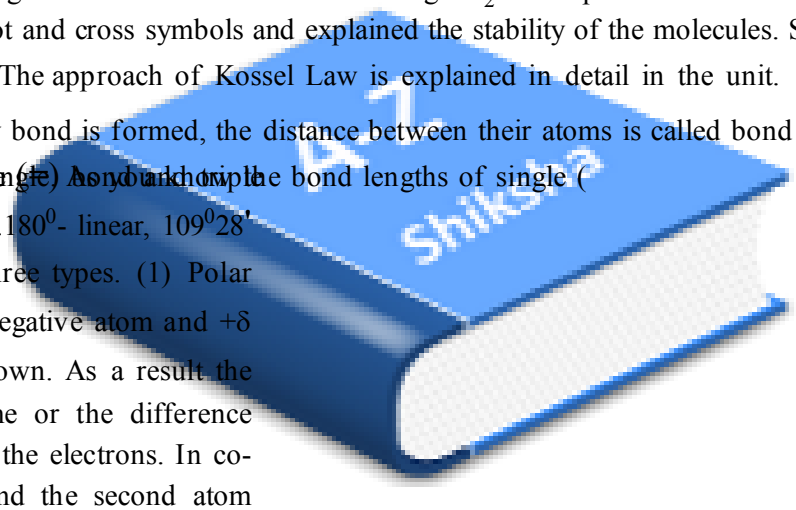
UNIT : 4 CHEMICAL BONDING AND MOLECULAR STRUCTURE

Important Points

In this unit, the study of chemical bonding and formation of molecule from the atoms are included. The smallest particle of element is atom and the smallest particle in a compound is molecule. The force or the binding that keeps the atoms in the molecule combined during the formation of molecule is called chemical bonding. The concepts like that of Kossel-Lewis, VSEPR principle, valence bond theory, molecular orbital theory have been presented. In chemical bonding, it has more relation with orbitals around the nucleus and especially the valence orbitals. We do not think about the nucleus but we take into consideration the effect due to its positive charge. Scientists Lewis and Kossel have mentioned the approach of chemical bonding. In this, the atom obtains the octet either by losing or by gaining the electron, which is chemically inert. This is called law of octet. Such bonds are called ionic bonds e.g. NaCl. Also, some atoms share electrons with each other and obtain octet structure resulting into stable covalent molecule. e.g. Cl_2. To explain the structures of such molecules he mentioned dot and cross symbols and explained the stability of the molecules. Such a bond is called covalent bond. The approach of Kossel Law is explained in detail in the unit.

When any bond is formed, the distance between their atoms is called bond length and the angle is called bond angle. As per the number of the bond lengths of single (



metrical shapes to molecules viz. 180^0- linear, $109^0 28'$

alent bond which can be of three types. (1) Polar

gged towards the more electronegative atom and +δ

n electronegative atoms are shown. As a result the

ies of the two atoms are same or the difference

med by both the atoms sharing the electrons. In co-

sharing a pair of electrons and the second atom

electron pair. viz. $F_3B \leftarrow NH_3$. Bond ← indicates

l length, bond angle, bond enthalpy (bond energy) is

h, more will be the stability and so more energy will

alpy may be different according to bond formation.

h we have studied in detail and also the formula to

py evolved in formation of compound is the math-

ons of atoms. It is explained in the unit by discussing

pair instead of being localised on any molecule it

in the molecule can be shown at different positions

. Such structures are called resonance structures and

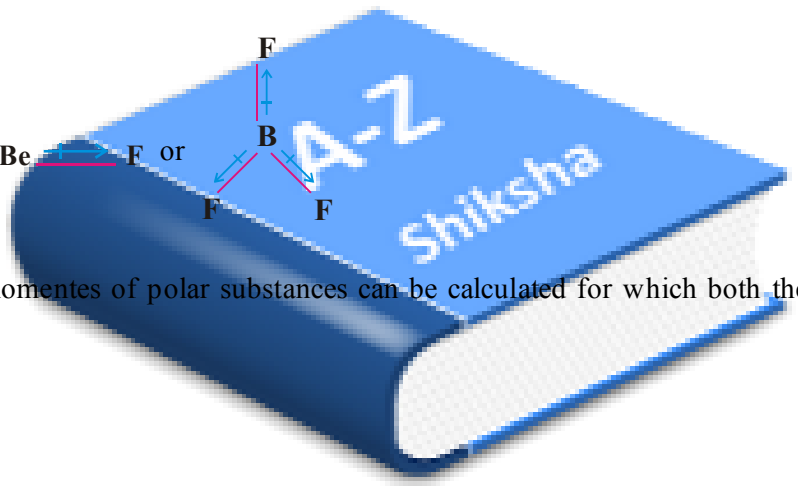
onance forms is called resonance energy. This can

on dioxide, benzene etc.

As we have seen earlier, structures like linear, tetrahedral etc, can be obtained on the basis of bond angle. This study can be used to show the shapes of the molecule by hybridisation of atoms in them, geometrical structures etc. viz. linear $BeCl_2$ - 180^0, trigonal BCl_3 - 120^0, tetrahedral CH_4 - $109^028'$.

