

Roll No.

Duplicate

Total Pages : 5

325303

December 2023

B.Sc. (LS) - III SEMESTER

Chemical Bonding

(BLS 303)

Time : 3 Hours]

[Max. Marks : 75

Instructions :

1. It is compulsory to answer all the questions (1.5 marks each) of Part-A in short.
2. Answer any four questions from Part-B in detail.
3. Different sub-parts of a question are to be attempted adjacent to each other.

PART-A

1. (a) Calculate the formal charge on each atom of $[:S-C \equiv \ddot{N}:]$ molecule. (1.5)
- (b) Suggest an appropriate hybridization scheme for the central atom in F₂O. (1.5)
- (c) Mention any two conditions required for LCAO (Linear Combination of Atomic Orbitals). (1.5)

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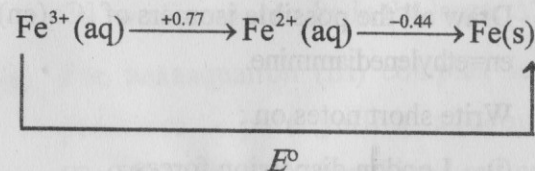
- (d) Which intermolecular force and among which molecules results in the assembly of a double-helical DNA structure? (1.5)
- (e) Comment on the observed magnetic moment of $[\text{FeF}_6]^{3-}$. (1.5)
- (f) Write the chemical formulae for the following complexes: Calcium hexafluorophosphate (V) and Tetraethyl ammonium heptafluorozirconate (IV). (1.5)
- (g) Write the general electronic configuration for actinides. (1.5)
- (h) Explain the term lanthanide contraction. (1.5)
- (i) Does $[\text{Mn}(\text{CN})_6]^{3-}$ complex ion show tetragonal distortion? Write the electronic configuration showing d orbitals splitting due to the ligand field. (1.5)
- (j) Mention the name and role of any one iron coordination compound in the biological system. (1.5)

PART-B

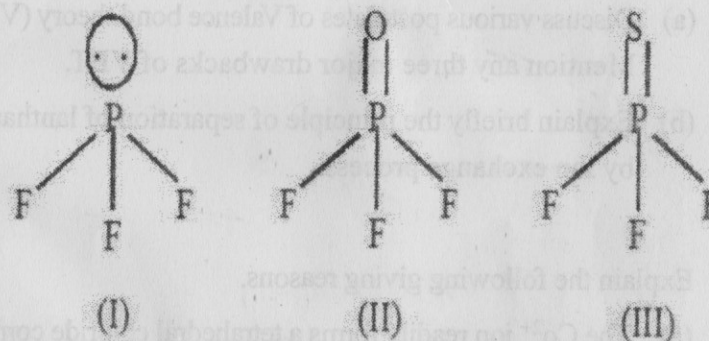
2. (a) The d^8 complexes $[\text{Ni}(\text{CN})_4]^{2-}$ and $[\text{NiCl}_4]^{2-}$ are square planar and tetrahedral respectively. Will these complexes be paramagnetic or diamagnetic? Explain using energy level diagrams for both complexes. (8)
- (b) Suppose an octahedral field is tetragonally elongated along the z -axis. (That is, assume that the z -axis ligands move farther from the metal while the x - and y -axis ligands get

closer.) Draw a well-labeled diagram showing the effect on the energy of the five d orbitals, starting from their positions in an octahedral field. Explain the reason for the splitting shown due to Jahn-Teller distortion. (7)

3. (a) Discuss the group trends of $3d$ transition series elements with reference to their variable valency and colour. (5)
- (b) The following potential diagram summarizes some of the redox chemistry of iron in aqueous solution. Calculate the value of E^0 for the reduction of $\text{Fe}^{3+}(\text{aq})$ to iron metal. (5)



- (c) State Bent's Rule. Arrange the angles in increasing order and explain the reason using Bent's rule if $\theta_1, \theta_2, \theta_3$, represent the $\angle\text{FPF}$ in I, II, and III respectively. (5)



4. (a) Three complex ions of cobalt (III), $[\text{Co}(\text{CN})_6]^{3-}$, $[\text{Co}(\text{NH}_3)_6]^{3+}$, and $[\text{CoF}_6]^{3-}$, absorb light at wavelengths of (in no particular order) 290 nm, 440 nm, and 770 nm. Calculate the crystal field splitting energy. Match each complex ion to the appropriate wavelength absorbed.

(5)

(b) Draw the MO diagram of CO molecule. Comment on its magnetic behavior and also calculate the bond order for the same. Write the molecular electronic configuration for CO^+ ion.

(10)

5. (a) Draw all the possible isomers of $[\text{Co}(\text{en})\text{Br}_2\text{I}_2]^-$ where en=ethylenediammine.

(5)

(b) Write short notes on :

(i) London dispersion forces.

(ii) Factors affecting the magnitude of CFSE value.

(10)

6. (a) Discuss various postulates of Valence bond theory (VBT). Mention any three major drawbacks of VBT.

(10)

(b) Explain briefly the principle of separation of lanthanides by ion exchange process.

(5)

7. Explain the following giving reasons.

(a) The Co^{2+} ion readily forms a tetrahedral chloride complex but Ni^{2+} does not. Comment.

(b) Both CrO_4^{2-} and MnO_4^- are d^0 complexes and yet are very colorful. What type of electronic transitions is responsible for the colors of the complexes? Explain.

(c) W, X, Y, and Z are different monodentate ligands. Is the tetrahedral $[\text{ZnWXYZ}]^{2+}$ optically active? Is the square planar $[\text{NiWXYZ}]^{2+}$ optically active?

(d) Two ligands, A and B, both form complexes with a particular metal ion. When the metal ion complexes with ligand A, the solution is green. When the metal ion complexes with ligand B, the solution is violet. Which of the two ligands results in the larger Δ ?

(e) The hexaaquairon (III) complex ion, $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$, produces a pale yellow aqueous solution and $[\text{Fe}(\text{H}_2\text{O})_5\text{SCN}]^{2+}$ gives blood-red colouration. Is the crystal field splitting energy, Δ , of $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$ smaller or larger than the Δ of $[\text{Fe}(\text{H}_2\text{O})_5\text{SCN}]^{2+}$? Explain.

(15)