

CHE-10

BACHELOR OF SCIENCE (B.Sc.)

Term-End Examination

December, 2005

CHE-10 : SPECTROSCOPY

Time : 2 hours

Maximum Marks : 50

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

$$h = 6.626 \times 10^{-34} \text{ Js}$$

$$c = 2.998 \times 10^8 \text{ ms}^{-1}$$

$$m_N = 14.004$$

$$e = 1.602 \times 10^{-19} \text{ C}$$

$$m_o = 15.9994$$

$$m_p = 1.672 \times 10^{-27} \text{ kg}$$

1. (a) Explain the terms 'normal and anomalous Zeeman effect'. 2

- (b) What do you understand by the 'term symbol' in the context of atoms ? Derive it for the *P* and *D* states of the hydrogen atom. 3

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P.T.O.

(c) What are symmetry elements and symmetry operations? Identify symmetry elements in case of ammonia molecule. 3

(d) How is molecular symmetry related to (i) dipole moment and (ii) optical activity? 2

2. (a) Discuss briefly the factors affecting the intensities of rotational spectral lines. 2

(b) The rotational constant (B) for NO molecule is 1.70 cm^{-1} . Calculate its bond length. 3

(c) Discuss the origin of P , Q , R branches in the IR spectrum of a vibrating rotator. 3

(d) Given below are two structures of CO_2 molecule :



How will you differentiate the two structures using IR and Raman spectra? 2

3. (a) Write the energy expressions for (i) a harmonic oscillator and (ii) an anharmonic oscillator explaining various terms involved in them. What are the selection rules for these oscillators? 4

(b) Explain Franck - Condon principle and discuss its use in explaining the intensities of spectral lines in electronic spectrum. 4

(c) The intensity of Stokes lines is generally greater than those of anti-Stokes lines. Explain. 2

4. (a) Calculate the stretching and bending modes of vibration for CHCl_3 and PF_3 molecules. 2
- (b) Name the source of radiation and detectors for the following spectrometers : 3
- (i) Microwave
- (ii) IR
- (iii) Raman
- (c) Starting from the electronic configuration of the oxygen molecule, show that the complete term symbols for its ground state are $^3\Sigma_g^-$ and $^1\Sigma_g^+$. 3
- (d) Distinguish between phosphorescence and fluorescence. 2
5. (a) Explain forbidden and allowed $d-d$ transitions with the help of examples. 2
- (b) Calculate CFSE for Sc^{2+} ion. (At. No. of Sc is 21) 2
- (c) Explain various terms involved in the expression for the magnetic moment of an electron. 2
- (d) Write short notes on the following : 4
- (i) Pascal triangle
- (ii) α -cleavage

6. (a) Calculate the value of nuclear magneton for a proton. 2
- (b) Distinguish between chemical shift and coupling constant. 2
- (c) Make a rough sketch of high resolution $^1\text{H-NMR}$ spectrum of ethylene. 1
- (d) Discuss the ESR spectrum of methyl radical. 3
- (e) An $M+2$ peak of almost equal intensity as M^+ peak appears in the mass spectrum of bromoethane. Explain giving reason. 2
7. (a) A compound with molecular formula $\text{C}_8\text{H}_8\text{O}$ gives negative iodoform test and exhibits the following spectral data :
- UV : λ_{max} 290 nm
- IR : 3040, 2935, 2856, 2735, 1720, 1600, 1570 and 1460 cm^{-1}
- NMR : (δ , CDCl_3) : 2.75 (d, 2H), 7.25 (s, 5H) and 9.72 (t, 1H)
- Using the above spectral data, arrive at the structure of the compound. 4
- (b) Mercury (II) iodide is intensely coloured, though there is no possibility of $d-d$ transition in it. Explain. 2
- (c) Give one example each for the nuclei having $I = 0, \frac{1}{2}$ and 1. $1\frac{1}{2}$