.8 N (d) 11.0 N

428. Gram equivalent of a solute dissolved per dm^{-3} of solution is called
(a) Molarity (b) Normality
(c) Molality (d) Mole fraction

429. The mole fraction of any component of solution is always
(a) Less than unity (b) More than unity
(c) Equal to unity (d) Zero

430. In 1 molal solution of ethyl alcohol in water, the mole fraction of C_2H_5OH
(a) 0.1 (b) 0.9
(c) 0.017 (d) 1.0

431. Hydrolysis of Na_2CO_3 yield the solution
(a) Acidic (b) Basic
(c) Both acidic and basic (d) Neither acidic nor basic

432. What is the mole fraction of solvent in one molal solution of sucrose?
(a) 0.475 (b) 0.982
(c) 0.658 (d) 0.789

433. One molar solution of glucose will contain 1 mole glucose in
(a) 100 g of H_2O (b) 180 g of H_2O
(c) 1000g of H_2O (d) 1000 ml of H_2O

434. It is preferred to deal with Molality instead of normality because
(a) It is easy to make calculation
(b) Weights are involved
(c) Molality does not depend on temperature

(d) Normality depends upon temperature

435. The molality of 50% aqueous solution of NaOH will be
(a) 2.8m (b) 1.25m
(c) 10.5 m (d) 12.5m

436. Water is known as universal solvent due to
(a) High dielectric constant (b) Strong intermolecular forces
(c) It is liquid in nature (d) Large quantity in nature

437. Addition of a substance to water followed by breaking of any O-H bond is known as
(a) Hydration (b) Hydrolysis
(c) Solvation (d) Hydrogenation

438. When180g glucose is added to 1000 g of water, the solution formed is
(a) 1.0 molal (b) 1.2 molal
(c) 1.5 molal (d) 2.0 molal

439. If we desire to make 1 molal sucrose solution, how much sucrose will be added to 1000 g of water?
(a) 312 g (b) 320g
(c) 340 g (d) 342 g

440. If 180g glucose is added to 1000g H_2O resulting solution is 1molal. Mass of solution becomes
(a) 1000g (b) 1080 g
(c) 1180 g (d) 1800g

441. When 5g of toluene is added to 250 g of benzene resulting solution has molality?
(a) 0.12 mol/Kg (b) 0.217 mol/Kg
(c) 0.113 mol/ Kg (d) 0.34 mol/ Kg

442. The molality of eight percent W/W sodium chloride solution is?
(a) 1.23 molal (b) 1.487 molal
(c) 2.123 molal (d) 2.341 molal

443. 1 molal aqueous solution of sucrose has mole fraction?
(a) 0.018 (b) 0.18
(c) 0.012 (d) (d)0.23

444. Dissolved oxygen in sea water is $5.65x10^{-3}$g per Kg. What will be the concentration in parts per million?
(a) 4.45 (b) 4.86
(c) 5.55 (d) 5.65

445. Solution of solid in gas?
(a) Fog (b) Cheese
(c) Dust in smoke (d) Opals

446. Solution of liquid in gas is
(a) CO_2 in H_2O (b) Mist
(c) Jellies (d) Milk

447. In a conjugate solution of phenol and water the upper layer of phenol water system at 25° C is solution of water in phenol
(a) 5% (b)7% (c) 9% (d) 10.10%

448. The lower layer of phenol water system at 25° C is solution of phenol in water
(a) 10 % (b) 20%
(c) 30% (d) 40%

449. When phenol water system becomes a homogenous mixture the percentage is
(a) 55.6% (b) 60.9%
(c) 65.9% (d) 70.9%

450. A single layer of water aniline system is obtained at 167.0C with water having percentage
(a) 10% (b) 12%
(c) 15% (d) 17%

451. NH_3 molecule with a lone pair of electrons on nitrogen atom has a shape of
(a) Tetrahedral (b) Trigonal pyramidal
(c) Angular (d) Square planar

452. One Debye is equal to
(a) 1.66×10^{-24} (c) m. (b) 9.1×10^{-31} (c) m.
(c) 6.02×10^{-23} (c) m. (d) 3.336×10^{-24} (c) m.

453. Which of following orbitals is associated with lowest energy?
(a) Atomic (b) Bonding molecular
(c) Antibonding molecular (d) b and c

454. A bond with maximum covalent character is formed between
(a) Chemically similar atoms
(b) Atoms of different electronegativity
(c) Atoms of different size
(d) Identical atoms

455. Among the following molecules the shortest carbon to carbon distance is in
(a) CH_3-CH_3 (b) $CH_2 = CH_2$
(c) $CH \equiv CH$ (d) CH_3-CH_2-CH_3

456. Which of the following has highest ionization potential?
(a) Li (b) Na
(c) K (d) Rb

457. Which of the following conducts electricity due to the movement of ions?
(a) Molten sodium chloride (b) Co
(c) Graphite (d) Mercury

458. The example of non-polar molecule with polar bonds is
(a) HCl (b) H_2O
(c) SO_3 (d) SO_2

459. Which of following molecules has shortest carbon to carbon bond length?
(a) C ≡ C (b) C = C
(c) C-C (d) All are same

460. Which of following pair of molecules is paramagnetic in nature?
(a) O_2 and B_2 (b) N_2 and O_2
(c) N_2 and F_2 (d) H_2 and N_2

461. Among the following chemical species bond order of ———— highest?
(a) H_2 (b) H_2^+
(c) H_2^- (d) All have same bond order

462. More stable products are obtained by a reaction which is
(a) Endothermic (b) Exothermic
(c) Isothermal (d) Simple

463. The energy is transferred from one body to an other in the form of
(a) Heat (b) Work

(c) Mechanical work (d) All above

464. Which one of the following enthalpies is always an exothermic process?
(a) Enthalpy of atomization (b) Enthalpy of neutralization
(c) Enthalpy of ionization (d) Enthalpy of dissociation

465. When a strong acid reacts with a strong base the heat of neutralization in (KJ/mol) is
(a) +218 (b) -57.4
(c) +51.1 (d) -25.0

466. Ethanol burns with heat of combustion in (KJ/mol)
(a) -1368 (b) -57.4
(c) -285.5 (d) -285.5

467. In how many ways energy transfer from a system can occur?
(a) One (b) Two
(c) Three (d) Four

468. What is the SI unit of work?
(a) Newton (b) Joul
(c) Calorie (d) Watt

469. Evaporation of water is ———— process
(a) Endothermic (b) Exothermic
(c) Non-energetic (d) Slow

470. The heat of combustion is measured by
(a) Calorimeter (b) Colorimeter
(c) Bomb calorimeter (d) Spectrophotometer

471. Unit of K_w are
(a) mole dm^{-3} (b) $mol^2\ dm^{-3}$
(c) $mol^2\ dm^{-6}$ (d) $mol^2\ dm^{+3}$

472. Which of the followings can explain the buffer action?
(a) Common ion effect (b) Law of mass action
(c) Le-Chatlier's Principle (d) All above

473. Which is the strongest bond?
(a) C-C (b) C-H
(c) C-N (d) C-F

474. The radius of ———— is smaller than its parent atom.
(a) Ion (b) Cation
(c) Anion (d) All

475. A polar bond is ———— than a non-polar bond.
(a) Stronger (b) Same in strength
(c) Weaker (d) All

476. The empirical formula and molecular formula of a chemical substance could be
(a) Different (b) Identical
(c) Both a & b (d) Ambiguous

477. One mole of Carbon (^{12}C) is equivalent to
(a) 0.0112 kg (b) 1 kg
(c) 120g (d) 12 g

478. Which of the following compounds has highest nitrogen contents?
(a) NH_3 (b) N_2H_4
(c) NO (d) NH_4OH

479. One mole of H_2O contains
(a) 81 g (b) 6.02×10^{23} atoms
(c) 6.02×10^{23} molecules (d) 6.02×10^{23} ions

480. Chlorine (Cl) and chloride (Cl^-)
(a) Are chemically identical
(b) Are allotropes
(c) Have same number of electrons
(d) Have same number of protons

481. X-ray diffraction work shows that the diameters of the individual atoms are of the order of
(a) 2×10^{-10} m (b) 2×10^{-8} m
(c) 2×10^{-6} m (d) 2×10^{-4} m

482. Formation of a negative ion is a type of reaction
(a) Exothermic (b) Endothermic
(c) Adiabatic (d) Isothermal

483. Sublimation cab be defined as
(a) Formation of a solution
(b) Volatile liquid
(c) Conversion of solid directly into vapors
(d) Conversion of solid to liquid

484. A crucible made of porcelain with a perforated bottom is called?
(a) Gooch crucible (b) Whatman crucible
(c) Glass crucible (d) All

485. Separation of an insoluble solid from a liquid phase is done by
(a) Sublimation (b) Vaporization
(c) Condensation (d) Filtration

486. The process of separation of crystals from the mother liquor is called
(a) Crystallization (b) Condensation
(c) Vaporization (d) Filtration

