

DEPARTMENT OF CHEMISTRY
SRM INSTITUTE OF SCIENCE AND TECHNOLOGY
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MODULE IV

Subject/Code: Chemistry/ 21CYB101J

MCQs

1. Which of the following polymer type is not classified on the basis of its application and properties?
- a) rubbers
 - b) plastics
 - c) fibres
 - d) synthetic

Answer: d

Explanation: Synthetic polymers are classified on the basis of their origin and are known as man-made polymers.

2. Which of the following is a thermosetting polymer?
- a) polystyrene
 - b) polyolefins
 - c) nylons
 - d) phenolic resins

Answer: d

Explanation: Phenolic resins falls under the clan of thermosetting polymers and rest are thermoplastic polymers which can be softened repeatedly on the application of heat.

3. The characteristics of condensation polymerization are given below-
- I. only $-C-C-$ linkages present in the polymer structure
 - II. use of bifunctional or polyfunctional monomers
 - III. elimination of a small byproduct molecule

Which of the following is true?

- a) I, II, III
- b) II and III
- c) I and II
- d) Only III

Answer: b

Explanation: Besides $-C-C-$ linkages, polymer structure also contains atoms as O, N, etc., at regular intervals in the main chain.

4. Which of the following monomers are unsuitable for condensation polymerization?

- a) propanoic acid and ethanol
- b) butane-dioic acid and glycol
- c) diamines and dicarboxylic acids
- d) hydroxy acids

Answer: a

Explanation: Propanoic acid and ethanol, both are monofunctional monomers which are not suitable for a polycondensation reaction to take place.

5. Which of the following is true for the resultant polymer product formed, when molecules of phthalic acid react with molecules of glycerol?

- a) branch polymer
- b) cross-link polymer
- c) linear polymer
- d) none of the mentioned

Answer: b

Explanation: The reaction between phthalic acid and glycerol initially results into linear or branched polymer but, due to trifunctionality of glycerol, ultimately cross-linking takes place between the molecules.

6. Which among the following polymers have lowest solubility?

- a) polyethylene
- b) polystyrene
- c) nylon 6
- d) epoxy resin

Answer: d

Explanation: Epoxy resin is a cross-linking polymer which has lowest solubility among them.

7. Which of the following polymer exhibit a lower value of molar cohesion?

- a) wool
- b) silk
- c) vulcanized rubber
- d) polystyrene

Answer: c

Explanation: Rubbers have the lowest value of molar cohesion in comparison to plastics and fibres.

8. What is the range of tensile strength, exhibited by fibres?

- a) 300-3,000
- b) 4,000-15,000
- c) 20,000-150,000
- d) 5,000-10,000

Answer: c

Explanation: Fibres possess highest tensile strength in comparison to other polymers.

9. Which of the following kind of polymers are known for their high crystallinity?

- a) isotactic
- b) syndiotactic
- c) atactic
- d) none of the mentioned

Answer: a

Explanation: There is high steric regularity in isotactic polymers which fosters close packing of molecular chains. Thus, they are highly crystalline.

10. Which of the following category does cellulose nitrate fall into?

- a) natural
- b) synthetic
- c) semi-synthetic
- d) none of the mentioned

Answer: c

Explanation: Cellulose nitrate is a chemically modified form of cellulose. That's why it falls under the category of semi-synthetic polymers.

11. The polymer in which steric placements of the substituent are arranged in such a way to give alternate d and l configurations, is known as _____

- a) isotactic polymer
- b) atactic polymer
- c) syndio-tactic polymer
- d) none of the mentioned

Answer: c

Explanation: Syndio-tactic sequence represents alternate d and l configurations, thus shows a good tendency to crystallize.

12. Which of the following is a co-polymer?

- a) Polythene
- b) Bakelite
- c) PVC
- d) Polyacrylonitrile

Answer: b

Explanation: A polymer formed from one type of monomer is called a homopolymer. Polythene, PVC and PAN are homopolymers. A polymer formed from two or more different monomers is a co-polymer or a mixed polymer.

13. Polymers are not classified on the basis of which of the following?

- a) Source
- b) Number of monomers
- c) Method of preparation
- d) Structure

Answer: b

Explanation: Polymers are very large molecules formed by joining together huge number of simple units, or monomers. They are mainly classified on the basis of their source, structure, mode of synthesis and molecular forces.

