K23P 0506

Reg. No. : .....

Name : .....

II Semester M.Sc. Degree (CBSS – Reg./Supple./Imp.) Examination, April 2023
(2019 Admission Onwards)
PHYSICS
PHY 2C09 : Spectroscopy

Time : 3 Hours

Max. Marks : 60

SECTION – A

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

1. a) Give main features of the pure rotational band spectrum of a heteronuclear diatomic molecule. How are they explained, treating the molecule as a rigid rotator ? What information is provided by the study of its spectrum ?

   OR

   b) Discuss the main features of the vibrational-rotational spectra of diatomic molecules. How are they explained ? Why are such spectra not obtained for molecules having identical nuclei ?

2. a) Give an account of the salient features observed in the electronic spectrum of a diatomic molecule. Discuss the conditions under which the band-heads are degraded towards violet or red in the electromagnetic spectrum.

   OR

   b) Discuss the main features of the vibrational and pure rotational Raman spectra of diatomic molecules. Give the necessary theory. **(2×12=24)**

SECTION – B

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

3. a) Name the new concepts introduced by vector atom model.
   b) Explain the Paschen-Back effect.
   c) Calculate the two possible orientations of the spin vector $\vec{S}$ with respect to a magnetic field $\vec{B}$.

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4. a) Give the necessary condition for a molecule to show pure rotational spectrum.
   b) Write a note on the intensity of pure rotational lines.
   c) The spacing of a series of lines in the micro wave spectrum of AlH is constant at 12.604 cm^{-1}. Calculate the moment of inertia and the internuclear distance of the molecule. What are the energy of rotation and the rate of rotation when J = 15 ?

5. a) What is predissociation ?
   b) Explain Frank-Condon principle.
   c) The fundamental band for CO molecule is centered at 2143.3 cm^{-1} and the first overtone is at 4259.7 cm^{-1}. Calculate the vibrational frequency and the simple harmonic force constant of the molecule.

6. a) Define chemical shift.
   b) Distinguish between δ and τ chemical shifts.
   c) Obtain the ratio of number of proton spins in the lower state to that in the upper state, if a system of protons at a temperature of 27°C is placed in a magnetic field of 3 T. Given, $g_N = 5.585$.

7. a) Explain the principle of ESR.
   b) What are the factors responsible for the hyperfine structure in ESR spectra ?
   c) Electron spin resonance is observed in atomic hydrogen at magnetic field B = 0.34 T. Calculate g value for the electron in the hydrogen atom, if the operating frequency is 9.50 GHz. Into how many lines this transition splits due to hyperfine interaction. Represent the transitions in an energy level diagram. Given $\mu_B = 9.274 \times 10^{-24} JT^{-1}$.

8. a) Anti-stokes lines have much less intensity than stokes line. Why ?
   b) Explain recoilless emission and absorption of gamma rays.
   c) The fine structure lines of CN band at 3883.4 Å can be represented by the following equation $\bar{\nu} = 25798 + 3.85\ m + 0.068\ m^2\ cm^{-1}$. Calculate the separation between the null line and the band head and the direction of degradation of the band. **(4×9=36)**

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