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**3 (Sem-5/CBCS) CHE HE 4/HE 5/HE 6**

**2023**

**CHEMISTRY**

(Honours Elective)

**Answer the Questions from any one Option.**

**OPTION-D**

**(Novel Inorganic Solids)**

Paper : CHE-HE-5046

**OPTION-E**

**(Polymer Chemistry)**

Paper : CHE-HE-5056

**OPTION-F**

**(Instrumental Methods of Chemical Analysis)**

Paper : CHE-HE-5066

Full Marks : 60

Time : Three hours

**The figures in the margin indicate  
full marks for the questions.**

Contd.

**OPTION-D**

**(Novel Inorganic Solids)**

Paper : CHE-HE-5046

1. Answer the following questions :  $1 \times 7 = 7$

(a) State whether the following statement is *True or False* :

Solid state reactions must go to completion as techniques for purification of formed solids are severely limited.

(b) Give *one* example of a solid electrolyte.

(c) Duralumin is an alloy of \_\_\_\_\_ and \_\_\_\_\_.  
(Fill in the blanks)

(d) What is the diameter range of nanowires ?

(e) Give the percentage composition of brass.

(f) Give an example of an one-dimensional metal.

(g) What is the anion of fullerene called ?

2. Answer the following questions :  $2 \times 4 = 8$

(a) What is co-precipitation method ?

(b) What is the importance of solid electrolyte ?

(c) How is glazing in ceramics done ?

(d) Write *two* differences between organic and inorganic pigments.

3. Answer the following questions : **(any three)**  
 $5 \times 3 = 15$

(a) Write a note on sol-gel method.

(b) Discuss the role of matrix in composites.

(c) Discuss applications of *two* different basic refractory materials.

(d) Briefly describe the environmental effects on composites.

(e) What is carbon tool steel ? Give its composition and discuss its applications.

4. Answer the following questions : **(any three)**

$$10 \times 3 = 30$$

(a) What are inorganic pigments ? Give their general properties. Name *two* inorganic pigments and give their uses.

$$1 + 3 + 3 + 3 = 10$$

(b) Give brief descriptions of the following :

$$2\frac{1}{2} \times 4 = 10$$

(i) Metal containing liquid crystals

(ii) Molecular magnets

(iii) Carbon nanotubes

(iv) Matrix materials

(c) What do you understand by inorganic nanowires ? Give synthetic strategies of the following nanowires :  $1 + 3 \times 3 = 10$

(i) MgO

(ii)  $Al_4C_3$

(iii) CdS

(d) Name the different types of ceramics and give applications of each of them.

(e) Discuss the advantages and disadvantages of solid state synthesis.

(f) What are carbon steels ? What are its various types ? Discuss heat treatment on carbon steel.

$$1 + 4 + 5 = 10$$

### OPTION-E

**(Polymer Chemistry)**

Paper : CHE-HE-5056

1. Answer the following questions :  $1 \times 7 = 7$

(a) Which of the following is not a polymer ?

(i) Sucrose

(ii) Enzyme

(iii) Cellulose

(iv) Nucleic acid

(b) Functionality of phenol is

(i) one

(ii) two

(iii) three

(iv) four

(c) Tubeless tyres are co-polymers of isoprene and

(i) neoprene

(ii) isobutylene

(iii) PAN

(iv) silicones

(d) Which of the following polymers can have strong intermolecular forces ?

(i) Nylon

(ii) Polystyrene

(iii) Rubber

(iv) Polyesters

- (e) The WLF Equation is :
- (i) a combination of Voigt and Maxwell models that describes creep
  - (ii) a four-parameter model for stress relaxation
  - (iii) an expression for the shift factor that is used in the time-temperature superposition principle
  - (iv) the relationship between intrinsic viscosity and molecular weight
- (f) Polypropylene produced commercially using a Ziegler-Natta catalyst is predominantly
- (i) atactic
  - (ii) isotactic
  - (iii) syndiotactic
  - (iv) None of the three
- (g) For a polymer to be completely miscible with a solvent at a given temperature (i.e. form a single-phase mixture at all compositions)
- (i) the free energy change  $\Delta G_m$  must be negative and the second derivative of the free energy (with respect to composition) must be positive
  - (ii)  $\Delta G_m$  must be positive and the second derivative negative
  - (iii)  $\Delta G_m$  must be negative and the second derivative must also be negative
  - (iv) they must both be positive

