INDIAN RUBBER INSTITUTE

DIRI EXAMINATION – 2010

Paper - I

Date : 29ᵗʰ June, 2010   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) A polymer easily dissolves in a solvent when
   (a) CED of Polymer   >   CED of solvent
   (b) CED of Polymer   =   CED of solvent
   (c) CED of Polymer   <   CED of solvent
   (d) None of these

(iii) Polymers show rubbery properties
   (a) Above T_g (b) Below T_g
   (c) Both below and above T_g (d) None of the above

(iv) A rubbery polymer should have
   (a) High CED and high molecular weight
   (b) Low CED and low molecular weight
   (c) Low CED and high molecular weight
   (d) High CED and low molecular weight

(v) 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

(vi) Polymer with higher strength is possible with
   (a) Low molecular weight   (b) Low unsaturation
   (c) High molecular weight   (d) High structural irregularity

(vii) Polymer with higher elongation at break arises from
  (a) Highly branched structure
  (b) Cis – configuration
  (c) Trans – configuration
  (d) Highly crystalline structure

(viii) T_g of a polymer is determined by
  (a) Viscometer   (b) Dilatometer
  (c) Osmometer   (d) Rheometer

(ix) Living polymers are formed by
  (a) Cationic polymerization   (b) Anionic polymerization
  (c) Polycondensation Polymerisation   (d) Polyaddition polymerization

(x) Polyethylene has molecular weight of 28,000. It has degree of polymerization
  (a) 280   (b) 2800   (c) 1000   (d) 2000

(xi) Strain-induced crystallization is shown by
  (a) NR   (b) SBR   (c) NBR   (d) BR

(xii) Cellulose is
  (a) A natural polymer   (b) A synthetic polymer
  (c) A regenerated polymer   (d) Not a polymer

(xiii) Polymerisation is always accompanied by
  (a) Increase in unsaturation with increase in molecular weight
  (b) Decrease in unsaturation with increase in molecular weight
  (c) Decrease in unsaturation with decrease in molecular weight
  (d) Increase in unsaturation with no change in molecular weight

(xiv) In free radical polymerization, Benzoyl peroxide is used as a
  (a) Co-catalyst   (b) Initiator
  (c) Inhibitor   (d) Chain transfer agent

(xv) Conversion of a monomer to a polymer involves
  (a) Only opening of bonds
  (b) Only formation of new bonds
  (c) Both opening of bonds and formation of new bonds
  (d) None of the above.

(xvi) Viscosity is defined as
  (a) Shear stress/ Shear strain
  (b) Shear strain/ Shear stress
  (c) Shear rate / Shear stress
  (d) Shear stress/ Shear rate

(xvii) Stress – strain behaviour of metal-to-rubber bonded components is comparatively linear in
  (a) Compression (b) Shear (c) Tension (d) Torsion

(xviii) Shape factor increases with increase in
  (a) Total load applied
  (b) Load-free area
  (c) Loaded area
  (d) Both loaded-area and load-free area.

(xix) Stored energy can be obtained from the stress-strain curve from the
  (a) Area under Hookean region
  (b) Area after Hookean region
  (c) Area under entire stress-strain curve
  (d) Slope of straight portion within Hookean region

(xx) Elasticity as defined by Stress/Strain is
  (a) More for rubber than steel
  (b) Less for rubber than steel
  (c) Almost similar for both rubber and steel
  (d) Not possible to calculate for rubber

$(1 \times 20) = 20$

2. (a) What is a Polymer? Give two examples of each natural and synthetic polymer.
   (b) What characteristics a single chemical compound must posses in order to be used as a monomer ?
   (c) What are the two different types of isomerism observed in polymers? Give examples in each case?

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

3. Name the synthetic rubbers used in each case, write down the structure of the monomers and the structure of the polymer in each case.
   (a) A copolymer used in hawai chappal sole
   (b) A flame resistant rubber
   (c) An oil resistant rubber
   (d) A terpolymer used in making automatic door channels
   (e) A heterochain rubber having wide range of service temperature

$(1+1+2) \times 5 = 20$

4. (a) What is meant by glass transition temperature (T_g)?
   (b) What is the significance of glass transition temperature in rubber technology?
   (c) What is crystallization in rubber and how does it differ from crystallization of elements or simple chemical compounds?
   (d) On what factors T_g of a polymer depends?

$(2+4+6+8) = 20$

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

(a) Free radical polymerization

(b) Short stop

(c) Step growth polymerization

(d) Thermoplastic and thermoset

(e) Block copolymers

(f) Solubility parameter

$$4 \times 5 = 20$$

GROUP – B

7. (a) What is meant by Rubber – like elasticity and how does it differ from elasticity shown by metals?

(b) Draw Stress-strain curve for steel and rubber and indicate the following :
   (i) Hookean region
   (ii) Yield point
   (iii) Breaking point

(c) Describe the different regions of the stress-strain curve of rubber and explain the same in relation to molecular structure of rubber.

$$(6 + 8 + 6) = 20$$

8. (a) Explain the terms – (i) Ideal elastic response (ii) Pure viscous flow and (iii) Viscoelasticity.

(b) Mention the factors that affect the flow behavior of rubbers.

(c) Define relative viscosity, specific viscosity, reduced viscosity, inherent viscosity and intrinsic viscosity of a polymer solution and mention their units.

$$(6 + 6 + 8) = 20$$