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

**2021**

**(Held in 2022)**

**CHEMISTRY**

**(Honours Elective)**

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

**OPTION-A**

Paper : CHE-HE-5046

**(Novel Inorganic Solids)**

Full Marks : 60

Time : Three hours

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

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

(a) The colour of gold nanoparticles is

(i) yellow

(ii) orange

(iii) red

(iv) variable

*(Choose the correct answer)*

Contd.

(b) Carbon nanotubes are also known as \_\_\_\_\_.  
(Fill in the blank)

(c) What is the basis of classification of composite materials ?

(d) Quartz is an acidic refractory.  
(State True or False)

(e) What are fullerides ?

(f) Give an example of a magnetic material used in data storage devices.

(g) What is solid electrolyte made of ?

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

(a) What are inorganic pigments ? How are they different from organic pigments ?

(b) What is the amount (%) of carbon in pure iron, cast iron and steel ?

(c) What are superalloys ? Mention two important applications of superalloy.

(d) Distinguish between natural and artificial nanoparticles.

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

(a) What are solid-state electrolytes (SSEs) ? In which batteries SSEs are used ?  
 $3 + 2 = 5$

(b) Discuss a method for the synthesis of silver nanoparticles. What is the colour of silver nanoparticles ?  $4 + 1 = 5$

(c) What is the role of matrix in a composite material ? Discuss the advantages of composite materials.  
 $2 + 3 = 5$

(d) What are polymer matrix materials ? Mention their important applications. Why are polymer matrix materials better than metals ?  $1 + 2 + 2 = 5$

(e) Based on the composition, how are ceramic materials classified ? Discuss each of them.  $2 + 3 = 5$

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

(a) (i) Discuss the top-down and bottom-up approach in nanomaterial synthesis.  $2\frac{1}{2} + 2\frac{1}{2} = 5$

(ii) What is the molecular structure of carbon nanotubes ? What are their uses in carbon nanotechnology ?  $3 + 2 = 5$

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

(i) Hydrothermal synthesis

(ii) Thermoplastics

- (iii) Molecular magnets
- (iv) Green synthesis of nanoparticles
- (c) (i) Discuss the effects of environmental factors on composite materials. 5
- (ii) What are fibre-reinforced composites? Discuss their applications. 2+3=5
- (d) What are alloying elements? Discuss the various types of aluminium alloys and their uses. 2+8=10
- (e) What is DNA nanotechnology? Write a brief note on biological applications of DNA nanomaterials. 3+7=10
- (f) Discuss the various methods used in the synthesis of inorganic solids. 10

### OPTION-B

Paper : CHE-HE-5056

(Polymer Chemistry)

Full Marks : 60

Time : Three hours

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

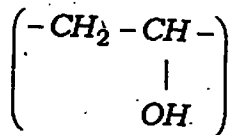
1. Answer the following as directed : 1×7=7
- (a) What do you mean by degree of polymerization?
- (b) What is an inorganic polymer?
- (c) Arrange the following polymers in increasing order of intermolecular forces :  
Buna-S, Polythene, Nylon 6,6
- (d) What is super fibre?
- (e) Which of the following natural products is not a polymer?
- (i) DNA
- (ii) Cellulose
- (iii) ATP
- (iv) Urease

(Choose the correct answer)

(f) Example of addition polymer is —

- (i) Buna-S
- (ii) Bakelite
- (iii) Nylon-6
- (iv) Dacron

(g) Write the IUPAC name of



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

(a) Draw the structure of the monomers of the following polymers

- (i) Teflon
- (ii) Polythene

(b) What is Ziegler-Natta catalysts ?

(c) Describe the classification of polymers on the basis of structure. Give examples.

(d) Define the term 'oriented polymers'.

