

INDIAN RUBBER INSTITUTE

DIRI EXAMINATION – 2016

Paper - I

Date: 22.07.2016

Time: 10.00-13.00 hrs.

Duration: 3 Hours

Full 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. Multiple choice questions: Select the correct answer from the given alternatives:

- (i) NBR is a  
(a) Homopolymer      (b) Crystalline Polymer  
(c) Heteropolymer    (d) Copolymer
- (ii) Condensation polymerization takes place between monomers such as  
(a) Monohydric alcohol and mono-carboxylic acid  
(b) Monohydric alcohol and di-carboxylic acid  
(c) Dyhydric alcohol and mono carboxylic acid  
(d) Dihydric alcohol and di-carboxylic acid
- (iii) Polymer with higher elongation at break arises from  
(a) Highly branched structure  
(b) Cis - configuration  
(c) Trans - configuration  
(d) Highly crystalline structure
- (iv)  $T_g$  of a polymer is determined by  
(a) Viscometer      (b) Dilatometer  
(c) Osmometer      (d) Rheometer
- (v) Polyethylene has molecular weight of 28,000. It has degree of polymerization  
(a) 280      (b) 2800      (c) 1000      (d) 2000
- (vi) EPDM is a  
(a) Homopolymer      (b) Copolymer  
(c) Terpolymer      (d) Fibre
- (vii) Example of self-reinforcing rubber is  
(a) NR      (b) BR      (c) SBR      (d) EPDM

[Turn Over]

- (viii) Dicumyl peroxide is an example of  
(a) Plasticizer (b) Crosslinking agent (c) Initiator (d) Peptizer
- (ix) Which one is a natural polymer  
(a) Silk (b) Rayon  
(c) Polyester (d) Nylon
- (x) Nylon is a  
(a) Polyester (b) Polyamide  
(c) Polyolefin (d) None of the above
- (xi) Cationic polymerization is generally used for making  
(a) SBR (b) PCP (c) Nitrile rubber (d) Butyl rubber
- (xii) Glass transition temperature of NR is  
(a)  $30^{\circ}\text{C}$  (b)  $0^{\circ}\text{C}$  (c)  $-30^{\circ}\text{C}$  (d)  $-74^{\circ}\text{C}$
- (xiii) A polymer which has oxygen atom in the main chain is  
(a) SBR (b) NBR (c) PMMA (d) MQ
- (xiv) Most important criteria of a polymer to form strong fibre is  
a) Partially crystalline b) Amorphous  
c) Highly crystalline d) Highly atactic
- (xv) Number-average molecular weight of a polymer can be determined by  
a) Osmometry b) Light scattering  
c) Viscometry d) Dilatometry
- (xvi) Polymers show rubbery properties  
(a) Above  $T_g$  (b) Below  $T_g$   
(c) Both below and above  $T_g$  (d) None of the above
- (xvii) 4 Grades of Polystyrene having Mw of  
a) 1,04,000 b) 2,08,000 c) 4,16,000 d) 8,32,000 respectively. Which one will have the lowest MFI?
- (xviii) SBR is a  
(a) Homopolymer (b) Alternating copolymer  
(c) Random Copolymer (d) Block copolymer
- (xix) Phenol formaldehyde resin is an example of  
(a) Natural polymer (b) Semi-synthetic polymer  
(c) Thermoplastic polymer (d) Thermosetting polymerization

(xx) Hydroquinone is an example of

- (a) Initiator
- (b) Inhibitor
- (c) Emulsifier
- (d) Hardener

(1 x 20) = 20

- 2.(a) What are 'monomer' and 'polymer'? Explain them with an example in each case.  
 (b) Give two examples of natural polymer and two examples of synthetic polymer.  
 (c) What should be the minimum functionality of a monomer? Give an example.  
 (d) What is the functionality of vinyl chloride ( $\text{CH}_2 = \text{CH}-\text{Cl}$ ) in polymerization reaction.  
 (e) Write down the stress-strain curves in the same plot for the following:  
 i) a rubber      ii) a rigid plastic      iii) a fiber

6+4+3+3+4= 20

3. Distinguish between the followings with suitable examples:

- (a) Addition and Condensation polymerization
- (b) Thermoplastics and Thermosets
- (c) Random and Alternating Copolymer
- (d) Isotactic and Syndiotactic Polymer
- (e) Bulk and Solution polymerization

(5 x 4) = 20

4. (a) Distinguish between homopolymer, copolymer and terpolymer with suitable examples.

- (b) Explain with examples the difference between natural and synthetic rubber.
- (c) What are different techniques of polymerization discuss their relative advantages and disadvantages.

(6+4+10) = 20

GROUP - B

5. (a) Why do polymers show average molecular weight in contrast to definite molecular weight of simple chemical compounds?

- (b) What is meant by polydispersity?
- (c) What is the importance of polydispersity in rubber technology?
- (d) Calculate  $\overline{M}_n$  and  $\overline{M}_w$  for a polydispersed polymer composed of the following mixture of fractions (mass % and molecular weight of each of the fractions are given):

Mass %	20	30	50
Mol. Weight	50,000	1,00,000	2,00,000

(4+4+4+8) = 20

6. Name the polymers used in each case with the structure of the corresponding monomer and polymer.

- (a) A rubber which exhibits very good low temperature flexibility.
- (b) A rubber which exhibits excellent weather resistant property.
- (c) A heat resistant rubber.
- (d) A rubber which shows strains induced crystallization.
- (e) A polar rubber.

(1+3) x 5 = 20

[Turn Over]



7. Explain the following statement. If any of the statement is incorrect, please correct this with proper explanation.
- (a) Trans-BR is more rubbery than Cis-BR.
  - (b) The properties of NBR depend on the acrylonitrile (ACN) content.
  - (c) Polychloroprene rubber (CR) has more heat and oil resistant properties than fluoro elastomer.
  - (d) As the styrene content increases, the rubbery properties of SBR gets improved.
  - (e) NR is more prone to undergo strain induced crystallization than NBR.
  - (f) Syndiotactic polystyrene is more crystalline than atactic polystyrene.
  - (g) Polypropylene has higher  $T_g$  than polyethylene.
  - (h) Butyl rubber is usually prepared by using redox initiators.
  - (i) Anionic polymerization is called stereo-regular polymerization.
  - (j) Carothers's equation is usually used for the polymerization of vinyl monomer.

(10 x2) = 20

8. Write short notes on any four of the following
- (a) Carothers's equation
  - (b) Stereoregular polymerization
  - (c) Glass transition temperature and its significance
  - (d) Block copolymer
  - (e) Viscoelasticity
  - (f) Ring opening polymerization

(4 x 5) = 20