
Unit-25 - POLYMER

IMPORTANT POINTS

■ INTRODUCTION

Polymer : Polymer (poly = many ; meros = parts) : is defined a material which is made by linking together a large number of small recurring units called monomers. For example, polythene $(-\text{CH}_2 - \text{CH}_2 -)_n$ is formed by linking together a large number of ethene (C_2H_4) molecules.

- **Difference between Polymer and Macromolecule.** Both polymer and macromolecules are very big molecules. In a polymer there must be repeating units. But in a macromolecule, the repeating unit may or may not be present. For example, polyethene containing the repeating unit $-\text{CH}_2 - \text{CH}_2 -$, is regarded as both a polymer and a macromolecule. But chlorophyll having formula $\text{C}_{55}\text{H}_{72}\text{O}_5\text{N}_4\text{Mg}$ does not have any repeating unit and hence it is known as a macromolecule but not a polymer.

■ CLASSIFICATION OF POLYMERS

(i) Classification Based on Source

Natural and Synthetic polymers. The polymers found in nature are known as natural polymers which control the life process in plants and animals and known as biopolymers, e.g., starch, cellulose, proteins and nucleic acids. The polymers which are made in the laboratories are known as synthetic polymers e.g., polythene, nylon, dacron etc.

Semi-synthetic polymers. Semi synthetic polymers are chemically modified naturally occurring polymers. e.g., semi synthetic cellulose diacetate fibers are obtained by acetylation of natural cellulose with acetic anhydride in presence of sulphuric acid. An explosive cellulose nitrate obtained on nitration of cellulose is another example of semi-synthetic polymer. Vulcanised rubber used for making rubber tyres is also a semi-synthetic polymer.

(ii) Classification based on Polymerisation reaction

- **Polymerisation.** It is the union of two or more of smaller molecules of similar or different type with or without elimination of a small molecule like water, HCl etc., resulting in the formation of a new C – C bond.
- The number of repeating units (n) which link together to form a molecule is known as the degree of **polymerisation**.

(iii) Classification Based on Mode of Polymerisation

- (a) Chain growth and step growth polymers
- **Chain growth polymers.** These polymers are formed by successive addition of monomer units to the growing chain having a reaction intermediate (free radical, carbocation or carbanions) at one end of the chain. Chain growth polymers are formed by a process which involves chain reactions and the process is called *chain growth polymerisation*.
- **Step growth polymers.** These polymers are formed through a series of independent steps (reactions). Each step involves the condensation (bond formation) between two bifunctional units (monomers) leading to the formation of a dimer, trimer, tetramer etc. Since the polymer is formed in a stepwise manner, the process is called step growth polymerisation.

- Some important differences between chain growth and step growth polymerisation are given below :

Sr. No.	Chain growth polymerisation	Step growth polymerisation
(i)	Addition polymerisation.	Condensation polymerisation.
(ii)	Monomers add to growing chain.	Monomers add in steps to form dimers, trimers.
(iii)	Takes place through chain reactions in the presence of initiators.	Takes place through condensation reaction
(iv)	Fast reaction	Slow reaction.

(b) Homopolymer and copolymer

- Homopolymer.** If a polymer is made up of identical monomers, it is called a homopolymer (.....-M-M-M-M.....). For example, polythene, polyvinyl chloride and neoprene.
- Copolymers.** If a polymer is made of monomers of different chemical structures, it is called a copolymer (..... -M₁ - M₂ - M₁ - M₂ -). For example Buna-S, butyl rubber and nitrile rubber.
- Copolymerisation** is the polymerisation of two or more different monomer species resulting in high molecular mass compounds called copolymerisation.

(c) Addition and condensation polymers

- Addition Polymerisation.** In this process, the simple monomers are joined together without loss of molecules like H₂O, NH₃, etc. Polythene is one example.
- Condensation Polymerisation.** In this process, the simple monomers are combined together with the loss of simple molecules like H₂O, NH₃, etc., e.g., nylon.
- Some important differences between Addition and Condensation polymers are given below :

Sr. No.	Addition polymers	Condensation polymers
1.	Formed by addition reaction.	Formed by condensation process with elimination of small molecule like H ₂ O.
2.	Mol. mass is whole number multiple of Monomer.	Mol. Mass is not whole number multiple of the monomer units.
3.	Generally involve one monomer Unit	Involve more than one monomer unit.
4.	Monomers are unsaturated molecules.	Monomer units must have two active functional groups.
5.	They are generally chain growth polymers.	They are generally step growth polymers.