Lewis approach being insufficient to explain the shapes of molecules, Sidgwick and Powell proposed one principle which is known as VSEPR principle which was developed by Nyholm and Gillespie and they proposed certain assumptions. In this it is important to note that when non-bonding electron pairs are there, then they show deviation in geometrical structure and bond angle due to repulsion between electron pairs. e.g. Molecule of water has sp^3 hybridisation and so its bond angle must be $109^028'$ but it becomes $104^0\ 30'$ due to repulsion by two non-bonding electron pairs. Hence, it is called distored tetrachedral. The polarity of bond is a vector quantity. Hence, if a polar bond is formed due to difference in electronegativities but another bond of the same type is formed in its opposite direction, then polar bond will be formed but the resultant polarity of the molecules becomes zero and molecule will be non-polar.

e.g F ← Be → F or



The dipole momentes of polar substances can be calculated for which both the charges +δ and δ- and the distance

the polar bond and r
only in polar solven
in water. Napthalene
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them : (1) Valence
quantum mechanics.
developed by Paulin

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The geometrical stru
In such valence bon

attains axial overlap of internuclear axis. The stability of this bond is more than that of π bond. In the π–bond the axis of the atomic orbitals undergoing overlapping remains parallel to each other and is perpendicular to internuclear axis. π– bonds are less stable in comparison to σ–bonds or they are weaker. Valence bond theory is based on overlapping of valence orbitals. It explains properties like the geometrical shapes, the bond angle etc. very simply but cannot explain magnetic properties.

Scientists Mulliken and Hund suggested molecular orbitals like atomic orbitals and proposed molecular orbital theory. Amongst its important points, the idea that atomic orbitals can also form molecular orbitals was taken into consideration. As many atomic orbitals take part in the formation, same number of molecular orbitals, their energy, symmetry etc. were taken into consideration. The formation of these types of atomic orbitals can be shown in the formation of homonuclear molecules like H_2, Be_2, F_2 etc. and heteronuclear molecules like CO, NO etc. Molecular orbitals are formed by linear combination of atomic orbitals–LCAO principle. On the basis of these types of combination two types of molecular orbitals are formed which are known as Bonding Molecular Orbitals (BMO) and Anti-Bonding Molecular Orbitals (ABMO). In the formation of rules these types of BMO and ABMO the principles like Hund's rule of maximum spin, Pauli's exclusion principle, Aufbau principle etc. which are applicable in formation of atomic orbital are also obeyed and maintained. In the unit the molecular orbital diagrams of construction of molecular orbitals from the atomic orbitals for formation of homonuclear molecules from H_2 to Ne_2 elements as well as for formation of heteronuclear molecules like CO, and NO are shown. From these diagrams, important property like bond order can be calculated. Bond order

$= \frac{1}{2}\{\text{electron in bonding molecular orbitals} - \text{electrons in anti} - \text{bonding orbital}\}$ viz. for N_2 molecule bond order $= \frac{1}{2}(10-4) = 3$ i.e. there will be triple bond N ≡ N. In the same way, in NO molecule bond order will be $= \frac{1}{2}[10 \quad 5] = 2.5$. Here, we will note that if the value of bond order becomes zero, the bond will not be formed e.g. He_2. If the value of bond order is integer, the bond will be single (—), double (=) and triple (≡) according to the integer 1, 2, or 3, there will be single (

on, then molecule will attain unstable
magnetic properties e.g. In O_2 molecule
nd in N_2 molecule, all the electrons are
y is superior to valence bond theory in

nd. The first element of 15, 16, and 17,
ments of the group it can form covalent
n. Afterwards the molecule like

H——F ····· H——F combines with each other by Hydrogen bond

H——F·····H——F where H ..... (dotted line) indicates hydrogen bond formation. HF, NH_3, H_2O possess hydrogen bonds and so their properties are different from those of other elements in the group. Hydrogen bond is of two types (1) Intermolecular and (2) Intramolecular hydrogen bonds. When hydrogen bond is formed between two molecules it is called intermoleculer hydrogen bond e.g. p-chlororphenol and between two groups in the same molecule, it is called intramoleculer hydrogen bond e.g. o-chlorophenol. Intermolecular hydrogen bond is stronger than intramolecular hydrogen bond. The presence of hydrogen bond is the reason for specific properties of the compounds. Viz the retaining of water in the soil, drying of terrylene clothes is faster than that of cotton clothes.

After knowing about ionic bond, covalent bond, co-ordinate covalent bond, we shall study the special type of bond present in metals which is called metallic bond. As there are 1, 2 or 3 electrons in the outermost orbit of the metals, they are not able to form covalent bonds. Their ionisation energy is less and attraction of electron towards the nucleus is less. One, two or three electrons are arranged around the nucleus of the atom. Hence, the positively charged nucleus or kernel is there. The electrons around it have attraction towards other nuclei of the atoms in the lattice. Thus, the electron instead of being localised for any one atom, remains delocalised in the whole metal crystal. For this theory Electron Sea model was proposed. In this, the atomic kernel is imagined as floating in the sea, delocalised electrons are arranged around kernel possessing positive charge. Because of this type of metallic bonds, the specific properties of metals, like density, ductility, malleability etc. are different.

