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(CBCS)

(5th Semester)

CHEMISTRY

FIFTH PAPER

(Inorganic Chemistry—II)

Full Marks : 75

Time : 3 hours

(PART : A—OBJECTIVE)

(*Marks* : 25)

The figures in the margin indicate full marks for the questions

SECTION—A

(*Marks* : 10)

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

1. Which of the following has the metal in the lowest oxidation state?

(a) $[Fe(CN)_6]^{3}$ ( ) *(b)* $[Fe(CO)_5]$ ( )

(c) $[Fe(H_2O)_6]^{3}$ ( ) *(d)* Fe_2O_3 ( )

2. Which of the following alkali metal hydrides is thermally most stable?

(a) LiH ( ) *(b)* NaH ( )

(c) KH ( ) *(d)* RbH ( )

3. Caro's acid is

(a) H_2SO_5 ( ) *(b)* H_2SO_8 ( )

(c) H_2SO_4 ( ) *(d)* H_2SO_7 ( )

4. A centre of symmetry is present in

(a) *cis*-1,2-dichloroethylene ( )

(b) *trans*-1,2-dichloroethylene ( )

(c) HCl ( )

(d) HCN ( )

5. Square planar complexes are usually

(a) low-spin complex ( )

(b) high-spin complex ( )

(c) Both (a) and (b) ( )

(d) None of the above ( )

6. The ratio between the number of close-packed atoms and the number of tetrahedral holes in cubic close-packing is

(a) 1 : 1 ( ) *(b)* 1 : 2 ( )

(c) 1 : 3 ( ) *(d)* 1 : 4 ( )

7. In corundum, oxide ions are arranged in hexagonal close-packing and Al^3 ions occupy two-third of the octahedral voids. Then the formula of corundum is

(a) Al_2O_3 ( ) *(b)* Al_2O ( )

(c) AlO ( ) *(d)* AlO_3 ( )

8. The number of antibonding electron pairs in O_2^2 ion on the basis of MO theory is

(a) 4 ( ) *(b)* 3 ( )

(c) 2 ( ) *(d)* 5 ( )

9. $_{oct}$ is

(a) greater than $_{tet}$ ( ) *(b)* lesser than $_{tet}$ ( )

(c) equal to $_{tet}$ ( ) *(d)* None of the above ( )

10. Dipole-dipole interactions are also called as

(a) London forces ( )

(b) Debye forces ( )

(c) Keesom forces ( )

(d) ion-dipole interactions ( )

SECTION—B

(*Marks* : 15)

Answer the following questions : 3×5=15

1. Give a brief account of hexagonal close-packed (hcp) structure of crystals.

OR

Explain non-stoichiometric defects in crystals and its consequence.

2. Using molecular orbital energy level diagram, explain the paramagnetism of O_2 molecule.

OR

Explain instantaneous dipole-induced dipole interactions (London forces).

3. HNO_3 only can act as an oxidizing agent but HNO_2 can act both as an oxidizing agent and a reducing agent. Explain.

OR

How do calcium carbide (CaC_2), magnesium carbide (Mg_2C_3) and silicon carbide (SiC) react with water?

4. What are the necessary conditions for a set to form a group?

OR

Compare the self-ionization of water and liq. NH_3.

5. Compare valence bond theory (VBT) and crystal field theory (CFT).

OR

What are the factors on which the magnitude of crystal field stabilization energy (CFSE) depend?

(PART : B—DESCRIPTIVE)

(*Marks* : 50)

The figures in the margin indicate full marks for the questions

1. *(a)* Define the term 'lattice energy' of an ionic solid. How is lattice energy of sodium chloride calculated with the help of Born-Haber cycle? Describe. 1+4=5

(b) Calculate the limiting radius ratio (r /r) for the tetrahedral coordination of a cation in an ionic lattice. 3

(c) Explain giving reason why LiI is soluble in H_2O while LiF is not. 2

OR

2. *(a)* What are *n*-type and *p*-type semiconductors? Discuss giving examples. 4

(b) Explain 'Li ion is most extensively hydrated among the alkali metal cations'. 2

(c) What are the three types of cubic crystals? Calculate the number of atoms per unit cell in each case. 1+3=4

3. *(a)* What are sigma- and pi-molecular orbitals? Give their characteristics. 1+2=3

(b) How can you deduce bond order from molecular orbital theory? 2

(c) Why is hydrogen diatomic but helium monoatomic? 2

(d) Arrange O_2, O_2 and O_2 in increasing order of their stability and bond length. 3

OR

4. *(a)* Write a note on 'bonding and antibonding molecular orbitals'. 2

(b) Draw molecular orbital energy level diagram of NO. Find its bond order and magnetic properties. 3+2=5

(c) How does MOT explain the difference in the reactivity of N_2, O_2 and F_2? 3

5. *(a)* Ge(II) is strong reducing agent and Ge(IV) is not, Pb(IV) is an oxidizing agent and Pb(II) is not. Explain. 2

(b) Discuss the structure and geometry of XeF_4 and XeF_6. 1½+1½=3

(c) What is catenation? Discuss with reference to nitrogen group elements. 2

(d) Discuss the structure and bonding in diborane (B_2H_6) molecule. 3

OR

6. *(a)* What are carbides? How are they classified? Specify the placement of the different elements from the different groups of the periodic table in different classes of the carbides. 1+1+2=4

(b) Write the structure of Marshall's acid and mention the oxidation state of sulphur atom in it. 2+1=3

(c) What are pseudohalogens? Give three examples of it. 1½+1½=3

7. *(a)* Discuss solvent system of acids and bases with suitable examples. 3

(b) What are conjugate acids and bases? Discuss with examples. 2

(c) Discuss the following reactions in liquid ammonia : 4
(i) Precipitation reactions
(ii) Redox reactions

(d) Define symmetry point group. 1

OR

8. *(a)* Find out all the symmetry elements present in H_2O and NH_3 and then specify their point groups. 3

(b) Discuss the action of liq. ammonia on alkali metals. 3

(c) Compare Lewis concept and Brönsted-Lowry concept of acids and bases. 2

(d) Define the following : 2

(i) A subgroup

(ii) Order of a group

9. (a) Discuss the splitting of *d*-orbitals in weak and strong field with reference to octahedral complexes. 2

(b) Discuss the properties of 3*d* series elements with respect to—

(i) oxidation states;

(ii) electronic configurations. 3

(c) Third and second rows of transition series elements resemble each other much more than they resemble first row transition elements. Explain. 3

(d) Discuss '$[Fe(CN)_6]^4$ is diamagnetic but $[Fe(CN)_6]^3$ is paramagnetic'. 2

OR

10. (a) How can the magnetic properties of transition metal complexes be explained on the basis of CFT? Discuss with at least two examples. 3

(b) Sc^3 is colourless but Ti^3 is coloured. Explain. 2

(c) Define 'crystal field stabilization energy'. For $[Cr(H_2O)_6]^3$ ion the mean pairing energy P is found to be 23500 cm ^{1}. The magnitude of $_0$ is 13900 cm ^{1}. Calculate the CFSE for this complex ion corresponding to high-spin and low-spin states. 1+4=5

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