(iv) Classification Based on Structure

- Linear Polymers.** In these polymers there are straight chains of polymer molecules. For example, nylon and polyester. Linear polymers possess high melting points and high density.
- Branched Chain Polymers.** In these polymers there are branches along the chains of polymer molecules. For example, amylopectin. Branched chain polymers possess low melting point and low density.
- Cross Linked polymers.** In these polymers the linear chains are joined together by a suitable cross link and as a result a three dimensional network structure is formed. For example, polystyrene – butadiene polymer and urea formaldehyde polymer. The cross linking the mechanical strength also increases.

- **(v) Classification Based on Molecular Forces.**
- **Elastomers** are polymers which possess elastic properties in excess of 300 percent. The elastic property arises from the fact that in a elastomer the monomer units are not linked in a straight chain but are arranged in the form of a coil and hence it can be stretched like a spring. When the deforming stress is released, the chains go back to their original coiled state. For example, natural rubber, styrene butadiene rubber. Elastomers are cross linked to some extent. However, extensive cross-linking reduces the elastic property.
- **Fibres** are polymers in which the chains are held by intermolecular forces e.g., hydrogen bonding or dipole-dipole interactions. For example, nylon and polyacrylonitrile.
- **Thermosetting polymers** are polymers which harden irreversibly on application of sufficient heat. For example bakelite, urea-formaldehyde and melamine-formaldehyde.
- **Thermoplastic** are polymers which soften on heating and harden on cooling reversibly. For example, polyvinyl chloride, polythene, teflon and polystyrene.
- **Plastics possess plasticity but no elasticity but rubbers possess elasticity and no plasticity.** Plasticity is the property to get deformed on application of force and elasticity is the property to regain the original shape when the deforming force is removed.
- **Some important differences between thermosetting and thermoplastic polymers are given below :**

Sr. No.	Addition polymers	Condensation polymers
(1)	Formed by condensation polymerisation.	Formed by addition polymerisation
(2)	Once hardened, they cannot be remelted. On prolonged heating they are charred.	Soften on heating and harden on cooling reversibly.
(3)	Cannot be reshaped and reused on heating (retain their structure and shape).	Can be softened, reshaped and reused.
(4)	Possess three dimensional network structure containing cross links.	Possess linear structure with negligible cross links
(5)	These are strong, hard and more brittle.	These polymers are weak, soft and less brittle
(6)		These polymers can be reclaimed
(7)	These polymers cannot be reclaimed. These are insoluble in common organic solvents.	These polymers are soluble in certain organic solvents

■ PROPERTIES OF POLYMRE SUBSTANCE

The properties of polymer substances depend upon (i) the structure of the macro molecules contained in them and (ii) Their avenger molecular mass.

Larger the number of molecules with higher molecular mass contained in it, the greater will be its density, melting point, hardness. Smaller the number of molecules with lower molecular mass contained in it, lower will be its density, melting point, hardness etc.

The properties with high degree of polymerisation called high degree polymers (HDP) and the polymers with low degree of polymerisation are called low degree polymers (LDP). Hard and

durable materials are made from high degree polymers while lower degree polymers are used to obtain soft and cheaper materials.

Modification in properties of polymer substances

The properties of the polymer substances can be modified to make them more useful by adding certain substances to them. For example ;

- (i) Inorganic substance like TiO_2 , BaSO_4 , CaCO_3 , SiO_2 , are added to the polymers to abrasion. These additives are called fillers.
- (ii) Organic substances like tricresyl phosphate, glyceryl phthalate, tertiary butyl phthalate, oleic acid are added to some polymers to introduce softness. These additives are called plasticizers.
- (iii) Organic substances like phenol, cresol, and quinol and carbon black are added to check the effect of sun light on the polymers and to avoid their decomposition. These additives are called

antioxidants.