Co-ordinate covalent bond is a type of covalent bond as seen earlier. The characteristic in it is that from the two atoms undergoing sharing of electrons, only one of the atoms provides a pair of electrons, and is shared by both the atoms. Hence, it is called co-ordinate covalent bond. e.g. In BF_3, three F atoms were bonded with B-atom through three covalent bonds but the octet of B is not complete. Similary in NH_3 molecule, three H atoms are bonded with N through three covalent bonds. But N has one non-bonding pair of electrons, which it gives to BF_3 molecule and is shared by both the molecules. Hence $F_3B \leftarrow NH_3$ Co-ordinate covalent bond is formed. In this, the molecule which gives pair of electrons is shown by arrow $(\rightarrow)$ from the molecule which donates it towards the molecule or atom which accepts and shares gained electron pair. You will study more about co-ordinate covalent bond in the unit of complex salts in Standard-12.

M.C.Q.

(1) Which of the following is ionic ?

(a) HCl (b) $CHCl_3$ (c) IF_5 (d) KI

(2) When molecule is form by chemical bonding between atoms then

(a) nucleous of combining atoms are participate

(b) valence electrons and inner cell electrons are participate

(c) only valence electrons of combining atoms are participate

(d) only inner cell electrons of combining atoms are participate

(3) Which factor is not responsible for the formation of ionicbond?

(a) crystal lattice energy (b) density

(c) ionisation enthalpy (d) electron gain enthalpy

(4) According to valence-bond theory which magnetic property oxygen possess ?

(a) Paramagnetic (b) Ferrimagnetic (c) Diamagnetic (d) Anti Ferromagnetic

(5) Who was proposed valence-bond theory ?

(a) Mulliken (b) Lenus Pauling (c) Hittler and Londan (d) Hund

(6) In H - C $\equiv$ C - CH = CH_2 molecule C^3 - C^2 single bond carbons has which type of hybridization ?

(a) sp^2 - sp^3 (b) sp - sp^2 (c) sp^3 - sp (d) sp^3 -sp^3

(7) Which of the following pair of species is isoelectronic and same structure ?

(a) NO_3^-, SO_3 (b) SO_3, CO_3^{2-} (c) CO_3^{2-}, ClO_3^- (d) NO_3^-, CO_3^{2-}

(8) Which of the following sentence is incorrect for covalent bond ?

(a) Strenght of covalent bond depenas upon overlapping at atomic orbitals.

(b) Covalent bond is not directional.

(c) There is sharing of electrons between atoms bonded by covalent bond

(d) Covalent bond is formed between atoms having less difference in their electronegativity.

(9) Which of the following compound possesses covalent bond ?

(a) $MgCl_2$ (b) NaH (c) BF_3 (d) CsCl

(10) Which of the following molecule possesses polar and nonpolar covalent bond ?

(a) NH_4Cl (b) CCl_4 (c) H_2O_2 (d) HCN

(11) Which of the following compound does not possesses coordinate covalent bond ?

(a) CO (b) SO_2 (c) HNO_2 (d) HNO_3

(12) Which of the following characteristic is not for covalent compound ?

(a) They do not possesses particular geometical structure

(b) They may be polar or nonpolar

(c) Their boiling and melting point is low

(d) Generally they are insoluble in water

(13) Which of the following possesses ionic and covalent bond ?

(a) CO_2 (b) H_2SO_4 (C) NH_4Cl (D) NaI

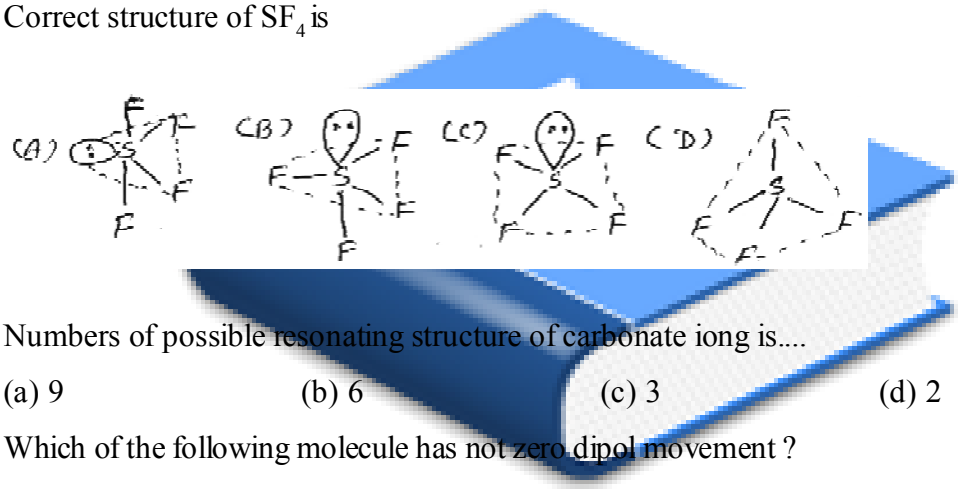
(14) Whhat is Geometrical Structure of ClF_3 molecule ?

(a) Triogonal bipyramid (b) Corn shpae (c) sea-saw (d) T-shape

(15) Which of the following molecule possesses linear structure ?

(a) SO_2 (b) CO_2 (c) H_2O (d) C_2H_4

(16) Correct structure of SF_4 is



(17) Numbers of possible resonating structure of carbonate iong is....

(a) 9 (b) 6 (c) 3 (d) 2

(18) Which of the following molecule has not zero dipol movement ?

(a) NF_3 (b) BF_3 (c) CO_2 (d) BeF_2

(19) Which of the following molecule possesses highest dipolspace movement ?

