

INDIAN RUBBER INSTITUTE
PGDIRI EXAMINATION – 2023

Paper – I

Date : 9th March, 2024
Duration : 3 Hours

Time : 10.00 – 13.00 hrs.
Full Marks : 100

Polymer Science

Answers should be illustrated with sketches wherever helpful

Question number 1 is compulsory. Answer **FOUR** from the remaining questions taking **TWO** from each group
GROUP – A

1. Multiple choice questions: select the correct answer from the given alternatives:

- (i) Rosin is a
a) Natural resin b) Synthetic resin c) Regenerated resin d) Rubber
- (ii) Example of a semi-synthetic polymer is
a) SBR b) Cellulose nitrate c) PVC d) Natural rubber
- (iii) Coefficient of friction is very low for
a) Polyamide b) Polyimide c) Polyether d) PTFE
- (iv) The weight average molecular weight is determined by
a) Spectroscopy b) Osmometry c) Viscometry d) Light scattering
- (v) For a Hookean region stress is directly proportional to
a) Viscosity b) Strain rate c) Strain d) Modulus
- (vi) Aramids are high performance
a) Aromatic Polyesters b) Polyurethanes c) Polyimides d) Aromatic Polyamides
- (vii) S-I-S is a
a) Random copolymer b) Alternate copolymer c) Block copolymer d) Homopolymer
- (viii) Polystyrene is known as
a) Fibre b) Amorphous polymer c) Crystalline polymer d) Ionomer
- (ix) Glass transition temperature of polybutadiene is around
a) -100°C b) -60°C c) 0°C d) +100°C
- (x) Glass transition temperature of a polymer is determined by
a) Infrared spectrophotometer b) Differential scanning calorimeter
c) Mass spectrometer d) Scanning electron microscopy
- (xi) Polymer produced from anionic polymerization is called
a) Dead polymer b) Living polymer c) Ladder polymer d) none of these
- (xii) Atactic polymers are
a) Crystalline b) Semi-crystalline c) Amorphous d) None of these
- (xiii) Copolymer of styrene and butadiene, which is used in tire is
a) SBS b) SBR c) SEBS d) XSBR

- (xiv) IIR is commercially prepared by
 a) Radical polymerization b) Ziegler – Natta polymerization
~~c) Cationic polymerization~~ d) Anionic polymerization
- (xv) Crystallinity of a polymer is quantitatively determined by
~~a) XRD~~ b) TGA c) DETA d) DMA
- (xvi) Density is the highest for
 a) LDPE ~~b) HDPE~~ c) LLPDE d) VLDPE
- (xvii) Name of a plasticizer for PVC is
 a) DRC b) DCP c) DPG ~~d) DOP~~
- (xviii) Gutta Percha is
 a) Cis 1,4 polyisoprene ~~b) Trans 1,4 polyisoprene~~
 c) Vulcanised polyisoprene d) Crosslinked PE
- (xix) A rubber having low solubility parameter is
 a) FKM b) CR c) NBR ~~d) EPDM~~
- (xx) Which of the following polymer exhibit a lower value of molar cohesion?
 a) wool b) silk ~~c) vulcanized rubber~~ d) polystyrene

(1x 20) = 20

2. (a) Write down the different steps of free radical polymerization by taking styrene as monomer and by using AIBN as initiator.
 (b) How do you classify polymers based on thermal response? Explain with examples.
 (c) Explain the free volume concept.
 (d) What is Ziegler-Natta Catalyst? Mention one of its application.

(8+4+4+4) = 20

3. (a) Write down the catalyst or initiator generally used to polymerize the following monomers and write down the structures of the resultant polymer and copolymer.
 i) Acrylonitrile and Butadiene ii) Isobutylene and Isoprene
 iii) Phenol and Formaldehyde iv) Ethylene, propylene and 1,4 hexadiene.
 v) Terephthalic acid and Ethylene glycol.
 (b) Give the name of the method of preparation of the following polymers mentioning the corresponding monomers used.
 i) SBR ii) PU iii) S-B-S iv) BR v) FKM

(5x2+5 x 2) = 20

4. (a) Explain the difference between suspension and emulsion polymerization.
 (b) Explain the difference between cationic and anionic polymerization.
 (c) Explain the difference between an initiator and an inhibitor.
 (d) Calculate the weight average molecular weight for the data shown below:

i	M_i	N_i
Interval No.	g/mole of chains in interval	No. of chains in interval
1	3,000	2
2	6,000	3
3	13,000	5
4	18,000	3
5	22,000	2

(8+5+3+4) = 20

GROUP - B

5. Discuss the differences between
- (a) Newtonian fluid and Non-Newtonian fluid.
 - (b) Maxwell model and Voigt model.
 - (c) Stress relaxation and Creep.
 - (d) Pseudoplastic and dilatant material.
 - (e) Narrow and broad molecular weight distribution

(5 x 4) = 20

6. Explain the following statements:
- (a) Polyacrylonitrile (PAN) is a plastic, but NBR is a rubber.
 - (b) NR is a self-reinforcing rubber.
 - (c) Silicone rubber shows excellent low temperature flexibility.
 - (d) Teflon coating is used in non-sticky frying pans.
 - (e) PVC is plastic, but PVC with DOP is a rubber-like material.
 - (f) NR is a rubber but Gutta Percha is more like a plastic.
 - (g) SBR is a rubber, but SBS is a thermoplastic elastomer.
 - (h) Fluorocarbon elastomers are both heat and oil resistant.
 - (i) Polychloroprene shows much better flame resistance property than Natural rubber.
 - (j) EPDM is useful for making automotive window seal.

(2 x 10) = 20

7. (a) Give a comparative account of the stress – strain plots with brief explanations for
- (i) A ductile plastic.
 - (ii) A typical rigid / brittle plastic.
 - (iii) A typical fibre.
 - (iv) A rubber having strain induced crystallization.
- (b) What is 'hysteresis'? Explain its importance.
- (c) Explain the term 'shape factor'. What is its importance?
- (d) Define the term 'toughness'.

(8+5+5+2) = 20

8. Write short notes on **any four** of the following
- (a) Viscosity average molecular weight
 - (b) Polydispersity index
 - (c) Dilatometer
 - (d) Polymer tacticity
 - (e) Cohesive energy density
 - (f) Spherulite

(4 x 5) = 20