Characteristics of polymer substances

- (i) They are light in weight and many types of material can be made out of them.
- (ii) They are not affected by atmosphere and moisture unlike wood, metal, leather, cotton clothes.
- (iii) They are insulators and possess heat resisting property.
- (iv) They are not affected by the germs and most of the chemicals.
- (v) Their properties can be easily modified to meet the requirement.
- (vi) Their raw materials are easily and cheaply available.

■ **GENERAL METHODS OF POLYMERISATION**

They are obtained either by addition polymerisation or by condensation polymerisation.

- (i) **Addition polymerisation.** Addition polymerisation involves the combination of a large number of monomers of one or two types having one or more double bonds. Through chemical bond formation this type of polymerisation is carried out by the formation of reactive intermediates such as free radical or carbocation/carbanion with monomers like ethene, propene, styrene, 1, 3-butadiene, isobutylene, vinyl chloride, vinyl nitrile etc.

When a large number of two types of different monomers carrying double bonds add on alternatively with each other, the reaction is called copolymerisation. Styrene butadiene rubber alternatively with each other, the reaction is called copolymerisation. Styrene butadiene rubber (SBR) obtained from styrene and butadiene monomers is copolymer.

- (a) **Free radical addition polymerisation.** Various types of unsaturated compounds such as alkenes or dienes and their derivatives undergo polymerisation via free radical reactive intermediates. Free radical generated by primary initiator like tertiary butyl peroxide at proper temperature and pressure. The free radical joins the double bond of monomer ethene forming a new free radical. This new free radical joins many other molecules one by one forming everytime bigger and bigger and bigger chain type new free radical. Finally depending upon the reaction conditions, two bigger long chain type of free radicals join each other to form a polymer molecule.

M.C.Q.

- (1) A high molecular weight molecule built from a large number of simple molecules is called a
(A) Monomer (B) Isomer (C) Polymer (D) Tautomer.
- (2) A high molecular weight molecule which does not contain repeating structural units is called a
(A) Polymer (B) Macromolecule (C) Both (A) and (B) (D) None of the above
- (3) The simple molecules from which a polymer is made are called
(A) Monomers (B) Metamers (C) Rotamers (D) Eantiomers.
- (4) Which of the following is not a biopolymer ?
(A) Proteins (B) Nucleic (C) Cellulose (D) Neoprene.
- (5) What is not true about polymers ?
(A) Polymers do not carry any charge (B) Polymers have high viscosity
(C) Polymers scatter light (D) Polymers have low molecular weights.
- (6) On the basis of the mode of their formation the polymers can be classified
(A) as addition polymers only (B) as condensation polymers only
(C) as copolymers (D) Both as addition and condensation polymers
- (7) Natural rubber is a polymer of
(A) Butadiene (B) Ethyne (C) Styrene (D) Isoprene
- (8) Terylene is a condensation polymer of ethylene glycol and
(A) Benzoic acid (B) Phthalic acid (C) Succinic acid (D) Terephthalic acid.
- (9) Which one of the following is not an example of chain growth polymer ?
(A) Neoprene (B) Buna-S (C) PMMA (D) Glyptal.
- (10) Which of the following is a synthetic polymer ?
(A) Starch (B) Silk (C) Protein (D) Polystyrene.
- (11) Homopolymers are made from
(A) Only one type of monomers (B) Two different of monomers
(C) Three different types of monomers (D) Several different types of monomers.
- (12) Amongst the following, a homopolymer is
(A) PMMA (B) Bakelite (C) Glyptal (D) Dacron
- (13) Which of the following is a copolymer.
(A) Buna-S (B) PAN (C) Polythene (D) PTFE
- (14) Which of the following is a linear polymer ?
(A) Nylon (B) Bakelite
(C) Alkyd resin (D) Melamine-formaldehyde polymer.
- (15) Amongst the following, the branched chain polymer is
(A) PVC (B) Polyester (C) Low density polythene (D) Nylon-66
- (16) A copolymer of acrylonitrile and 1, 3-butadiene is called.
(A) Buna-N (B) Polystyrene (C) Neoprene (D) Buna-S.
- (17) Which of the following is wrong ?
(A) PMMA is called plexiglass (B) PTFE is called teflon
(C) SBR is natural rubber (D) LDPE is called low density polythene.

