



K16P 0429

Reg. No. :

Name :

Second Semester M.Sc. Degree (Regular/Supplementary/Improvement)
Examination, March 2016
(2014 Admn. Onwards)
PHYSICS
PHY 2C09 : Spectroscopy

Time : 3 Hours

Max. Marks : 60

SECTION – A

Answer **both** questions (either **a** or **b**) :

1. a) Distinguish between Normal Zeeman effect and anomalous Zeeman effect. Discuss the theory of Normal Zeeman effect and prove that the frequency shift is the same for all Normal Zeeman effect lines.

OR

- b) Discuss the rotation-vibration spectra of polyatomic linear molecules. Explain the effect of nuclear spin.

2. a) Describe the construction and working of a Raman spectrometer. Explain the importance of Raman effect for phase transition studies.

OR

- b) Explain recoilless emission and absorption of gamma rays. Discuss the working of a Mossbauer spectrometer. (2×12=24)

SECTION – B

Answer **any four** :

(1 mark for part **a**, 3 marks for part **b**, 5 marks for part **c**) :

1. a) What are linear molecules ? Give example.
b) Explain how rotational energy transitions take place.
c) Discuss the rotational spectra of rigid molecules. Draw the rotational energy levels and transitions for a rigid diatomic molecule.

P.T.O.



2. a) What is vibrational spectra ?
b) Derive an expression for the vibrational energy of a diatomic molecule.
c) The normal modes of vibration of CO_2 molecule are $\bar{\nu}_1 = 1330 \text{ cm}^{-1}$, $\bar{\nu}_2 = 667 \text{ cm}^{-1}$ and $\bar{\nu}_3 = 2349 \text{ cm}^{-1}$. Calculate the zero point energy of CO_2 molecule.
3. a) What is a diatomic vibrating rotator ?
b) In the vibration rotation spectrum of HBr, why is it that the rotational lines at the high frequency end of the R branch are closely spaced and those at the low frequency end of the P-branch widely spaced.
c) The fundamental band for HCl is centered at 2886 cm^{-1} . Assuming that the inter nuclear distance is 1276 \AA . Calculate the wave number of the first two lines of each of the P and R branches of HCl.
4. a) What is Raman effect ?
b) Why are anti stokes lines less intense than stoke lines ?
c) Explain a method for the determination of bond distance of a homo nuclear diatomic molecule.
5. a) What is a V' progression ?
b) Explain why the wave number separation of bands in the V' progression decreases towards shorter wavelengths while the wave number separation in the V'' progression decreases towards longer wavelengths.
c) The values of $\bar{\nu}_e$ for the lower and upper states of CO are 2170.21 cm^{-1} and $.0062$. The $(0, 0)$ transition observed at 64746.55 cm^{-1} . Estimate the energy difference of the two electronic states if for the lower and upper states of CO are 1515.61 cm^{-1} and $.0014$.
6. a) What is NMR ?
b) Explain how NMR frequency is related to the external magnetic field applied.
c) Find the energy difference between the spin up and spin down states of a proton in a magnetic field of $B = 1.00 \text{ Tesla}$. Estimate the Larmour frequency of the proton in the field ($g = 5.586$ and $\mu_n = 5.051 \times 10^{-27} \text{ J/T}$). **(4×9=36)**