487. Which of following is truly is Avogadro constant
(a) Atoms in 1g of helium gas
(b) Molecules in 35.5g chlorine gas
(c) Electrons needed to deposit 24g magnesium ions
(d) Atoms in 24g of magnesium

488. Isotopes of an element do not have
(a) Same chemical properties (b) Same number of electrons
(c) Same number of protons (d) Same number of neutrons

489. Which of the following will be heaviest?
(a) 2 mol N_2 (b) 1 mol of O_3
(c) 2 mol of O_2 (d) 2 mol of CO2

490. CO^+ is an example of
(a) Stable molecule (b) Cationic molecular ion
(c) Anionic molecular ion (d) Free radical

491. What is the number of covalent bonds in 0.001Kg of ammonia are
(a) 6.02×10^{23} (b) 1.062×10^{23}
(c) 10.62×10^{24} (d) 1.062×10^{24}

492. Electron microscopes are based upon interaction of objects with
(a) Ultraviolet light (b) visible light
(c) Infrared light (d) X-rays

493. Paper chromatography can be performed in
(a) Radial (b) Descending
(c) Ascending (d) All

494. In chromatography the K stands for
(a) Rate Law (b) Rate
(c) Distribution coefficient (d) Both a & b

495. If the stationary phase is solid then it is called
(a) Adsorption chromatography (b) Partition chromatography
(c) Gas chromatography (d) Paper chromatography

496. Which of the following gas diffuses most rapidly
(a) Cl_2 (b) N_2
(c) CH_4 (d) CO_2

497. On temperature scale the absolute zero is equal to
(a) -273.15K (b) -273.15°C
(c) -237.15°C (d) -273°C

498. In SI units the value of gas constant is
(a) 2.987 atm $dm^3K^{-1}mol$ (b) 8.314 atm $dm^3K^{-1}mol^{-1}$
(c) 1.987 atm $dm^3K^{-1}mol^{-1}$ (d) 8.313 N-m $K^{-1}mol^{-1}$

499. van der Waal's week intermolecular forces are present in
(a) Only gases (b) Only liquids
(c) Only solids (d) All

500. Rydberg constant is a fundamental constant of atomic physics and has value of
(a) $1.6 \times 10^7\ m^{-1}$ (b) $1.7904 \times 10^7\ m^{-1}$
(c) $1.09768 \times 10^7\ m^{-1}$ (d) $1.9678 \times 10^7\ m^{-1}$

501. Poison for platinum catalyst is?
(a) Arsenic (b) Silver
(c) Argon (d) Zinc

502. Catalyst usually belongs to block elements
(a) s (b) p
(c) d (d) f

503. The substance that lowers the efficiency f catalyst are called
(a) Promoters (b) Inhibitors
(c) Both promoters & Inhibitors (d) Speeders

504. The chemical substance which increase the effect of catalyst
(a) promoters (b) inhibitors
(c) Both promoters & inhibitors (d) Speeders

505. The pH of water is greater at temperature
(a) 14°C (b) 15°C
(c) 18°C (d) 25°C

506. A reaction has rate equation rate=k $[NO_2]^2$, it is
(a) First order (b) Second order
(c) Third order (d) Zero order

507. $2H_2+2NO \rightarrow 2H_2O+N_2$ order for this reaction is
(a) 1 (b) 2
(c) 3 (d) 4

508. By the use of catalyst energy of activation is
(a) Lower (b) Higher
(c) Increased (d) Released

509. By adding suitable catalyst, reaction rate is
(a) Increases (b) Decreases
(c) Remains constant (d) Increase as well as decrease

510. A substance that effect the rate of reaction but remains unaltered at the end of reaction is called
(a) Acid (b) Base
(c) Catalyst (d) Activator

511. Reaction cannot be initiated by a catalyst but only its speed can be increased which is possible
(a) Physically (b) Thermodynamically
(c) Chemically (d) In laboratory

512. The catalysts are of
(a) Two types (b) Three types
(c) Five types (d) Four types

513. The branch of chemistry in which reaction rates are studied is known as
(a) Chemical kinetics (b) Chemical equilibrium
(c) Electrochemistry (d) Thermochemistry

514. The study of chemical kinetics becomes highly complicated if there occurs
(a) Reversible reaction (b) Surface reaction
(c) Side reaction (d) Any or all above

515. To explain the subject of chemical kinetics which theories has been proposed
(a) Collision theory of bimolecular reactions
(b) Absolute reaction rates or activated complex theory
(c) Both of these
(d) None of these

516. A chemical reaction has characteristic?
(a) Concentration (b) Temperature
(c) Catalyst (d) All of the above

517. Which of the following is not the characteristic of balanced thermochemical equation
(a) Number of moles of various species
(b) Formulae of the species
(c) State of species
(d) Condition of T and P

518. That reaction which progresses slowly showing measurable rate is known as
(a) Slow reaction (b) Fast reaction
(c) Moderate reaction (d) None of these

519. As compared to non-ionic reactions Ionic reaction are
(a) Slower (b) moderate
(c) Faster (d) not faster

520. Those reactions which shows moderate rate are
(a) Very fast (b) Very slow

(c) Normal (d) High

521. Molecular reactions are show normally
(a) very faster (b) Slower rates
(c) Moderate rates (d) ordinary rates

522. More reactive type of phosphorus is
(a) White (b) red
(c) both are equal (d) It is impossible to predict

523. Molecularity of the reaction $A+2B \rightarrow$ Products is
(a) 3 (b) 2
(c) 1 (d) 0

524. Reaction $NO_2+CO \rightarrow NO+CO_2$ is
(a) Uni molecular (b) bi molecular
(c) Tri molecular (d) Ter molecular

525. For ionic reaction which method is suitable to determine the rate of reaction
(a) Spectrometry (b) Conductometry
(c) Potentiometry (d) Dilatometry

526. Chemical reaction that lowers the energy surrounding is
(a) Endothermic (b) Exothermic
(c) Reversible (d) Irreversible

527. Reaction $N_2 + O_2 \rightarrow 2NO$ is
(a) Exothermic reaction (b) Endothermic reaction
(c) Reversible reaction (d) Irreversible reaction

528. Exothermic heat of reaction does not confirm that reaction is always
(a) Spontaneous (b) Nonspontaneous
(c) Negative (d) Positive

529. If Zn is added to H_2SO_4 reaction will be
(a) Synthesis (b) Decomposition
(c) Single displacement (d) Double displacement

530. q_p at constant pressure will be equal to
(a) Qv (b) ΔH
(c) Δ (d) Zero

531. When system is not working the volume
(a) Increases (b) Decreases
(c) Remains constant (d) Fluctuate

532. Expression for pressure volume work
(a) pv (b)Δpv (c) $\Delta p \Delta v$ d) $P\Delta V$

533. If work done is negative it means it
(a) is done by the system (b) is done on the system
(c) is not done at all (d) is expected to be done

534. In an exothermic reaction the enthalpy change is expressed by sign
(a) Negative (b) positive
(c) zero (d) none of them

535. For reaction $CO_{2(l)} \rightarrow CO_{2(g)}$
(a) ΔH=Zero (b) ΔH>Zero
(c) ΔH<Zero (d) None of the above

536. A solid having multiple crystalline forms has ΔH values
(a) One (b) more than one
(c) one or more (d) is makes no difference

537. Change in enthalpy for $NaOH + HCl \rightarrow NaCl + H_2O$ will be
(a) Heat of the reaction (b) heat of formation
(c) heat of neutralization (d) heat of combustion

538. The law of mass action was proposed by
(a) Guldberg and Waage (b) Charle
(c) Dalton (d) Millikan

539. K_c derived by law of mass action is
(a) Rate constants (b) products to reactants
(c) reactants to products (d) reactants or products

540. When equilibrium is established rate of forward reaction is
(a) greater than the rate of reverse reaction
(b) Lesser than the rate of reverse reaction
(c) Equal to the rate of reverse reaction
(d) None of these

541. When KI is ionized in water, its dissociation is
(a) Favored at high temperature (b) favored at low temperature
(c) not favored at high temperature (d) none of these

542. Soft water is at the
(a) More pH than pure water (b) less pH than pure water
(c) same pH as pure water (d) None of these

543. Solubility product K_{sp}
(a) is not for sparingly soluble ionic compounds
(b) is for sparingly soluble ionic compounds
(c) is useful for sparingly soluble ionic compounds
(d) none of these

544. What will be milk pH at 25° C is
(a) 9.5 (b) 7.5
(c) 6.5 (d) 5.5

545. What is egg pH
(a) 7.8 (b) 8.8
(c) 9.8 (d) 10.8

546. The salt that suppresses the solubility of $KClO_3$ in the water is
(a) CH_3COOH (b) KCl
(c) HCl (d) H_2SO_4

547. The cause of suppression of dissociation of H_2S in water is
(a) CH_3COOH (b) KCl
(c) HCl (d) H_2SO_4

548. At equilibrium when one of the product is removed then what happens
(a) Forward reaction is favored (b) Forward reaction is not favored
(c) Backward reaction is favored (d) None of these

549. Heat of fusion of ice as compared to the heat of vaporization of water
(a) is greater than (b) is less than
(c) is equal to (d) may be equal to or less than