14. Which of the following types of polymers is not based on the classification by the source?

- a) Natural
- b) Semi-synthetic
- c) Elastomers
- d) Synthetic

Answer: c

Explanation: On the basis of source, polymers are classified as natural, semi-synthetic or synthetic. Elastomers are a class of polymers based on the molecular forces.

15. Which of the following is not a natural polymer?

- a) Rayon
- b) Starch
- c) Cellulose
- d) RNA

Answer: a

Explanation: The polymers obtained from plants and animals are called natural polymers. Rayon is a semi-synthetic polymer which is derived from a natural polymer by chemical modification.

Cellulose on acetylation with acetic anhydride in sulphuric acid gives cellulose acetate polymer or rayon.

16. Which of the following polymers has a structure as shown?



- a) Low-density polythene
- b) High-density polythene
- c) Polyvinyl chloride
- d) Bakelite

Answer: a

Explanation: The shown structure has unconnected linear chains with some intermediate branches. This is a branched chain polymer. They are irregularly packed and have lower density and strength than linear polymers.

17. The type of linkage present in polyurethane is

- a) **Amide linkage**
- b) Glycosidic linkage
- c) Ester linkage
- d) Phospho diester linkage

Answer: a

18. The synthesis of which of the following polymers involves the repeated loss of small molecules?

- a) Polythene
- b) Buna-S
- c) Buna-N
- d) Nylon-6,6

Answer: d

Explanation: Condensation polymers are formed by the repeated condensation reaction between two different bi-functional or tr-functional monomeric units, along with the loss of small molecules like water, alcohol, HCl, etc. Nylon-6,6 is formed by the condensation of hexamethylene diamine and adipic acid, resulting in loss of water molecules.

19. The compound $[-\text{CH}_2-\text{CH}(\text{C}_6\text{H}_5)-]_n$ is a _____

- a) homopolymer
- b) co-polymer

- c) condensation polymer
- d) network polymer

Answer: a

Explanation: $[-\text{CH}_2-\text{CH}(\text{C}_6\text{H}_5)-]_n$ is a homopolymer with a linear structure. It is obtained from the addition polymerisation of the monomer styrene, $\text{C}_6\text{H}_5\text{CH}=\text{CH}_2$.

20. Which of the following is an initiator molecule in the free radical polymerization?

- a) Sulphuric acid
- b) Benzoyl peroxide**
- c) Potassium permanganate
- d) Chromium oxide

Answer: b

21. Which of the following is not an elastomer?

- a) Buna-S
- b) Buna-N
- c) PVC
- d) Neoprene

Answer: c

Explanation: Elastomers are polymers that have rubber like elastic properties. The polymer chains are held together by the weakest intermolecular forces, which facilitate the stretching of the polymer. PVC is a plastic and not an elastomer.

22. Which of the following fibres does not have dipole-dipole interactions?

- a) Nylon
- b) Terylene
- c) Dacron
- d) Orlon

Answer: a

Explanation: Fibres are polymers which have strong intermolecular forces between the chains, either by hydrogen bonding or dipole-dipole interactions. In case of polyamides (nylon), the forces are hydrogen bonding, whereas in polyesters (terylene, dacron) and polyacrylonitriles (orlon) it is dipole-dipole interactions.

23. What are the intermolecular forces in acrilan?

- a) Hydrogen bonds
- b) Dipole-dipole interaction between carbonyl groups

- c) Dipole-dipole interaction between carbonyl and cyano groups
- d) Van der Waals forces

Answer: c

Explanation: Acrilan is a fibre of polyacrylonitrile. It forms strong intermolecular bonds through dipole-dipole interactions between the carbonyl and cyano groups.

24. Which of the following has the weakest intermolecular forces?

- a) Buna-N
- b) Nylon-6,6
- c) Polythene
- d) Polystyrene

Answer: a

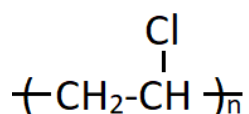
Explanation: Elastomers (buna-N) have the weakest intermolecular forces whereas fibres (nylon-6,6) have very strong intermolecular forces due to hydrogen bonds and dipole-dipole forces. Thermoplastic polymers (polythene, polystyrene) have intermolecular attractions intermediate to that of elastomers and fibres.

