

INDIAN RUBBER INSTITUTE

PGD-IRI EXAMINATION – 2010

Paper - I

Date : 29th June, 2010

Duration : 3 Hours

Time: 10.00-13.00 hrs.

Total Marks : 100

Polymer Science

Answers should be illustrated with sketches wherever helpful
Total FIVE questions are to be answered. From "Group-A" answer FOUR questions out of which Question No. 1 is Compulsory and From "Group-B" answer ONE question only.

GROUP - A

1. Choose the correct answer from the given alternatives
- (i) Fundamental to any polymerization scheme is the number of.....
(a) Carbon atoms present in monomer (b) Hydrogen atoms present in monomer
(c) Bonds that a given monomer can form (d) Single bonds
 - (ii) Addition polymers are produced by monomers containing
(a) Sigma bonds (b) Ionic bonds
(c) Unsaturated pi bonds (d) None of these
 - (iii) Polyisoprene can be prepared by
(a) Condensation polymerization (b) Addition polymerization
(c) Ring opening polymerization (d) Blending
 - (iv) The following are the stereo regular structures
(a) Atactic and syndiotactic (b) Isotactic and syndiotactic forms
(c) Isotactic and atactic forms (d) All the above
 - (v) The functionality of styrene monomer is
(a) One (b) Two
(c) Three (d) Four
 - (vi) Hydroquinone, nitrobenzene and dinitrobenzene are some of the examples for
(a) Initiators (b) Chain transfer agents
(c) Inhibitors (d) diluents
 - (vii) Cationic polymerization can be initiated by
(a) Azo bis isobutyro nitrile (AIBN) (b) Alkali metals
(b) Dicumyl peroxide (d) Brownsted acids such as BF_3
 - (viii) In suspension polymerization, the initiators used should be
(a) Water soluble (b) Monomer soluble
(c) Monomer soluble or water soluble (d) None of these
 - (ix) An amorphous polymer is characterized by
(a) Sharp meting temperature (b) Glass transition temperature
(c) Broad crystallization temperature (d) One spring and one dashpot in parallel

- (x) Celluloid is a
 (a) Semi synthetic plastic (b) Semi synthetic rubber
 (c) Synthetic plastic (d) Natural polymer
- (xi) Polymerization temperature of hot SBR is
 (a) 80°C (b) 70°C
 (c) 50°C (d) 100°C
- (xii) A rubber prepared by condensation polymerization is
 (a) Poly sulphide rubber (b) PU
 (c) SBS (d) Nylon
- (xiii) The rubber prepared by anionic polymerization is
 (a) Emulsion SBR (b) Solution SBR
 (c) NBR (d) CR
- (xiv) Which polymerization gives a latex?
 (a) Bulk polymerization (b) Solution polymerization
 (c) Suspension polymerization (d) Emulsion polymerization
- (xv) Example of a terpolymer is
 (a) NR (b) IIR (c) EPDM (d) EPM
- (xvi) Molecular weight distribution is :
 (a) $\overline{M}_w / \overline{M}_n$ (b) $\overline{M}_w / \overline{n}$ (c) $\overline{M}_n / \overline{N}$ (d) $\overline{M}_n / \overline{M}_w$
- (xvii) The following is not an example of ring opening polymerization :
 (a) Nylon 6 (b) Nylon 66
 (c) Poly alkenamer (d) Poly epichlorohydrin
- (xviii) Polar forces of attraction between polymer chains
 (a) Increases T_g (b) Decreases T_g
 (c) Has no effect on T_g (d) Insufficient information to predict
- (xix) GPC gives
 (a) Number average molecular weight (b) Molecular weight distribution
 (c) Weight average molecular weight (d) Viscosity average molecular weight
- (xx) Cold flow occurs in
 (a) Branched polymer (b) Linear polymer
 (c) Plastics (d) All rubbers

1 x 20 = 20

2. (a) Give reasons for the following:
- (i) Why does the end-to-end distance of a polymer molecule keep on varying?
 - (ii) Polymers are obviously different from small molecules. How does polyethylene differ from oil, grease, and wax, all of these materials being essentially $-\text{CH}_2-$?
 - (iii) Why HDPE is more crystalline than LDPE?
 - (iv) Why thermosets cannot be re-melted?
 - (v) Why oxygen inhibits free radical polymerization?
 - (vi) Why viscosities of raw rubbers are higher than those of plastics?
 - (vii) Why emulsion polymerization is the most convenient method for producing polymers?
 - (viii) Why polyethylene is not a rubber though it has a low T_g ?
 - (ix) A stretched rubber band, contracts on heating, instead of expanding.

- (x) Why is Ziegler Natta polymerization preferred for homopolymer rubbers while free radical polymerization is preferred for copolymers? 2 x 10 = 20
3. (a) Write pertinent equations for number average molecular weight (\overline{M}_n) and weight average molecular (\overline{M}_w) and explain their significance. 6 + 4 + 5 + 5 = 20
- (b) What is meant by degree of polymerization? Show the relation between \overline{M}_n and \overline{M}_w .
- (c) Explain how molecular weight and its distribution affect processing and final mechanical properties of polymers.
- (d) How do you determine molecular weight of a polymer by viscometry method
4. (a) Explain the importance of emulsion polymerization and how is it valuable in preparing copolymers. 5 + 10 + 5 = 20
- (b) Why is control of stereoregularity is important in some polymers and how coordination polymerization is useful in preparing stereoregular polymers. Explain the mechanism of the polymerization of propylene by coordination polymerization.
- (c) Explain the preparation of PMMA as sheets directly from the monomer.
5. (a) Explain shear stress vs shear rate relationship for various types of fluids. Why do some fluids show shear thinning and some others show shear thickening? 10 + 10 = 20
- (b) Explain the concept of viscoelasticity and its implications on creep and stress relaxation, using Maxwell and Voigt models and their combinations.
6. Write short notes on **any four** of the following:
- (a) Interfacial polymerization (b) Auto acceleration
 (c) Factors influencing T_g of a polymer (d) Vibration damping of rubbers
 (e) Hysteresis in polymers (f) Ring opening polymerization 4 x 5 = 20

GROUP - B

- (a) What is reactivity ratio? How do reactivity ratio r_1 and r_2 of two monomers influence the formation of alternate, random and block copolymers. 10 + 5 + 5 = 20
- (b) What are living polymers? Explain.
- (c) Write and explain Carothers equation.
8. (a) Distinguish between rubbers, plastics, ~~leathers~~ and fibres in terms of T_g and structural factors. *any two of the*
- Name* (b) ~~Explain~~ the roles of following materials in polymerization: (i) aluminium chloride (ii) hydroquinone (iii) $TiCl_4$ (iv) AIBN (v) alkyl lithium
- (c) Draw a stress-strain curve for (i) Rubber (ii) ~~Rigid~~ *Hard* rubber (iii) Ductile plastic and explain them. 8 + 4 + 8 = 20