550. For ammonium chloride Enthalpy of solution (ΔH_{sol}) is
(a) 12.1 kj/mole (b) 16.2 kj/mole
(c) 18.3 kj/mole (d) 20.1 kj/mole

551. The glycolytic pathway from glucose to 2 pyruvate formation is found
(a) In all living organisms
(b) primarily in animals excluding particles
(c) only in eukaryotes
(d) only in yeast

552. Specie that perform the function as an uncoupler of electron transport and ATP synthesis is
(a) The Fo base-piece of ATP synthase (without the Fl subunit)
(b) Dinitrophenol
(c) neither (a) nor (b)
(d) Both (a) and (b)

553. Important role is played by Acyl carrier protein in the biosynthesis of
(a) fatty acids (b) amino acids
(c) Sugars (d) Carbohydrates

554. reduced coenzymes are
(a) NADH and $FADH_2$ (b) NAD+ and FAD
(c) ATP and GTP (d) Coenzyme A and ubiquinone

555. Vitamins are vital because the organisms
(a) can't synthesize these compounds at all
(b) can synthesize these compounds partially
(c) can't synthesize these compounds in the adequate amounts
(d) none of the above

556. Iron does not perform the function of?
(a) Oxygen transport (b) Immune function
(c) Brain function (d) Gene regulation

557. Glycolysis is inhibited and activated respectively by
(a) ATP and PEP (b) AMP and Pi
(c) ATP and ADP (d) Citrate and ATP

558. The major energy producing step during glycolysis is
(a) pyruvate kinase
(b) phosphoglycerate kinase
(c) glyceraldehyde-3 –dehydrogenase
(d) Phosphofructokinase

559. Breakdown of glycogen generates glucose in
(a) the liver by phosphorolysis (b) the muscles by phosphorolysis
(c) the muscles by hydrolysis (d) both (a) and (b)

560. Insulin hormone performs the main function to
(a) increase glycogen in liver (b) decrease glycogen in liver
(c) increase blood sugar (d) decrease blood sugar

561. Ascorbic acid works as
(a) reducing agent
(b) oxidizing agent
(c) oxidizing and reducing agent both
(d) none of the above

562. During pregnancy deficiency of Iodine causes a disease, characterized by stunted growth, mental retardation and deafness
(a) Cretinism (b) Keshan disease
(c) Multiple sclerosis (d) Crohn's disease

563. Copper deficiency often affects
(a) Elderly woman (b) Alcoholics
(c) Active toddlers with limited (d) Preterm infants food variety

564. Mark the correct statement.
(a) Cobalt is part of vitamin B_{12}.
(b) Cobalt will not replace the need for vitamin B_{12} in humans
(c) Both (a) and (b)
(d) Cobalt will replace the need for vitamin B_{12} in humans

565. Successful purification scheme is evidenced by the
(a) specific activity increases
(b) specific activity decreases
(c) number of proteins in the sample decreases
(d) both (a) and (c)

566. In ion-exchange chromatography
(a) proteins are separated on the basis of their net charge
(b) proteins are separated on the basis of their size
(c) proteins are separated on the basis of their shape
(d) either (b) or (c)

567. Separation in Gel-filtration chromatography occurs on the basis of
(a) size and shape using porous beads packed in a column
(b) size using porous beads packed in a column
(c) shape using porous beads packed in a column
(d) none of the above

568. Breakdown of glycogen while muscle is exercising is activated by
(a) insulin (b) cortisol
(c) increased Ph (d) none of the above

569. Muscle fiber is relaxed when
(a) the nerve stimulus is removed
(b) the nerve stimulus is too forceful
(c) the actin binding sites are uncovered
(d) the actin binding sites are saturated

570. amino acids in a protein are linked by?
(a) peptide bonds (b) hydrogen bonds
(c) ionic bonds (d) glycosidic bonds

571. Amino acid that is found in proteins is
(a) adenosine (b) adenine
(c) alanine (d) linoleic acid

572. ———— can affect enzyme activity?
(a) temperature
(b) pH
(c) the presence of certain metal ions
(d) all of the above

573. The energy for all forms of muscle contraction is provided by:
(a) ATP (b) ADP
(c) phosphocreatine (d) oxidative phosphorylation

574. In glycolysis, the net generation of ATP through substrate-level phosphorylation is:
(a) 2 from glucose and 3 from glycogen
(b) 2 from glucose and 4 from glycogen
(c) 3 from glucose and 4 from glycogen
(d) 3 from glucose and 2 from glycogen

575. If diet is subjected to low intake of carbohydrates, it
(a) does not influence exercise performance in events lasting less than 10 minutes
(b) affects the resting muscle ph
(c) may impair high intensity exercise performance
(d) is associated with a metabolic alkalosis

576. The process of decomposition of a salt by passing current
(a) Hydration (b) Hydrolysis
(c) Electrolysis (d) Solvolysis

577. Oxidation is indeed
(a) Addition of Oxygen
(b) Increase in positive valiancy agent
(c) Removal of hydrogen
(d) All of the above

578. A specie which accepts electron is regarded as
(a) Acid (b) Base
(c) Oxidizing agent (d) Reducing agent

579. During electrolytic process +ve ions
(a) Move towards cathode (b) Move towards anode
(c) Do not move at all (d) Move through solution

580. During electrolysis, the -ve ions
(a) Move towards cathode (b) Move towards anode
(c) Do not move at all (d) Move through solution

581. Electric conduction is governed by
(a) By the application of electricity (b) By itself
(c) Due to presence of electrolyte (d) All of above

582. By passing current through electrolyte
(a) Ions are produced in solution
(b) Ions in the solution come in contact either electrodes
(c) The solution is polarized
(d) The molecule of solution move

583. At anode ions are
(a) Reduced (b) Oxidized
(c) Repelled (d) None of theses

584. At cathode, the electrolyte is
(a) Reduced (b) Oxidized
(c) Neither reduced nor oxidized (d) Either reduced or oxidized

585. Electrolytic conduction continues until
(a) Oxidation reduction occurring at the electrode continuous

(b) reduction reaction occurs at the electrode continuous
(c) Both (a) and (b)
(d) None of the above

586. Products of molten salt electrolysis
(a) Are not predictable
(b) Are predictable
(c) Sometimes predictable some time not
(d) Are not obtained

587. In electrolysis of water
(a) Hydrogen appears at cathode
(b) Oxygen appears at anode
(c) Both (a) and (b)
(d) Hydrogen appears at anode, oxygen at cathode

588. Current flow due to the difference of electrical potential in a cell that is known as
(a) Cell reaction (b) Cell capacity
(c) Cell potential (d) None of the above

589. Standard electrode potential can also be regarded as
(a) Standard oxidizing potential (b) Standard reducing potential
(c) Standard zero potential (d) All of the above

590. SHE has been arbitrarily taken
(a) A (b) 2
(c) Infinite (d) Zero

591. Zinc has standard electrode potential
(a) 1 (b) 0.25
(c) 0 (d) 0.76

592. Copper has standard electrode potential
(a) 0.12 (b)0.34 (c) 0.54 (d) 0.76

593. Electrochemical series can be applied for the
(a) Prediction of the feasibility of a chemical reaction
(b) Calculation of voltage
(c) Comparison of relative tendency of metals to get oxidized and reduce
(d) All of the above

594. If total cell potential of a reaction is positive then
(a) The reaction will not be feasible
(b) The reaction will be feasible
(c) The reaction may or may not feasible
(d) No prediction can be made

595. Total cell potential of a reaction is negative then
(a) The reaction will be feasible
(b) The reaction will not be feasible
(c) The reaction may or may not feasible
(d) No prediction can be made

596. Element that is at higher positon in electrochemical series means
(a) Anode (b) Oxidation will take place
(c) Cathode (d) Both (a) and (b)

597. Electrode having lower position in electrochemical series mean
(a) Cathode (b) Oxidation will take place on it
(c) Reduction will take place on it (d) Both (a) and (c)

598. Reduction potential of an element tells the tendency
(a) To lose electrons (b) To act as reducing agent
(c) To gain electrons (d) All the above

599. During electrolysis of lead bromide
(a) Pb is collected at anode (b) Pb is collected at cathode
(c) Br2 is collected at cathode (d) Br is collected at anode

600. During electrolysis of copper sulphate solution
(a) Cu is collected at anode (b) Cu is collected at cathode
(c) O_2 is collected at anode (d) O_2 is collected at cathode

601. 60% N_2, 25% CO and the rest CO_2 and H_2 mixture is called
(a) Blast furnace gas (b) Oil gas
(c) Natural gas (d) Water gas

602. Blast furnace is used for extraction of
(a) Fe from its ore (b) Ag from its ore
(c) Pb from galena (d) A1 from bauxite

603. The blast furnace slag is used for making
(a) Fertilizers (b) Glass moulds
(c) Plastics (d) Roads

604. Process of ammonia synthesis is known as
(a) Ostwald process (b) Birkland eyed process
(c) Haber process (d) Contact process

