Time: 2 Hours **Marks: 50**

1. Attempt **ANY TWO** of the following.

   i) On the basis of molecular orbital theory explain the structure and bonding in diborane molecule. 5

   ii) On the basis of hybridization explain the structure and bonding of iodine heptafluoride & sulphur tetrafluoride. 5

   iii) Derive the wave functions for sp^2 hybrid orbitals considering sigma bonding only. 5

   iv) Explain the concept of resonance. Draw the resonating structures for carbonate ion. 5

2. Attempt **ANY TWO** from the following.

   i) Derive the matrix representation for translation operation. 5

   ii) Show that C_2v point group is an Abelian group. 5

   iii) Define subgroup. Give its characteristics 5

   iv) What are Mullikens notations for irreducible representations? 5

3. Attempt **ANY TWO** of the following.

   i) What is Band Theory? Explain the property of solids as semiconductors and insulators on the basis of Band theory. 5

   ii) Explain the structural features of Rutile (TiO_2) compound. 5

   iii) Discuss with suitable example, the role of rare earth ions in solid state laser materials. 5

   iv) Write a note on,' Biological method for preparation of nanomaterials' 5

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4. Attempt **ANY TWO** of the following.

i) Explain how absorption spectra and pH method help in detection of complex formation. 5

ii) Derive the expression for stepwise formation constant in complexes. 5

iii) Draw Orgel diagram for d^4 metal ion in octahedral complex. Assign the electronic transitions. 5

iv) Explain the significance of Tanabe-Sugano diagrams in interelectronic repulsions. 5

5. Attempt **ANY FIVE** of the following 10

i) Calculate the formal charge of sulphur in the sulphate ion.

ii) What is hydrogen bonding. Give two examples of molecules which shows hydrogen bonding.

iii) Define group and symmetry elements with examples.

iv) Construct character table for C_2h point group with suitable example.

v) State the principle underlying the preparation of nanomaterial by ceramic method.

vi) Explain in brief the terms: 1. Fermi Energy 2. First Brillouin zone

vii) Give electronic transitions for d^1 and d^3 configurations on the basis of Orgel diagram.

viii) State any four methods of detection of complex formation.

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TIME: 2 HOURS **MAX. MARKS: 50**

NB:

1) **All questions are compulsory.**
2) **Figures to the right indicate full marks.**
3) **Use of logarithmic table/non-programmable calculator is allowed.**
4) **At. Wts: H=1, C=12,N=14,O=16,Na=23,Al=27,S=32, Cl=35.5, K=39, Ca=40,Ag=108 , Ba=137, Pb=207,Mg= 24.3,F=19,Cu= 63.5, Cr = 52, Sn=118.7 Fe = 55.8**

Q.1 Answer **any two** of the following: 10

A. Discuss performance characteristics of analytical method.

B. Write note on basic safety in laboratory.

C. Give classification of Analytical methods.

D. What is the principle of NABL accreditation?

Q.2 Answer **any two** of the following: 10

A. A buffer solution was prepared by mixing 0.05 mole acetic acid with 0.06 mole sodium acetate in distilled water to make 1 dm^3 solution. Calculate the pH of the solution. [Given Ka for acetic acid is 1.8×10^{-5}].

B. Calculate the volume of HCl (density 1.19 gm / cm^3, 38% HCl by weight) required to prepare 18 dm^3 of 0.02 N HCl.

C. 161 g of ethanol and 145 g of acetone are mixed together. Find the mole fraction of each compound in the mixture.

D. 100 g of Na_2CO_3 reacts with 100 g of HCl. Calculate the amount of NaCl formed, in moles and in grams. Which is the limiting reagent.

Q.3 Answer **any two** of the following: 10

A. Draw a labelled schematic diagram of Michelson's interferometer. Explain its working in FTIR

B. Name the Infra-red (IR) sources and describe any two in detail.

C. In what way the Fourier Transform (FT) instruments differ from the optical instruments?

D. With the help of block diagram describe the dual wavelength spectrophotometer. What type of samples can be analysed by it?

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Q.4 Answer **any two** of the following: 10

A. Explain the principle of Differential Scanning Calorimetry (DSC) and discuss any one of its application.

B. Differentiate between power-compensated and heat-flux DSC instruments.

C. Discuss the factors affecting DSC Curves.

D. Describe the role of multilayered films in automated analysis.

Q.5 Answer **any five** of the following: 10

A. What are determinate errors? Enlist two determinate types of error.

B. What is the meaning of government standards like HALLMARK and AGMARK?

C. Assign oxidation number to each element in $Cr(OH)_4^-$.

D. Solid $BaSO_4$ is dissolved in water at 25 °C. Its solubility is 1.04×10^{-5} mol/dm^3. Calculate the solubility product (Ksp) of the compound.

E. Explain the effect of temperature on the λ_{max} values in the UV-visible spectra.

F. What are the photoconducting transducers in FTIR?

G. Describe the quantity measured for each of the following techniques.
a) TGA b) DTA

H. Discuss the advantages of automated analyses.

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Time: 2 Hours **Marks-: 50**

N.B. -1) All questions are compulsory.

2) Figures to the eight indicate full marks.

Q.1) Answer the following (Any Two) (10)

1) What are three types of sources? Explain each with suitable example.

2) What is a search engine? Discuss any four types of search engine.

3) Write a short note on- Citation index and impact factor of journal.

4) What are the internet and the world wide concept?

Q. 2) Answer the following (Any Two) (10)

1) Define- Accuracy, Precision, Mean, Mode, and Median.

2) What is a scientific method? Give different steps involved in scientific method?

3) Write a short note on- Curve fitting.

4) What is ANOVA? Give its basic principle? Why is ANOVA method used? Give various types of ANOVA.

Q.3) Answer the following (Any Two) (10)

1) Give different types of scientific writing.

2) Discuss outline for writing of scientific papers?

3) Define plagiarism. How can be plagiarism avoided?

4) What is a research? Give various steps involved in scientific research?

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Q.4) Answer the following (Any Two) (10)

1) What are the safe working procedure and protective environment in laboratory?

2) What is chemical waste? Write a short note on- Recycling of laboratory chemicals

3) Discuss the methods for laboratory disposal of explosive?

4) What is a chemical hazard? Explain different types of chemical hazards?

Q.5 Answer the following (Any Five) (10)

1) Define H-index. If a researcher has published 66 articles and out of these 23 articles having minimum 23 citations then what is the H-index of the author?

2) How do you cite publication information?

3) Differentiate between correlation and Regression.

4) What is SI system? Give SI unit of mass?

5) Why publishing research article is important?

6) Write a short note on- Scientific poster.

7) What are the examples of protective clothing?

8) Mention the full form and three types of first aid.

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