

**INDIAN RUBBER INSTITUTE
PGD-IRI EXAMINATION – 2014**

Paper – I

**Date: 11th July, 2014
Duration: 3 Hours**

**Time: 10.00 – 13.00 hrs.
Full Marks: 100**

Polymer Science

Answers should be illustrated with sketches wherever helpful

Total **FIVE** questions are to be answered. **Question No. 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) Which of the following is an initiator for suspension polymerization
(a) Potassium persulphate (b) Lewis acids (c) Benzoyl peroxide (d) Butyl Lithium

- (ii) The function of soap in emulsion polymerization is
(a) Stabilizing the latex (b) Increase molecular weight (c) Chain transfer agent
(d) None of the above

- (iii) Glass transition temperature is dependent on
(a) Chemical structure of the polymer (b) Addition of plasticizer (c) Crosslink density
(d) All a, b and c

- (iv) Which of the following materials are always highly crystalline
(a) Plastic (b) Rubber (c) Fibre (d) Coatings

- (v) Styrene butadiene styrene is a
(a) Resin (b) Thermoplastic elastomer (c) Crystalline polymer (d) Brittle plastic

- (vi) A copolymer which is non oil resistant:
(a) NBR (b) SBR (c) CR (d) Polyisoprene

- (vii) Terylene is a
(a) Polyamide (b) Polyester (c) Vinyl polymer (d) Acrylic polymer

- (viii) Living anionic polymerization can be used for the preparation of
 (a) Block copolymers (b) Thermosets (c) Random copolymers (d) Homopolymers
- (ix) The commonly used packing material in GPC is
 (a) Polystyrene beads (b) Crosslinked polystyrene beads
 (c) Crosslinked porous polystyrene beads (d) Porous polystyrene beads
- (x) Weight average molecular weight of a polymer can be determined by
 (a) Membrane Osmometry (b) Viscometry
 (c) Light scattering (d) Sedimentation velocity analysis
- (xi) Natural rubber is
 (a) Cis -1,4 polyisoprene (b) Trans - 1,4 polyisoprene
 (c) Trans -1, 2 polyisoprene (d) Cis -1, 2 polyisoprene
- (xii) Which of the following initiators can be used for chain polymerization?
 (a) Peroxides (b) Redox systems (c) Lewis acids (d) All a,b and c
- (xiii) At any time when the chain polymerization progresses the system contains
 (a) Only monomer (b) Monomer and polymer
 (c) Monomer, polymer, dimer, trimer etc (d) Polymer, dimer, trimer, tetramer etc.
- (xiv) Addition of plasticizer increase the following property of a polymer
 (a) Viscosity (b) Tensile modulus
 (c) Low temperature flexibility (d) None of the above
- (xv) Which of the following polymers has highest value of T_g
 (a) Polyethylene (b) Polypropylene (c) Polystyrene (d) Polybutadiene
- (xvi) Elastomers are generally
 (a) Amorphous (b) Having low glass transition temperature
 (c) Having high molecular weight (d) All of the above
- (xvii) Which one of the following can be used as a fibre:
 (a) Polyethylene (b) Polystyrene (c) Nylon (d) Gutta percha
- (xviii) Non Newtonian behavior means
 (a) Variation of viscosity with shear (b) Variation of viscosity with temperature
 (c) Variation of viscosity with pressure (d) All a,b and c

(xix) Which of the following is suitable for describing the behaviour of polymers

- (a) Creep behavior of Maxwell model
- (b) Stress relaxation behavior of Maxwell model
- (c) Creep and stress relaxation behavior of Maxwell model
- (d) Stress relaxation behavior of Voigt model

(xx) A polymer having unsaturation in the side chain is

- (a) NBR
- (b) SBR
- (c) EPDM
- (d) All a,b and c

(1 x 20) = 20

2. Explain the following statements:

- (a) Polyethylene and polypropylene are plastics while ethylene propylene copolymer is a rubber.
- (b) Even though polybutadiene has more than 95 % Cis content it shows poor gum tensile strength.
- (c) PVC needs a stabilizer.
- (d) EPDM can be extended with a large amount of filler.
- (e) Neoprene rubber is highly resistant to oxidative degradation.
- (f) Redox initiators can initiate polymerization at any temperature.
- (g) Teflon coating is used in non-sticky frying pans.
- (h) Sedimentation velocity analysis is not usually used for molecular weight determination of a polymer.
- (i) Natural rubber is a self-reinforcing rubber.
- (j) Polyethylene is insoluble in most of the solvents where as polystyrene is soluble in most of the solvents.

(2 x 10 = 20)

3. (a) What are the structural factors contributing to T_g value of a polymer?

(b) What are the advantages and disadvantages of bulk polymerization?

(c) Why polymerization of SBR is stopped after 60% conversion in cold emulsion polymerization?

(d) Explain the behavior of rubber under tension and compression.

(e) Explain how molecular weight is controlled in step growth and chain polymerization.

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

4. (a) A typical polystyrene system with molecular chains of different molecular weights are 30 with 10000, 25 with 20000, 30 with 15000 and 50 with 5000. Calculate the number average, weight average molecular weight and polydispersity index.

(b) Explain briefly the preparation, properties and applications of the following polymers

(any two)

(i) Solution SBR (ii) Nitrile rubber (iii) Neoprene rubber

(c) Derive the kinetic equation for the rate of chain addition polymerization. Explain briefly how monomer and initiator concentration affect the rate of polymerization.

(4+ 6+10=20)

GROUP – B

5. Discuss the differences between:

- (a) Modifier and short stop
- (b) Graft copolymer and block copolymer
- (c) Ideal elasticity and viscoelasticity
- (d) Elasticity shown by steel and elasticity shown by vulcanized rubber
- (e) Short term testing and long term testing

(5 x 4=20)

6. (a) Explain loss modulus and storage modulus
(b) State and explain the Power law expression.
(c) What do the constant in the equation denotes?
(d) How are the constants determined? What are the advantages and disadvantages of the Power law expression?

(4+3+3+10=20)

7. (a) Explain briefly the method of determination of glass transition temperature by DSC.
(b) Explain briefly the determination of molecular weight of a polymer by Gel Permeation Chromatography
(c) Compare solution polymerization and emulsion polymerization

(7+7+ 6=20)

8. Write notes on **any four**

- (a) Membrane osmometry
- (b) Stress-strain behavior of an elastomers, plastics and fibre
- (c) Modified forms of natural rubber
- (d) Rearrangement polymerization
- (e) Tacticity of polymers

(4 x 5= 20)