Total number of printed pages–16

3 (Sem–5/CBCS) CHE RE 4/RE 5/RE 6

2021

(Held in 2022)

CHEMISTRY

(Regular Elective)

Answer the Questions from any one Option.

OPTION – A

Paper : CHE–RE– 5046

DSE (R) – 1(B)

(Novel Inorganic Solids)

Full Marks : 60

Time : Three hours

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

1. Answer the following questions as directed : 1×7=7

    (a) The colour of gold nanoparticles is

    (i) yellow

    (ii) orange

    (iii) red

    (iv) variable

    (Choose the correct answer)

(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 : 2×4=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 super alloys ? Mention *two* important applications of super alloys.

(d) Distinguish between natural and artificial nanoparticles.

3. Answer **any three** of the following : 5×3=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 : 10×3=30

    (a) (i) Discuss the top-down and bottom-up approach in nanomaterial synthesis. 2½+2½=5

Contd.

(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:

2½×4=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–RE– 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) Define the term polymerisation.

   (b) Terylene is an example of
   - (i) fibre
   - (ii) plastics
   - (iii) rubber
   - (iv) resins

     (Choose the correct answer)

   (c) Bakelite is obtained from phenol by reacting with

   - (i) $(CH_2OH)_2$
   - (ii) $CH_3CH\,O$
   - (iii) CH_3COCH_3
   - (iv) $HCHO$

     (Choose the correct answer)

   (d) Which one of the following polymers is prepared by condensation polymerization ?
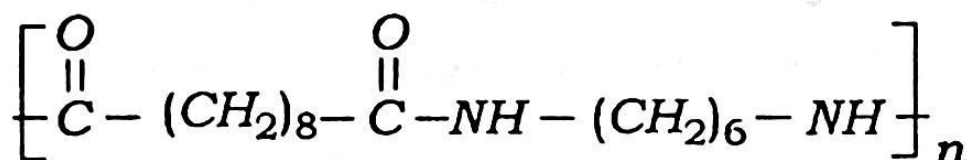
   - (i) Nylon-66
   - (ii) Teflon

Contd.

      (iii) Rubber

      (iv) Polystyrene

                    (Choose the correct answer)

(e) Give an example of inorganic polymer.

(f) Define branched polymer.

(g) Identify the monomer in the following polymeric structure :

$$\left[\overset{\overset{O}{\parallel}}{C} - (CH_2)_8 - \overset{\overset{O}{\parallel}}{C} - NH - (CH_2)_6 - NH \right]_n$$

2. Answer the following questions :   2×4=8

  (a) Draw the structures of the monomers of the following polymers :

      (i)   Polystyrene

      (ii) Buna-S

  (b) What is super fibre ? Give *one* example.

  (c) Differentiate between thermoplastic and thermosetting polymers. Give *one* example of each.

  (d) What is meant by living polymer ?

3. Answer **any three** of the following questions :   5×3=15

  (a) What are natural and synthetic polymers ? Distinguish between the terms homopolymer and copolymer and give an example of each.   2+3=5

(b) Write short notes on the following :

2+3=5

(i) Glass transition temperature

(ii) Heat of mixing of polymer solutions.

(c) Differentiate between chain growth and step growth polymerisation. What is conducting polymer ?   3+2=5

(d) Write the name and structure of *one* of the common initiators used in free-radical addition polymerisation. Write the free-radical mechanism for the polymerisation of ethene.   2+3=5
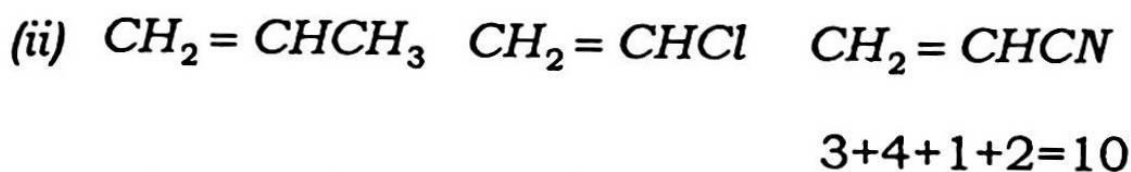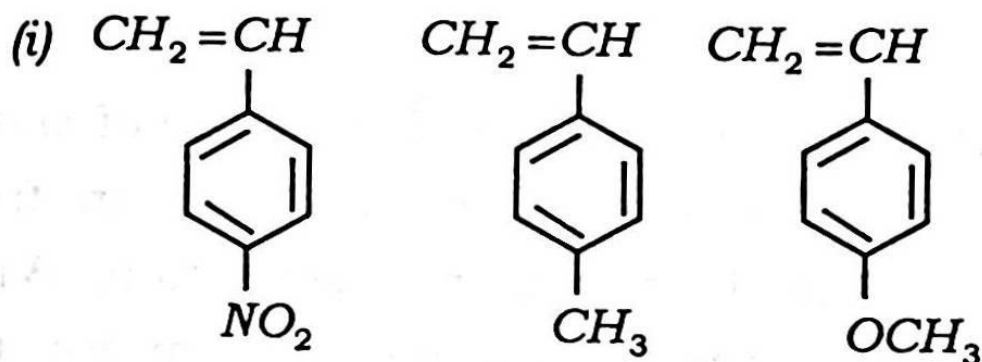
(e) Discuss the main purpose of vulcanisation of rubber. How does the presence of double bonds in rubber molecules influence their structure and reactivity ?   5

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

   (a) What are three different types of mechanism of Chain-growth polymerization of polymer ? Explain the detailed mechanism of anionic polymerization. Name *any two* initiators used in anionic polymerization. List the following groups of monomers in order of decreasing ability to undergo anionic polymerization.

   (i) $CH_2=CH$ $CH_2=CH$ $CH_2=CH$

   with NO_2, CH_3, OCH_3 substituents on benzene rings respectively

   (ii) $CH_2=CHCH_3$ $CH_2=CHCl$ $CH_2=CHCN$

   3+4+1+2=10

   (b) Write short notes on the following : 4+3+3=10

   (i) Coordination polymer

   (ii) Molar masses of polymer

   (iii) Polydispersity index.

(c) What is an elastomer ? Briefly discuss the preparation, properties and uses of following polymers : 1+3+3+3=10

   (i) Bakelite

   (ii) Nylon 6,6

   (iii) Polyvinyl chloride (PVC)

(d) Give a summary on presence of molecular forces and chemical bonding in polymers. How are polymers classified based on molecular forces and mode of polymerization ? Explain the terms isotactic, syndiotactic and atactic polymers. 4+3+3=10

(e) What is solubility parameter ? How is this determined for small organic molecules and polymers ? List the factors on which solubility of polymers depend. Write briefly about thermodynamics of polymer solutions. 2+3+2+3=10

(f) 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. How are ionic chain polymerizations different from radical chain polymerization in regards to solvent polarity and inherent termination steps ? 4+3+3=10

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OPTION – C

Paper : CHE–RE– 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 :

$1 \times 7 = 7$

(a) What is the source of visible light used in a modern UV-visible spectrophotometer ?

(b) The reference compound used in $^1H–NMR$ 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 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
(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 : 2×4=8

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

(b) Mention *two* requirements of 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 ? 1

(ii) Convert $20000 \, cm^{-1}$ to nm. 1

(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 : 5×3=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 : 10×3=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 trytophan 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

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