

**S-484**

Total Pages : 3

Roll No. ....

## **MPHY-604**

### **Atomic and Molecular Spectroscopy**

M.Sc. Physics (MSCPHY)

3rd Semester Examination, 2022 (Dec.)

**Time : 2 Hours]**

**[Max. Marks : 35**

**Note :** This paper is of Thirty Five (35) marks divided into two (02) Sections A and B. Attempt the questions contained in these sections according to the detailed instructions given therein.

### **SECTION–A**

#### **(Long Answer Type Questions)**

**Note :** Section 'A' contains Five (05) long answer type questions of Nine and Half ( $9\frac{1}{2}$ ) marks each. Learners are required to answer any Two (02) questions only.

( $2 \times 9\frac{1}{2} = 19$ )

1. Derive the expression for Lande's splitting g-factor and explain it with help the Zeeman effect of sodium doublet components  $D_1$  and  $D_2$ .

2. Derive the rotational energy value for a diatomic rigid rotator by using the quantum mechanical model. Identify the transition frequency value for two rotational level transition.
3. What is Raman effect and how it is different from infrared spectra? Discuss how the change in polarizability leads to appearance of Stoke's and anti-Stoke's line.
4. Discuss the Stark effect and show that the first order Stark effect for the ground state of hydrogen is zero.
5. Distinguish between normal Zeeman, anomalous Zeeman and Paschen-Back effects. Determine the Lande g-values for the various levels of  $^3P$  and  $^3D$  multiplets.

### SECTION-B

#### (Short Answer Type Questions)

**Note :** Section 'B' contains Eight (08) short answer type questions of Four (04) marks each. Learners are required to answer any Four (04) questions only. (4×4=16)

1. State the Franck-Condon principle and briefly explain the three typical situations of intensity distribution in absorption band.
2. What do you understand by Lande g factor? Calculate the Lande g factor for an atom in the state  $^4D_{1/2}$ .

3. Differentiate between L-S and j-j coupling. Give examples to support your answer.
  4. Explain clearly the phenomenon of Zeeman effect and Paschen-Back effect.
  5. Write a short note on P, Q and R branches observed in IR spectrum of a diatomic molecule.
  6. Discuss Stark effect in weak field and strong field in hydrogen.
  7. Explain effect of isotopic substitution on rotational constant B.
  8. The first line ( $J = 0 \rightarrow J = 1$ ) in the rotational spectrum of carbon monoxide ( $^{12}\text{C}^{16}\text{O}$ ) has a frequency of  $3.8424 \text{ cm}^{-1}$ . Calculate the rotational constant and the C-O bond length in CO. Given Avogadro number is  $6.023 \times 10^{23} / \text{mol}$ .
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