(a) CCl_4 (b) $CHCl_3$ (c) $CHCl_2$ (d) CH_3Cl

(20) Which of the following molecule possesses dipol movement ?

(a) trans - 1, 2 - dichloro ethene (b) trans pent - 2 - ene

(c) 2, 2- dimethyl propane (d) 2, 2, 3, 3- tetra methyl butane

(21) Which of the following molecule has lowest bond space angle ?

(a) NH_3 (b) SO_2 (c) H_2O (d) H_2S

(22) Which orbital has highest energy ?

(a) $\sigma(2Px)$ (b) $\pi^*(2Py)$ (c) $\sigma(2S)$ (d) $\sigma^*(1S)$

(23) Which is the paramagnetic species ?

(a) $C\bar{N}$ (b) $\bar{O}_2$ (c) NO^+ (d) CO

(24) Which of the following statement is incorrect when N_2 and O_2 are convert into N_2^+ and O_2^+ respectively ?

(a) In O_2^+, O - O bond order increases. (b) In N_2^+, N - N bond become weaker.

(c) N_2^+ become paramagnetic (d) Increasing dimagnetism in O_2^+

(25) According to VSEPR theory geomety of which block elements can be explain ?

(a) s (b) p (c) d (d) f

(26) Atoms complete octet in valence shell electron during the bond formation. This postulate was proposed by which scientist ?

(a) Powel (b) Lewis (c) Sigdwick (d) Mulliken

(27) Crystal formation is which type of reaction ?

(a) endothermic and exothermic (b) endothermic

(c) exothermic (d) no heat change occurs

(28) Lattice energy of ionic compound depends upon which factor ?

(a) Size of ion (b) Size of ion and charge

(c) charge on ion (d) Arrangement of ion

(29) Which is correct order for C - O bond length in CO, CO_3^{2-}, CO_2

(a) $CO_3^{-2} < CO_2 < CO$ (b) $CO_2 < CO_3^{2-} < CO$

(c) $CO < CO_2 < CO_3^{2-}$ (d) $CO < CO_3^{2-} < CO_2$

(30) Maximum how many numbers of hydrogen bond can be form by H_2O molecule ?

(a) 2 (b) 4 (c) 3 (d) 1

(31) In buta 1, 3 - diene

(a) only one sp hybridised carbon atom

(b) only sp^2 hybridised carbon atoms

(c) Two sp^3 and two sp^2 hybridised carbon atoms

(d) sp, sp^2 and sp^3 hybridized carbon atoms

(32) Which of the following statement is irrelevant for sigma bond ?

(a) strength of sigma bond is not related with overlapping of atomic orbitals.

(b) σ - bond can form by overlapping of S - P orbitals.

(c) σ - bond can form by overlapping of end of atomic orbitals of inner center axis.

(d) This type of overlapping is also known as axial overlaping

(33) In which molecule inter molecular hydrogen bond can be form ?

(a) methanol (b) ethelene glycol (c) p - nitrophenol (d) phenol

(34) In which molecule intra molecular hydrogen bond can be form ?

(a) o - nitro phenol (b) aniline (c) ethylene glycol (d) all of these

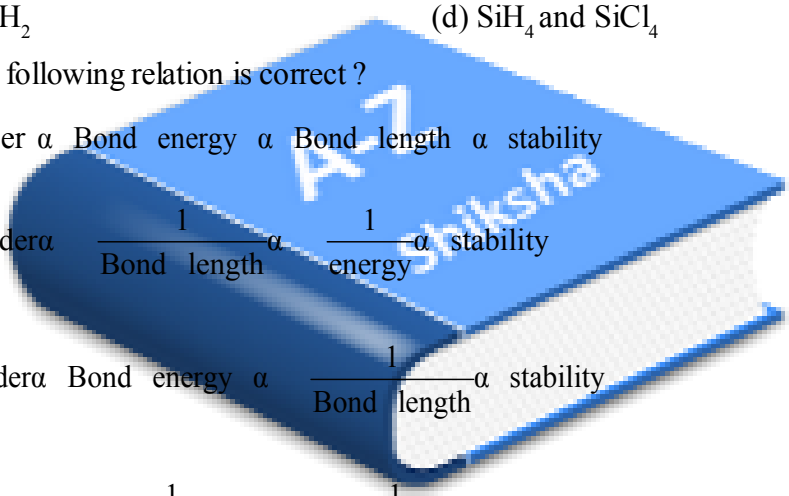
(35) Which of the following pair possesses very strong H - bond ?

(a) CH_3COCH_3 and $CHCl_3$ (b) HCOOH and CH_3COOH

(c) H_2O and H_2 (d) SiH_4 and $SiCl_4$

(36) Which of the following relation is correct ?

(a) Bond order α Bond energy α Bond length α stability



(b) Bond order $\alpha \frac{1}{\text{Bond length}} \alpha \frac{1}{\text{energy}} \alpha$ stability

(c) Bond order α Bond energy $\alpha \frac{1}{\text{Bond length}} \alpha$ stability

(d) Bond order $\alpha \frac{1}{\text{Bond length}} \alpha \frac{1}{\text{Bond energy}} \alpha$ stability

(37)

Molecule :	H_2	F_2	Cl_2	Br_2
Bondlength :	74pm	144pm	199pm	228pm

Mention more stable molecule from above

(a) Cl_2 (b) H_2 (c) Br_2 (d) F_2

(38) In water bond angle is $104^o 30$ because

(a) Oxygen atom is sp^3 hybridised

(b) Repulsion between lone pair election and bonding pair electron

(c) Oxygen has high electronegetivity.