605. Fertilizer that is inorganic is
(a) Urea (b) Ammonium nitrate
(c) Manure (d) All above

606. The acidity generated by nitrogen fertilizers can be neutralized by
(a) Gypsum (b) Lime
(c) Milk of magnesia (d) Water

607. Percentage of nitrogen in anhydrous ammonia is
(a) 92 (b) 82 (c) 72 (d) 62

608. In urea manufacture, reaction of carbon dioxide with ammonia gives
(a) Ammonium carbonate (b) Ammonium carbamate
(c) Ammonium cyanide (d) Ammonium cyanate

609. How many stages are involved for the evaporation of urea solution by heating?
(a) One evaporation stage (b) Two evaporation stages
(c) Three evaporation stages (d) Four evaporation stages

610. Which one is not used as phosphate fertilizer?
(a) P_2O_5 (b) $Ca_3(PO_4)_2$
(c) $Ca(H_2PO_4)_2$ (d) $(NH_4)_2HPO_4$

611. Nitrogen and phosphorous is provided to the plants at the same place by
(a) Potassium iodide (b) Urea
(c) Diammonium phosphate (d) Calcium super phosphate

612. Ammonium nitrate is manufactured by the reaction of ammonia and
(a) Nitric acid (b) Sulphuric acid

(c) Ammonium chloride (d) Hydrochloric acid

613. Ammonium sulphate as fertilizer can yield 21% nitrogen and 25% of
(a) Hydrogen (b) Chlorine
(c) Phosphorous (d) Sulphur

614. Dehydration process of ammonium carbamate generates
(a) Urea (b) Ammonia
(c) CO_2 (d) HNO_3

615. Diammonium hydrogen phosphate (DAP) fertilizer is manufactured by reacting ammonia with
(a) Nitric acid (b) Phosphoric acid
(c) Sulphuric acid (d) Calcium phosphate

616. Potassium nitrate fertilizer is produced by reacting $NaNO_3$ with
(a) Potassium chloride (b) Nitric acid
(c) Hydrochloric acid (d) Calcium nitrate

617. Potassium nitrate has
(a) Nitrogen 33% Potash 67% (b) Nitrogen 40% Potash 60%
(c) Nitrogen 13% Potash 44% (d) Nitrogen 23% Potash 55%

618. If ammonia is to be used directly as a fertilizer, depth to which it is injected is
(a) 1 Inch (b) 2 inches
(c) 4 Inches (d) 6 inches

619. In soil, quick hydrolysis of urea yields
(a) Ammonium hydroxide (b) Ammonium nitrate
(c) Ammonium chloride (d) Ammonium carbonate

620. Simple, double or triple super phosphates all are soluble in
(a) Water (b) Alcohol
(c) Ether (d) Benzene

621. Setting of cements is based upon the process of
(a) Oxidation (b) Hydration
(c) Dehydration (d) Hydrolysis

622. In paper making process filler used is
(a) Starch (b) Cellulose
(c) Glucose (d) Fructose

623. Additive used in paper industry is
(a) Glucose (b) Starch
(c) Alum (d) TiO_2

624. In which type of paper additive is not added?
(a) Carbon paper (b) Filter paper
(c) Glazed paper (d) Art paper

625. The branch of chemistry which deals with study of chemical reactions in living organisms is called
(a) Biochemistry (b) Genetics
(c) Chemicalbiology (d) Biotechnology

626. If ΔH =110 k calorie/mole the reaction is
(a) Endothermic (b) Exothermic
(c) No stable (d) Catalyst

627. Maximum energy is exhibited by
(a) Reactants (b) Products

(c) Transition state (d) Catalyst

628. If reaction is endothermic, heat content of
(a) Product is more the reactant
(b) Reactant more than that of product
(c) Both (a) and (b)
(d) Neither (a) and (b)

629. Force/pressure is equal to
(a) Length (b) Volume
(c) Area (d) Work

630. Energy and heat are expressed in SI unit of
(a) Joule (b) K. caloric
(c) Caloric (d) K .watt Hours

631. If an abject is moved one meter by one newton force in its direction of application, the force is called.
(a) Joule (b) Ers
(c) Kilojoule (d) Watt

632. Which unit is usually used for the measurements of energy changes in chemical reaction
(a) Kilojoule (b) Caloric
(c) Kilo caloric (d) Joule

633. 1 caloric is equal to
(a) 4.18 KJ (b) 3.18 KJ
(c) 4.54 KJ (d) 3.60 KJ

634. Highest heat capacity is accompanied by
(a) 1 kg H_2O (b) 2 kg H_2O
(c) 3 kg H_2O (d) 4 kg H_2O

635. Units having greater value is
(a) BTU (b) KJ
(c) KWH (d) CAL

636. Units KWH are used for
(a) Volume (b) Power
(c) Energy (d) Force

637. 1 BTU is equal to
(a) 1 KWh (b) 1.055×10^3 J
(c) 3.6×10^5 J (d) 4.184 Cal

638. Flow of water from upper to lower place is
(a) Spontaneous process (b) Nonspontaneous
(c) Endothermic process (d) Exothermic process

639. Neutralization reaction of strong acid and base is
(a) Spontaneous process (b) Nonspontaneous
(c) Exothermic process (d) a and c

640. Properties to indicate the complete state of the system can be expressed by
(a) Volume (b) Composition
(c) Temperature & pressure (d) All of the above

641. Anything under study is called
(a) Electrolyte (b) Reactant

(c) System (d) Substrate

642. Conditions of a system are expressed by its
(a) Condition (b) Law
(c) State (d) Position

643. Path function among these is
(a) Enthalpy (b) Temperature
(c) Entropy (d) Work

644. All types of the energies accompanied by a system is called
(a) Entropy (b) Heat
(c) Internal energy (d) Enthalpy

645. Sum of all the energies of an object under study is called its
(a) External energy (b) Internal energy
(c) Bond energy (d) Summation energy

646. Internal energy of the system is the
(a) K.E off all its mole ales
(b) P.E of all its mole ales
(c) Sum of K. E and P. E of all mole ales
(d) Heat energy

647. Mathematically first law of thermodynamics can be expressed as
(a) $\Delta E = q + w$ (b) $\Delta E = q-1$
(c) $Q=w$ (d) Q / w

648. If ΔV becomes zero then PV work is
(a) Zero (b) +ve
(c) -ve (d) Both B and C

649. KWh can be expressed as
(a) 3.6×10^6 J (b) 3.6×10^5 KJ
(c) 3.6×10^2 KJ (d) 3.6×10^3 KJ

650. Endothermic reaction is expressed by heat
(a) Released (b) Absorbed
(c) Increased (d) Decreased

651. Rate determining step has velocity
(a) Minimum (b) Maximum
(c) Intermediate (d) Depends on case

652. The least amount of energy that is necessary for the formation of activated complex is called
(a) Reaction energy (b) Activation energy
(c) Deactivation energy (d) Completion energy

653. Reactions requiring high activation energy proceeds with speed
(a) Slow (b) High fast
(c) Moderate (d) Does not take place

654. In an exothermic reaction on lower energy scale resides
(a) Reactants (b) Products
(c) Catalysts (d) Transition state

655. The order of reaction for $H_2+I_2 \rightarrow 2HI$ is
(a) 1 (b)2 (c) 3 (d) 2.5

656. In zero order reaction, the rate is independent of
(a) T of the reaction (b) Concentration of reaction

(c) concentration of product (d) None of these

657. The number of atoms or molecules that actively take part in reaction determines the
(a) Rate of reaction (b) order of reaction
(c) Molecularity (d) Rate constant

658. Reaction independent of the initial concentration of reactants are called
(a) Zero order reaction (b) First order reaction
(c) Second order reaction (d) Third order reaction

659. The sum of the exponents in rate equation are direct measure of the
(a) Molecularity (b) order of reaction
(c) Both of these (d) A&B are same

660. Order of reaction for $2N_2O_5 \rightarrow 4NO_2+O_2$ is
(a) First (b) Second
(c) Third (d) None of these

661. The experimental relationship between rate of reaction and reactant concentration expresses
(a) Order law (b) Rate law
(c) Molecularity (d) Order of reaction

662. The change in concentration of reactant or products per unit time is
(a) Rate of reaction (b) order of reaction
(c) Molecularity (d) order law

663. Rate of reaction depends upon
(a) Nature of reactants
(b) . Concentration of reactants
(c) Temperature at which the reaction is carried out
(d) All of the above

664. By rising every 10° C, the reaction rate becomes
(a) Double (b) Four times
(c) Three times (d) Five times

665. Units of Arrhenius constant are same as the units of
(a) T (b) R
(c) logn (d) Concentration

666. The substances that lowers the rate of reaction in their presence are called
(a) Activators (b) Promoters
(c) Inhibitors (d) Poisons

667. The unit of rate constant are same to the units of
(a) First order reaction (b) Second order reaction
(c) Zero order reaction (d) Third order reaction

668. Consider a reaction $2A+B \rightarrow A_2B$, the reactant A will disappear at
(a) Half the rate that B will decrease
(b) The same the rate that B will decrease
(c) Twice the rate that B will decrease
(d) The same rate that A2B will form

