

Total number of printed pages-16

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

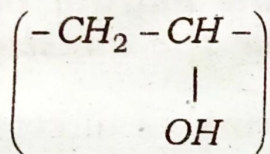
(ii) Cellulose

(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.

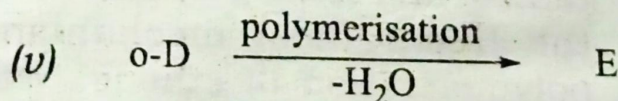
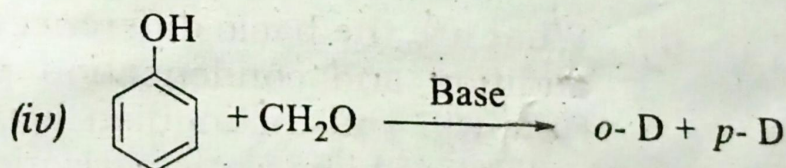
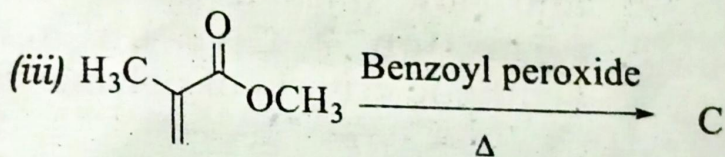
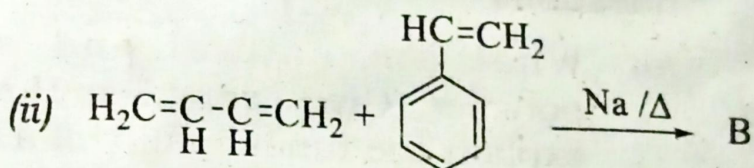
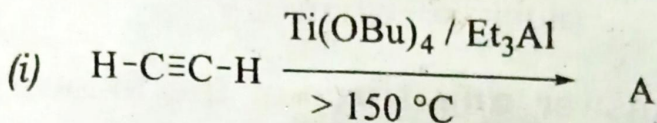
(d) Define the term 'oriented polymers'.

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.

(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 ? $3+2=5$

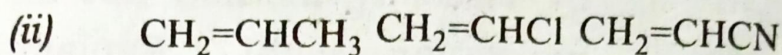
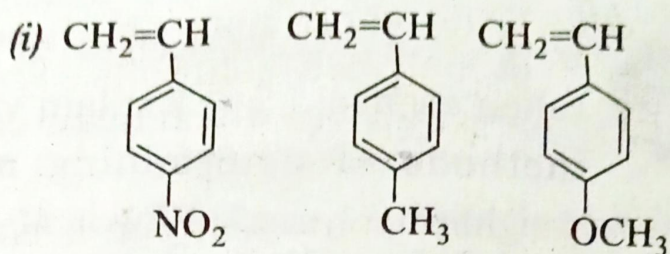
(e) Differentiate between copolymerization and homopolymerization. Give *one* example of each. What is graft and block copolymer ? $2+1+2=5$

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

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) \rightarrow (iii); (b) \rightarrow (iv); (c) \rightarrow (ii); (d) \rightarrow (i)
- (B) (a) \rightarrow (iii); (b) \rightarrow (i); (c) \rightarrow (iv); (d) \rightarrow (ii)
- (C) (a) \rightarrow (iv); (b) \rightarrow (iii); (c) \rightarrow (ii); (d) \rightarrow (i)
- (D) (a) \rightarrow (ii); (b) \rightarrow (iii); (c) \rightarrow (iv); (d) \rightarrow (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 O_2 unsuitable as a carrier gas ?

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

(ii) Convert 20000 cm^{-1} to *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 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