(d) H_2O molecule possesses "V" - shape.

(39) In which of the following strong H-bond is present ?

(a) F - H.....F (b) O - H.....N (c) O - H.....O (d) O - H.....F

(40) Which is correct order for bond dissociation energy in O_2, O_2^+, O_2^- and O_2^{2-}

(a) $O_2 > O_2^+ > O_2^{2-} > O_2^-$ (b) $O_2^+ > O_2 > O_2^- > O_2^{2-}$

(c) $O_2^- > O_2^{2-} > O_2^+ > O_2$ (d) $O_2^- > O_2^{2-} > O_2 > O_2^+$

(41) O, P, Q, R elements electronic configuration is given below

$O = 1s^2$ $P = 1s^2, 2s^2, 2p^2$

$Q = 1s^2, 2s^2, 2p^5$ $R = 1s^2, 2s^2, 2p^6$

Which atom has strong behaviour of electrovalent bond ?

(a) O (b) P (c) Q (d) R

(42) In which molecule bond distorsion is more according to VSEPR theory ?

(a) SO_2 (b) NH_3 (c) O_3 (d) H_2O

(43) Which of the following species is more stable ?

(a) O_2^- (b) Ne_2^+ (c) O_2 (d) F_2

(44) Number of nonbonding electron pair in XeF_6, XeF_4 and XeF_2 respectively

(a) 2, 3, 1 (b) 1, 3, 2 (c) 3, 2, 1 (d) 1, 2, 3

(45) On keeping two cube of ice on each other which become one cube which factor is responsible for it ?

(a) Van-der waals attraction (b) Hydrogen bond (c) Dipole attraction (d) Covalent bond

(46) Determine lattice energy of $LiF_{(S)}$ according to given data.

(i) $Li_{(S)} \rightarrow Li_{(g)}$ 155.2 KJ mol^{-1} ($\Delta_S H$)

(ii) $F_{2(g)} \rightarrow 2F_{(g)}$ 75.2 KJ $\Delta\left(H_{\frac{D}{2}}\right)$

(iii) $Li_{(g)} \rightarrow Li^+_{(g)} + e^-$ 520.0 KJ $mol \Delta^1 H(_i)$

(iv) $F_{(g)} + e^- \rightarrow \bar{F}_{(g)}$ −33.0 KJ $\Delta(H_{eg})$

(v) $Li_{(s)} + \frac{1}{2}F_{2(g)} \rightarrow LiF_{(S)}$ −504.1 KJ mol^{-1} $(\Delta_f H)$

(a) $-86.7\,KJ\,mol^{-1}$ (b) 86.7 $KJ\ mol^{-1}$ (c) −867 $KJ\ mol^{-1}$ (d) 867 $KJ\ mol^{-1}$

(47) Which of the following statment is incorrect for metallic bond ?

(a) There is attraction between delocalised electrons and atomic karnel

(b) Directionl property is shown by metal

(c) Delocalised electron can change their position easily in crystal

(d) Explanation of metallic bond can be given by 'electron sea model'

S - Orbital

(48) Why lattice energy of NaCl > KBr ?

(a) When size of negative ion decrease in ionic crystal then lattice energy increases.

(b) When volume of positive and negative ion is small than then interionic attraction become more and hence latice energy increases.

(c) In ionic crystal when size of positive ion decrease, then lattice energy increases.

(d) All of given

(49) Number of H - bond form by unpaired electrons of liquid NH_3, H_2O and HF respectively are

(a) 3, 4, 2 (b) 4, 4, 2 (c) 3, 2, 1 (d) 1, 2, 1

(50) Which of the following pair is not in order for boiling point for 14, 15, 16 and 17 group ?

(a) $H_2O > H_2S$ (b) HF > HCl (c) $CH_4 > SiH_4$ (d) $NH_3 > PH_3$

(51) Which of the following compound possesses ionic bond ?

(a) CH_4 (b) $SiCl_4$ (c) BF_3 (d) $MgCl_2$

(52) Which of the following relation between BMO and ABMO electrons is correct for stability of diatomic malecule or ion ?

(a) $N_a > N_b$ (b) $N_b > N_a$ (c) $N_a + N_b = 0$ (d) $N_a = N_b$

(53) At what distance van-derwaals attraction exist ?

(a) 4.5×10^{-10} m (b) 0.45nm (c) 4.5 A° (d) Given all

(54) What is bond energy of H-bond ?

(a) 40 J mol^{-1} (b) 40 KgJ mol^{-1} (c) 40 cal. mol^{-1} (d) 40 Kg cal mol^{-1}

(55) In which molecule inter molecular H-bond is possible ?

(a) CH_3COCH_3 (b) CH_4 (c) SiH_4 (d) NH_3

(56) Which of the following characterstic does not possesses by metal ?