669. Reaction $2NO+O_2 \rightarrow 2NO_2$ is a
(a) Third order (b) Second order
(c) First order (d) none of these

670. If the sum of exponents of rate equation is_____, reaction will be first order
(a) one (b)Two (c) Three (d) four

671. If reactants and catalyst are in different phases, the catalysis is
(a) Homogenous (b) Heterogeneous
(c) Both (d) None

672. A specie that increase the rate of reaction without being used is called
(a) Catalyst (b) Catalysis
(c) Inhibitors (d) Promoters

673. The reduced catalytic property of a catalyst is known as the
(a) Poisoning of a catalyst (b) limit of a catalyst
(c) Specifity of a catalyst (d) Deficiency of a catalyst

674. By using catalyst in a reaction, _____ changes
(a) Enthalpy (b) Entropy
(c) Internal energy (d) Activation energy

675. The types of catalysts used are
(a) Homogenous (b) Both A & C
(c) Heterogeneous (d) None of these

676. Moles of solute per one liter of solution is known as
(a) Molarity (b) Normality
(c) Molality (d) Standardization

677. What molarity of HCl solution is required to completely neutralize 10ml of 1.5M sodium hydroxide is reacted with 20ml hydrochloric acid
(a) 1.0 (b) 0.75
(c) 0.5 (d) 0.25

678. The solution known strength is known as?
(a) Aqueous solution (c) original solution
(b) Standard solution (d) Unsaturated solution

679. That component of binary solution that is in large concentration is called
(a) Solvent (c) Solute
(b) Both solvent and solute (d) Liquid

680. Solution having relatively lesser concentration of solute is called?
(a) Concentrated solution (b) Saturated solution
(c) Dilute solution (d) Weak solution

681. Solution having larger concentration of solute is called?
(a) Saturated solution (b) Dilute solution
(c) original solution (d) Standard solution

682. Solution comprises of only two components is
(a) Binary solution (b) Dilute solution
(c) original solution (d) Saturated solution

683. A 20 percent solution of NaCl by weight means?
(a) 5.58g NaCl / 100 ml (b) 58.5g NaCl/ 100 ml
(c) 10.0 g NaCl/100 ml (d) 20.0 g NaCl/100 ml

684. Necessary condition to form precipitates by the reaction of Cu^{+2}ions with H_2S gas is
(a) Copper ions must not ionize
(b) Cu^{++} nor CU^{+} ion be present
(c) Enough S^{-2} ions must be present
(d) Acidic medium will be provided before passing H_2S

685. If we have a 50% by weight sugar solution having 5g of sugar in 100g of solution in H_2O, it contains
(a) 100 g of H_2O (b) 95 g of H_2O
(c) 105 g Of H_2O (d) 90 g of H_2O

686. If 2.0 g NaCl is dissolved in 20 g of water the solution will be (W/W)
(a) 10.5% (b) 9.09 %
(c) 8.02% (d) 11.5%

687. If $10cm^3$ of alcohol is dissolved in water, overall weight of solution becomes 100 g, then it is percentage solution of alcohol in water
(a) 10 %V/W (b) 10 %V/V
(c) 10 % W/V (d) 10% W/W

688. Molarity of 500ml solution having dissolved 49g of sulphuric acid will be
(a) 1.0 M (b) 2. 0 M
(c) 1.5 M (d) 2.5M

689. If a solution is prepared by dissolving 20g NaOH in 500ml solution, its molarity will be
(a) 0.25 (b) 0.5 (c) 1 (d) 20

690. One liter of pure water has molarity
(a) 1 (b) 18
(c) 55.5 (d) 6

691. In which of the following process hydrogen oxygen bond is not broken?
(a) Hydrolysis (b) Hydration
(c) Hydrogenation (d) Oxidation

692. H_2O has highest density at
(a) 4°C (b) 0C
(c) 100°C (d) -4C

693. If,a solution is prepared by dissolving 20.7g K_2CO_3 in $500cm^3$ of the given solution, its molarity will be
(a) 0.1M (b) 0.2M
(c) 0.3M (d) 0.4M

694. Molarity of HCl solution available in lab, that is 36%W/W with the density $1.19g/cm^3$ is
(a) $10.23mol/cm^3$ (b) $11.55 mol/cm^3$
(c) $11.73 mol/cm^3$ (d) $12.67 mol/cm^3$

695. A solution is prepared by mixing 96g methyl alcohol, 92g ethyl alcohol, and 90g water. What will be the Mol %age of water in it
(a) 10 (b) 20
(c) 25 (d) 50

696. Solution containing 1 mole of solute per 1kg of solvent is called
(a) 1 Molal (b) 1 Molar
(c) 1 Normal (d) None of these

697. Number of moles of solute per kilogram of solvent is called
(a) Normality (b) Molality
(c) Molarity (d) All of the above

698. If a solution contains 1g equivalent of solute in one liter solution, it is called
(a) 1 normal (b) 1 molar
(c) 1 molal (d) concentrated solution

699. If a solution of H_2SO_4 has molarity 0.5M, what will be its normality
(a) 0.5 N (b) 1.0 N
(c) 0.25 N (d) 2.0 N

700. If 49g sulphuric acid is dissolved in so much of water H_2O that make 500 ml volume, its normality will be
(a) 1N (b) 1.5 N
(c) 2N (d) 3 N

701. The disintegration of uranium (U-235) occurs in
(a) 24 minutes (b) 7.1×10^8years
(c) 48 minutes (d) 9.1×10^8 years

702. How many million years it will take to decompose one Kg of uranium (U-235) to its half?
(a) 710 (b) 355
(c) 720 (d) 360

703. $KClO_3$ decomposition speeds up in the presence of?
(a) Platinum (b) $CuCl_2$
(c) MnO_2 (d) NO

704. Which of the following catalyzes the decomposition of H_2O_2?
(a) H_3O (b) Pt
(c) Ni (d) V_2O_5

705. Which enzyme is used to hydrolyze a sugar solution into glucose and fructose?
(a) Urease (b) Invertase
(c) Zymase in yeast (d) All

706. Enzyme has
(a) Active cites (b) Specific in nature
(c) Work at specific pH (d) All

707. By their nature and function the enzymes are
(a) Catalyst (b) Complex protein molecules
(c) Present in living organisms (d) All

708. In group VII-A of periodic table, moving down from fluorine to iodine the boiling points of elements.
(a) Increase (b) Decrease
(c) Remain constant (d) Negligible

709. On formation of ice from water the volume expands by
(a) 5% (b) 9%
(c) 10% (d) 18%

710. Liquid crystals are not used for?
(a) Temperature sensor
(b) Liquid crystal display
(c) Skin thermography
(d) Energy supply in electrical devices

711. The boiling point of ethylene is
(a) -88.6 °c (b) +68.7 °c
(c) -68.7 °c (d) +88.6 °c

712. How many spiral chains are present in DNA molecule?
(a) One (b)Two (c) Three (d) Four

713. Transition temperature of grey tin having cubic structure into white tin of tetragonal structure is?
(a) 13.2°C (b) 14.2C
(c) 15.2°C (d) 16.2C

714. In proteins the amino acid chains are coiled into spiral structure due to
(a) Covalent bond (b) Ionic bond
(c) Hydrogen bond (d) Van der Waal's forces

715. Which one is the weakest type of intermolecular force?
(a) Hydrogen bonding (b) Ion-dipole forces
(c) Dipole-dipole forces (d) London dispersion forces

716. Which discovery was made first?
(a) Charge of electron (b) Mass of electron
(c) Charge to mass ratio of electron (d) All the three simultaneously

717. Which of following has highest speed?
(a) Electron (b) Proton
(c) Neutron (d) Alpha particle

718. The electronic configuration of Cu is
(a) $1s^2\ 2s^2\ 2p^6\ 2s^3\ 3p^6\ 4s^2\ 3d^9$ (b) $1s^2\ 2s^2\ 2p^6\ 2s^3\ 3p^6\ 4s^1\ 3d^{10}$
(c) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1\ 3d^9$ (d) $1s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2$

719. A photon with wavelength of 600 nm will have energy
(a) 3.3125×10^{-19} J (b) 6×10^2 J
(c) 4.9×10^{-10} J (d) 2×10^{-15} J

720. An anode ray (also positive ray or canal ray) particle has charge
(a) 1.6022×10^{-19} Coulombs (b) 1.4022×10^{-19} Coulombs
(c) 1.6022×10^{-18} Coulombs (d) 1.6022×10^{-17} Coulombs

721. The ground state electron in an atom will be
(a) Far from the nucleus (b) In the second shell
(c) Nearest to the nucleus (d) d-orbitals

722. Positron is a nuclear particle with a positive charge and weight equal to
(a) An electron (b) A proton
(c) A neutron (d) A meson

723. CsF is an ionic compound because of the
(a) Low ionization potential of Cs and low electron affinity of F
(b) Low IE of Cs and high EA of F
(c) High IE of Cs and low EA of F
(d) High IE of Cs and high EA of F