- (18) Which of the following statement/s is /are correct?
 (A) Vinyon is a copolymer of vinyl chloride and vinyl acetate
 (B) Saran is a copolymer of vinyl chloride and vinylidene chloride
 (C) Butyl rubber is a copolymer of isobutylidene and isoprene
 (D) All are correct
- (19) Mark the correct statement about thiokol rubber
 (A) It is a synthetic polysulphide rubber
 (B) It is obtained by condensation of ethylene chloride with sodium tetrasulphide
 (C) It is resistant to oils and abrasion
 (D) All are correct
- (20) Which of the following is an addition (chain growth) polymer?
 (A) Nylon-66 (B) Polyester (C) PVC (D) Glyptal
- (21) Which of the following is not an addition polymer?
 (A) Polystyrene (B) PVC (C) Polypropylene (D) Nylon
- (21) An example of addition copolymer is
 (A) Polythene (B) Butyl rubber (C) Neoprene (D) Natural rubber
- (22) Which of the following is an addition homopolymer?
 (A) polythene (B) Teflon (C) PVC (D) All the three above
- (23) Which of the following sets contain only addition homopolymer?
 (A) Polythene, natural rubber, cellulose (B) Starch, nylon, polyester
 (C) Teflon, bakelite, orlon (D) Neoprene, PVC, polythene
- (24) Which of the following is not a condensation (step growth) polymer?
 (A) Melamine-formaldehyde resin (B) Bakelite
 (C) Polythene (D) Polyester
- (25) An example of a condensation homopolymer is
 (A) Bakelite (B) Melamine-formaldehyde resin
 (C) Alkyd resin (D) perlon or Nylon-6
- (26) A polymer formed by coordination polymerization is
 (A) Low density polythene (B) High density polythene
 (C) Nylon-6 (D) Dacron
- (27) Low density polythene is prepared by
 (A) Free radical polymerization (B) Cationic polymerization
 (C) Anionic polymerization (D) Zeigler-Natta polymerization
- (28) The best way to prepare polyisobutylene is
 (A) Coordination polymerization (B) Free radical polymerization
 (C) Cationic Polymerization (D) Anionic polymerization
- (29) Natural rubber is a polymer of
 (A) Ethylene (B) Vinyl chloride (C) Phenol (D) Isoprene
- (30) Isoprene is
 (A) 1,3-butadiene (B) 2-methyl-1,3-butadiene
 (C) 2-methoxy-1,3-butadiene (D) 2-chloro-1,3-butadiene