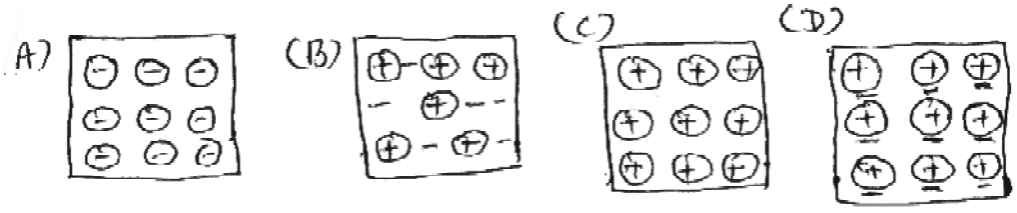
(a) luminus (b) ductility

(c) increase in conductance by increase in temperature (d) malleability

(57) On which factor conductance of metals responsible ?

(a) ions (b) delocalised (c) atomic kernel (d) number of atoms

(58) Which of the following figure shows electron-sea model ?



(59) According to which group, hydrogen bond is form in protein molecule present in musecls of living organism ?

(a) -CO- (b) -COOR (c) -CONH- (d) -COOH

(60) On which factor van-der waalls attraction force does not depend ?

(a) numbers of molecules (b) contact surface area of molecules

(c) shape of molecules (d) numbers of electron in molecules

(61) Practicol dipal movement of HCl is 1.03D. If bond length of HCl is 1.275 A^o than what will be the pereentage of ionic nature in HCl ?

(a) 7 (b) 17 (c) 43 (d) 21

(62) Which sentence is correct with respect to bond enthalpy ?

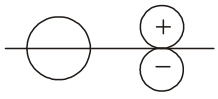
(a) As bond order is more, then bond dissociation enthalpy is less

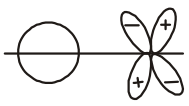
(b) As atomic volume is more, then bond energy is more.

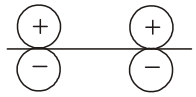
(c) As bond enthalpy is more, then stability of molecule or ion is less.

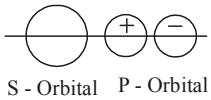
(d) As number of nonbonding election pair on bonded atom then bond enthalpy is less.

(63) which of the following orbitals form bonding orbital ?

(a) 

(b) 

(c) 

(d) 

(64) Mention number of bonding electron pairs and nonbonding electron pairs in NO_3^- ion

(a) 3, 1 (b) 2, 2 (c) 4, 0 (d) 1, 3

(65) How many numbers of bonding and nonbonding electron pairs in CO_2 ?

(a) 4, 4 (b) 2, 4 (c) 4, 2 (d) 2, 2

(66) Mention proper order of bond length given below.

(a) $N_2 < N_2^{2-} < N_2^-$ (b) $N_2^{2-} < N_2^- < N_2$ (c) $N_2^- < N_2 < N_2^{2-}$ (d) $N_2 < N_2^{2-} < N_2$

(67) Show paramagnetic compound given below.

(a) O_3 (b) KO_2 (c) N_2O (d) Na_2O_2

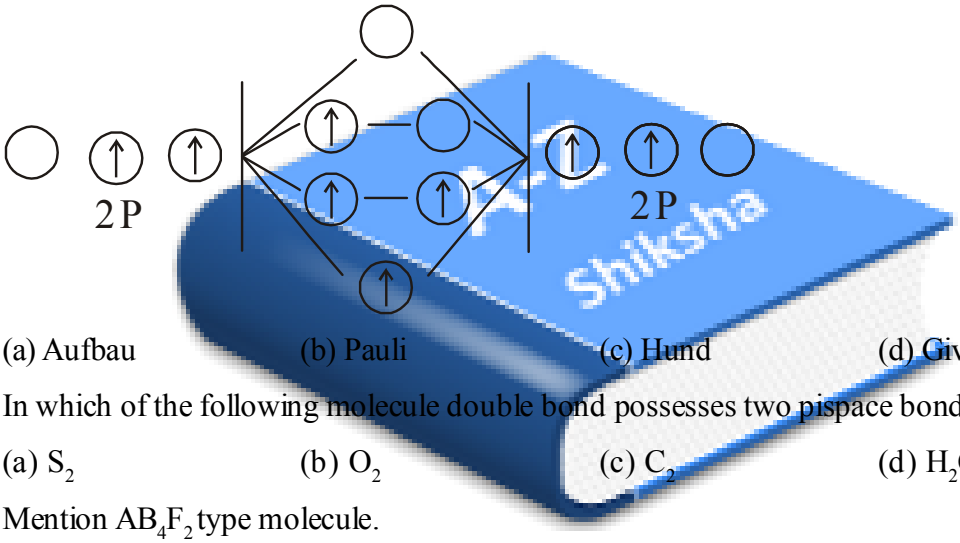
(68) Which species possesses pyramidal shape ?

(a) OsF_2 (b) SO_3 (c) BrF_3 (d) SiO_3^{2-}

(69) Which of the following does not possesses bond order as CO ?

(a) $N\overset{+}{O}$ (b) $N\overset{-}{O}$ (c) N_2 (d) $C\overset{-}{N}$

(70) Which rule is violated in the given electronic configuration ?



(a) Aufbau (b) Pauli (c) Hund (d) Given all

(71) In which of the following molecule double bond possesses two pispace bond ?

(a) S_2 (b) O_2 (c) C_2 (d) $H_2C = CH_2$

(72) Mention AB_4F_2 type molecule.

