

Exam. Code : 224802
Subject Code : 104778

M.Sc. Physics 2nd Semester (Batch 2023-25) (CBGS)
ATOMIC AND MOLECULAR SPECTROSCOPY
Paper : PHY-454

Time Allowed—3 Hours] [Maximum Marks—100

Note :—Attempt FIVE questions in all, selecting at least ONE question from each section. The fifth question may be attempted from any section. All questions carry equal marks.

SECTION—A

1. (i) Derive an expression for the Larmor precessional frequency. What is its importance? 10
- (ii) State and explain Lande interval rule for Russell-Saunders coupling. 10
2. (i) State Burger-Dorgelo-Ornstein rule for the relative intensity of spectral lines. Determine the ratio of the intensities of a principal-series doublet of sodium. 10
- (ii) Discuss the vector model of an atom consisting of two valence electrons in terms of L-S and j-j couplings. Show that the same number of terms is obtained for the configuration p-s in the two coupling schemes. 10

SECTION—B

3. (i) Show that line width due to Doppler broadening increases with temperature and decreases with increasing atomic weight. 10
- (ii) The ground state of chlorine atom is $^4P_{1/2}$. Find its magnetic moment. Into how many substates will the ground state split in a weak magnetic field? 10
4. What is anomalous Zeeman effect? Derive an expression for Lande's splitting g-factor and explain with its help, the Zeeman effect of the sodium doublet components D_1 and D_2 . <https://www.gnduonline.com> 20

SECTION—C

5. 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 this spectrum regarding the molecule? 20
6. (i) Discuss in detail the fine structure of infrared bands of molecule as vibrating-rotator. What are P, Q and R branches in the vibration-rotation spectrum. Explain their origin. 15

- (ii) Find the most populated rotational level for the molecule HCl at a temperature of 600 K. The moment of inertia of the molecule is $2.71 \times 10^{-47} \text{ kg m}^2$. Given : $h = 6.63 \times 10^{-34} \text{ Js}$ and $k = 1.38 \times 10^{-23} \text{ JK}^{-1}$. 5

SECTION—D

7. Discuss the quantum theory of Raman effect and describe the rotational and vibrational Raman spectrum of a diatomic molecule. 20
8. Describe Franck-Condon principle in emission and absorption. Discuss its importance. 20