**2024**

( CBCS )

( 6th Semester )

**CHEMISTRY**

NINTH PAPER

**( Inorganic Chemistry—I )**

*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. The hybridization of carbon in the bridging carbonyl group is

   (a) $sp$ ( )

   (b) $sp^2$ ( )

   (c) $dsp^2$ ( )

   (d) $sp^3$ ( )

2. What is the missing reactant in the reaction given below?

$$SnX_4 + \_\_\_\_ \longrightarrow SnR_4 + MgX_2$$

(a) RMgX ( )

(b) $MgR_2$ ( )

(c) Mg + R ( )

(d) RX ( )

3. The coordination number of iron in oxymyoglobin is

(a) 4 ( )

(b) 5 ( )

(c) 6 ( )

(d) 7 ( )

4. How is the zinc ion coordinated with the apoenzyme of the carbonic anhydrase?

(a) Three imidazole nitrogens of three histidine groups ( )

(b) Two imidazole nitrogens of two histidine groups and glutamic acid ( )

(c) One imidazole nitrogen of histidine group and two glutamic acids ( )

(d) Two imidazole nitrogens of two histidine groups and two glutamic acids ( )

5. The electronic configuration of gadolinium is

(a) $[Xe]4f^{7}5d^{2}6s^{1}$ ( )

(b) $[Xe]4f^{8}5d^{0}6s^{2}$ ( )

(c) $[Xe]4f^{6}5d^{2}6s^{2}$ ( )

(d) $[Xe]4f^{7}5d^{1}6s^{2}$ ( )

6. The +4 oxidation state is exhibited by which elements among the actinides?

(a) The first 8 elements (Ac to Cm) ( )

(b) The first 5 elements (Th to Pu) ( )

(c) The last 4 elements (Pa to Pu) ( )

(d) All actinide elements ( )

7. The magnetic susceptibility of antiferromagnetic substance is

(a) small and negative ( )

(b) large and positive ( )

(c) small and positive ( )

(d) zero ( )

8. Which one of the following ions will have the highest number of unpair electrons in an octahedral complex?

(a) a high-spin $d^5$ ion ( )

(b) a low-spin $d^5$ ion ( )

(c) a high-spin $d^6$ ion ( )

(d) a low-spin $d^4$ ion ( )

9. The number of normal modes of vibration for $SO_2$ molecule is

(a) 2 ( )

(b) 3 ( )

(c) 4 ( )

(d) 5 ( )

10. Which one of the following is expected to show the lowest M-X stretching frequency?

(a) $[AlF_4]^-$ ( )

(b) $[AlCl_4]^-$ ( )

(c) $[GaCl_4]^-$ ( )

(d) $[GaBr_4]^-$ ( )

## ( SECTION : B—SHORT ANSWERS )

( *Marks* : 15 )

Answer the following : 3×5=15

### UNIT—I

**1.** What are π-acid ligands? Explain how CO acts as a π-acid ligand.

**OR**

**2.** What are the characteristics of ionic organometallic compounds?

### UNIT—II

**3.** Point out the basic differences between inorganic polymers and organic polymers.

**OR**

**4.** What are condensation polymers and addition polymers? Give examples.

### UNIT—III

**5.** Give reasons, why the separation of lanthanides is difficult.

**OR**

**6.** Explain how the lanthanide contraction affects the atomic size of transition elements.

### UNIT—IV

**7.** Compare the magnetic properties of $Ni^{2+}$ ion in tetrahedral and square planar complexes.

**OR**

**8.** Discuss the origin of the spin magnetic moment.

## UNIT—V

**9.** Give at least three differences of Raman spectroscopy and Infrared spectroscopy.

**OR**

**10.** Differentiate between Rayleigh scattering and Raman scattering.

## ( SECTION : C—DESCRIPTIVE )

( *Marks* : 50 )

Answer the following : 10×5=50

## UNIT—I

**1.** *(a)* Discuss how carbonyl to metal coordinate bond is formed in metallic carbonyls. 3

*(b)* How will you prepare the following compounds? 1×3=3

*(i)* $Ni(CO)_4$

*(ii)* $BR_3$

*(iii)* $Co_2(CO)_8$

*(c)* What is meant by $\pi$-metal alkene complexes? Citing suitable example, explain the bonding in the metal-alkene complex. 1+3=4

**OR**

**2.** *(a)* Explain how back bonding stabilized the metal carbonyls. 3

*(b)* Give one method of preparation of Grignard reagent and also write two uses of this reagent in the preparation of alcohol. 1+2=3

*(c)* How will you obtain $Fe_2(CO)_9$? Discuss its bonding and structure. 1+3=4

## UNIT—II

3. *(a)* Write one method of preparation of $(NPCl_2)_3$ and explain its structure. 1+2=3

   *(b)* What are the roles of sodium and potassium ions in biological systems? 3

   *(c)* Draw the structure of the heme group present in hemoglobin and discuss the cooperativity effect in hemoglobin. 1+3=4

**OR**

4. *(a)* Discuss the functioning of carboxypeptidase. 3

   *(b)* Explain how oxyhemoglobin passes on its oxygen to myoglobin. 3

   *(c)* What are silicones? Discuss the method of preparation of a linear tetramer silicone. 1+3=4

## UNIT—III

5. *(a)* Why do lanthanides show lower oxidation number than actinides? 3

   *(b)* Comment on the colour of tripositive $(M^{3+})$ actinide ions. 3

   *(c)* What is lanthanide contraction? What are its causes? 1+3=4

**OR**

6. *(a)* Give reasons why the magnetic moments of lanthanides cannot be obtained from the spin-only formula. 3

   *(b)* Compare the complexation tendency of lanthanides and actinides. 3

   *(c)* Discuss how lanthanides are separated by ion exchange method. 4

## UNIT—IV

7. *(a)* What are the important properties of paramagnetic substances? 3

   *(b)* Explain the following terms : 1×3=3

   *(i)* Magnetic induction

   *(ii)* Bohr magneton

   *(iii)* Curie temperature

(c) What is meant by magnetic susceptibility? Explain the temperature dependence of the magnetic susceptibilities of paramagnetic and antiferromagnetic substances. 1+3=

**OR**

**8.** (a) Write a short note on ferromagnetism. 3

(b) How was the Curie's law corrected in Curie-Weiss law and why? 3

(c) Under strong field ligands, Co(III) forms diamagnetic complexes wherein weak field ligands it forms paramagnetic complexes. Explain. 4

## UNIT—V

**9.** (a) Differentiate between Stokes' lines and anti-Stokes' lines. Which one has greater intensity and why? 3

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

(c) Give reasons for the difference in the observed Ni-X stretching frequencies of the given species : 4

| | | |
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| $NiCl_2$<br>521 | $Ni(PPh_3)_2Cl_2$<br>341 | *trans*-$Ni(py)_4Cl_2$<br>207 |
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**OR**

**10.** (a) What are the fundamental vibrations of $CO_2$ molecules? Indicate whether they are IR and Raman active or not. 3

(b) Arrange the given species in the increasing order of their Fe-X stretching frequency and give reasons to support your answer : 3

$[FeCl_4]^-$, $[FeBr_4]^-$ and $[FeBr_4]^{2-}$

(c) What is mutual exclusion principle? Explain how it can be used for the structural elucidation of $N_2O$ molecules. 1+3=4

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**Student's Copy**

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