25. Markovnikov's law is applied in

- a) Addition of propylene with Cl_2
- b) Addition of propylene with HBr
- c) Addition of ethylene with Br_2
- d) Addition of ethylene with H_2

Answer: b

26. The polymer shown is a _____.



- a) elastomer
- b) fibre
- c) thermoplastic
- d) thermosetting plastic

Answer: c

Explanation: The shown polymer is polyvinyl chloride. It is a dense linear polymer which is capable of repeatedly softening on heating and hardening on cooling.

27. _____ undergoes permanent deformation on heating.

- a) Polythene
- b) PVC
- c) Teflon
- d) Bakelite

Answer: d

Explanation: Bakelite is a cross-linked thermosetting polymer, which on heating undergoes extensive cross-linking and undergo permanent change. They cannot be reused.

28. Molecular mass of polymers are expressed as a/an _____

- a) average
- b) median
- c) mode
- d) percentage

Answer: a

Explanation: The length of polymer and their molecular mass depends on the number of monomers available for reaction. As a result, the chain lengths of polymers are varying and are expressed as an average.

29. Polydispersity index is defined as _____ where M_w and M_n are the weight average and number average molecular masses respectively.

- a) $M_w \times M_n$
- b) M_w/M_n
- c) M_n/M_w
- d) $M_w - M_n$

Answer: b

Explanation: Polydispersity index (PDI) is defines as the ratio of weight average molecular mass to the number average molecular mass. It gives an idea of the homogeneity of the polymer.

30. The polydispersity index of natural polymers is _____

- a) 0
- b) <0.8
- c) 1
- d) >1.2

Answer: c

Explanation: Natural polymers generally have chains of identical lengths and have definite

molecular masses ($M_w=M_n$). This makes them more homogeneous and monodisperse, with a PDI of approximately 1.

31. Calculate the number average molecular mass of a polymer having four different monomers A, B, C and D present in equal number. The molecular masses of the monomers are 10000, 15000, 30000 and 50000 respectively.
- a) 10050
 - b) 17350
 - c) 26250
 - d) 35475

Answer: c

Explanation: Since the 4 monomers are present in equal amount, there is 25% of each monomer in the polymer. The number average molecular mass is,

$$M_n = (25 \times 10000 + 25 \times 15000 + 25 \times 30000 + 25 \times 50000) / (25 + 25 + 25 + 25)$$

$$M_n = (250000 + 375000 + 750000 + 1250000) / 100$$

$$M_n = 2625000 / 100$$

$$M_n = 26250.$$

32. Polymeric molecules _____ a definite crystalline structure.
- a) Have
 - b) Do not have
 - c) Completely having
 - d) Partially having

Answer: b

Explanation: The polymeric molecules do not have a definite crystalline structure. The non-polymeric molecules have a definite crystalline structure.

33. As the crystallinity increases The brittleness of the polymer _____
- a) Increases
 - b) Decreases
 - c) Moderate
 - d) Remains constant

Answer: b

Explanation: As the crystallinity of the polymer increases then the brittleness of the polymer also increases. The strength and chemical resistance of the polymers also increases.

34. Polymeric molecules possess the molecular weight _____

- a) Different
- b) Fixed
- c) That cannot be determined
- d) May be determined

Answer: a

Explanation: When polymerisation takes place, the growing polymeric chains are terminated at different sizes of molecules. So, as a result the polymeric molecules have different molecular weights.

35. Weight average molecular weight _____ on the weight of molecules in a polymer.

- a) Dependent
- b) Independent
- c) Partially dependent
- d) Neither dependent nor independent

Answer: a

Explanation: Weight average molecular weight depends on the weight of the molecules of each type and determined by making use of colloidal properties.

36. The polymer absorbs _____ and swells in size.

- a) Ethyl alcohol
- b) Ether
- c) Water
- d) Methanol

Answer: c

Explanation: The polymer absorbs the water and swells in size. Slowly polymer goes into the solution viscous polymer solution which is heterogeneous.

37. _____ is the property of recovering original shape after the removal of deforming strain.

- a) Rigidity modulus
- b) Youngs modulus
- c) Elasticity
- d) Bulk modulus

Answer: c

Explanation: The elasticity is the property of recovering the original shape after removal of deforming strain. Natural rubber possesses high elasticity due to the coiled helix structure of poly isoprene.

38. The impact strength is measured as _____

- a) Elasticity

- b) Strength
- c) Permeability
- d) Toughness

Answer: d

Explanation: The impact strength is measured as the toughness. Below the glass transition temperature, the polymers break.

