2022

(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 (✓) the correct answer in the brackets provided : 1×10=10

1. Which one of the following is not the characteristic of ionic crystals?

(a) High heats of vaporization ( )

(b) High vapour pressures at ordinary temperatures ( )

(c) High melting and boiling points ( )

(d) Insulators in the solid state ( )

2. If N is the total number of spheres in a closed packed arrangement, the number of tetrahedral holes will be

(a) $2N$ ( )

(b) N ( )

(c) $N / 2$ ( )

(d) N^2 ( )

3. What is the bond order of oxygen?

(a) 1 ( )

(b) 0 ( )

(c) 2·5 ( )

(d) 2 ( )

4. Which one of the following combinations of atomic orbitals is not allowed according to MOT (taking z-axis as the molecular axis)?

(a) $p_y \quad p_y$ ( )

(b) $s \quad p_z$ ( )

(c) $p_z \quad p_z$ ( )

(d) $s \quad p_y$ ( )

5. An example of acetylide is

(a) Al_4C_3 ( )

(b) Be_2C ( )

(c) CaC_2 ( )

(d) Mg_2C_3 ( )

6. Which one is a neutral oxide?

(a) N_2O ( )

(b) N_2O_3 ( )

(c) N_2O_4 ( )

(d) N_2O_5 ( )

7. A Lewis base among the following is

(a) BF_3 ( )

(b) H ( )

(c) CO_2 ( )

(d) NH_3 ( )

8. The principal axis of BF_3 molecule is

(a) C_4 ( )

(b) C_2 ( )

(c) C_3 ( )

(d) $_h$ ( )

9. Which one of the following transition elements has positive standard potential?

(a) Cr ( )

(b) Cu ( )

(c) Fe ( )

(d) Zn ( )

10. Transition metals are generally coloured because

(a) they radiate electromagnetic radiation ( )

(b) they undergo *d-d* transition ( )

(c) they have hybridized orbitals ( )

(d) they have unpaired electrons ( )

(SECTION : B—SHORT ANSWER)

(*Marks* : 15)

Answer the following : 3×5=15

UNIT—I

1. What do you mean by cubic close packing of spheres?

OR

2. Determine the number of octahedral holes for each sphere present in a face-centred cubic unit cell.

UNIT—II

3. What are the differences between sigma and pi molecular orbitals?

OR

4. On the basis of molecular orbital theory, explain why hydrogen forms diatomic molecule while helium remains monatomic.

UNIT—III

5. Discuss the structure and bonding of B_2H_6 molecule.

OR

6. Explain the hybridization and structure of XY_3-type of interhalogen compounds.

UNIT—IV

7. What are the advantages of liquid ammonia as a solvent?

OR

8. What is meant by conjugated acid-base pairs?

UNIT—V

9. Write the valence shell electronic configurations of Sc, Cr and Cu.

OR

10. Discuss the hybridization and structure of $[NiCl_4]^{2}$ ion.

(SECTION : C—DESCRIPTIVE)

(*Marks* : 50)

Answer the following : 10×5=50

UNIT—I

1. *(a)* Write a short note on *n*-type semiconductor. 3

(b) Define lattice energy. Explain the factors that affect the magnitude of lattice energy of ionic solids. 1+2=3

(c) Give a brief account of Schottky defect and its consequences. 4

OR

2. *(a)* Differentiate between stoichiometric defects and non-stoichiometric defects. 3

(b) Discuss briefly the characteristic features of colour centres and Frenkel defects with suitable examples. 3

(c) Discuss by taking suitable example how lattice energy is determined using Born-Haber cycle. 4

UNIT—II

3. *(a)* Explain how molecular orbitals are formed by the combination of two p_z orbitals (taking *z*-axis as the molecular axis). 3

(b) Using molecular orbital theory, explain the magnetic property of O_2 molecule. 3

(c) Draw the molecular orbital energy-level diagram of nitric oxide (NO) molecule and write the MO electronic configurations of NO and NO . 2+2=4

OR

4. *(a)* Draw the molecular orbital energy-level diagram of N_2. Explain the bond order and magnetic properties of N_2 using the MO diagram. 3

(b) How does molecular orbital theory explain the difference in the stability and reactivity of N_2 and O_2? 3

(c) What do you mean by van der Waals' forces? Explain dipole-induced dipole interactions. 1+3=4

UNIT—III

5. *(a)* How is nitrous acid prepared? Give one example each where it acts as an oxidizing agent and as a reducing agent, respectively. 3

(b) Write the uses of covalent carbides. 3

(c) Define inert pair effect. Explain the relative stability of different oxidation states of group 14 elements based on inert pair effect. 1+3=4

OR

6. *(a)* What is Caro's acid? How is it prepared? Give one reaction which shows its oxidizing property. 3

(b) Explain how helium and neon are separated from the first fraction in the fractionation of noble gases from liquid air. 3

(c) How is XeF_4 prepared? Discuss its hybridization and structure. 1+3=4

UNIT—IV

7. *(a)* Write a brief note on solvolysis reactions in liquid ammonia. 3

(b) Explain the following terms : 3

(i) Plane of symmetry

(ii) Centre of symmetry

(iii) Order of a group

(c) Briefly discuss the colour, magnetic, electrical and reducing properties of alkali metal-ammonia solution. 4

OR

8. *(a)* Explain by taking suitable example, how molecules whose central atom has incomplete octet of electrons in its valence shell can act as a Lewis acid. 3

(b) Evaluate the symmetry elements and deduce symmetry point group of NH_3. 3

(c) What are ammono acids and ammono bases? Explain acid-base neutralization reactions in liquid ammonia. 2+2=4

UNIT—V

9. *(a)* Discuss the complex formation tendency of transition elements. 3

(b) For the $[Cr(H_2O)_6]^{2}$ ion, the mean pairing energy, P, is found to be 23500 cm ^{1}. The magnitude of $_{oh}$ is 13900 cm ^{1}. Calculate the CFSE for this complex ion corresponding to high-spin and low-spin states. 3

(c) Compare the hybridization and magnetic properties of $[Co(NH_3)_6]^{3}$ and $[CoF_6]^{3}$ ions. 4

OR

10. *(a)* Give a brief account of the variable oxidation states of the first row of transition elements. 3

(b) Define crystal field stabilization energy. Calculate the CFSE of a $3d^6$ ion in a tetrahedral environment. 1+2=3

(c) Draw and explain the crystal field splitting pattern in octahedral geometry. 4

★ ★ ★