**[Time: 2.5 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.

**Q.1. a) Attempt ANY TWO of the following:**

**i)** Derive the wave functions for $sp^2$ hybrid orbitals considering sigma bonding only. **4**

**ii)** Explain the concept of resonance. Draw the resonating structures for sulphate ion. **4**

**iii)** On the basis of molecular orbital theory explain the structure and bonding in diborane molecule. **4**

**iv)** What are Van der Waals forces? Explain any two types with suitable examples. **4**

**Q.1. b) Attempt ANY ONE of the following:**

**i)** On the basis of Valence Bond Theory, explain the structure and bonding of $ClF_3$ and $PF_5$ . **4**

**ii)** Draw a molecular orbital diagram for triiodide ion and explain its structure and bonding. **4**

**Q.2. a) Attempt ANY TWO of the following:**

**i)** On the basis of group theory, explain optical activity in a molecule. **4**

**ii)** Discuss the criteria for a set of elements to form a group by giving suitable example. **4**

**iii)** With the help of suitable example explain Abelian and non -Abelian point groups. **4**

**iv)** On the basis of Symmetry Adapted Linear Combination (SALC), draw the molecular orbital diagram for methane molecule. **4**

**Q.2. b) Attempt ANY ONE of the following:**

**i)** Give and explain the character table for $C_{3v}$ point group. **4**

**ii)** Derive the matrix representation for rotation operation. **4**

**Q.3. a) Attempt ANY TWO of the following:**

**i)** Explain the electrical property of alkali metal on the basis of band theory. **4**

**ii)** Draw the structure of $TiO_2$ and discuss its salient features. **4**

**iii)** Describe the precursor method for the preparation of inorganic solids. Mention its merits and demerits. **4**

**iv)** Explain the Co-precipitation method for the preparation of nanomaterials. **4**

**Q.3. b) Attempt ANY ONE of the following:**

**i)** Discuss the structure for an inorganic solid of type AB. **4**

**ii)** Describe the microwave method for the preparation of nanomaterials. **4**

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

**i)** With respect to complex formation , explain the following evidences: **4**
1) dissolution of insoluble precipitate 2) pH metric study.

**ii)** Draw the Orgel diagram for $[Ni(H_2O)_6]^{2+}$. Assign the electronic transitions. **4**

**iii)** Rationalize the IR data for the following : **4**

| Species | $\upsilon_{CO}$ in $cm^{-1}$ |
|---|---|
| $[V(CO)_6]^-$ | 1860 |
| $[Cr(CO)_6]$ | 2000 |
| $[Mn(CO)_6]^-$ | 2090 |

**iv)** Explain the potentiometric method for the determination of formation constant in complexes. **4**

**Q.4. b) Attempt ANY ONE of the following:**

**i)** Discuss the Faraday's method for the determination of magnetic moment. **4**
Calculate $\mu_{eff}$ for the complex $[Cr(H_2O)_6]Cl_2$.

**ii)** Explain the slope-ratio method for the determination of formation constant. **4**

**Q.5. Attempt ANY FOUR of the following.** **12**

**a)** Explain in brief any two methods for the detection of hydrogen bonding.

**b)** What are limitations of valence bond theory?

**c)** Write a note on Mulliken's notations for irreducible representations.

**d)** Give the characteristics of a subgroup. Write the subgroups for $C_{2v}$ point group.

**e)** Mention the merits and demerits of ceramic method.

**f)** Discuss the applications of nanomaterials in the field of solar cells.

**g)** The $^1H$ NMR for the complex $[Fe(\eta^1\text{-}C_5H_5)(\eta^5\text{-}C_5H_5)(CO)_2]$ shows two peaks. Explain.

**h)** Write a note on continuous variation method for the determination of formation constant.

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