

CHE-10

BACHELOR OF SCIENCE (B.Sc.)

Term-End Examination

June, 2005

CHE-10 : SPECTROSCOPY

Time : 2 hours

Maximum Marks : 50

Note : Attempt any **five** questions. All questions carry equal marks.

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1. (a) Explain the vector nature of orbital angular momentum (L). Draw the diagram showing components of angular momentum corresponding to $l = 1$. 5
 - (b) Compare the number and type of axes of symmetry present in NH_3 and BF_3 molecules. 3
 - (c) Write the expression relating kinetic energy and moment of inertia. Also, give the significance of various terms appearing in it. 2
 2. (a) State the meaning of the term, group frequency. Explain the use of IR spectra in structure determination using any two examples. $3\frac{1}{2}$

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P.T.O.

- (b) State Hooke's law. Also write its mathematical form. $2\frac{1}{2}$
- (c) Explain any **two** of the following terms : 2×2
- (i) Zero point energy
 - (ii) Fundamental transitions and overtones
 - (iii) P and R branches
3. (a) Draw diagrams illustrating the stretching and bending vibrations of $-\text{CH}_2-$ group. 3
- (b) Calculate the stretching and bending modes in CH_4 molecule. 3
- (c) Explain the terms, Stokes lines and anti-Stokes lines. 2
- (d) In the S-branch of rotational Raman spectrum of CO_2 (g), a series of absorption peaks is separated by 3.16 cm^{-1} . Calculate the value of rotational constant, B for CO_2 molecule. 2
4. (a) Derive the term symbol for the ground state of hydrogen molecule. 5
- (b) Explain why an aqueous solution of $\text{Ti}_2(\text{SO}_4)_3$ is red purple in colour. 3
- (c) Name one source of radiation each for recording spectrum in IR and UV regions. 2

5. (a) Draw the block diagram of a microwave spectrometer. 3

(b) Define chemical shift. State the name and structure of the standard reference compound used for measuring chemical shift. Give the names of two factors that affect chemical shift. $3\frac{1}{2}$

(c) Explain why $2+1\frac{1}{2}$

(i) ESR spectra are recorded as derivative spectra.

(ii) ESR spectrum of SO_3^- shows a single line.

6. (a) Write short notes on the following : 4

(i) Base peak

(ii) α -cleavage

(b) An organic compound having molecular formula $\text{C}_4\text{H}_8\text{O}$ showed the following spectral data :

Mass spectrum : m/z 72, 43 and 57

IR spectrum : 1716, 1460 and 2941 – 2857 cm^{-1}

UV spectrum : 274 nm

^1H – NMR spectrum : (δ , CDCl_3) :

1.0 (3H, triplet),

2.47 (2H, quartet) and

2.20 (3H, singlet)

Assign the structure of this compound on the basis of the above spectral data. Also correlate various signals to the structural units present in the molecule. 6

7. (a) N_2O and CO_2 are both linear molecules. The bands occur at the same wave number in the IR and Raman spectra of N_2O whereas it is not observed for CO_2 . Justify these results drawing their skeletal structure. 3
- (b) Define the term, polarisability of a molecule. State the requirement for Raman band in terms of polarisability. 2
- (c) State Franck – Condon principle. Using a diagram, explain any **one** of the following : 5
- (i) Predissociation
 - (ii) Phosphorescence