CHEM/V/CC/09

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Student's Copy

2023

(CBCS)

(5th Semester)

CHEMISTRY

FIFTH PAPER

(Inorganic Chemistry—II)

Full Marks : 75

Time : 3 hours

The figures in the margin indicate full marks for the questions

(SECTION : A-OBJECTIVE)

(Marks: 10)

Tick (\checkmark) the correct answer in the brackets provided :

1×10=10

- The coordination numbers of sphere in b.c.c., h.c.p. and c.c.p. structures are respectively
 - (a) 8, 8 and 12 ()
 - (b) 8, 12 and 12 ()
 - (c) 8, 12 and 8 ()
 - (d) 12, 12 and 8 ()

- 2. The ionic radii of Cs^+ and Cl^- ions are 1.69 Å and 1.8 Å respectively. The probable geometry exhibited by CsCl will be
 - (a) cubic ()
 - (b) octahedral ()
 - (c) tetrahedral ()
 - (d) plane trigonal ()
- 3. What is the total number of molecular orbitals formed by the combination of two atomic orbitals?
 - (a) 4
 ()

 (b) 1
 ()

 (c) 2
 ()

 (d) 8
 ()
- 4. What type of intermolecular force will exist between HCl and argon?
 - (a) Keesom force ()
 (b) Cohesive force ()
 (c) London force ()
 (d) Debye force ()
- 5. Which one of the following hydrides will have the highest ionic character?
 - (a) NaH ()
 - (b) CsH ()
 - (c) RbH ()
 - (d) KH ()
- 6. A neutral oxide among the given oxides is
 - (a) NO_2 ()
 - (b) N₂O₃ ()
 - (c) N₂O ()
 - (d) N_2O_5 ()

7. Which one is a Lewis base?

- (a) BF_3 ()
- (b) H^+ ()
- (c) CO_2 ()
- (d) NH₃ ()
- 8. The principal axis in NH₃ is
 - (a) C_3 () (b) C_4 () (c) C_2 () (d) C_6 ()
- 9. In the d-block elements, the last electron enters the
 - (a) valence shell ()
 - (b) penultimate shell ()
 - (c) antipenultimate shell ()
 - (d) outermost shell ()
- **10.** Which one of the following transition elements has positive standard potential?
 - (a) Cr ()
 - (b) Fe ()
 - (c) Cu ()
 - (d) Zn ()

(SECTION : B-SHORT ANSWERS)

(Marks: 15)

Answer the following :

Unit—I

1. What do you mean by thermal defects?

OR

2. How is an octahedral void formed in a closed-packed arrangement?

UNIT-II

3. Differentiate between bonding and antibonding molecular orbitals.

OR

4. Discuss the conditions under which atomic orbitals combine to form molecular orbital.

Unit—III

5. Write a brief note on the properties of ionic carbides.

OR

6. Give one example of the XY_3 -type of interhalogen compound and explain its structure.

UNIT-IV

7. What is meant by conjugate acid-base pair?

OR

8. What do you mean by the solvent-system concept of acid and base?

Unit—V

9. Why do the d-block elements show variable oxidation states?

OR

 Write a brief note on the stability of complexes formed by the transition elements.

3×5=15

(SECTION : C-DESCRIPTIVE)

(Marks : 50)

Answer the following :

UNIT-I

1.	(a)	What are the factors that affect the magnitude of lattice energy of ionic solids?	3
	(b)	Write a short note on p-type semiconductors.	3
	(c)	Define lattice energy. Taking a suitable example, explain how the lattice energy is determined by using the Born-Haber cycle. $1+3=1+3=1+3=1+3=1+3=1+3=1+3=1+3=1+3=1+3=$	=4
		OR	
2.	(a)	How will you obtain the limiting radius ratio for a tetrahedral site?	3
	(Ъ)	Discuss how the solubility of an ionic solid depends upon its lattice energy and solvation energy.	3
	(c)	Give a brief account of Frenkel defect and its consequences.	4
		Unit—II	
3.	(a)	Mention how molecular orbitals are formed by the combination of two p_z -orbitals (taking z-axis as the molecular axis).	3
	(b)	Explain the magnetic property of the O_2 molecule based on molecular orbital theory.	3
	(c)	Draw the molecular orbital energy level diagram of the N ₂ molecule and calculate its bond order. 3+1	=4
		OR	
4	. (a) Why is the molecular orbital energy level diagram of ${\rm O}_2$ different from that of ${\rm N}_2?$	3
	(b	Write the molecular orbital electronic configurations of NO, NO ⁺ and NO ⁻ species and calculate their bond orders.	3
	(0	What do you mean by van der Waals' forces? Explain instantaneous dipole-induced dipole interactions. 1+3	3=4

