[Time: $2\frac{1}{2}$ Hours]   [Marks: 60]

Please check whether you have got the right question paper.

N.B: 1. All questions are compulsory.
        2. Figures to the right indicate full marks.
        3. Please check whether you have received the right question paper.

Q. 1 a) Answer ANY TWO of the following.
   i) Using the concept of hybridization, obtain expressions for the wave function of *sp* hybrid   4
       orbitals.
   ii) Discuss the geometry of PCl_5 and SF_4 on the basis of hybridization.   4
   iii) What do you mean by electron deficient molecule? Explain the nature of bonding in diborane on   4
        the basis of molecular orbital theory.
   iv) Derive the equation of resonance energy showing the contributing resonance structure with the   4
        lowest potential energy.

   b) Answer ANY ONE from the following:
   i) What are ion-dipole and dipole-dipole interactions? Give suitable examples.   4
   ii) Construct a labelled molecular orbital diagram for the V_2 molecule. Calculate the bond order and   4
        explain the magnetic behaviour of the molecule.

Q. 2 a) Attempt ANY TWO of the following:
   i) Explain the optical activity in molecules on the basis of group theory.   4
   ii) Explain abelian and non abelian point group using suitable example for each.   4
   iii) Obtain matrix representation for rotation operation.   4
   iv) On the basis of Symmetry Adapted Linear Combination (SALC), draw the molecular orbital   4
        diagram for ammonia molecule.

   b) Attempt ANY ONE of the following:
   i) Construct group multiplication table for symmetry operations for C_{2v} point group.   4
   ii) What are irreducible representations? State their characteristics.   4

Q. 3 a) Attempt ANY TWO of the following:
   i) Discuss the fundamentals of band theory. On the basis of this theory, justify that Lithium metal   4
       is a good conductor of electricity.
   ii) Draw the structure of TiO_2 and explain it's salient features.   4
   iii) Describe the ceramic method for the preparation of inorganic solids. Mention it's merits and   4
        demerits.
   iv) How are the nanomaterials prepared by the solvothermal method?   4

   b) Attempt ANY ONE of the following:
   i) Explain the origin of first Brillouin zone in inorganic crystals.   4
   ii) Discuss the co-precipitation method for the preparation of nanomaterials.   4

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Q. 4 a) Attempt ANY TWO of the following:

i) Explain the following methods for the detection of complex formation in solution. 4
   1) Chemical test 2) Dissolution of an insoluble precipitate

ii) Explain the following IR data. 4

molecule/complex	v_{co} cm^{-1}
CO	2145
Mo (CO)$_6$	2000
Mo(CO)$_3$(NH$_3$)$_3$	1855

iii) Draw and explain the Orgel diagram for the complex ion $[Fe(H_2O)_6]^{2+}$. Assign the electronic transitions. 4

iv) Discuss the potentiometric method for the determination of formation constant. 4

b) Attempt ANY ONE of the following:

i) The spectral characteristics of high spin $[CoF_6]^{4-}$ are : 4
   $v_1 = 7, 150$ cm^{-1} $v_2 = 15,200$ cm^{-1} $v_3 = 19,200$ cm^{-1}
   Assign the electronic transitions. Find 10Dq, β and B'. Given $B_o = 970$ cm^{-1}

ii) Discuss Job's method of continuous variation for the determination of formation constant of complexes. 4

Q. 5   Answer ANY FOUR from the following: 12

a) Justify the following statement. "In CuSO$_4$.5H$_2$O, all the water molecules are not lost at the same temperature on gradual heating.

b) Draw the Lewis dot structure for SCN⁻ ion Give all possible resonating structures and calculate formal charges. Predict the most stable structure.

c) Discuss Mulliken's notations for irreducible representation.

d) Define subgroup. Give it's characteristics.

e) Write a note on Fermi Level in solids.

f) Discuss any four applications of nanomaterials in the field of semiconductors.

g) Explain the salient features of Tanabe Sugano diagrams.

h) Write a short note on the determination of formation constant of complexes by mole ratio method.

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