

Q.P. Code :29470

[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.

Q.1 a) Answer ANY TWO of the following:

- i) Derive expressions for the wave function of sp^3 hybrid orbitals using the concept of hybridization. 4
- ii) On the basis of hybridization, explain the structures of Iodine heptafluoride and Xenon hexafluoride. 4
- iii) Construct a labelled molecular orbital diagram for the divanadium molecule. Calculate the bond order and explain its magnetic property. 4
- iv) What are Van der Waals Forces? Discuss any two types of forces with examples. 4

Q.1 b) Answer ANY TWO of the following:

- i) Discuss any two methods of detection of hydrogen bonding in the molecules. 4
- ii) Explain the bonding in SF_6 molecule on the basis of molecular orbital theory. Draw the molecular orbital diagram showing the distribution of electrons in various molecular orbitals. 4

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

- i) Give the systematic procedure for symmetry classification of molecules. 4
- ii) Construct the group multiplication table for C_{2v} point group. 4
- iii) Obtain matrix representation for rotation operation. 4
- iv) On the basis of Symmetry Adapted Linear Combination (SALC), draw the molecular orbital diagram for ammonia molecule. 4

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

- i) Explain abelian and non abelian point group with the help of suitable example for each. 4
- ii) Give and explain the character table for C_{3v} point group. 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 an alkali metal is a good conductor of electricity. 4
- ii) Draw the structure of Nickel arsenide and explain its salient features. 4
- iii) Describe the precursor method for the preparation of inorganic solids. Mention its merits and demerits. 4
- iv) How are nanomaterials prepared by the sol-gel method? Explain with an example. 4

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

- i) Discuss the origin of first Brillouin zone in inorganic crystals. 4
- ii) Explain the Langmuir-Blodgett 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 (1) Migration of the species in an electric field and abnormal transport number (2) pH – metric study **4**
- ii) Account for the following IR vibrational frequencies of complexes. Account for M-C stretching vibrations. **4**
- | Complex | M-C stretching ν in cm^{-1} |
|----------------------------|--|
| $\text{Ni}(\text{CO})_4$ | 422 |
| $[\text{Co}(\text{CO})_4]$ | 532, 439 |
| $[\text{Fe}(\text{CO})_4]$ | 550, 464 |
- iii) Draw and explain the Orgel diagram for the complex ion $[\text{V}(\text{H}_2\text{O})_6]^{3+}$ and assign the electronic transitions. **4**
- iv) Discuss the mole-ratio method for the determination of formation constant. **4**

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

- i) The absorption spectrum of $[\text{Ni}(\text{H}_2\text{O})_6]^{+2}$ shows peaks at $9,000\text{ cm}^{-1}$, $14,000\text{ cm}^{-1}$ and $25,000\text{ cm}^{-1}$. Assign the electronic transitions. Calculate $10Dq$ and Racah parameter for the complex ion. (B_0 for the free Ni^{+2} ion $= 1034\text{ cm}^{-1}$). **4**
- ii) Explain the potentiometric method for the determination of formation constant of complexes. **4**

Q.5 Answer ANY FOUR from the following:**12**

- a) Draw the Lewis dot structure for nitrate ion. Give all possible resonating structures and calculate the formal charges. Predict the most favourable structure.
- b) Explain “HF forms stronger H-bond than H_2O , still ΔH_{vap} of HF is lower than of H_2O .”
- c) Discuss Mulliken’s notation for irreducible representations.
- d) Explain the symmetry restriction on the dipole moment in molecule.
- e) Describe the Ceramic method for the preparation of inorganic solids.
- f) Explain the synthesis of nanomaterials using microorganisms.
- g) Discuss ESR spectra of $[\text{Cu}(\text{en})_2(\text{ClO}_4)_2]$ complex.
- h) Explain the stepwise and overall formation constant for metal complexes.