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10×5=50

Unit—III

5.	(a)	Discuss the structure and bonding of B_2H_6 molecule.	3
	(b)	How is Caro's acid prepared? Give reactions that show its oxidizin property.	g +2≈3
	(c)	Discuss how HNO_3 oxidizes the metals that lie above hydrogen in the electrochemical series.	e 4
		OR	
6.	(a)	Explain the relative stability of different oxidation states of group 14 elements based on the inert pair effect.	3
	(b)	What is meant by pseudohalide ions? Write the similarities of pseudohalide and halide ions.	3
	(c)	How is XeF_4 prepared? Discuss its hybridization and structure. 1+	3=4
		Unit—IV	
7.	(a)	Explain the following terms : 1×3 (i) Plane of symmetry (ii) Ionizing solvents (iii) Bronsted acid	3=3
	(b)	Illustrate the precipitation reaction shown by ammono acids in liq. $\rm NH_3$ solvent.	3
	(c)	Briefly discuss the colour, magnetic character, electrical property and reducing property of alkali metal-ammonia solution.	4
		OR	
8.	(a)	Explain how the molecule whose central atom has incomplete octet of electrons in its valence shell acts as Lewis acid.	3
	(b)	Evaluate the symmetry elements and symmetry point group of BF_3 .	3
	(c)	What are ammono-acids and ammono-bases? Explain acid-base	

[Contd.

UNIT-V

- 9. (a) Write a short note on the colour of 3d transition metal ions and their compounds.
 - (b) Define crystal field stabilization energy. Calculate CFSE for $[Fe(CN)_6]^{4-}$ ion, given that the mean pairing energy (P) and Δ_o are 14100 cm⁻¹ and 33000 cm⁻¹ respectively. 1+2=3
 - (c) Compare the hybridization of $[Co(CN)_6]^{3-}$ and $[CoCl_6]^{3-}$ ions.

OR

- 10. (a) Discuss the hybridization and structure of $[Ni(CN)_4]^{2-1}$ ion.
 - (b) Which one is expected to show the higher value of Δ_o and why? 3 (i) $[Fe(H_2O)_6]^{2+}$ and $[Fe(H_2O)_6]^{3+}$
 - (*ii*) $[Co(NH_3)_6]^{3+}$ and $[Rh(NH_3)_6]^{3+}$
 - (c) Draw and explain the crystal field splitting pattern in tetrahedral complexes.

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 - (d) plane trigonal ()
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 - (c) 2 ()
 - (d) 8 ()
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 - (c) London force ()
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- 6. A neutral oxide among the given oxides is
 - (a) NO_2 ()
 - (b) N_2O_3 ()
 - (c) N_2O ()
 - (d) N_2O_5 ()

- 7. Which one is a Lewis base?
 - (a) BF_3 ()
 - (b) H⁺ ()
 - (c) CO_2 ()
 - $(d) NH_3$ ()
 - 8. The principal axis in NH₃ is
 - (a) C_3 ()
 - (b) C₄ ()
 - (c) C_2 ()
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 - 9. In the d-block elements, the last electron enters the
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 - (b) Fe ()
 - (c) Cu ()
 - (d) Zn ()

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(SECTION : B---SHORT ANSWERS)

(Marks: 15)

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UNIT-III

5. Write a brief note on the properties of ionic carbides.

OR

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UNIT-IV

7. What is meant by conjugate acid-base pair?

OR

8. What do you mean by the solvent-system concept of acid and base?

UNIT-V

9. Why do the d-block elements show variable oxidation states?

OR

10. Write a brief note on the stability of complexes formed by the transition elements.

3×5≈15

| Contd.