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

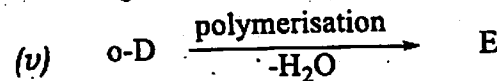
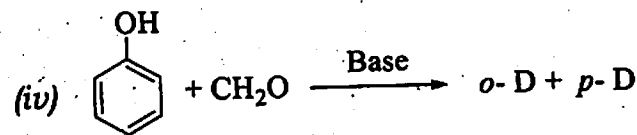
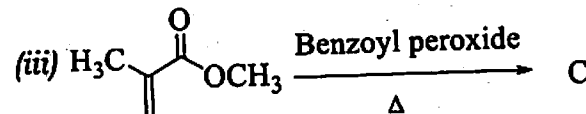
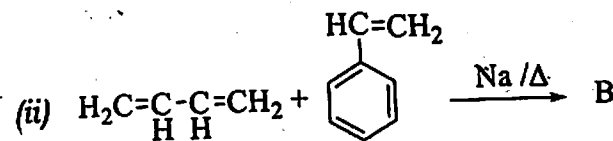
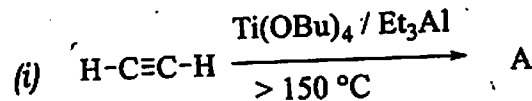
$5 \times 3 = 15$

- (a) (i) 'All polymers are macromolecules but all macromolecules are not polymers' — Justify the statement.

3

(ii) Write the importance of plasticizer in polymer chemistry with an example. 2

(b) Identify A-E in the following polymeric reactions : 5



(c) Briefly discuss the preparation, properties and uses of the following polymers :  $2.5 \times 2 = 5$

- (i) Polyamides
- (ii) Polyvinyl chloride (PVC)

(d) Write short note on thermodynamics of polymer solutions. What are *two* main factors which helps crystallization of polymers ?  
3+2=5

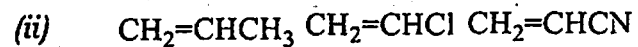
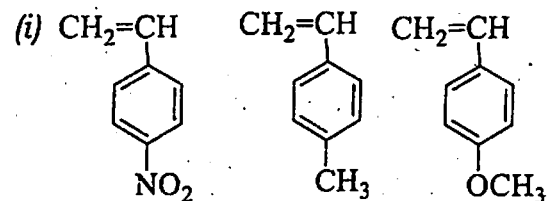
(e) Differentiate between copolymerization and homopolymerization. Give *one* example of each. What is graft and block copolymer ?  
2+1+2=5

4. Answer **any three** of the following questions :  
10×3=30

(a) What are natural and synthetic polymer. Give examples. How do you explain the functionality of a monomer and how does it affect the polymer formation ? Give an account of synthetic criteria of polymer formation.  
3+4+3=10

(b) What are the basic differences between addition and condensation polymer ? How will you distinguish between free radical and ionic polymerization ? Write the free radical mechanism for the polymerisation of ethene.  
3+3+4=10

(c) Name *any two* initiators used in anionic polymerization. Describe the polymerization of 2,2-dimethyloxirane by an anionic and cationic mechanism. List the following groups of monomers in order of decreasing ability to undergo anionic polymerization.  
2+3+3+2=10



(d) What is glass transition temperature ( $T_g$ ) ? Discuss various factors affecting glass transition temperature. Which of the polymers in each pair is expected to have higher  $T_g$  and why ?

(i) polyethylene and polypropylene

(ii) poly(but-1-ene) and poly(but-2-ene).

Write a short note on Conducting polymer:  
1+3+3+3=10

(e) Define living polymerization. Mention *two* benefits of living polymerization in general over conventional non-living polymerizations. Mention *two* techniques of living radical polymerization. Give an example of block co-polymer that is usually synthesized by living anionic polymerization.  
2+3+3+2=10

- (f) Why is molecular weight of polymers taken as 'average'? Explain viscometry methods of determining molecular weight of polymers. Why is  $M_v$  measured by viscosity method not an absolute molecular weight? Explain the term Polydispersity index.  $2+4+2+2=10$

**OPTION-C**

Paper : CHE-HE-5066

**(Instrumental Methods of Chemical Analysis)**

Full Marks : 60

Time : Three hours

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

1. Answer **all** the questions as directed : 1×7=7
- (a) What is the source of visible light used in a modern UV-visible spectrophotometer ?
- (b) The reference compound use in  $^1\text{H-NMR}$  spectroscopy is \_\_\_\_\_.  
(Fill in the blank)
- (c) Which of the following is used as the source of radiation in atomic absorption spectroscopy ?
- (A) Tungsten lamp  
(B) Xenon-mercury arc lamp  
(C) Deuterium lamp  
(D) Hollow cathode lamp  
(Choose the correct answer)

(d) Which of the following statements is wrong ?