39. If the polymer is in the room temperature, then it is _____

- a) Brittle
- b) Viscofluid state
- c) Amorphous
- d) Rubbery

Answer: d

Explanation: The effect of heat on polymer is high. If the temperature changes, the state of the polymer will be changed.

40. The strength of the polymer increases with _____ in molecular weight.

- a) Increase
- b) Decrease
- c) No change
- d) Slightly decrease

Answer: a

Explanation: The strength of the polymer increases with an increase in the molecular weight. The inter molecular attraction, presence of polar groups and chain length increases the strength.

41. The neighbouring polymeric chains in thermosets are held together by _____

- a) Vander Waal's force
- b) Hydrogen bond
- c) Covalent bond
- d) Electrovalent bond

Answer: c

Explanation: The neighbouring polymeric chains in thermosets are held together by covalent bonds. A covalent bond is bond by the sharing of electrons and has good strength.

42. Select the incorrect statement from the following option.

- a) Thermosets have 3-dimensional, cross-linked network structure
- b) Thermosets cannot be remoulded, reused or reclaimed

- c) Thermosets are hard, strong and brittle
- d) Thermosets are soluble in suitable solvents

Answer: d

Explanation: Thermosets are insoluble in any solvent. They have a 3-D cross-linked network structure and cannot be remoulded, reused or reclaimed. They are hard, strong and brittle.

43. Which of the following is not an example of thermosets?

- a) Epoxy
- b) Teflon
- c) Vulcanised rubber
- d) Bakelite

Answer: b

Explanation: Epoxy, vulcanised rubber, Bakelite are some of the examples of thermosets. Teflon is not an example of thermosets. PTFE (Teflon) is best known for its use in coating non-stick frying pans and other cookware.

44. What is the trade name for natural polyisoprene?

- a) Natural rubber
- b) Neoprene
- c) Silicone
- d) Buna acrylonitrile

Answer: a

Explanation: Natural rubber is a common material consisting of isoprene combined with impurities and water. Natural rubber is also known as India rubber and belongs to natural polyisoprene chemical group.

45. What is Buna N rubber?

- a) Styrene-butadiene
- b) Chloroprene
- c) Polyisoprene
- d) Acrylonitrile butadiene

Answer: d

Explanation: Buna N is a synthetic rubber composed of acrylonitrile and butadiene. It is also commonly known as NBR, Krynac, or Europrene. This rubber is used in O-rings and hoses.

46. What is the hardening temperature of unvulcanized natural rubber?

- a) 5°C
- b) 30°C
- c) 105°C
- d) 150°C

Answer: a

Explanation: Unvulcanized natural rubber is a tough and elastic material which softens on heating. It becomes tacky at 30°C and hardens at around 5°C. This rubber oxidizes to a sticky mass when out in the sun.

47. _____ is reinforcement filler.

- a) Carbon black
- b) Chinaclay
- c) Barium sulfate
- d) Chalk

Answer: a

Explanation: Fillers can be classified as either reinforcing fillers or inactive fillers. Carbon black and synthetic white fibers based on silica and alumina are examples of reinforcing fillers. Talc, barium sulfate, chalk, and china clay are examples of inactive fillers.

48. Which of the following is not a characteristic of natural rubber?

- a) Cheap
- b) High strength
- c) High hysteresis
- d) Abrasion and tear resistant

Answer: c

Explanation: Natural rubber is processed from a liquid known as rubber latex. It has high strength and possesses good tear and abrasion resistance. However, it is easily attacked by solvents and gasoline, and also possesses low hysteresis.

49. Which of the following is not an application of conducting polymers?

- a) Rechargeable batteries
- b) Analytical sensors
- c) Electronics
- d) Adhesives

Answer: d

Explanation: Rechargeable batteries, analytical sensors, electronics are some of the applications of conducting polymers.

50. Which of the following is used for making rechargeable batteries?

- a) Polypyrrole
- b) Polyester
- c) Polyaniline
- d) Polyacrylonitrile

Answer: c

Explanation: Polyaniline is used for making rechargeable batteries in the shape of flat buttons or as laminated rolled films.

51. The advantage of using conducting polymers in place metals is their _____

- a) Cost
- b) Light-weight
- c) Thermal conductivity
- d) Solubility

Answer: b

Explanation: The advantage of using conducting polymers in place metals is their light-weight and they do not corrode.

52. An example for semi synthetic polymer is -----.

- a) Rayon
- b) Nylon
- c) Polyester
- d) Carbon fibre

Answer: a)

53. In which of the following polymer steric placements of the substituent are arranged in such a way to give alternate d and l configurations?

