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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
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## OPTION-B

Paper : CHE-HE-5056

(*Polymer Chemistry*)

Full Marks : 60

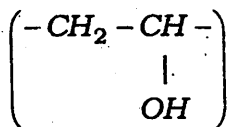
Time : Three hours

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

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

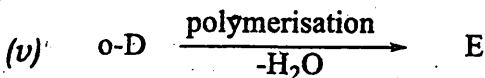
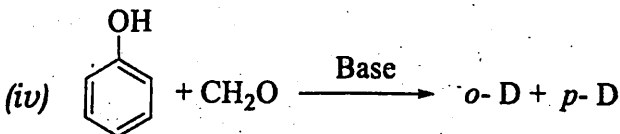
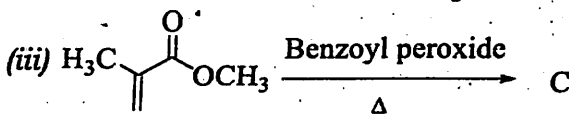
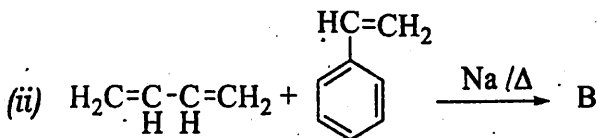
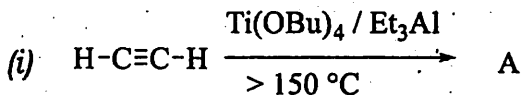
3. Answer **any three** of the following questions :  $5 \times 3 = 15$

- (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 : 2.5×2=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 ?  $2+1+2=5$

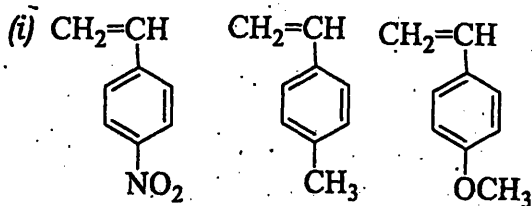
4. Answer **any three** of the following questions :  $10 \times 3 = 30$

(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

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## 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  $280\text{ nm}$  is passed through  $1\text{ cm}$  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  $280\text{ nm}$ . What would be the transmittance through a cell of thickness  $2\text{ cm}$  ? 2+2+1=5