2. Answer the following questions :  $2 \times 4 = 8$
- (a) Why do polymers do not have sharp melting point ?
  - (b) Differentiate between rubbers and plastics on the basis of intermolecular forces.
  - (c) Can nucleic acids, proteins and starch be considered as step growth polymers ?
  - (d) A particular sample of polymer has 100 chains with molecular weight 1000, 200 chains with molecular weight 10000, and 200 chains with molecular weight 100000. Calculate the polydispersity of the sample.
3. Answer **any three** of the following questions :  $5 \times 3 = 15$
- (a) Explain Flory-Huggins theory and enlist the assumptions.
  - (b) Bring out the differences between chain growth and step growth polymerization.
  - (c) Discuss the various factors which affect the crystallinity of polymers with suitable examples.
  - (d) Write short notes on :
    - (i) Living radical polymerization
    - (ii) Biodegradable polymer

(e) Explain the mechanism of anionic polymerization with suitable examples.

4. Answer **any three** of the following questions :

10×3=30

(a) What is number average molecular weight and weight-average molecular weight of polymer? Derive an expression for it. Define degree of polymerisation and polydispersity index of a polymer sample. Draw the molecular weight distribution curves of three hypothetical polymer samples having same number-average molecular weight, but different polydispersities.

2+3+2+3=10

(b) Define glass transition temperature ( $T_g$ ) and melting temperature ( $T_m$ ) for polymers. What is the interrelationship between these two parameters? Explain with suitable diagram the dilatometric method for the determination of  $T_g$  in polymers.

2+2+6=10

(c) Describe the structure of Ziegler-Natta catalyst used in co-ordination polymerization of olefins. Write the mechanism of polymerization of olefins when Ziegler-Natta catalyst is used. How is it different from polymerization of olefins using free radical initiators?

2+5+3=10

(d) What do you mean by chain transfer in polymerization process? Derive an expression for kinetics of chain polymerization. Write a note on kinetic chain length in free radical polymerization.

2+5+3=10

(e) What are the different kinds of polymerization techniques? Citing advantages and limitations, describe the bulk and solution polymerization technique.

2+4+4=10

(f) Write the differences between thermosetting and thermoplastics. Discuss preparation, properties and uses of following polymer molecules (**any two**)

(i) Polyethylene

(ii) Synthetic rubber

(iii) Polycarbonates

2+4+4=10

**OPTION-F**

**(Instrumental Methods of Chemical Analysis)**

Paper : CHE-HE-5066

1. Answer the following :  $1 \times 7 = 7$

- (a) What is electromagnetic radiation ?
- (b) What quantities in the  $x$  and  $y$  axes are displayed in a typical IR spectrum ?
- (c) Conductometry is an instrumental method. (State True or False)
- (d) Why  $KBr$  is used in recording IR spectrum ?
- (e) Why silica gel is used in chromatography ?
- (f) How many signals will be observed in the  $^1H-NMR$  spectrum of benzene ?
- (g) Give the name of a lamp used in uv-visible spectrometer.

2. Answer the following :  $2 \times 4 = 8$

- (a) Why argon gas is used as a carrier gas in gas chromatography ? Why oxygen gas can not be used ?

(b) Why a three-electrode set-up is used in cyclic voltammetry measurements ?

(c) How is a double-beam uv-visible spectrometer different from a single-beam spectrometer ?

(d) Give two applications of mass spectrometry.

3. Answer **any three** from the following :  $5 \times 3 = 15$

(a) Write briefly about the instrumentation of a Fourier-Transform IR spectrometer.

(b) Discuss the various causes of deviation from the Lambert-Beer's law.

(c) What are fluorescence and phosphorescence ? Explain with the help of a Jablonski diagram.

(d) Describe the photovoltaic cell with example.

(e) Write briefly about the instrumentation of a modern NMR spectrometer.

4. Answer **any three** from the following :

10×3=30

- (a) What are accuracy and precision ? Give examples. Discuss the various types of errors in a measurement. 4+6=10
- (b) Write short notes on : 5+5=10
- (i) Principle of solvent extraction
- (ii) Photomultiplier tube for detection
- (c) Describe the principle and instrumentation of HPLC chromatography. 5+5=10
- (d) Describe the instrumentation of a double-beam uv-visible spectrometer. Give *three* applications of uv-visible spectroscopy. 7+3=10
- (e) What is DNA gel electrophoresis ? Describe the working principle and instrumentation. What are the various forms of DNA that can be detected in gel electrophoresis ? 1+6+3=10
- (f) Describe the principle and instrumentation of AAS. Give *two* sources of interferences in AAA measurement. 8+2=10