



LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

M.Sc. DEGREE EXAMINATION – PHYSICS

THIRD SEMESTER – NOVEMBER 2022

PPH 3502 – SPECTROSCOPY

Date: 25-11-2022

Dept. No.

Max. : 100 Marks

Time: 09:00 AM - 12:00 NOON

PART A

Q. No Answer all questions

(10 x 2 = 20 Marks)

- 1 What are the advantages of Gunn diodes over klystrons as microwave source in microwave spectrometers?
- 2 The bond length of HF molecule is 0.0927 nm. What is the moment of inertia of the HF molecule?
- 3 How many normal modes of vibration are possible for (a) HBr (b) NO₂ (c) C₂H₄ and (d) C₆H₆?
- 4 What are hot bands? Why are they called so?
- 5 Define dissociation energy and predissociation.
- 6 Calculate the ESR frequency of a free electron in a magnetic field of 2.5 T. Given that $g = 2.0023$, $\mu_B = 9.274 \times 10^{-24} \text{ JT}^{-1}$.
- 7 Calculate the recoil velocity of a free Mossbauer nucleus of mass $1.67 \times 10^{-25} \text{ kg}$ when it emits a γ -ray of 0.1 nm wavelength
- 8 What are spin-spin and spin-lattice relaxation processes?
- 9 What is fluorescence spectroscopy?
- 10 Write two applications of SEM.

PART – B

Answer any four questions

(4 x 7.5 = 30 Marks)

- 11 (a) Explain the factors that determine the intensity of a spectral line. Obtain an expression for J at which maximum population occurs. **(4.5 marks)**
- (b) The average spacing between successive rotational lines of carbon monoxide molecule is 3.8626 cm^{-1} . Determine the transition which gives the most intense spectral line at temperature 300 K. **(3 marks)**

- 12 (a) Outline briefly each section of a Raman spectrometer. **(4.5 marks)**
(b) Calculate the vibrational frequency of NO molecule whose force constant is 1609 Nm^{-1} . **(3 marks)**
- 13 State Franck-Condon principle and discuss how it is used to explain variation in intensity of vibrational electronic spectra.
- 14 Using family tree method, explain how spectral splitting is taking place in NMR spectrum due to coupling of other nuclei. Give examples.
- 15 Explain the chemical shift in NMR spectroscopy.
- 16 Outline the principle of photoelectron spectroscopy.

PART – C

Answer any four questions

(4 x 12.5 = 50 Marks)

- 17 (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. **(9 marks)**
(b) The fundamental and first overtone transitions of CO are centered at 2143.3 cm^{-1} and 4260 cm^{-1} . Calculate the equilibrium oscillation frequency, the anharmonicity constant and force constant of the molecule. **(3.5 marks)**
- 18 (a) Explain Born – Openheimer approximation. Describe with theory, the rotation – vibration spectra of a diatomic molecule. **(6.5 marks)**
(b) Explain the spectrum of symmetric top molecule. **(6 marks)**
- 19 Write the principle of ESR with necessary theory. With relevant diagram, outline the working of ESR spectrometer. How it is used to characterize samples?
- 20 Explain the theory of pure rotational Raman spectra of (i) Linear molecule and (ii) Symmetric top molecule.
- 21 Explain the impact of Doppler effect and uncertainty principle in Mossbauer spectroscopy. With a diagram, explain the working of Mossbauer spectrometer.
- 22 Discuss in detail the electron energy loss spectroscopy (EELS).
