LOYOLA COLLEGE (AUTONOMOUS) CHENNAI – 600 034

M.Sc. DEGREE EXAMINATION – **PHYSICS**

THIRD SEMESTER – **NOVEMBER 2024**

PPH3MC02 – SPECTROSCOPY

Date: 09-11-2024 Dept. No. Max. : 100 Marks

Time: 01:00 pm-04:00 pm

	SECTION A – K1 (CO1)	
	Answer ALL the questions	**(5 x 1 = 5)**
1	**Answer the following**	
a)	Write the magnitude and number of orientations of the angular momentum vector of a molecule with rotational quantum number J = 3.	
b)	What are hot bands in vibrational spectrum?	
c)	Why Stoke's lines are more intense than anti-Stoke's lines?	
d)	A free electron is placed in a magnetic field of strength 0.34 T. Calculate the resonance frequency if g = 2.0 and $\beta = 9.274 \times 10^{-24}$ JT^{-1}.	
e)	Define the relaxation time in NMR.	
	SECTION A – K2 (CO1)	
	Answer ALL the questions	**(5 x 1 = 5)**
2	**MCQ**	
a)	Which of the following is a symmetric top molecule? a) OCS b) BCl_3 c) CH_4 d) H_2O	
b)	The number of fundamental vibrations of CO_2 molecule is a) 3 b) 6 c) 4 d) 10	
c)	The first Stoke's line and the first anti-Stoke's line in the rotational Raman spectrum of N_2O are displaced from the Rayleigh line by -2.514 cm^{-1} and + 2.514 cm^{-1} respectively. Determine the rotational constant of N_2O. a) 0.629 cm^{-1} b) 0.419 cm^{-1} c) 1.257 cm^{-1} d) 2.514 cm^{-1}	
d)	The explanation on the variation in intensity of vibrational electronic spectra is given by a) Born-Oppenheimer approximation b) Raman Scattering c) Franck-Condon Principle d) Mossbauer effect	
e)	The spin quantum number, of O^{17} nucleus is 5/2. The number of orientations of angular momentum vector, **I** of O^{17} nuclei in external magnetic field is a) 3 b) 6 c) 5 d) 10	

	SECTION B – K3 (CO2)
	Answer any THREE of the following **(3 x 10 = 30)**
3	Explain how molecules are classified based on their moment of inertia.
4	Discuss the vibration spectra of a diatomic anharmonic oscillator.
5	Draw the schematic diagram of a Raman spectrometer and explain the working of each section.
6	Write about dissociation energy and derive the expression, $1 + \upsilon_{max} = \frac{1}{2\chi_e}$
7	Discuss the interaction of nuclear spin with a magnetic field and deduce an expression for the energy associated with the transitions.
	SECTION C – K4 (CO3)
	Answer any TWO of the following **(2 x 12.5 = 25)**
8	(a) Derive an expression for the moment of inertia of OCS molecule, in terms of the bond length. Hence, explain how the bond lengths can be found by isotopic substitution method. (10) (b) The rotational constant of NO is 1.7021 cm^{-1}. Calculate the moment of inertia of the molecule. (2.5)
9	Discuss the fundamental vibrations and their symmetry of H_2O molecule.
10	State Franck-Condon principle and discuss its use to explain variation in the intensity of vibrational electronic spectra.
11	Explain about chemical shift and its measurement in NMR spectroscopy.
	SECTION D – K5 (CO4)
	Answer any ONE of the following **(1 x 15 = 15)**
12	Explain the principle of ESR spectroscopy. With necessary diagram, explain the working of ESR spectrometer and its use to characterize samples.
13	(a) Explain the theory of pure rotational Raman spectra of linear and symmetric top molecules. (12) (b) The first rotational Raman line of H_2 appears at 346 cm^{-1} from the exciting line. Calculate the bond length of the H_2 molecule. (mass of hydrogen = 1.67×10^{-27} kg) (3)
	SECTION E – K6 (CO5)
	Answer any ONE of the following **(1 x 20 = 20)**
14	(a) Explain with theory, the spectrum of a linear diatomic molecule of rigid rotor type. (10) (b) Outline the classical theory of Raman effect. (10)
15	(a) Illustrate the influence of rotation on the vibration spectra of linear molecule. (10) (b) Using the family tree method, explain how spectral splitting is taking place in NMR spectrum due to coupling of other nuclei. Give examples. (10)

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