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

**2022**

**CHEMISTRY**

**(Honours Elective)**

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

**OPTION-A**

**(Novel Inorganic Solids)**

Paper : CHE-HE-5046

**OPTION-B**

**(Polymer Chemistry)**

Paper : CHE-HE-5056

**OPTION-C**

**(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-A**

**(Novel Inorganic Solids)**

Paper : CHE-HE-5046

1. Answer the following questions : **(any seven)**  
1×7=7

(a) Which one of the following is not an example for top-down approach?

(i) Ball milling technique

(ii) Sol-gel process

(iii) Lithography

(iv) Gas phase agglomeration

(b) Which of the following is a non-oxide ceramic?

(i) Alumina

(ii) Zirconia

(iii) Carbide

(iv) Fiber-reinforced

(c) Give an example for nanowires of metals.

(d) What are composite materials?

(e) 'Alumina' comes under the category of traditional ceramics.

*(State True or False)*

(f) What is meant by plain carbon steel?

(g) What is the percentage of Cu and Sn in bronze alloy?

(h) What is the major load carrier in dispersion-strengthened composites?

(i) Which metal nanoparticle is extensively used as a catalyst?

(j) Which alloy of aluminum is used in the construction of aircraft?

(k) Titanium (IV) oxide ( $TiO_2$ ) is a \_\_\_\_\_ pigment. *(Fill in the blank)*

(l) \_\_\_\_\_ is the field in which the nanoparticles are used with silica coated iron oxide.

*(Fill in the blank with appropriate option)*

(i) Magnetic application

(ii) Electronic

(iii) Medical diagnosis

(iv) Structural analysis

2. Answer the following : **(any four)**

2×4=8

- (a) What makes a molecule magnetic ?
- (b) What are natural and artificial nanoparticles ?
- (c) What is a one-dimensional metal ? Give examples.
- (d) What are the different techniques used for the synthesis of carbon nanotubes ?
- (e) What do you understand by conventional heat and beat methods ?
- (f) What are metal-containing liquid crystals ? Give examples.
- (g) What are the raw materials of ceramic tile ? Give their percentage.
- (h) What is the molecular structure of carbon nanotubes ?

3. Answer **any three** of the following :

5×3=15

- (a) What are SSEs ? Give suitable examples. What are their advantages over other electrolytes ?

- (b) What do you mean by self-assembled nanostructures ? How are these nano-architectures controlled ?

2+3=5

- (c) What is the composition of a metal matrix composite (MMC) ? Discuss the manufacturing methods of these materials.

2+3=5

- (d) What are refractories ? How are they classified on the basis of their melting points ? What are the primary reasons behind using refractories ?

1+2+2=5

- (e) What is a ceramic coating ? How do they work ?

2+3=5

- (f) Discuss the basic working principle of Li ion battery.

- (g) Distinguish between thermoplastics and thermosets.

- (h) Discuss the advantages and disadvantages of polymer matrix composites.

2½+2½=5

4. Answer **any three** of the following questions:  $10 \times 3 = 30$

(a) (i) Discuss the co-precipitation and sol-gel methods used in the syntheses of inorganic solids.  $2\frac{1}{2} + 2\frac{1}{2} = 5$

(ii) Discuss the intercalation method giving suitable example. 5

(b) Write notes on the following:  $2\frac{1}{2} \times 4 = 10$

(i) Fullerenes

(ii) Black pigments

(iii) Bionano composites

(iv) Intercalation method

(c) (i) What do you mean by reinforcement ratio? Discuss the effect of reinforcement ratio on the structure of composite material.  $2 + 3 = 5$

(ii) Discuss the applications of fibre-reinforced composites. 5

(d) What do you mean by DNA nanotechnology? Discuss the biological applications of DNA nanomaterials.  $4 + 6 = 10$

(e) What are alloys? Discuss the various types of copper alloys and give their applications.  $2 + 8 = 10$

(f) Discuss the composition, mechanical characteristics and applications of various types of cast irons.

(g) Discuss the methods of preparation of Au and Ag nanoparticles.  $5 + 5 = 10$

(h) Discuss the application of nano-materials in medicine.

**OPTION-B**  
**(Polymer Chemistry)**

Paper : CHE-HE-5056

1. Answer **any seven** of the following questions :  $1 \times 7 = 7$

(i) Bakelite is condensation polymer of

- (a) phenol and urea
- (b) phenol and formaldehyde
- (c) urea and formaldehyde
- (d) urea and melamine

(ii) In cationic polymerization, termination occurs by

- (a) rearrangement
- (b) chain transfer
- (c) coupling
- (d) both rearrangement and chain transfer

(iii) Surfactants used in emulsion polymerization are

- (a) anionic
- (b) cationic
- (c) non-ionic
- (d) All of the above

(iv) Which of the following polymers is more amorphous ?

- (a) Isotactic
- (b) Atactic
- (c) Syndiotactic
- (d) All of the above

(v) For solubility of a polymer in a solvent  $\Delta G$  must be

- (a) positive
- (b) negative
- (c) zero
- (d) infinite

(vi) Which one of the following pairs is not correctly matched ?