724. Which of the following molecules will have some value of dipole moment?
(a) CF_4 (b) BF_3
(c) NF_3 (d) H_2

725. How many sigma bonds are present in methane molecule?
(a) 1 (b) 0
(c) 2 (d) 4

726. A crucible with a sintered glass bottom is called?
(a) Whatman crucible (b) Gooch crucible
(c) Pyrex crucible (d) Buchner crucible

727. The process in which a solid material is directly changed into liquid is called?
(a) Freezing (b) Melting
(c) Decomposition (d) Sublimation

728. What is the function of Gooch Crucible?
(a) To obtain precipitates for ignition
(b) Crystallization
(c) Purification of solid materials
(d) All

729. Evaporation of water occurs at
(a) 0°C (b) 75°C
(c) 100°C (d) At all temperatures

730. At 23.7 torr of external pressure, boiling point of water is
(a) 200°C (b) 100°C
(c) 98°C (d) 25°C

731. How boiling point of water changes higher altitudes than sea level?
(a) Drops at high altitudes (b) Elevates at high altitudes
(c) Does not change (d) Equal to atmospheric pressure

732. Boiling point of glycerine can be reduced from 290°C to 120°C by
(a) Increasing external pressure (b) Decreasing external pressure
(c) Slow heating of a liquid (d) Fast heating of a liquid

733. Which of the following is not an example of molecular crystals?
(a) Sugar (b) Iodine
(c) Ice (d) Sodium Chloride

734. Which of following solid types has diffused melting point?
(a) Covalent (b) Amorphous
(c) Ionic (d) Crystalline

735. What is the number of Cl^- ions per unit cell in a cubic lattice?
(a) 4 (b) 1
(c) 3 (d) 0

736. Buchner funnel is used for
(a) Slow filtration (b) Quick filtration
(c) Crystallization (d) Sieving

737. Which of the following techniques is based upon the distribution of a solute between a stationary and a mobile phase?
(a) Solvent precipitation (b) Sublimation
(c) Chromatography (d) Crystallization

738. A nanometer is a unit of length scale which is equivalent to
(a) 10^{-16} m (b) 10^{-9} m
(c) 10^{-12} m (d) 10^{-15} m

739. Stoichiometric calculations are difficult to calculate for reversible reactions due to the fact that
(a) Products again change into reactants
(b) Reaction yield is very low
(c) Reaction goes only in one direction
(d) Products do not disappear

740. The number of neutrons and protons in the nucleus of an atom collectively is known as?
(a) Relative atomic mass (b) Atomic number
(c) Isotopic ratio (d) Mass number

741. On a size exclusion chromatography (SEC) plot molecular weight increases
(a) Remains constant (b) Left to right
(c) Right to left (d) Does not change

742. Gel permeation chromatography (GPC) is used to determine?
(a) Fatty acids (b) Essential oils
(c) Molecular weight (d) Atomic number

743. Which chromatography is used to separate the optical isomers?
(a) Ion exchange chromatography (b) Chiral chromatography
(c) Adsorption chromatography (d) Partition chromatography

744. Near ultraviolet (UV) region of the electromagnetic spectrum generally lies between
(a) 10–200 nm (b) 300–400 nm
(c) 400–750 nm (d) 300–500 nm

745. In quantitative spectroscopic analysis, which of the following is taken as function of concentration?
(a) Absorbance (b) Percent transmission
(c) Transmission (d) All

746. Which of the following devices can be used as heat detectors?
(a) Thermocouple (b) Thermistor
(c) Bolometer (d) All

747. Photomultipliers are used to detect light signals and are very sensitive and rapid in their response to radiations in the spectral region
(a) 1000–12000 Å (b) 1000–500 Å
(c) 500–20000 Å (d) 1–1000 Å

748. In column chromatography the resolution is proportional to?
(a) Square root of the number of theoretical plates in a column
(b) Inverse of square root of the number of theoretical plates in a column
(c) The number of theoretical plates in a column
(d) Square of the number of theoretical plates in a column

749. In column chromatography, Van Deemter plot provides the information about
(a) The capacity factor (b) The selectivity factor
(c) Optimum column temperature
(d) Optimum mobile phase flow rate

750. Which of following chemical substance is used to absorb the water in combustion analysis?
(a) $Mg(ClO_4)_2$ (b) 50% KOH
(c) Lime water (d) Dilute solution of NaOH

751. Both prokaryotes and eukaryotes has?
(a) Lysosome (b) Chloroplast
(c) Plasma membrane (d) Vacuole

752. In a dehydration reaction?
(a) molecules are broken apart
(b) monomers are bonded together and a water molecule is released
(c) atoms are joined
(d) It depends on what molecule it is

753. Polymers are broken apart by?
(a) hydrolysis reactions (b) dehydration reactions
(c) neutralization reactions (d) catalytic reactions

754. Fats and oils comprises of
(a) Starch and sugar (b) Glucose and fructose
(c) Fatty acids and glycerol (d) Water and cellulose

755. Steroid molecules contain?
(a) Molecular rings (b) Proteins
(c) Waxes (d) Double helixes

756. Metabolism is determined by
(a) size of proteins in the cell
(b) availability of amino acids
(c) proteins formed as dictated by the genetic material
(d) protein composition of the dna

757. Skeletal muscles principally accompany
(a) actin and troponin (b) actin and myosin
(c) troponin and tropomyosin (d) myosin and tropomyosin

758. The function of sarcoplasmic reticulum in muscle cells is to
(a) store of digestive enzymes (b) store of sodium ions
(c) store of lipid (d) store of calcium ions

759. ATP generation by anaerobic metabolism refers to process
(a) without the involvement of ADP
(b) without the use of glycogen
(c) without the use of oxygen
(d) in the absence of available oxygen

760. Glycolysis involves the conversion of
(a) glycogen to glucose-6-phosphate
(b) glycogen or glucose to fructose
(c) glycogen or glucose to pyruvate or lactate
(d) glycogen or glucose to pyruvate or acetyl CoA

761. When one molecule of glucose is converted into two molecules of pyruvate net result is the formation of
(a) six molecules of water (b) two molecules of ATP
(c) three molecules of ATP (d) thirty-eight molecules of ATP

762. Glycolysis enzymes are cited in
(a) mitochondrion (b) nucleus
(c) cytoplasm (d) lysosomes

763. Pyruvate produced by glycolysis during strong exercise, is converted to
(a) Acetate (b) Lactate
(c) monosodium phosphate (d) pyruvic acid

764. Only about 40% of the energy produced during catabolism by oxidizing glucose is utilized in the synthesis of ATP while rest 60%
(a) is lost as heat
(b) is used to reduce NADP
(c) remains in the products of metabolism
(d) is stored as fat.

765. Energy obtained by oxidation of glucose is stored in the form of
(a) a concentration gradient across a membrane
(b) ADP
(c) ATP
(d) NAD+

766. A kinase enzyme
(a) removes phosphate groups of substrates
(b) uses ATP to add a phosphate group to the substrate
(c) uses NADH to change the oxidation state of the substrate
(d) removes water from a double bond

767. Gluconeogenesis uses
(a) 3 ATPs and 2 GTPs per glucose
(b) 2 ATPs and 1 GTPs per glucose
(c) 3 ATPs and 3 GTPs per glucose
(d) 4 ATPs and 2 GTPs per glucose

768. The pyruvate to oxaloacetate conversion
(a) requires biotin
(b) involves the fixation of carbon dioxide
(c) occurs in the mitochondria
(d) all of the above

769. Lactose hydrolysis yields
(a) galactose and fructose (b) galactose and glucose
(c) glucose and fructose (d) fructose and galactose

770. Major products of pentose phosphate pathway are
(a) nicotinamide adenine dinucleotide and ribose 5-phosphate
(b) flavine adenine dinuclueotide and glucose 5-phosphate
(c) FAD and CoA
(d) NADPH and NAD

771. Chair and boat conformations are found
(a) in pyranose sugars
(b) in any sugar without axial -OH groups
(c) in any sugar without equatorial -OH groups
(d) only in D-glucopyranose

772. Glycosidic bond
(a) in maltose is not hydrolyzed in lactose intolerant humans
(b) in sucrose is hydrolyzed by bees
(c) joins glucose and fructose to form sucrose
(d) both (b) and (c)

773. Regulation of glycolytic pathway involves
(a) allosteric stimulation by ADP
(b) allosteric inhibition by ATP
(c) feedback, or product, inhibition by ATP
(d) all of the above

774. The dephosphorylation of which active form of glycogen phosphorylase occurs?
(a) Glycogen synthase (b) Glycogensemisynthase
(c) Glycogen hydrolase (d) Glycogen dehydrogenase

775. In a eukaryotic cell the enzymes of glycolysis are sited in the
(a) intermembrane space (b) plasma membrane
(c) Cytosol (d) mitochondrial matrix

776. Which device is used for the formation of an atomic vapour in atomic absorption?
(a) Flame atomization (b) Electric atomization
(c) Sputtering devices (d) Ovens

777. The units of the rate constant (k) for a first order reaction are?
(a) S^{-1} (b) mol dm^{-3} s
(c) mol dm^{-3} s (d) mol^{-1} dm^3 s