(a) BrF_5 (b) XeF_4 (c) SF_6 (d) $XeOF_4$

(73) Which of the following is the correct order for lone pair and bonding pair electrons ?

Lp = Lone pair and Bp = Bonding pair

(a) Lp - Lp > Lp - Bp > Bp - Bp (b) Lp - Bp > Lp - Lp > Bp - Bp

(c) Bp - Bp > Lp - Lp > Lp - Bp (d) Lp - Lp > Bp - Bp > Lp - Bp

(74) Which theory is useful to determine geometrical structure of molecules ?

(a) molecular orbital theory (b) VSEPR theory

(c) Resonance theory (d) Quantam mechanics

(75) The one outermost electron present in Na element at

(a) one corner of simple cube (b) eight corner of simple cube

(c) center of simple cube (d) each corner of simple cube

(76) In which molecules / ion have not all the equal bonds ?

(a) SF_4 (b) BF_4^- (c) XeF_4 (d) SiF_4

(77) Which of the following has maximum bond angle ?

(a) NH_3 (b) CH_4 (c) CO_2 (d) H_2O

(78) Which of the following have equal bond order ?

(a) O_2^- (b) CN^- (c) $N\overset{+}{O}$ (d) B and C

(79) The type of bond present in $CuSO_4 .5H_2O$

(a) covalent and co-ordinate covalent (b) electrovalent and covalent

(c) electrovalent and co-ordinate covalent

(d) electrovalent, covalent and co-ordinate covalent

(80) Which of the following statement is wrong

(a) sp^2 hybrid orbitals are formed from two p - atomic and one s - orbitals

(b) hybridization is the mixing of atomic orbitals prior to their combing into molecular orbitals

(c) d^2p^2 hybrid orbitals are all at go to one an other

(d) d^2sp^3 hybrid orbitals are directed towords the corners of a regular tetrahedron

(81) CO_2 is isostructual with

(a) $SnCl_2$ (b) $HgCl_2$ (c) C_2H_2 (d) SO_2

(82) NH_3 has a higher boiling point than expected because

(a) its density decreases on freezing

(b) with water it forms NH_4OH

(c) it has strong inter molecular covalent bonds ?

(d) it has intermolecular hydrogen bonds.

(83) The molecule with zero dipole moment is

(a) chloroform (b) methyl chloride

(c) carbon tetrachloride (d) methylene chloride

(84) Molecular shaper of SF_4, CF_4, XeF_4 are

(a) the same with 1, 1 and 1 lone pairs of electrons respectively

(b) different with 1, 0 and 2 lone pairs of electrons respectively

(c) different with 0, 1 and 2 lone pairs of electrons respectively

(d) different with 2, 0 and 1 lone pairs of electrons respectively

(85) Which of the following has the regular tetrahedral structure ?

(a) SF_4 (b) $[Ni(CN)_4]^{2-}$ (c) BF_4^- (d) XeF_4

(86) In OF_2, number of bond pairs and lone pairs of electrons are respectively

(a) 2, 8 (b) 2, 6 (c) 2, 9 (d) 2, 10

(87) In O_2^-, O_2, O_2^{2-} molecular species the total number of antibonding electrons respectively are

(a) 7, 6, 8 (b) 1, 0, 2 (c) 6, 6, 6 (d) 8, 6, 8

(88) Match the following and choose the correct Answer

Column - I	**Column -II**
(i) sp^3d^2	(a) $Ni[(CN)_4]^{2-}$
(ii) sp^3d	(b) $SnCl_2$
(iii) dsp^2	(c) ICl_4^-
(iv) sp^2	(d) $TeCl_4$

(a) i $\rightarrow$ d, ii $\rightarrow$ a, iii $\rightarrow$ c, iv $\rightarrow$ b (b) i $\rightarrow$ c, ii $\rightarrow$ d, iii $\rightarrow$ a, iv $\rightarrow$ d

(c) i $\rightarrow$ b, ii $\rightarrow$ c, iii $\rightarrow$ d, iv $\rightarrow$ a (d) i $\rightarrow$ a, ii $\rightarrow$ b, iii $\rightarrow$ c, iv $\rightarrow$ d

(89) Among the following compounds, the one that is polar and has the central atom with sp^2 hyridisation is

(a) $HClO_2$ (b) BF_3 (c) H_2CO_3 (d) SiF_4

(90) Match the following

Set A	**Set B**
(1) stability of bond	(p) Bond energy
(2) Molecular orbital theory	(q) Bond order
(3) octet rule	(r) Variable Valency
(4) Valence bond theory	(s) Electronic concept of valency

(a) 1 $\rightarrow$ q, 2 $\rightarrow$ p, r, 3 $\rightarrow$ p, 4 $\rightarrow$ s (b) 1 $\rightarrow$ p, q, 2 $\rightarrow$ p, 3 $\rightarrow$ r, 4 $\rightarrow$ s

(c) 1 $\rightarrow$ p, q, 2 $\rightarrow$ r, 3 $\rightarrow$ s, 4 $\rightarrow$ r (d) 1 $\rightarrow$ p, q, 2 $\rightarrow$ q, 3 $\rightarrow$ s, 4 $\rightarrow$ r