- (a) Terylene-Condensation polymer of terephthalic acid and ethylene glycol
- (b) Teflon-Thermally stable cross-linked polymer of phenol and formaldehyde
- (c) Perspex-a homopolymer of methyl methacrylate
- (d) Synthetic rubber-a copolymer of butadiene and styrene

(vii) Which is/are true for elastomers?

- (a) These are synthetic polymers possessing elasticity
- (b) These possess very weak intermolecular forces of attractions between polymer chains
- (c) Vulcanised rubber is an example of elastomer
- (d) All of the above

(viii) PDI for natural polymer is generally close to

- (a) zero
- (b) 100
- (c) 1
- (d) 50

(ix) The catalyst used in the manufacture of polythene by Ziegler method is

- (a) Titanium tetrachloride and triphenyl aluminium
- (b) Titanium tetrachloride and triethyl aluminium
- (c) Titanium oxide
- (d) Titanium isopropoxide

(x) Buna S is a natural rubber. (True/False)

(xi) Light scattering method is used for the determination of osmotic pressure of polymers. (True/False)

(xii) The Flory-Huggins theory explains the miscibility of a polymer with solvent. (True/False)

2. Answer **any four** of the following questions :  $2 \times 4 = 8$

(i) What are initiators in chain growth polymerization? Give one example.

(ii) What do you mean by high density polyethylene (HDPE)? Write its one application.

(iii) Write the brand name of polytetrafluoroethylene (PTFE). Explain its behaviour on heating.

(iv) Why are silicones called inorganic polymer?

(v) What are polycarbonates? Write one method of its preparation.

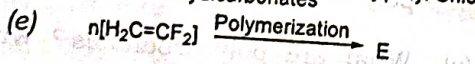
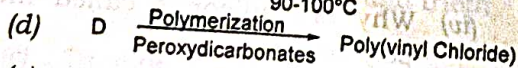
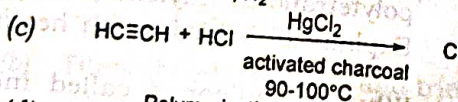
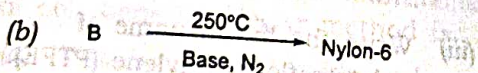
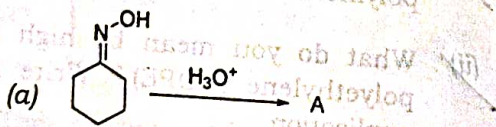
(vi) What is meant by living and dead polymer?

(vii) Define the term 'super fibre' with an example.

(viii) How do you explain functionality of a polymer?

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

(i) Identify A-E in the following polymeric reactions:



(ii) Give the method of preparation of the following polymers: (**any two**)  $2.5 \times 2 = 5$

(a) Nylon 6,6

(b) Buna-S

(c) Polystyrene

(iii) Mention **two** conditions for a polymer to be conducting. Explain the conducting behaviour of polyaniline (PANI).  $2+3=5$

(iv) Explain with examples the practical significances of copolymerization. Write the differences between graft and block copolymers.  $3+2=5$

(v) Show with suitable examples the classification of polymer on the basis of tacticity. Describe briefly how crystallinity of a polymer is related to its tacticity.  $3+2=5$

(vi) Explain with suitable example the radical mechanism of chain growth polymerization.

(vii) Discuss the kinetics of condensation polymerization.

(viii) What are acrylic polymers? Give an account of different acrylic polymers, their formation, properties and uses.

2+3=5

4. Answer **any three** of the following questions:  $10 \times 3 = 30$

(i) What are coordination polymers? Explain the detailed mechanism of Ziegler-Natta polymerization of propylene. How can you explain the source of stereoregularity in the formation of isotactic polypropylene using Ziegler-Natta catalyst?

2+6+2=10

(ii) Discuss the basic principle of bulk polymerization. Briefly outline the advantages and disadvantages of bulk polymerization. What are the differences between suspension and emulsion polymerization?

3+3+4=10

(iii) Differentiate between addition and condensation polymers. What are the different types of mechanism by which chain-growth polymerization proceeds? For a monomer of general structure  $CH_2 = CHX$ , complete the following table. Put '+' if the monomer can be polymerized by the method mentioned at the top of the column, and '-' if polymerization by the method is not feasible. Briefly justify your answer.

3+2+5=10

X	Free radical	Anionic	Cationic
-CN			
-Ph			
-OCH <sub>3</sub>			

(iv) What are crystalline polymers? What are the different factors which affect degree of crystallinity? Differentiate between crystalline and amorphous polymers. Define functionality of a monomer.

2+4+2+2=10

(v) What are the factors that affect the solubility of polymers? Derive an expression for enthalpy change and free energy change of mixing of polymers. What are the assumptions of Flory-Huggins theory?