- a. Syndio-tactic polymer
- b. isotactic polymer
- c. atactic polymer
- d. none of the mentioned

Answer: a

Explanation: Syndio-tactic sequence represents alternate d and l configurations, thus shows a good tendency to crystallize.

54. Aramid fibers are used for

- a. Apparels
- b. Shoe soles
- c. Packing materials
- d. Bullet proof jackets**

55. type of bonding is seen in thermoset plastic polymers

- a. Ionic
- b. Vander Waals
- c. Covalent**

- d. Molecular
56. Which of the below polymers show higher crystallinity ?
- a. Syndiotactic
 - b. Atactic
 - c. Isotactic**
 - d. Random
57. In place of natural rubber can be used
- a. SBR
 - b. Buna – S
 - c. Buna – N
 - d. Butyl rubber**
58. Weak intermolecular attraction forces are seen in
- a. Thermosets
 - b. Thermoplastic
 - c. Elastomers**
 - d. Fibers
59. One of the below is used as insulator and as a lubricant
- a. PVC
 - b. PTFE**
 - c. Polystyrene
 - d. SBR
60. Haemodialysis tubes are made with
- a. Thermoplastic polyurethane
 - b. Polyurethane intermediate**
 - c. Polystyrene
 - d. Silicone rubber
61. Organic solvent containers are made with
- a. Polypropylene**
 - b. PET
 - c. Polystyrene
 - d. PVC
62. X-Y-Y-X-X-X-Y-X is an example of
- a. Cross linked polymer
 - b. Addition polymer
 - c. Copolymer**
 - d. Condensation polymer

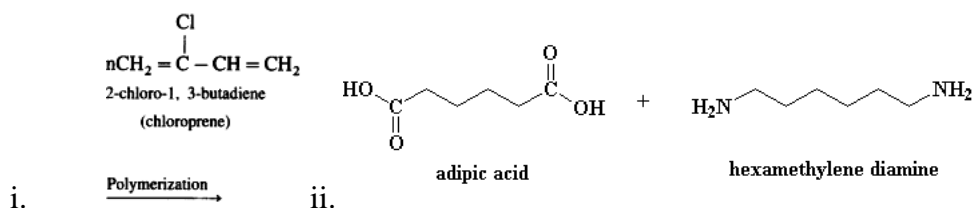
63. Glycerol and phthalic acid react to give
- a. Branch polymer
 - b. Cross link polymer**
 - c. Linear polymer
 - d. Copolymer
64. Monomer used in the synthesis of neoprene is
- a. $\text{F}_2\text{C} = \text{CF}_2$
 - b. $\text{Cl}_2\text{C} = \text{C} \cdot \text{Cl}_2$
 - c. $\text{CH}_2 = \text{C} \cdot \text{Cl} - \text{CH} = \text{CH}_2$**
 - d. $\text{CH}_2 = \text{CHCl}$
65. Which one of the following is a linear polymer?
- a. Nylon**
 - b. Melamine
 - c. PVC
 - d. Polystyrene
63. The random orientation of polymeric chain in a polymer is called
- a. Isotactic
 - b. Atactic**
 - c. Syndiotactic
 - d. Elastomer
64. Which of the following polymers is a thermosetting polymer?
- a. Polyethene
 - b. Polystyrene
 - c. Polyvinyl chloride
 - d. Bakelite**
65. The advantage of using conducting polymers in place metals is their _____
- a. Cost
 - b. Light-weight**
 - c. Thermal conductivity
 - d. Solubility

66. Glass transition temperature (T_g) for Nylon-6 is 50°C , which is higher than polyethylene due to _____
- a. **Inter-molecular hydrogen bonding**
 - b. Intra-molecular hydrogen bonding
 - c. Vander Waals forces
 - d. Covalent forces
67. Composites can be classified based on _____
- a. Matrix type
 - b. Reinforcement constituent
 - c. **Matrix type & Reinforcement constituent**
 - d. Neither on matrix type nor on reinforcement constituent type