- (A) A mass spectrometer uses high energy UV radiation.
- (B) A mass spectrometer does not use a spectrophotometric detector.
- (C) Mass spectrometry does not always require samples of high purity.
- (D) A mass spectrum does not show signals due to uncharged radicals.

(e)

Column-1	Column-2
(a) Mass spectrometry	(i) Deuterium lamp
(b) NMR	(ii) Michelson Interferometer
(c) FT-IR	(iii) Base peak
(d) UV-visible	(iv) Chemical shift

Choose the correct option for the matching pairs from both the columns:

- (A) (a) → (iii); (b) → (iv); (c) → (ii); (d) → (i)
- (B) (a) → (iii); (b) → (i); (c) → (iv); (d) → (ii)
- (C) (a) → (iv); (b) → (iii); (c) → (ii); (d) → (i)
- (D) (a) → (ii); (b) → (iii); (c) → (iv); (d) → (i)

(f) Which of the following statements is wrong ?

- (A) UV light absorption causes electronic transitions.
- (B) UV spectra provide information about valence electrons.
- (C) IR absorption causes transitions between rotational energy levels of a molecule.
- (D) NMR spectrometers use radiofrequency electromagnetic radiation.

(g) Consider the following instrumental methods :

- (i) IR spectroscopy
- (ii) UV-visible spectroscopy
- (iii) Mass spectrometry
- (iv) Chromatography

Which method(s) can give structural information regarding a molecule ?

- (A) (i) and (ii)
- (B) (ii) and (iii)
- (C) (i), (ii) and (iii)
- (D) All of the above

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

(a) Give *two* advantages of using tetramethyl silane (TMS) as the reference standard in  $^1\text{H-NMR}$  spectroscopy.

(b) Mention *two* requirements of a carrier gas in gas chromatography. Why is  $\text{O}_2$  unsuitable as a carrier gas ?

(c) (i) What quantities are usually displayed in a typical FT-IR spectrum ?

(ii) Convert  $20000 \text{ cm}^{-1}$  to  $\text{nm}$ .  
 $1 + 1 = 2$

(d) Two analysts determined the percentage of silver in a coin and reported the following results :

Analyst 1 : 100.00, 99.60, 99.70, 99.10

Analyst 2 : 98.80, 98.82, 98.84, 98.81

If the true value is 100.00, comment on the accuracy and precision of the measurements of both the analysts.

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

(a) Briefly discuss about the working principle of a double-beam UV-visible spectrometer by using a neat diagram.

(b) Discuss the advantages and limitations of instrumental methods in chemical analysis.

(c) Discuss the methods of sample preparation in IR spectroscopy.

(d) Briefly discuss about the importance of column chromatography in the separation of mixtures.

(e) The electronic absorption spectrum of a molecule recorded in a solution phase is typically broad in appearance. Explain using appropriate diagram.

4. Answer the following questions :  $10 \times 3 = 30$

(a) Discuss the principle and instrumentation of atomic absorption spectroscopy (AAS).  $5 + 5 = 10$

**Or**

(i) Briefly discuss the principle of NMR spectroscopy. 5

(ii) What is chemical shift ? What are the factors that affect chemical shift ?  $1 + 4 = 5$

(b) Discuss the principle, instrumentation and applications of gas chromatography.  $4 + 4 + 2 = 10$

**Or**

Discuss the principle and instrumentation of mass spectrometry. 10



- (c) Answer **either** (i) to (iii) **or** (iv) to (vii) :
- (i) Discuss the instrumentation of FT-IR spectroscopy. 5
  - (ii) Discuss the advantages of FT-IR spectrometers over dispersive instruments. 4
  - (iii) What is fingerprint region in IR spectroscopy ? 1

**Or**

- (iv) Write down the mathematical form of the Beer-Lambert law and explain the various terms involved. 2
- (v) Give *two* important causes of deviations from the Beer-Lambert law. 2
- (vi) What is the significance of the molar extinction coefficient ? 1.
- (vii) Radiation of wavelength 280 nm. is passed through 1 cm of an aqueous solution of the amino acid tryptophan present at a concentration of  $0.50 \text{ mol dm}^{-3}$ . The light intensity is reduced to 54% of its initial value. Calculate the absorbance and the molar extinction coefficient of tryptophan at 280 nm. What would be the transmittance through a cell of thickness 2 cm ? 2+2+1=5