3+4+3=10

(vi) Define number average molecular weight and weight average molecular weight. Explain osmotic pressure methods to determine molecular weight of the polymers. A box of mangoes contains sets A, B, and C with their numbers and weight as shown below:

Set A : 30 mangoes with weight of each mango 200gm

Set B : 20 mangoes with weight of each mango 300gm

Set C : 40 mangoes with weight of each mango 100gm

Calculate number average molecular weight ( $M_n$ ) for the mangoes.

$$2+5+3=10$$

(vii) Give a detailed account of thermal properties of polymers. Give a detailed account on preparations, properties and uses of various phenol formaldehyde resins.

$$4+6=10$$

(viii) Explain kinetic chain length in free radical polymerization and derive equation of rate of polymer formation. Discuss the effect of temperature on chain polymerization.

$$8+2=10$$

### OPTION-C

#### (Instrumental Methods of Chemical Analysis)

Paper : CHE-HE-5066

1. Answer **any seven** questions :  $1 \times 7 = 7$

(a) The typical range of visible radiation is

(i) 200-400nm

(ii) 400-700nm

(iii) 700-1100nm

(iv) 1100-1600nm

(b) Define the term precision of a measurement.

(c) Colorimetric determination of  $\text{Cu}^{2+}$ , a supplied sample, is an instrumental method. (State whether True or False)

(d) In which of the following instruments ZnSe (Zinc selenide) is used as detector?

(i) UV-visible spectrometer

(ii) NMR spectrometer

(iii) X-ray diffractometer

(iv) IR spectrometer

(e) What is diffraction grating?

- (f) What is fluorescent tag?
- (g) Which of the following quantities are displayed in a typical mass spectrum?
- Absorbance vs wavelength
  - Transmittance vs wavenumber
  - Counts vs  $m/z$
  - Counts vs ppm
- (h) Which of the following materials is used in column chromatography?
- Silica gel
  - Activated charcoal
  - KBr
  - $CDCl_3$
- (i) Argon can be used as a carrier gas in gas chromatography.  
(State whether True or False)
- (j) Which of the following methods is used in combination with a separation method to develop a hyphenated technique?
- NMR spectroscopy
  - Mass spectroscopy
  - Polarography
  - Potentiometry

- (k) Which of the following solvents is used in NMR spectroscopy?

- $CD_3OD$
- $CH_3OH$
- $H_2O$
- $CH_3CN$

- (l) How many  $^1H$ -NMR signal is observed for cyclohexane?

2. Answer **any four** from the following :  $2 \times 4 = 8$

- Why are liquid  $N_2$  and He used in NMR spectrometers?
- Convert  $1eV$  to  $kJmol^{-1}$ .
- What are the advantages of a double-beam spectrometer over single-beam spectrometer?
- Why is three-electrode setup used in cyclic voltametry?
- What information can be obtained from mass spectrometry?

(f) What is the advantage of coupling gas chromatography with mass spectrometry?

(g) What are the disadvantages of neutron activation methods?

3. Answer the following : **(any three)**

5×3=15

(a) Describe the sample preparation techniques in FT-IR spectroscopy.

(b) Discuss the principle of XPES.

(c) What are different decay processes of radioactive isotopes? Discuss.

(d) Write briefly about the laminar flow burner. What are the advantages and disadvantages of this type of burner?

(e) Write a note on DNA gel electrophoresis.

(f) Give a schematic diagram of a single-beam UV visible spectrometer and briefly explain its various components.

(g) What are different types of interference observed in atomic absorption spectroscopy?

(h) Describe the advantages of using Fourier transform than dispersive measurement in the infrared.

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

10×3=30

(a) (i) Give a brief account for neutron activation analysis. What are the advantages and utilities of the techniques? 2+3=5

(ii) Describe the different types of interactions of  $\gamma$ -radiation with matter. 5

(b) (i) How does electromagnetic radiation interact with matter? Explain by showing different energy terms associated with a molecule. 5

(ii) Write five causes for deviation of Beer-Lambert law. 5

(c) (i) What is the most common source used in UV-visible spectrometer? Which parameter affect in the emitting capacity of a source? 1+1=2

- (ii) What are the types of filters used in optical instruments? Write briefly. 2
- (iii) What is the purpose of using monochromator in spectrometer? What are dispersing units in monochromator? 2
- (iv) Describe the photovoltaic cell with schematic diagram. 4
- (d) (i) What are determinate and indeterminate errors? Name *three* types of determinate errors. 2+3=5
- (ii) What is normal error curve? Describe the salient features of the normal error curve. 2+3=5
- (e) (i) What are the factors that favours separation of a constituent from a mixture by solvent extraction process? Briefly discuss each. 6
- (ii) From a solution containing nickel and iron in microquantities, how can you separate nickel by solvent extraction? Then how will you estimate nickel spectrophotometrically? 4

- (f) (i) How is chromatography used for qualitative and quantitative analyses? 4
- (ii) What are retention time and retention volume in gas chromatography?  $1\frac{1}{2} \times 2 = 3$
- (iii) Draw the schematic diagram showing the important component of GLC experiment. 3
- (g) Draw a block diagram showing the major component of high performance liquid chromatography (HPLC) instrument and explain briefly the functions of each component.
- (h) (i) Define chemical shift. What are the factors affecting the chemical shift? 1+3=4
- (ii) How is separation of ions done in case of time of flight (TOF) mass analyser? Discuss the theory involved in it. 4
- (iii) Describe briefly electrospray ionization [ESI] method. 2