(91) Bond strength increases with

(a) Bond length increasing

(b) Antibonding eletrons being higher in number

(c) Bond order increasing (d) Bond angle increasing

(92) O_2^{2+} will have

(a) Bond order lower than O_2

(b) Bond order higher than O_2

(c) Bond order lower than H_2

(d) Bond order higher than N_2

(93) In a molecule number of electrons in BMO are more as compared to ABMO, hence

(a) a bond will be formed

(b) no bond will be formed

(c) information is not sufficient

(d) none of the above

(94) The bond angle in the ammonium ion is equal to

(a) 90^o (b) 104^o (c) 120^o (d) $109^o.28^1$

(95) The correct order of dipole moment is

(a) $CH_4 < NF_3 < NH_3 < H_2O$ (b) $NF_3 < CH_4 < NH_3 < H_2O$

(c) $NH_3 < NF_3 < CH_4 < H_2O$ (d) $H_2O < NH_3 < NF_4 < CH_4$

(96) The correct order of the O – O bond length in O_2, H_2O_2 and O_3 is

(a) $O_2 > O_3 > H_2O_2$ (b) $O_3 > H_2O_2 > O_2$

(c) $H_2O_2 > O_3 > O_2$ (d) $O_2 > H_2O_2 > O_3$

(97) The bond order of O_2^- is

(a) 1.0 (b) 1.5 (c) 2.5 (d) 0.5

(98) Choose the incorrect statement.

(a) σ bond is weaker than π bond

(b) π bond is weaker than σ bond

(c) π bond is present along with a σ bond

(d) σ bond can be present alone

(99) Which of the following is not paramagnetic ?

(a) NO (b) S^{2-} (c) O_2^- (d) N_2^-

(100) Which one of the following compound has sp^2 hybridization ?

(a) CO_2 (b) SO_2 (c) CO (d) N_2O

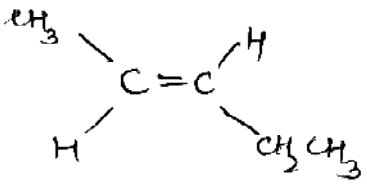
Answer key

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

Hints

1. Electronegative difference in KI is more
2. ACC to V.B.T, O_2 contain all e^- paired. So they are diamagnetic
6. Here C - C contain double and triple bond
7. NO_3^- and CO_3^{-2} contains 32 e^- so they are iso electric ions Both possess sp^2 hybridization
10. In H_2O_2, O - H is polar

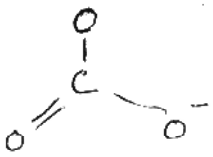
    O - O is non-polar
11. H-O-N = 0
16. Struchure A is stable
18. In NF_3, polarity of N F bond and non-bonding e^- pair are in opposite direction
19. In CH_3Cl, dipole moment is due to C-Cl and C-H

20. 

trans - pent - 2 - ene
possess magnetic moment

21.

Compound	SO_2	H_2O	H_2S	NH_3
Bond angle	119.5°	104.5°	92.5°	106.5°

29. $C \equiv O$ $O = C = O$ 

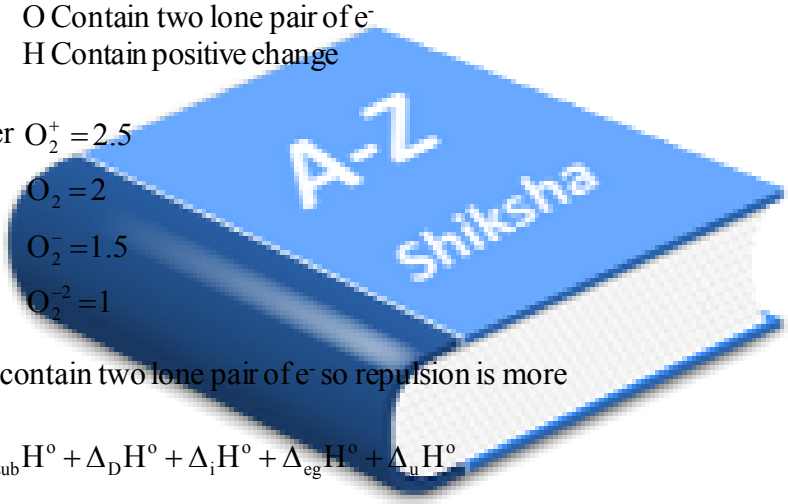
30. In H_2O, O Contain two lone pair of e^-
H Contain positive change

40. Bond order $O_2^+ = 2.5$

$O_2 = 2$

$O_2^- = 1.5$

$O_2^{-2} = 1$



42. In H_2O, O contain two lone pair of e^- so repulsion is more

46. $\Delta_f H^\circ = \Delta_{sub} H^\circ + \Delta_D H^\circ + \Delta_i H^\circ + \Delta_{eg} H^\circ + \Delta_u H^\circ$

61. Theorectical dipole momentum

$$H = q \times d \quad [1\ D = 1 \times 10^{-18}\ esa\ cm]$$
$$= 4.8 \times 10^{-10} \times 1.275 \times 10^{-8}$$
$$= 6.12 \times 10^{-10}\ e.s.u.cm$$
$$= 6.12\ D$$

$$\% \text{ of ionic character} = \frac{\text{Practical}(\mu)}{\text{Theoretical}(\mu)}$$
$$= \frac{1.03}{6.12} \times 100$$
$$= 16.83$$
$$\approx 17\%$$