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Date : 19.08.2017   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. **Question number 1**: is compulsory.

Answer **Four** from the rest the remaining questions taking **Two** from each group.

Group – A

Q. 1. Select the right answer from the given alternatives :

(i) Vinyl polymerization is accompanied by
   a) Increase unsaturation with increase in molecular weight
   b) Decrease unsaturation with increase in molecular weight
   c) Decrease unsaturation with decrease in molecular weight
   d) Increase unsaturation with no change in molecular weight

(ii) Which polymerization produces living polymer?
   a) Radical polymerization   c) Polycondensation polymerization
   b) Anionic polymerization   d) Polyaddition polymerization

(iii) PET is
   a) Polyamide b) Polyimide
   c) Polyether d) Polyester

(iv) Gutta-percha is a
   a) Natural polymer   b) Artificial polymer
   c) Synthetic polymer   d) Regenerated polymer

(v) Glass transition temperature (Tg) of polybutadiene rubber (BR) is
   a) $10^\circ C$ b) $-110^\circ C$ c) $100^\circ C$ d) $50^\circ C$

(vi) Copolymer of styrene and butadiene which is used in car tyre is
   a) SBR   b) SEBS   c) SBS   d) SEPS

(vii) In the typical stress-strain curve, the stiffness is measured by calculating the
   a) Total area under the curve till the point of rupture
   b) Area within the Hookean region
   c) Slope of straight portion within the Hookean region
   d) Energy at break

[TURN OVER]

(viii) The polymer having lowest coefficient of friction is

    a) NR   b) PVC   c) PTFE   d) EPDM

(ix) Which one is transparent polymer?

    a) Nylon   b) NBR   c) Silicone   d) Polystyrene

(x) EPDM is commercially prepared by

    a) Cationic polymerization   b) Anionic polymerization

    c) Ziegler-Natta polymerization   d) Radical polymerization

(xi) Functionality of propylene is

    (a) Two   (b) Four   (c) Three   (d) One

(xii) Cellulose acetate is an example of

    (a) Natural polymer   (b) Fibre

    (c) Rubber   (d) Semi-synthetic polymer

(xiii) Tg of copolymer can be determined using

    (a) Carother's Equation   (b) Bragg Equation

    (c) Fox Equation   (d) Hildebrand Equation

(xiv) Polystyrene has Mw of 1,04,000. It has degree of polymerization

    (a) 100   (b) 500   (c) 1000   (d) 10000

(xv) Chain flexibility of polymers depends on

    (a) Segmental motion   (b) Brownian motion

    (c) Molecular motion   (d) None of the above

(xvi) In radical polymerization, AIBN (azo-bisisobutyro nitrile)

    (a) Inhibitor   (b) Initiator

    (c) Co-catalyst   (d) Chain transfer agent

(xvii) Conversion of vinyl 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.

(xviii) 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

(xix)   Mechanical properties of polymer will be better if

    (a)   Molecular weight distribution is broader

    (b)   Molecular weight distribution is narrower

    (c)   Higher molecular weight

    (d)   Glass transition temperature is higher

(xx)   Solubility parameter of a polymer depends on its

    (a) Polarity   (b) Modulus   (c) Tackiness   (d) Hardness

$$20 \times 1 = 20$$

Q. 2)   Give reasons for the following:

(a)   Why plastics exhibit lesser elongation at break than rubbers?

(b)   Tg of Polyethylene is well below room temperature like rubber but it is plastics. Why?

(c)   Tg will decrease on extent of branching. Why?

(d)   EPDM rubber is more weather resistance than NR. Why?

(e)   Vinyl polymerization are highly exothermic. Why?

(f)   Chain transfer agents are used to control molecular weight of a polymer. Why?

(g)   Why Diene rubbers are susceptible to oxidation?

(h)   Why IIR are more air impermeable than BR?

(i)   Why cationic polymerization is normally done at high temperature?

(j)   All crystalline polymers are stereoregular. Why?

$$10 \times 2 = 20$$

3.a)   Classify polymers in as many ways as you can giving basis of classification and suitable example in each case.

b)   Define T_g and Tm. How do you determine T_g and Tm of a polymer?

c)   How you can distinguish a rubber and a plastic in term of their T_g, Molecular weight, mechanical strength and crystallinity? Explain this with an example in each case?

d)   What are the factors on which T_g of a polymer depends?

$$6+5+5+4=20$$

4.a)   Write down a typical recipe for emulsion polymerization of a vinyl monomer and discuss the role of different ingredients used?

b)   Why this particular technique is often used for making rubbers?

c)   What are the two different types of isomerism observed in polymers? Give examples in each case.

d)   How does molecular weight affect the processing properties and vulcanizate properties of polymer?

$$9+3+5+3 = 20$$

[TURN OVER]

Group - B

5.a) Write down the chemical structure of the repeat unit of the following polymers:
i) Teflon   ii) Natural rubber   iii) PMMA   iv) HNBR   v) EPR.

$$5 \times 2 = 10$$

b) Give one example with structure of repeat unit for each of the following

i) A terpolymer which is useful for making automotive seal.

ii) A polymer which can be prepared by radical, coordination, cationic and / or anionic polymerization method.

iii) An inorganic polymer which is useful as a rubber over a wide range of temperature.

iv) A rubber having good oxidation resistance and highly impermeable to gases used mainly in tyre inner tubes

v) A polar homopolymer which is useful for making contact adhesives

$$5 \times 2 = 10$$

6. a) What is the significance of area under a stress- strain curve?

b) How does the stress-strain curve of a viscoelastic material differ from that of a perfectly elastic material?.

c) What is meant by 300% modulus and for which type of material this is important?

d) Explain with diagram

(i) Newtonian and non- Newtonian behavior of polymers. Show shear stress vs. shear rate plots for various fluid materials.

e) What do you mean by the terms "creep and stress relaxation" and Shape factor?.

$$2+4+3+6+5 = 20$$

7. Differentiate between the following pair of terms giving suitable example (**Any Five**) :

i) Homopolymer and copolymer.
ii) Cationic and anionic polymerization
iii) Inhibitor and short stop.
iv) Nylon 6,6 and Nylon 6
v) Elasticity and Viscoelasticity
vi) Polymer and Oligomer.
vii) Short stop and Inhibitors

$$5 \times 4 = 20$$

8. Write short notes on any **Four** of the following :

    a) Creap and stress relaxation

    b) Living polymer and dead polymer

    c) Addition polymer polymerization

    d) Tacticity in polymer

    e) Hysteresis loss.

    d) Solubility parameter.

$4 \times 5 = 20$