778. What are the units of k if rate equation is Rate = k [A]?
(a) S^{-1} (b) mol dm^{-3}
(c) mol dm^{-3} s^{-1} (d) $mol^{-1}dm^3s^{-1}$

779. An aqueous solution with pH value around zero will be
(a) Highly acidic (b) Basic
(c) Neutral (d) Strong base

780. The pH of 0.005 M H_2SO_4 will be
(a) 2 (b) 3
(c) 4 (d) 5

781. What will be Ksp of $PbBr_2$? Solubility of Pb Br_2 is 2.3×10^{-2} M at 25°C
(a) 5.3×10^{-4} (b) 1.2×10^{-5}
(c) 2.4×10^{-5} (d) 4.8×10^{-5}

782. Which acid is present in the soft drinks?
(a) Cinnamic (b) Phosphoric
(c) Humic (d) Carbonic

783. The acid is moderately strong if
(a) $Ka=1 \times 10^{-3}$ (b) $Ka< 10^{-3}$
(c) $Ka> 1$ (d) All

784. A buffer solution with having ratio of molar concentration of salt and base equal to one the pH of the buffer will be
(a) pka (b) pkb
(c) pkw (d) a & c

785. Solubility product constant (ksp) of $PbSO_4$ at 25°C
(a) 1.6×10^{-8} (b) 1.5×10^{-8}
(c) 1.6×10^{-7} (d) All

786. Which solvent is considered to be the universal solvent?
(a) Acetone (b) Hexane
(c) Water (d) Benzene

787. Which of the following is not correct for an ideal solution of two components?
(a) $\Delta H = 0$ (b) $\Delta V = 0$
(c) $P = P^0X_2$ (d) $P = P^0X_1$

788. Sugar juice can be purified and concentrated by which technique?
(a) Vacuum distillation (b) Distillation
(c) Fractional crystallization (d) Sublimation

789. How many significant figures in answer of 47.987 – 47. 213.
(a) 1 (b) 2
(c) 5 (d) 3

790. Which of the following gas is not suitable for gas chromatography?
(a) Oxygen (b) Helium
(c) Nitrogen (d) b and c

791. Xanthophylls and carotenoids can be separated using following intermediate adsorbent
(a) Silica gel (b) Alumina
(c) Starch (d) Calcium carbonate

792. If the components of stationery phase get soluble in mobile phase and leak during operation this condition is known as
(a) Creeping (b) Flushing
(c) Bleeding (d) Broadening

793. Which of following metals show more than one oxidation states?
(a) Al (b) Mg
(c) Fe (d) Na

794. NaCl is an example of the chemical formula of
(a) An ionic molecule (b) An ionic compound
(c) A covalent compound (d) A crystal

795. Which of the following bonds generally absorb in the region
1900–1500 cm^{-1} (5.3 – 6.7 μm)
(a) N = O (b) C = N
(c) C = O (d) C ≡ C

796. Which of the following bonds absorb in the region 3800 – 2700 cm^{-1} (2.6 – 3.7 μm)
(a) O – H (b) N – H
(c) C – H (d) All

797. Which of the following molecules show rotational spectra?
(a) HCl (b) CO
(c) CH_3Cl (d) All

798. The absorption frequency or wavelength depend upon the
(a) relative masses of the atoms (b) the force constant of the bonds
(c) geometry of the atoms (d) all

799. The triatomic linear CO_2 molecule has the following fundamental vibrations.
(a) 4 (b) 2
(c) 3 (d) 6

800. The number 9.761 after rounding to two digits is:
(a) 9.8 (b) 9.7
(c) 9.6 (d) Any one of above

801. Conventionally reactant concentration is taken as
(a) Denominator (b) numerator
(c) both of these (d) fractions

802. The number of moles in chemical equation are shown in rate equation as coefficients of the
(a) Reactants and products (b) concentrations
(c) Gaseous components (d) solutions

803. The units of equilibrium constants are
(a) mol/litre (b) g. lit
(c) mol/ml (d) it is dimensionless

804. Equilibrium constant in the form of pressure
(a) Kc (b) Kp
(c) K (d) Ka

805. The change in equilibrium constant during formation of HCl
(a) Temperature (b) pressure
(c) catalyst (d) amount of H_2 and I_2

806. When a stress is applied on the system then the system will act in such a way to nullify the effect of applied stress
(a) Law of mass action (b) law of conservation of mass
(c) Le-Chatlier principle (d) law of constant proportions

807. What will be the effect of addition of catalyst at equilibrium on reactants concentration
(a) Decreases (b) increases
(c) remains constant (d) sharply increases

808. In gaseous equilibrium the change in volume is affected by change in .....
(a) Catalyst (b) concentration
(c) pressure (d) temperature

809. How exothermic reactions are favored to proceed forward at equilibrium
(a) Adding reactants (b) compressing
(c) cooling (d) heating

810. PCl_5 decomposition by increasing pressure will favor
(a) Forward reaction (b) backward reaction
(c) equilibrium state (d) any of the above

811. If an endothermic reaction is heated the
(a) Rate of reverse reaction will increases
(b) Rate of reverse reaction will decrease
(c) Rate of forward reaction will increases
(d) Rate of forward reaction will decreases

812. Le-Chatelier's principle is followed by
(a) all irreversible reactions (b) all systems at equilibrium
(c) all chemical reactions (d) only gaseous reactions

813. Optimum temperature for NH_3 gas synthesis is
(a) 250 C (b) 350 C
(c) 450 C (d) 55°C

814. Yield of NH_3 can be enhance in Haber's process by
(a) increasing temperature (b) increasing pressure
(c) increasing amount of ammonia (d) all above

815. Numerical relationship between K_c and K_a of a weak acid has values
(a) same
(b) different
(c) sometimes different, sometimes same
(d) cannot be predicted

816. Common ion affects solubility of the salt toward
(a) Reaches to saturation (b) decrease
(c) increase (d) Neither increase nor decrease

817. When a salt is dissolved in a solution containing one of its ions, its solubility becomes
(a) Lower (b) higher
(c) very high (d) normal

818. Rock salt is purified by passing HCl due to
(a) Ionization effect (b) common ion effect
(c) solubility effect (d) catalytic effect

819. In common ion effect solubility of an electrolyte is suppressed by adding another electrolyte, that should be
(a) Weak (b) strong
(c) either (a) or (b) (d) neither (a) nor (b)

820. Electrochemistry is the study of
(a) The conversion of electrical energy into chemical energy
(b) The conversion of chemical energy into electrical energy
(c) Both (a) and (b)
(d) Nether (a) Nor (b)

821. By increasing the temperature degree dissociation of a salt
(a) Increases (b) Remains Same
(c) Decreases (d) Both (a & c)

822. Solution conduct electricity due to
(a) Ions (b) Molecules
(c) Atoms (d) All of the above

823. Electrolysis means the process will consume
(a) Chemical Energy (b) Electrical energy
(c) Heat energy (d) None of above

824. In dissociation reaction $FeCl_3 + 3Cl_2 \rightarrow FeCl_3$
(a) Fe is reduced (b) Fe is Oxidized
(c) Cl2 is Oxidized (d) None of these happens

825. When current is passed through $PbBr_2$
(a) Bromine appears at anode (b) Lead is deposited at cathode
(c) Lead appears at anode (d) None of these happens

ANSWERS

1.	D
2.	D
3.	D
4.	C
5.	B
6.	D
7.	D
8.	C
9.	B
10.	B
11.	D
12.	C
13.	C
14.	D
15.	C
16.	C
17.	A
18.	C
19.	A
20.	A
21.	D
22.	B
23.	B
24.	D
25.	C
26.	B
27.	D
28.	C
29.	D
30.	A
31.	B
32.	A
33.	B
34.	B
35.	A
36.	A
37.	B
38.	C
39.	B
40.	B
41.	D
42.	A
43.	A
44.	A
45.	B
46.	B
47.	B
48.	C
49.	C
50.	A
51.	C
52.	A
53.	C
54.	A
55.	B
56.	D
57.	B
58.	A
59.	C
60.	B
61.	D
62.	C
63.	A
64.	D
65.	D
66.	B
67.	B
68.	A
69.	C
70.	B
71.	C
72.	B
73.	B
74.	A
75.	C
76.	B
77.	C
78.	D
79.	A
80.	B
81.	A
82.	A
83.	B
84.	C
85.	D
86.	C
87.	A
88.	D
89.	C
90.	A
91.	C
92.	C
93.	A
94.	B
95.	C
96.	B
97.	C
98.	A
99.	B
100.	C
101.	D
102.	A
103.	D
104.	D
105.	B
106.	D
107.	B
108.	D
109.	C
110.	D
111.	A
112.	C
113.	D
114.	D
115.	C
116.	A

