K20P 0354

Reg. No. : .....

Name : .....

II Semester M.Sc. Degree (CBSS – Reg./Suppl./Imp.)
Examination, April 2020
(2014 Admission Onwards)
PHYSICS
PHY2C09 : Spectroscopy

Time : 3 hours Max. Marks : 60

SECTION – A

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

1. a) Distinguish between symmetric top, spherical top and asymmetric top molecules. Discuss the rotational spectra of a linear polyatomic molecule.

OR

b) Explain the principle of NMR and obtain the resonance condition. Derive and discuss the Bloch equations.

2. a) Explain Raman effect with the help of an energy level diagram. Discuss the vibrational Raman spectra.

OR

b) Explain the rotational fine structure of electronic vibration spectra. **(2×12=24)**

SECTION – B

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

3. a) What is L-S coupling ?

b) Explain Paschen back effect.

c) Draw the Zeeman splitting of the ground state level $^3S_{1/2}$ and the excited state levels $3^2P_{1/2}$ and $3^2P_{3/2}$ of sodium. Also, draw the transitions allowed by the selection rules.

P.T.O.

4. a) Diatomic molecules such as CO, HF will show a rotational spectrum whereas N_2, O_2 will not. Comment.

   b) Give the schematic representation of a microwave spectrometer.

   c) What is the average period of rotation of HCl molecule of it is in the J = 1 state. The internuclear distance of HCl is 0.1274 nm. Given the mass of hydrogen and chlorine atoms are 1.673×10^{-27} kg and 58.06×10^{-27} kg respectively.

5. a) What parameters one can get from the study of vibration-rotation spectrum of a heteronuclear diatomic molecule ?

   b) What are hot bands ?

   c) The fundamental and first overtone transition of $^{14}N^{16}O$ are centred at 1876.06 cm^{-1} and 3724.20 cm^{-1} respectively. Evaluate the equilibrium vibration frequency, the anharmonicity constant, zero point energy and force constant of the molecule.

6. a) Why Anti Stokes lines are less intense than Stokes lines ?

   b) Explain mutual exclusion principle with example.

   c) If the bond length of H_2 is 0.07417 nm, what would be the position of the first three rotational Raman lines in the spectrum. What is the effect of nuclear spin on the spectrum ? $^1H = 1.673 \times 10^{-27}$ kg.

7. a) What is Fermi contact interaction ?

   b) A free electron is placed in a magnetic field of strength 1.3 T. Calculate the resonant frequency if g = 2.0023.

   c) i) Explain the principle of ESR.

      ii) Give the factors responsible for the hyperfine structure in ESR spectra.

8. a) Explain recoilless emission and absorption of gamma rays ?

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

   c) A Mossbauer nucleus ^{57}Fe makes the transition from the excited state of energy 14.4 keV to the ground state. What is its recoil energy ? **(4×9=36)**
