

[Time: 2 ½ 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.**

1. a) Answer any **two** of the following:

- By applying the concept of hybridization, derive the wave functions for the hybrid orbitals of Boron trichloride molecule. **4**
- Draw a molecular orbital diagram for triiodide ion a polyatomic species considering  $\sigma$  interaction and explain the bonding. **4**
- State and explain significance of valence bond theory and any two limitations. **4**
- What are Vander Waals forces of attraction? Explain various dipole attractions. **4**

b) Answer any **one** of the following :

- Define resonance energy? Derive equation for resonance energy showing the contributing resonance structure with the lowest potential energy. **4**
- What is hydrogen bonding? Explain its effects on physical properties of compounds. **4**

2. a) Answer any **two** of the following:

- Draw a flow sheet and explain various steps involved in the procedure for symmetry classification of the molecule. **4**
- Show that the  $C_{2v}$  point group is an Abelian group. **4**
- State the great orthogonality theorem. Construct the character table for water molecule. **4**
- With help of character table and reduction formula, calculate translation, rotational and vibrational modes in ammonia molecule. **4**

- b) Answer any **one** of the following :
- On the basis of symmetry Adapted Linear combination, draw the molecular orbital diagram for methane molecule. **4**
  - Discuss optical activity in a molecule on basis of group theory. **4**
3. a) Answer any **two** of the following :
- Explain the origin of first Brillouin zone boundary in K space and diffraction of electron in 100 plane. **4**
  - Describe the microwave method for the preparation of inorganic solids. **4**
  - Explain the structure and salient features of NiAs. **4**
  - Give the applications of nanomaterial in the field of semiconductors. **4**
- b) Answer any **one** of the following :
- How are nanomaterial prepared by using microorganisms? **4**
  - Mention the merits and demerits of sol gel method. **4**
4. a) Answer any **two** of the following :
- With reference to Complex formation, explain the following evidences : **4**
    - Ion exchange Adsorption
    - Magnetic method
  - Justify “ The measurement of molar conductance of aqueous solution of cobaltamines compounds helps Werner to assigned correct formulae.” **4**
  - Draw the Orgel diagram for the complex ion  $[\text{CrF}_6]^{3-}$  and assign the electronic transitions. **4**
  - Prove that the formation constant of  $[\text{Cu}(\text{NH}_3)_4]^{2+}$  from  $\text{Cu}^{2+}$  and  $\text{NH}_3$  ,  
 $B_4 = K_1 \times K_2 \times K_3 \times K_4$  .
- b) Answer any **one** of the following :
- Discuss the continuous variation method for the determination of formation constant. **4**

- ii) Draw simplified Tanabe - Sugano diagram for  $d^3$  system. The  $\Delta_0$  for the complex has been evaluated to be  $17600 \text{ cm}^{-1}$ . Evaluate the wave number of first two Spin-allowed bands in its spectrum. (Given  $\frac{\Delta_0}{B} = 19.2$ ,  $B = 918 \text{ cm}^{-1}$ ) 4

5. Answer any **four** of the following :

- a) Draw a molecular orbital diagram for diborane molecule. Explain bonding in the molecule. 3
- b) State rules for the construction of resonating structures with the suitable examples. 3
- c) Derive the matrix representation for reflection operation on the basis of group theory. 3
- d) Explain Mulliken's Notations for irreducible representation for  $C_{2h}$  and  $C_{2v}$  point groups. 3
- e) On the basis of band theory, explain the electrical properties of lithium and beryllium metals. 3
- f) Explain the precursor method for the preparations of inorganic materials. 3
- g) The electronic spectrum of  $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$  has an absorption maximum at  $20,300 \text{ cm}^{-1}$ . Calculate the  $\Delta_0$  for this complex. 3  
(Given :  $h = 6.62608 \times 10^{-34} \text{ Js}$  and  $c = 2.997 \times 10^8 \text{ ms}^{-1}$ )
- h) Write advantages of Tanabe – Sugano diagram over Orgel diagram. State noncrossing rule 3