

DEPARTMENT OF SCIENCES III SEMESTER M.Sc. (PHYSICS) END SEMESTER REGULAR EXAMINATIONS, NOVEMBER & DECEMBER 2023 ATOMIC AND MOLECULAR SPECTROSCOPY [PHY 6101] (CHOICE BASED CREDIT SYSTEM - 2020)

Time: 3 Hours

Date: 28-11-2023

MAX. MARKS: 50

Note (i) Answer ALL questions.

(ii) Draw diagrams, and write equations wherever necessary

Q. No.		Marks	CO	BL
1A	Considering the interaction energy of the atom in a magnetic field to be	4	1	2
	$\Delta E = -\mu_L.B$, obtain an expression for frequencies of the spectral lines due to normal			
	Zeeman effect.			
1B	How does pressure broadening contribute to the spectral broadening.	3	1	2
1C	Calculate the width of the spectral line if a molecule makes a transition from an	3	1	3
	excited state to the ground state when the lifetime of the excited state is 1 milli			
	second. Given: Planck constant is 6.626 x 10 ⁻³⁴ J. s			
2A	Why do you observe chemical shift during nuclear magnetic resonance? Illustrate	4	2	2
	with an example.			
2B	Draw allowed transitions due to ESR for one electron system coupled to a nucleus	3	2	3
	of Spin I = 1. Given:			
	$E_{m_s,m_I} = g\mu_{\rm B}Bm_s + am_sm_I,$			
2C	Show that spin-lattice relaxation time is inversely proportional to the transition	3	2	3
	probability per unit time for induced absorption (for a spin half system).			
3A	Give semi-classical explanation for interaction of electromagnetic radiation with	4	2	2
	a rotating molecule.			
3B	Obtain the frequency of the absorption lines for a rotating rigid diatomic	3	2	2
	molecule. Given energy eigen value:			
	$F_{L} = \frac{\hbar^2}{2} I(I + 1)$ joules			
	2I = 2I			

3C	The frequency of OH stretching group in CH ₃ OH is 3300 cm ⁻¹ , estimate the	3	2	3
	frequency of OD stretching vibration in CH ₃ OD. Given: When hydrogen atom is			
	replaced with Deuterium atom, then it forms OD group.			
4A	Obtain frequency of rotational Stokes and anti-Stokes line for a linear molecule.	4	2	2
	Given: $E_J=BJ(J+1)$ cm ⁻¹ .			
4B	How to relate Raman and IR active vibrations for a given molecule? Illustrate with	3	2	3
	an example.			
4C	Irradiation of carbon tetra chloride by 4358 A° radiation gives Raman lines at 4400	3	2	3
	A°, 4419 A° and 4449 A°. Calculate the Raman shift for each of these lines in			
	cm ⁻¹ .			
5A	What is the principle of x ray photoelectron spectroscopic (XPS) technique.	4	3	2
5B	What is Photoluminescence (PL) Spectroscopy and explain its applications.	3	3	2
5C	Estimate is the recoil energy of a free Mossbauer nucleus ⁵⁷ Fe, when emitting a	3	3	3
	gamma ray of frequency 3.5×10^{18} Hz? Given: Speed of light is 3×10^{8} ms ⁻¹ .			
