K19P 0306

Reg. No. : .....

Name : .....

II Semester M.Sc. Degree (Reg./Suppl./Imp.) Examination, April 2019
(2014 Admission Onwards)
PHYSICS
PHY2C09 : Spectroscopy

Time : 3 Hours Max. Marks : 60

SECTION – A

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

1. a) Explain with necessary theory normal and anomalous Zeeman effect.

   OR

   b) Find out the vibrational energy levels of a diatomic molecule undergoing anharmonic oscillations. Draw the energy level diagram showing some transitions between them.

2. a) Discuss the Raman spectra of (a) Symmetric top molecules (b) Spherical top molecules and (c) Asymmetric top molecules.

   OR

   b) What is Born-Oppenheimer approximation ? Explain the vibrational coarse structure. **(2×12=24)**

SECTION – B

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

3. a) What is Stark effect ?

   b) Explain the fine structure of hydrogen line of the hydrogen spectra on the basis of vector atom model.

   c) Evaluate the Lande's g factor for (i) pure orbital angular momentum (ii) pure spin angular momentum (iii) the state $^3P_1$.

P.T.O.

4. a) Give the different classification of molecules.

   b) Outline the effect of isotopic substitution on the rotational spectra of molecules.

   c) The observed rotational spectrum of HF shows the $J = 0 \rightarrow J = 1$ absorption at 41.11 cm^{-1}, the spacing between adjacent absorptions is 40.08 cm^{-1} around $J = 5 \rightarrow J = 6$ transition and only 37.81 cm^{-1} around $J = 10 \rightarrow J = 11$ transition. Calculate B values and I values from these three given data. Give the explanation for this variation.

5. a) Write the expression for the number of molecules in the J^{th} level of a diatomic molecule.

   b) Explain the various components of a microwave spectrometer.

   c) The band origin of a transition in C_2 is observed at 19378 cm^{-1} while the rotational fine structure indicates that the rotational constants in excited and ground states are respectively $B' = 1.7527\ cm^{-1}$ and $B'' = 1.6326\ cm^{-1}$. Estimate the position of the band head. Which state has the largest internuclear distance.

6. a) Give the principle of ESR.

   b) Electron spin resonance is observed for atomic hydrogen with an instrument operating at 9.5 GHz. If the g value for the electron in the hydrogen atom is 2.0026, what is the magnetic field applied ? Bohr Magneton, $\mu_B = 9.274 \times 10^{-24}\ JT^{-1}$.

   c) Write a note on the Interaction between nuclear spin and magnetic field.

7. a) List the basic requirements of a typical NMR spectrometer.

   b) Explain chemical shift with examples.

   c) Calculate the frequency for proton resonance at 1.5 T. Compare this with the vibrational frequency in H_2, $\bar{\nu}_{vib} = 4390\ cm^{-1}$ and the rotational frequency for the $J = 0 \rightarrow 1$ transition. Rotational constant $B = 61\ cm^{-1}$.

8. a) What is isomer shift ?

   b) Outline briefly the magnetic hyperfine interaction in Mossbauer spectroscopy.

   c) Calculate the recoil velocity of a free Mossbauer nucleus of mass $1.6\,7 \times 10^{-25}$ kg (equivalent to atomic weight 100) when emitting a γ-ray of wavelength 0.1 nm. What is the Doppler shift of the γ-ray frequency to the outside observer ?

(4×9=36)