(SECTION : C-DESCRIPTIVE)

(Marks : 50)

Answer the following :

Unit—I

1.	(a)	What are the factors that affect the magnitude of lattice energy of ionic solids?	3
	(b)	Write a short note on p-type semiconductors.	3
	(c)	Define lattice energy. Taking a suitable example, explain how the lattice energy is determined by using the Born-Haber cycle. $1+3$	=4
		OR	
2	. (a)	How will you obtain the limiting radius ratio for a tetrahedral site?	3
	(b)	Discuss how the solubility of an ionic solid depends upon its lattice energy and solvation energy.	3
	(c)	Give a brief account of Frenkel defect and its consequences.	4
		Unit—II	
3	. (a,	Mention how molecular orbitals are formed by the combination of two p_z -orbitals (taking z-axis as the molecular axis).	3
	(b)	Explain the magnetic property of the O_2 molecule based on molecular orbital theory.	3
	(c)	Draw the molecular orbital energy level diagram of the N_2 molecule and calculate its bond order. $3+1$	1=4
		OR	
4	I. (a) Why is the molecular orbital energy level diagram of O_2 different from that of N_2 ?	3
	(b	Write the molecular orbital electronic configurations of NO, NO ⁺ and NO ⁻ species and calculate their bond orders.	3
	(0	What do you mean by van der Waals' forces? Explain instantaneous dipole-induced dipole interactions.	3=4

10×5=50

UNIT-III

		OMI-M	
5.	(a)	Discuss the structure and bonding of B_2H_6 molecule. 3	
	(b)	How is Caro's acid prepared? Give reactions that show its oxidizing property. $1+2\approx_3$	
	(c)	Discuss how HNO_3 oxidizes the metals that lie above hydrogen in the electrochemical series. 4	
		OR	
6.	(a)	Explain the relative stability of different oxidation states of group 14 elements based on the inert pair effect. 3	
	(b)	What is meant by pseudohalide ions? Write the similarities of pseudohalide and halide ions.	
	(c)	How is XeF ₄ prepared? Discuss its hybridization and structure. $1+3=4$	
		Unit—IV	
7.	(a)	Explain the following terms : 1×3=3 (i) Plane of symmetry (ii) Ionizing solvents (iii) Bronsted acid	
	(b)	Illustrate the precipitation reaction shown by ammono acids in liq. 3 NH ₃ solvent.	
	(c)	Briefly discuss the colour, magnetic character, electrical property and reducing property of alkali metal-ammonia solution.	
		OR	

- 8. (a) Explain how the molecule whose central atom has incomplete octet of electrons in its valence shell acts as Lewis acid.
 - (b) Evaluate the symmetry elements and symmetry point group of BF_3 . 3
 - (c) What are ammono-acids and ammono-bases? Explain acid-base neutralization reactions in liquid ammonia. 1+3=4

Unit—V

g. ((b)	Write a short note on the colour of $3d$ transition metal ions and their compounds. Define crystal field stabilization energy. Calculate CFSE for $[Fe(CN)_6]^{4-}$ ion, given that the mean pairing energy (P) and Δ_o are	3
		$_{14100} \text{ cm}^{-1} \text{ and } 33000 \text{ cm}^{-1} \text{ respectively.}$ 1+2	=3
	(c)	Compare the hybridization of $[Co(CN)_6]^{3-}$ and $[CoCl_6]^{3-}$ ions.	4
10.	(0)	OR	
	(a)	Discuss the hybridization and structure of $[Ni(CN)_4]^{2-}$ ion.	3
	100	which one is expected to show the higher value of Δ_o and why?	3
	(D)	(i) $[Fe(H_2O)_6]^{2+}$ and $[Fe(H_2O)_6]^{3+}$	
		(ii) $[Co(NH_3)_6]^{3+}$ and $[Rh(NH_3)_6]^{3+}$	
	(C)	Draw and explain the crystal field splitting pattern in tetrahedral complexes.	4

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