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- (31) Natural rubber is
 (A) Polyvinyl chloride (B) cis-Polyisoprene (C) trans- Polyisoprene (D) Polychloropene
- (32) Gutta percha is
 (A) trans- Polyisoprene (B) a synthetic polymer
 (C) a very hard material (D) All statement are correct
- (33) Natural silk is a
 (A) Polypeptide (B) polysaccharide (C) polychloropene (D) polyacrylonitrile
- (34) artificial silk is a
 (A) Polypeptide (B) polysaccharide (C) polythene (D) Polyvinyl Chloride
- (35) Which of the followin is not a polyamide?
 (A) Wool (B) Leather (C) Nylon (D) Natural rubber
- (36) Among the following polymer, the strongest intermolecular forces of attraction are present in
 (A) Elastomers (B) Fibres
 (C) Thermoplastics (D) Thermosetting polymers
- (37) Among the following the weakest interparticle forces of attraction present in
 (A) Thermosetting polymers (B) Thermoplastics polymers
 (C) Fibers (D) Elastomers
- (38) Thermoplastics are
 (A) Linear polymers
 (B) Soften or melt on heating
 (C) Molten polymer can be moulded in desired shape
 (D) All the correct
- (39) Which of the following is not a thermosetting polymer?
 (A) Alkyd resin (B) Bakelite (C) Melmac (D) SBR
- (40) Which of the following can be remelted time and again without producing any change
 (A) Thermosetting polymers (B) Thermoplastics polymers
 (C) Bakelite (D) Melamine-formaldehyde polymer
- (41) The tensile strength, elasticity and resistance to abrasion can be increased by a process called
- (A) Diazotisation (B) Vulcanization (C) Isomerization (D) Polymerization
- (42) The process of vulcanization was introduced by
 (A) Charles' goodyear (B) Kolbe (C) Wohler (D) Zeigler
- (43) Vulcanized rubber resists
- (A) Wear and tear due to friction (B) Cryogenic temperature
 (C) High temperature (D) Action of acids
- (44) The polymer obtained by condensation of sevacic acid and hexamethylenediamine is called
- (A) Nylon-66 (B) Nylon-6 (C) Nylon-610 (D) Decron
- (45) The liner chains in nylon are held together by
 (A) H-bonds (B) Covalent (C) Ionic bonds (D) van der waal's forces
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- (46) Caprolactam needed for manufacture of nylon-6 is obtained by beckmann rearrangement of
- (A) Benzophenone oxime (B) Acetophenone oxime
(C) Cyclohexanone oxime (D) Cyclopentanone oxime
- (47) The repeating structural unit in neoprene is
- (A) Chloroprene (B) Chloropicrin
(C) Chloroethene (D) Chlorotrifluoroethylene
- (48) Chloroprene is obtained by addition of HCL to
- (A) Acetylene (B) Vinylacetylene (C) Divinylacetylene (D) Phenylacetylene
- (49) To make PVC a flexible plastic, the additive used is called
- (A) Filler (B) Antionxidant (C) Stabilizer (D) Plasticizer
- (50) A polymer of prop-2-enenitrile is called
- (A) Saran (B) Orlon (C) Dacron (D) Teflon
- (51) Starch is the condenstion polymer of
- (A) α -Glucose (B) β -Glucose (C) α -Fructose (D) β -Fructose
- (52) Repeating disaccharide unit of starch is
- (A) Lactose (B) Sucrose (C) Maltose (D) Cellobiose
- (53) The repeating disaccharide unit of cellulose is
- (A) cellobiose (B) Maltose (C) Lactose (D) Sucrose
- (54) A polymer which has bette light transmission properties tha even glass is
- (A) Perspex (B) Bakelite (C) Buna-S (D) Poly(ethyl acrylate)
- (55) The polymer used in manufacture of electrical goods such as switches ,plugs etc. is
- (A) Polythene (B) Bakelite
(C) Melamine-formaldehyde resin (D) Neoprene
- (56) The polymer used for coating electrical wires, cables etc. is
- (A) Natural rubber (B) Neoprene (C) Nitrile rubber (D) PVC
- (57) A polymer which is commonly used as a packing material
- (A) Polythene (B) Polypropylene (C) PVC (D) Bakelite
- (58) A synthetic rubber which is resistant to the action of oils, gasoline and other solvents is
- (A) Buna-S (B) Polyisoprene (C) Neoprene (D) Polystyrene
- (59) The abbreviation Pdi refers to
- (A) Name of the polumer (B) Poly dispersity index
(C) Planck's disposal index (D) Polydiagonal index
- (60) PDI for natural polymers is generally close to
- (A) Zero (B) 100 (C) 1 (D) 10
- (61) Nylon-66 is made by using
- (A) Phenol (B) Benzaldehyde (C) Adipic acid (D) Succinic acid
- (62) The process involving heating of rubber with sulphur is called
- (A) Galvanisation (B) Vulcanization (C) Bessemerisatiom (D) Sulphonation

