

**INDIAN RUBBER INSTITUTE
PGDIRI EXAMINATION – 2022**

Paper – I

Date : 25th March, 2023
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) Butyl rubber is a
(a) Homopolymer (b) Copolymer (c) Terpolymer (d) Fibre
- (ii) Example of a very high heat resistant rubber is
(a) NR (b) SBR (c) Silicone rubber (d) EPDM
- (iii) Mark Houwink equation is related to
(a) Crystallinity (b) Cohesive energy density
(c) Tacticity (d) Intrinsic viscosity
- (iv) Silicone rubber shows its T_g at around
(a) – 50°C (b) – 70°C (c) – 100°C (d) – 120°C
- (v) Light scattering is used to determine
(a) Viscosity average molecular weight (b) Weight average molecular weight
(c) Number average molecular weight (d) Z-average molecular weight
- (vi) SBR is an example of
(a) Block copolymer (b) Random copolymer
(c) Graft copolymer (d) None of the above
- (vii) Number of branches is maximum in
(a) LDPE (b) LLDPE (c) HDPE (d) VLDPE
- (viii) Example of self-reinforcing rubber is
(a) NR (b) BR (c) SBR (d) EPDM
- (ix) Stereo – regular polymers are synthesized by using
(a) Peroxide Catalyst (b) Ziegler – Natta Catalyst
(c) Metal Oxide Catalyst (d) Heavy Metal Catalyst
- (x) Ring opening polymerization is related to
(a) Isoprene (b) Caprolactam (c) Butadiene (d) Styrene

- (xi) Example of a flame retardant rubber is
 (a) NR (b) EPDM (c) CR (d) PDMS
- (xii) Which polymer has very low coefficient of friction?
 (a) PP (b) PVC (c) PTFE (d) HDPE
- (xiii) AIBN is an example of
 (a) Plasticizer (b) Cross-linking agent (c) Initiator (d) Peptizer
- (xiv) The diene present in EPDM is
 (a) ENB (b) Butadiene (c) Heptadiene (d) None of the above
- (xv) Thermal stability of polymer can be determined by
 (a) XRD (b) TGA (c) DSC (d) SEM
- (xvi) Which rubber shows strain induced crystallization?
 (a) NBR (b) SBR (c) FKM (d) NR
- (xvii) Polyethylene terephthalate is a
 (a) Addition polymer (b) Condensation polymer
 (c) Ring opening polymer (d) None of the above
- (xviii) Example of a heat as well as oil resistant rubber is
 a) NR (b) BR (c) EPDM (d) FKM
- (xix) Tg of a copolymer can be determined using
 (a) Bragg Equation (b) Fox Equation
 (c) Hildebrand Equation (d) Carothers' Equation
- (xx) Example of a semi-synthetic polymer is
 (a) Cellulose nitrate (b) PF resin (c) Butyl rubber (d) Polycarbonate
 (1 x 20) = 20
2. (a) What are the different techniques of polymerization? Discuss their relative advantages and disadvantages.
 (b) How do you control the degree of polymerization?
 (c) Explain one method to determine number average molecular weight of polymer.
 (12+4+4) = 20
3. Distinguish between the following:
 (a) Viscosity and Elasticity
 (b) Isotactic and Syndiotactic polymer
 (c) Random and Alternating Copolymer
 (d) Cationic and Anionic polymerization
 (e) Emulsion SBR and Solution SBR
 4 x 5 = 20
4. (a) What are the necessary molecular requirement for rubber-like elasticity?
 (b) Explain with figures the differences between Maxwell and Voigt Model.
 (c) Explain the differences between pseudoplastic and dilatant materials.
 (d) What is the Power law equation and explain its significance.
 (4+6+4+6) = 20

GROUP - B

5.

- (a) Define the term 'glass transition temperature (T_g)'.
- (b) Is glass transition a first order or second order transition? Explain.
- (c) Explain briefly the method of determined of T_g of polystyrene by a dilatometer (with a sketch).
- (d) Explain various factors that control T_g of polymers.
- (e) 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	5,000	4
3	15,000	5
4	30,000	3

(2+2+5+8+3) = 20

6. (a) Explain the terms Modulus and Toughness with a figure.
(b) What is shape factor? Explain its significance.
(c) Explain the terms with figures: (i) stress relaxation and (ii) creep.
(d) What is die swell?
(e) Explain the term with a figure: polymer spherulite.

(4+5+4+2+5) = 20

7.

- (a) Define the terms: (i) monomer (ii) oligomer and (iii) polymer
- (b) Explain the basic difference with examples between addition and condensation polymers.
- (c) How do you classify polymer based on thermal response? Give examples.
- (d) Explain with examples the difference between linear polymer, branched polymer and cross-linked polymer.
- (e) Show and explain stress-strain plots of a fibre, a brittle plastic, a ductile plastic and an elastomer.

(3+4+3+5+5) = 20

8. Write short notes on **any four** of the following

- (a) Polydispersity
- (b) Viscosity average molecular weight
- (c) Living polymer
- (d) Free volume concept
- (e) Ring opening polymerization
- (f) Solubility parameter

(4 x 5) = 20