PART B {2/4/6/8/12/15}

1. With proper example compare and contrast Atactic, Syndiotactic and Isotactic polymers.
2. Discuss the synthesis, properties and applications of a) PTFE and b) Polystyrene
3. Explain n and p doping in conducting polymers
4. Discuss the synthesis, properties and applications of a) PET and b) Polypropylene
5. Write the preparation, properties, and applications of the following polymers:
 - i. Polyurethane
 - ii. PET
 - iii. Nylon-6
6. What are the differences between Thermoplastic and Thermosets. Give examples.
7. Compare addition with condensation polymerization with examples.
8. Suggest the products when 1, 3 – butadiene reacts with the following and provide suitable equations:

9. Give the products for the following reactions:


$$\begin{array}{c}
 \text{CH}_3 \qquad \qquad \qquad \text{CH}_3 \\
 | \qquad \qquad \qquad | \\
 -\text{CH}_2-\text{C}=\text{CH}-\text{CH}_2-\text{CH}_2-\text{C}=\text{CH}-\text{CH}_2- \\
 | \qquad \qquad \qquad | \\
 \text{CH}_3 \qquad \qquad \qquad \text{CH}_3 \\
 + \\
 -\text{CH}_2-\text{C}=\text{CH}-\text{CH}_2-\text{CH}_2-\text{C}=\text{CH}-\text{CH}_2- \\
 | \qquad \qquad \qquad | \\
 \text{CH}_3 \qquad \qquad \qquad \text{CH}_3 \\
 + \\
 \text{Sulphur} \\
 \downarrow
 \end{array}$$

14. Draw the structure of the monomer each of the following polymers-

(a) Poly(vinyl chloride), (b) Nylon-6.

15. How the following Engineering plastics synthesized?

i. Nylon 6:6 and ii. PTFE

16. What are the three methods of production of conductive polymers? And what are their limitations?

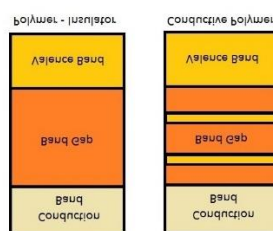
Ans: The chemical, electrochemical, and the photoelectrochemical. The chemical needs a high control in the process, since the reaction is very exothermic, which releases a big amount of energy. The electrochemical limitation is related to the shape of the polymer that has the shape of the electrode, being necessary the posterior processing. Finally, the photoelectrochemical results a material that does not have good mechanical properties.

17. Why do most of polymers have a poor conductivity? And why does a conductive polymer have a great conductivity? [Hint: Your answer may have these words: covalent bond, band theory, band gap, delocalized electrons, resonance, dopants.]

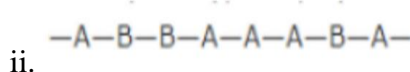
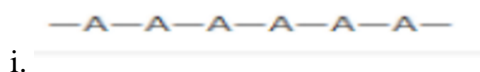
18. Draw the band structure of a polymer and a conductive polymer. Discuss what results

this difference.

Ans: When a polymer is doped, there are charges in it. Due to resonance the charge can drift through the chain, generating the conductivity. Due to the resonance contributors, the electron can occupy other energy levels. These new levels, that can be called polaronic bands, decreases the amount of energy that the electron needs to be excited to the conduction band, making these polymers as a semiconductor.



19. How polyaniline and polyacetylene made conductive? Explain.
20. Define i. Number average molecular mass ii. Weight average molecular mass and iii. Polydispersity index.
21. A sample of polymer contains 30% molecules with molecular mass 20,000, 40% with molecular mass 30,000 and 30% with molecular mass 60,000. What is the number average molecular mass of the polymer? [Ans: 36,000]
22. The number average molecular mass and mass average molecular mass of a polymer are 30,000 and 40,000 respectively. What is the PDI of the polymer? [Ans: 1.33]
23. In a polymer sample 30% of molecules have a molecular mass of 20,000, 40% have 30,000 and the rest 60,000. What is the weight average molecular mass of the polymer? [Ans: 43,333]
24. Identify the type of polymer for the following and write a note on it:



25. Differentiate between rubbers and plastics on the basis of intermolecular forces.

[Points to remember: the appropriate answers are highlighted:

- a) Polymers are macro/micro molecules composed mostly by coordinate/covalent bonds, which it results in an conductor/semiconductor/insulator material.
- b) Highest bands are called covalent/conduction/valence band. The forbidden bands, conversely, are named band gap/ polaronic bands.
- c) As the temperature increases/decreases the doping level decreases/increases,

resulting in a greater/lower value of conductivity/insulation.

d) A delocalized electron is shared by at least $\frac{1}{2}$ atoms. The movement of these delocalized electron is called resonance/ semiconduction.]