117.	B
118.	C
119.	A
120.	A
121.	A
122.	B
123.	B
124.	C
125.	A
126.	A
127.	A
128.	A
129.	C
130.	A
131.	B
132.	B
133.	C
134.	B
135.	A
136.	D
137.	C
138.	A
139.	C
140.	C
141.	D
142.	A
143.	B
144.	B
145.	B
146.	C
147.	B
148.	B
149.	A
150.	A
151.	B
152.	B
153.	D
154.	D
155.	D
156.	D
157.	A
158.	A
159.	B
160.	A
161.	C
162.	B
163.	D
164.	C
165.	C
166.	B
167.	A
168.	D
169.	A
170.	C
171.	B
172.	A
173.	B
174.	A
175.	C
176.	A
177.	A
178.	C
179.	C
180.	C
181.	A
182.	A
183.	C
184.	B
185.	B
186.	A
187.	A
188.	B
189.	A
190.	A
191.	B
192.	D
193.	A
194.	B
195.	A
196.	C
197.	A
198.	B
199.	B
200.	D
201.	B
202.	C
203.	B
204.	A
205.	C
206.	A
207.	D
208.	B
209.	C
210.	C
211.	A
212.	A
213.	B
214.	C
215.	C
216.	C
217.	C
218.	B
219.	C
220.	B
221.	A
222.	B
223.	D
224.	C
225.	C
226.	D
227.	C
228.	D
229.	C
230.	A
231.	B
232.	B
233.	A
234.	B
235.	A
236.	A

237.	B
238.	B
239.	D
240.	C
241.	A
242.	A
243.	A
244.	A
245.	A
246.	B
247.	C
248.	D
249.	D
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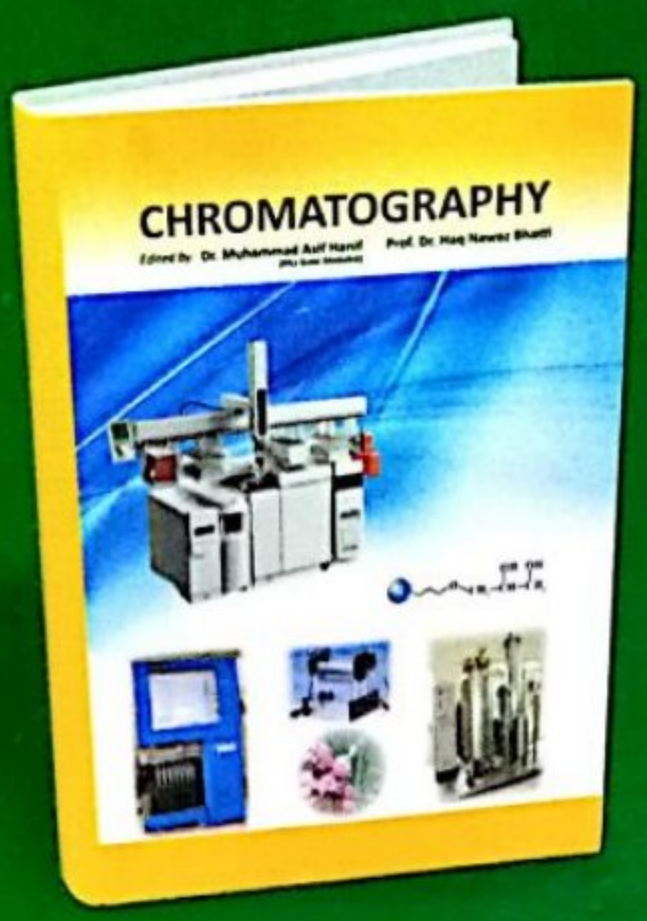

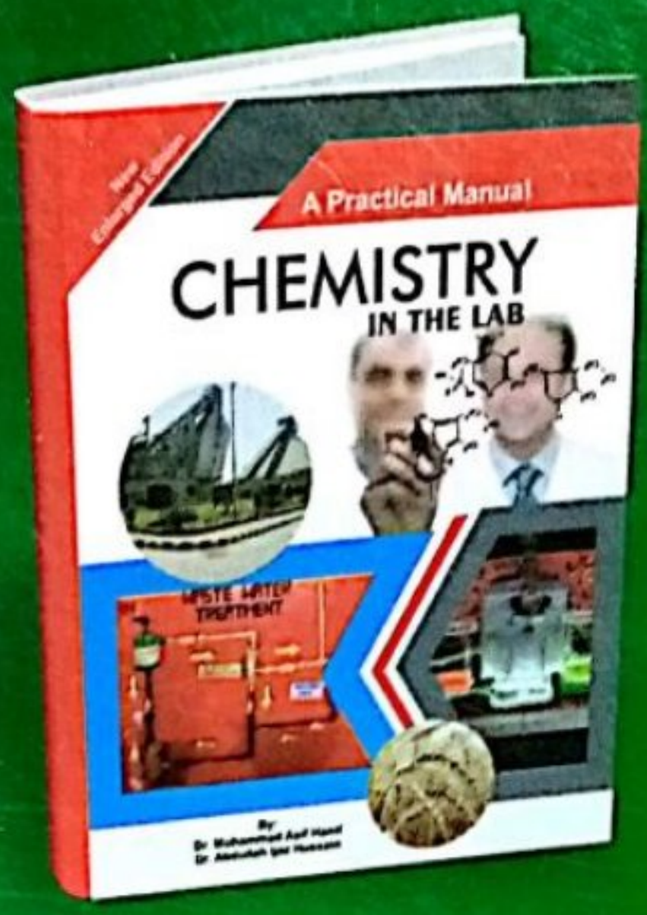

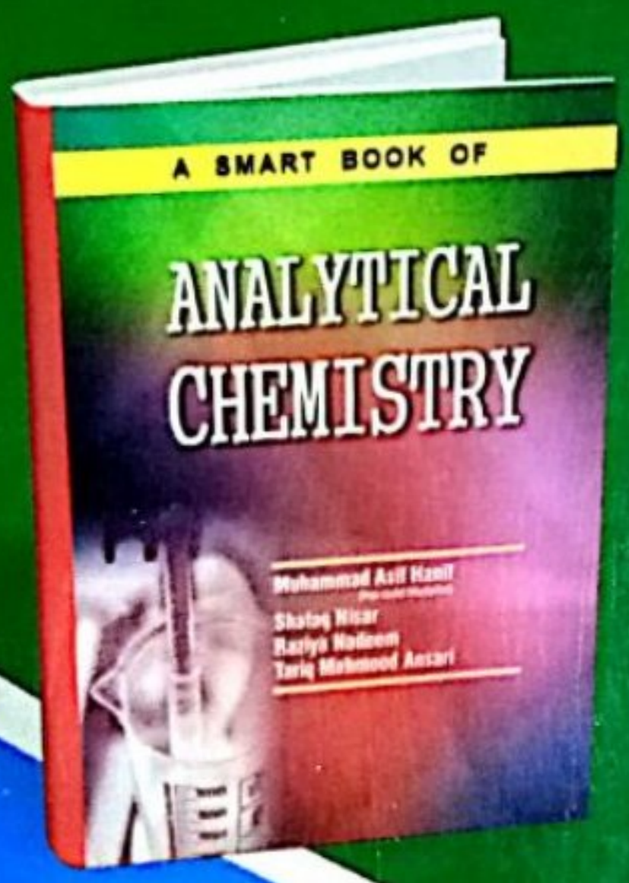

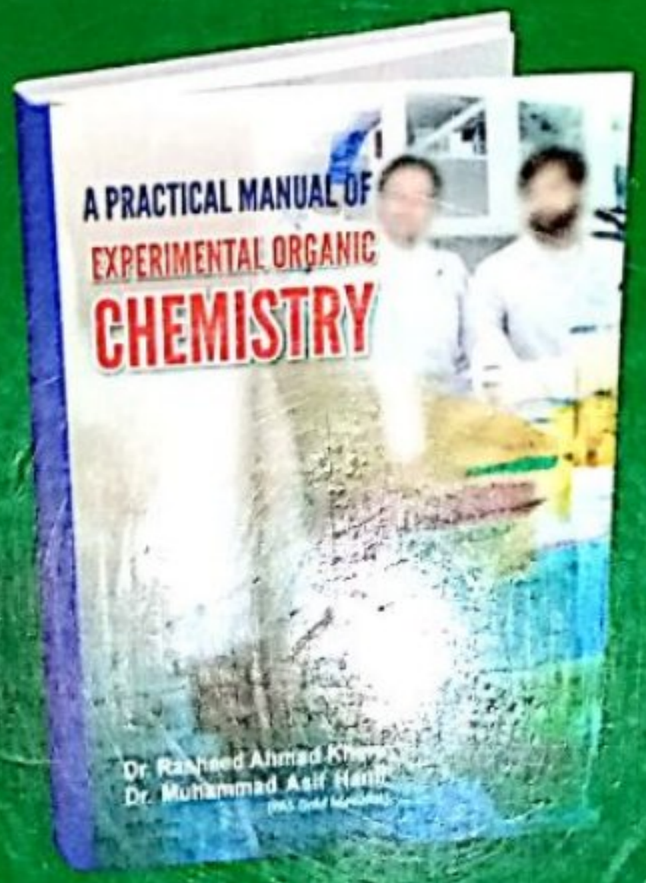

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