K24P 0869

Reg. No. : .....

Name : .....

Second Semester M.Sc. Degree (C.B.S.S. – Supple. (One Time Mercy Chance)/Imp.) Examination, April 2024
(2014 to 2022 Admissions)
PHYSICS
PHY 2C09 : Spectroscopy

Time : 3 Hours Max. Marks : 60

SECTION – A

Answer both the questions (Either **a** or **b**).

I. a) Distinguish between normal and anomalous Zeeman effects. Explain clearly the phenomenon of anomalous Zeeman effect and hence derive an expression for the magnetic interaction energy.

OR

b) Discuss the quantum theory of Raman effect. With the help of a schematic diagram, explain the working of a Raman spectrometer.

II. a) Discuss the rotational fine structure of electronic-vibrational transitions. Write a note on Fortrat diagram.

OR

b) Discuss the rotational spectrum of a non-rigid heterogeneous diatomic molecule and compare the spectrum with that of a rigid heterogeneous diatomic molecule. Describe the effect of isotopic substitution on the rotational spectrum of a rigid rotator. **(2×12=24)**

SECTION – B

Answer **any four** questions (**1** mark for Part **a**, **3** marks for Part **b**, **5** marks for Part **c**).

III. a) Give the expression for the wave number of H_α line in terms of Rydberg constant.

b) Write a note on Stark effect.

c) Calculate the possible orientations of the total angular momentum vector $\bar{j}$ corresponding to $j = \frac{3}{2}$ with respect to a magnetic field along the z-axis.

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IV. a) What are hot bands ?

b) Explain the effect of anharmonicity on the vibrational spectra of diatomic molecules.

c) Calculate the energy in cm^{-1} of the photon absorbed when NO molecule goes from the state $v = 0, J'' = 0$ to $v = 1, J'' = 1$. Assume that the $v = 0$ and $v = 1$ states have the same B values. Given $\bar{\nu}_e = 1904\ cm^{-1}$, $x_e = 0.00733$ and $r_{NO} = 0.1151$ nm. Here $\bar{\nu}_e$ is the equilibrium oscillation frequency expressed in wave number units and x_e is the anharmonic constant. Mass of $N^{14} = 23.25 \times 10^{-27}$ kg and Mass of $O^{16} = 26.56 \times 10^{-27}$ kg.

V. a) What are symmetric top molecules ?

b) Explain any reason for the occurrence of pre-dissociation in the rotational fine structure of electronic spectra.

c) In the vibrational Raman spectrum of HF, the Raman lines are observed at wavelengths 2670 Å and 3430 Å. Find the fundamental vibrational frequency of the molecule.

VI. a) Name the different relaxation process available in NMR.

b) Write a note on Larmor precession and obtain an expression for Larmor frequency.

c) Calculate the NMR frequency of F^{19} nucleus when it is placed in the magnetic field of 1.0 tesla. Given that $g_I = 5.256$ and $\mu_N = 5.0504 \times 10^{-27}\ JT^{-1}$. Also calculate the relative population in the two spin states.

VII. a) What is dipolar shift in ESR ?

b) What do you mean by nuclear quadrupole resonance ?

c) Obtain the recoil velocity of a free Mossbauer nucleus of mass 1.67×10^{-25} kg when emitting a γ-ray of wavelength 0.1 nm. What is the Doppler shift of the γ-ray frequency to an outside observer ?

VIII. a) What do you mean by Fermi resonance ?

b) Discuss the symmetry and fundamental modes of vibrations of CO_2 molecule.

c) The $J = 0 \rightarrow J = 1$ rotational absorption line occurs at 1.153×10^{11} cycles/s in $^{12}C^{16}O$ and at 1.102×10^{11} cycles/s in $^{n}C^{16}O$. Calculate the mass number of the unknown carbon isotope ? **(4×9=36)**