

INDIAN RUBBER INSTITUTE  
PGDIRI EXAMINATION – 2019

Date : 6<sup>th</sup> July, 2019  
Duration : 3 Hours

Paper – I

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) When the  $T_g$  of the polymer is well below room temperature, it is a  
a) Plastic    b) Rubber    c) Fibre    d) Dendrimer
- (iii) Polyethylene terephthalate is a  
a) Polyamide    b) Polyimide    c) Polyether    d) Polyester
- (iv) NBR is a  
a) Homopolymer    b) Copolymer    c) Terpolymer    d) non polymeric material
- (v) The weight average molecular weight is determined by  
a) Spectroscopy    b) Osmometry    c) Viscometry    d) Light scattering
- (vi) For a Hookean region stress is directly proportional to  
a) Viscosity    b) Strain rate    c) Strain    d) Modulus
- (vii) Aramids are high performance  
a) Polyesters    b) Polyethers    c) Polyimides    d) Polyamides
- (viii) SBS is a  
a) Random copolymer    b) Alternate copolymer  
c) Block copolymer    d) none of the above
- (ix) HDPE is known as  
a) Glassy polymer    b) Amorphous polymer    c) Crystalline polymer    d) rubber
- (x) Glass transition temperature of Natural rubber is  
a)  $-100^\circ\text{C}$     b)  $-70^\circ\text{C}$     c)  $+100^\circ\text{C}$     d)  $+150^\circ\text{C}$

- (xi) Glass transition temperature of a polymer is determined by  
 a) Infrared spectrophotometer      b) Differential scanning calorimeter  
 c) Mass spectrometer                  d) Scanning electron microscopy
- (xii) Polymer produced from anionic polymerization is called  
 a) Dead polymer    b) Living polymer    c) Ladder polymer    d) None of these
- (xiii) Syndiotactic PP is generally  
 a) Crystalline      b) Semi-crystalline    c) Amorphous          d) None of these
- (xiv) Copolymer of styrene and butadiene, which is used in tire is  
 a) SBS              b) SBR                  c) SEBS                d) None of these
- (xv) IIR is commercially prepared by  
 a) Radical polymerization              b) Ziegler – Natta polymerization  
 c) Cationic polymerization              d) Anionic polymerization
- (xvi) Crystallinity of a polymer is quantitatively determined by  
 a) XRD              b) TGA                  c) DETA                d) DMA
- (xvii) If PE has a molecular weight ( $M_n$ ) of 28000, what is its degree of polymerization?  
 a) 100              b) 1000                c) 10000                d) None of the these
- (xviii) Example of a plasticizer for PVC is  
 a) DRC              b) DCP                  c) DPG                d) DBP
- (xix) Gutta Percha is  
 a) Cis 1,4 polyisoprene                  b) Trans 1,4 polyisoprene  
 c) Vulcanised polyisoprene              d) Ebonite
- (xx) A rubber having good biocompatibility is  
 a) NR                b) SBR                  c) NBR                d) PDMS

(1 x 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 can you prepare Nylon 6 and Nylon 66?  
 (c) Explain the term 'back biting mechanism'.  
 (d) What is Ziegler – Natta Catalyst?

(8+6+4+2) = 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.
- Acrylonitrile and Butadiene
  - Isobutylene and Isoprene
  - Phenol and Formaldehyde
  - Ethylene, propylene and 1,4 hexadiene.
  - 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) IIR    iv) BR    v) FKM

$$5 \times 2 + 5 \times 2 = 10$$

4. 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.

$$(2 \times 10) = 20$$

#### 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) Elasticity and viscosity.

$$(6 \times 4) = 20$$

6. (a) Give a comparative account of the stress – strain plots 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'.

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

7.

- (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.

$$(10+6+4) = 20$$

8. Write short notes on any four of the following

- (a) Z-average molecular weight
- (b) Tacticity
- (c) Dilatometer
- (d) Crystallization of rubber
- (e) Solubility parameter
- (f) Polymer spherulite

$$(4 \times 5) = 20$$