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- (63) Terylene is made by polymerization of terephthalic acid with
(A) Ethylene glycol (B) Phenol (C) Ethanol (D) Catechol
- (64) Teflon, styron and neoprene are all
(A) copolymers (B) Condensation polymers
(C) homopolymers (D) monomers
- (65) Interparticle forces present in Nylon-66 are
(A) van der waals (B) Hydrogen bonding
(C) Dipole-dipole interactions (D) None of the above
- (66) Soft drinks and baby feeding bottles are generally made up of
(A) polyester (B) polyurethane (C) Polyurea (D) Polyamide
- (67) Polymer used in bullet proof glass is
(A) PMMA (B) Lexan (C) Nomex (D) Kevlar
- (68) Which of the following is a constituent of nylon?
(A) Adipic acid (B) Styrene (C) Teflon (D) None of these
- (69) Caprolactam polymerises to give
(A) Terylene (B) Teflon (C) Glyptal (D) Nylon-6
- (70) Which of the following is a polyamide molecule?
(A) Terylene (B) Rayon (C) Nylon-6 (D) Polystyrene
- (71) A condensation polymer among the following is
(A) Dacron (B) PVC (C) Polystyrene (D) Teflon
- (72) The catalyst used for the polymerization of olefins is
(A) Ziegler-natta catalyst (B) Wilkinson's catalyst
(C) Pd- catalyst (D) Zeise's salt complex
- (73) Cellulose acetate is a
(A) natural polymer (B) semisynthetic polymer
(C) synthetic polymer (D) plasticier
- (74) Teflon is a polymer of
(A) tetrafluoroethylene (B) tetraiodoethylene (C) tetrabromoethylene (D) tetrachloroethylene
- (75) Natural rubber is which type of polymer?
(A) condensation of polymer (B) addition polymer
(C) co-ordination polymer (D) none of these
- (78) Which is a protein?
(A) Nylon (B) Rayon (C) Natural silk (D) Terylene
- (79) Natural rubber is a polymer of
(A) Isoprene (B) Styrene (C) Ethylene (D) Butadiene
- (80) Which of the following is not an example of addition polymer?
(A) Polystyrene (B) Polyethylene (C) Polypropylene (D) Dacron
- (81) Buna-S is obtained by the copolymerisation of butadiene and
(A) chloroprene (B) styrene (C) acrylonitrile (D) adipic acid
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- (82) Melmac is a polymer of melamine and
(A) glycerol (B) formaldehyde (C) cyclohexane (D) caprolactum
- (83) Which of the following is a condensation polymer?
(A) Polystyrene (B) PAN
(C) Neoprene (D) Polyethyleneglycol terephthalate
- (84) Which of the following is a natural polymer?
(A) Bakelite (B) Cellulose (C) PVC (D) Nylon
- (85) The monomer unit of PVC is
(A) Vinyl chloride (B) ethylene (C) chloroprene (D) acrylonitrile
- (86) Which one is a synthetic polymer?
(A) Starch (B) Silk (C) Protein (D) Neoprene
- (87) Natural rubber is
(A) polyisoprene (B) polyvinyl chloride (C) polychloroprene (D) polyfluoroethylene
- (88) Which interparticle forces between linear chains in Nylon-66 are
(A) H-bonds (B) covalent bonds (C) Dacron (D) Glyptal
- (89) Which of the following is a common example of fibres?
(A) Bakelite (B) Buna-S (C) Nylon-66 (D) PVC
- (90) The weakest interparticle forces are present in
(A) Thermosetting polymers (B) Thermoplastic polymers
(C) Fibres (D) elastomers
- (91) Which of the following is an example of co-polymer?
(A) Buna-s (B) PAN (C) Polythene (D) PTFE
- (92) Which of the following represents the example of homopolymer?
(A) PMMA (B) Bakelite (C) Glyptal (D) Nylon-66
- (93) Polyacrylonitrile is an example of
(A) addition polymer (B) condensation polymer
(C) natural polymer (D) none of the above
- (94) Caprolactum is used to prepare which of the following polymer
(A) Nylon-66 (B) Melamine (C) Nylon-6 (D) PMMA
- (95) Artificial silk is
(A) nylon-6 (B) rayon (C) nylon-66 (D) none of these
- (96) Natural silk is a
(A) polypeptide (B) polyacrylate (C) polyester (D) polysaccharide
- (97) The process of vulcanization of rubber was introduced by
(A) Zeigler (B) MRF (C) Charles goodyear (D) Wohler
- (98) A polymer of prop-2-cyanoacrylonitrile is called
(A) Saran (B) Orlon (C) Dacron (D) Tetron
- (99) copolymer is
(A) Nylon-6 (B) Nylon-66 (C) PMMA (D) Dacron

(100) Ebonite is

(A) Natural rubber

(B) Synthetic rubber

(C) Highly vulcanized rubber

(D) polypropene

ANSWER KEY

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