

2025

(CBCS)

(6th Semester)

CHEMISTRY

NINTH PAPER

(Inorganic Chemistry—III)

Full Marks : 75

Time : 3 hours

The figures in the margin indicate full marks for the questions

(SECTION : A—OBJECTIVE)

(Marks : 10)

Tick (✓) the correct answer in the brackets provided :

1×10=10

1. CO behaves as a π -acceptor ligand in metal carbonyls, due to

- (a) its ability to donate electrons through its lone pair ()
- (b) its ability to accept electron density through its π^* orbitals ()
- (c) its high electronegativity ()
- (d) its molecular geometry ()

2. How are aryls of magnesium typically prepared?

(a) By reaction of magnesium with alkyl halides ()

(b) By reaction of magnesium with aryl halides ()

(c) By reaction of magnesium with alkene ()

(d) By heating magnesium in air ()

3. The primary function of carbonic anhydrase in biological systems is

(a) to synthesize ATP ()

(b) to facilitate the exchange of oxygen and carbon dioxide ()

(c) to catalyze the conversion of carbon dioxide to bicarbonate ()

(d) to facilitate proteins synthesis ()

4. Which of the following is not a general property of inorganic polymers?

(a) High thermal stability ()

(b) High electrical conductivity ()

(c) Low molecular weight ()

(d) Resistance to oxidation ()

5. Which one of the following is a radioactive lanthanide?

(a) Praseodymium ()

(b) Promethium ()

(c) Plutonium ()

(d) Protactinium ()

6. In lanthanides, the last electron enters

(a) valence shell ()

(b) penultimate shell ()

(c) anti-penultimate shell ()

(d) either penultimate shell or anti-penultimate shell ()

7. The permeability of antiferromagnetic substance is

(a) small and positive ()

(b) large and positive ()

(c) small and negative ()

(d) zero ()

8. Which one of the following materials has temperature-independent magnetic susceptibility?
- (a) Paramagnetic ()
 - (b) Ferromagnetic ()
 - (c) Antiferromagnetic ()
 - (d) Diamagnetic ()
9. The number of normal modes of vibration for SO_2 molecule is
- (a) 2 ()
 - (b) 3 ()
 - (c) 4 ()
 - (d) 5 ()
10. Which of the following is true about the Raman spectrum of CO_2 ?
- (a) It shows a strong Raman band at a low-frequency due to the symmetric stretching mode. ()
 - (b) It shows no Raman active bands because CO_2 is a linear molecule. ()
 - (c) It shows a strong Raman band due to asymmetric stretching vibrations. ()
 - (d) It only shows bands due to bending vibrations. ()

(SECTION : B—SHORT ANSWERS)

(Marks : 15)

Answer the following :

3×5=15

UNIT—I

1. Discuss the uses of alkyl-boron in organic synthesis.

OR

2. Describe the hybridization and structure of $\text{MO}_2(\text{CO})_8$.

UNIT—II

3. How does haemoglobin's structure facilitate cooperative oxygen binding?

OR

4. Describe the polymerization process of polyphosphonitrilic chloride.

UNIT—III

5. Why are lanthanide elements often found in the +3 oxidation state?

OR

6. Point out six differences of lanthanides and actinides.

UNIT—IV

7. Discuss the origin of spin magnetic moment.

OR

8. What are the properties of ferromagnetic substances?

UNIT—V

9. Give at least three differences of Raman spectroscopy and infrared spectroscopy.

OR

10. What is the significance of the metal-halogen IR absorption peak in identifying the bonding environment in a complex?

(SECTION : C—DESCRIPTIVE)

(Marks : 50)

Answer the following :

10×5=50

UNIT—I

1. (a) How does the low oxidation state of metal favour the formation of metallic carbonyls? 3
- (b) Citing a suitable example, discuss the bonding in metal-alkene complex. 3
- (c) Discuss the different types of bonds found in metallic carbonyls. 4

OR

2. (a) Write the uses of Grignard reagent in the preparation of alcohols. 3
- (b) How will you prepare $[\text{Fe}_2(\text{CO})_9]$? Draw its structure and explain how the bridging carbonyl groups are bonded to iron atoms. 3
- (c) Citing a suitable example, discuss the bonding in metal-alkene complex. 4

UNIT—II

3. (a) Write a brief note on sodium-potassium pump. 3
- (b) Discuss the method of preparation of a cross-linked silicone. 3
- (c) Write the structure of the heme group present in haemoglobin and discuss the cooperativity effect in haemoglobin. 1+3=4

OR

4. (a) Discuss the structure and functioning of carbonic anhydrase. 3
- (b) Explain how the partial pressure of oxygen affects the binding capacity of oxygen to haemoglobin and myoglobin. 3
- (c) What are phosphazenes? Write one method of preparation of $(\text{NPCl}_2)_3$ and comment on its structure. 1+1+2=4

UNIT—III

5. (a) Write a short note on the colour of tripositive (M^{3+}) lanthanide ions. 3
- (b) Compare the complexation tendency of lanthanides and actinides. 3
- (c) Discuss how lanthanides are separated by ion-exchange method. 4

OR

6. (a) Give reasons why the magnetic moments of lanthanides cannot be obtained from the 'spin-only formula'. 3
- (b) Compare the oxidation states of lanthanides and actinides. 3
- (c) What are the causes of lanthanide contraction? Explain how lanthanide contraction affects the separation of lanthanides. 2+2=4

UNIT—IV

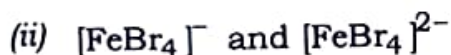
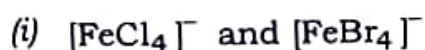
7. (a) What is meant by paramagnetism? What are the properties of paramagnetic substances? 3
- (b) Mention the advantages of Curie-Weiss law over the Curie law. 3
- (c) What is magnetic susceptibility? Draw the plots of inverse of molar susceptibility versus temperature for paramagnetic and antiferromagnetic substances and explain the difference. 1+3=4

OR

8. (a) Discuss the origin of the spin magnetic moment. 3
- (b) Write a short note on ferromagnetism. 3
- (c) Explain, why the magnetic moment of the first transition series is calculated by using 'spin-only formula', whereas the magnetic moment of the second transition series is calculated by using spin and orbital angular momentum. 4

UNIT—V

9. (a) Compare the Fe-X stretching vibrational frequency of the given pairs and give reasons to support your answer : 3



- (b) Why is SO_2 bent, and how is this reflected in its Raman spectrum? 3
- (c) What is mutual exclusion principle? Explain how it can be used for the structural elucidation of NO_3^- ion. 1+3=4

OR

10. (a) What are the fundamental vibrations of CO_2 molecule? Indicate whether they are IR or Raman active. 3
- (b) The IR spectra for *trans*- and *cis*-isomers of $[\text{Pd}(\text{NH}_3)_2\text{Cl}_2]$ and $[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$, show the following M-X vibrational frequencies. Comment on the observed IR bands : 4

Complexes	$\nu(\text{M-X})$ (in cm^{-1})
<i>trans</i> - $[\text{Pd}(\text{NH}_3)_2\text{Cl}_2]$	333
<i>cis</i> - $[\text{Pd}(\text{NH}_3)_2\text{Cl}_2]$	327, 306
<i>trans</i> - $[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$	365
<i>cis</i> - $[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$	330, 323

- (c) Give reasons, why the N-H stretching frequencies of ammine complexes are lower than those of the free NH_3 molecule. 3
