

22023

M. Sc. Physics 2nd Semester  
Examination – May, 2019

ATOMIC AND MOLECULAR PHYSICS

Paper : Phy(H)-203

Time : Three hours ]

[ Maximum Marks : 80

Before answering the questions, candidates should ensure that they have been supplied the correct and complete question paper. No complaint in this regard, will be entertained after examination.

Note : Attempt five questions in all, selecting one question from each Unit. Question No. 1 is compulsory. All questions carry equal marks.

1. (a) What are the possible values of  $n$ ,  $l$  and  $m_s$  if a hydrogen atom has  $m_l = -2$  ?
- (b) Distinguish between the normal and anomalous Zeeman Effect.
- (c) The intensity of  $J = 0 \rightarrow J = 1$  is often not the most intense line. Why ?

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- (d) Write the main features of Vibrational rotational spectra of diatomic molecules.

UNIT – I

2. (a) Drive an expression for the spin orbit interaction energy. Draw energy level diagram for hydrogen atom. 10
- (b) Define gyromagnetic ratio. Find the relation between  $\mu_s$  and  $S$  of an electron. 6
3. Calculate the spin orbit interaction energy for a single non penetrating valence electron. How will you explain the separation of  $^2P$  and  $^2D$  terms of alkali spectra ? 16

UNIT – II

4. (a) Distinguish between normal Zeeman, anomalous Zeeman and Paschen back effects. Determine the Lande g-value for the various levels of  $^3P$  and  $^3D$  multiplets. 8
- (b) Illustrate with an energy level diagram, Paschen Back effect for the  $D_2$  line of sodium. 8
5. (a) Calculate Zeeman pattern for  $^3P_1 - ^3D_2$  transition in one electron atom. 6
- (b) Show by actual transitions the Stark effect components of  $H_\alpha$  line of hydrogen. 10

**UNIT – III**

6. Obtain the expression for the energy of a rigid-rotator model of diatomic molecule and predict the pure rotational spectra of the molecule. 10
7. (a) The far infra-red spectrum of  $\text{H}^1\text{Br}^{79}$  consists of a series of lines spaced  $17 \text{ cm}^{-1}$ . Find the internuclear distance of  $\text{H}^1\text{Br}^{79}$ . ( $h = 6.63 \times 10^{-34} \text{ J s}$ ,  $c = 3 \times 10^8 \text{ m/s}$  &  $N_A = 6.023 \times 10^{23} \text{ mol}^{-1}$ ). 8
- (b) Diatomic molecules such as CO, HF will show a rotational spectra whereas  $\text{N}_2$ ,  $\text{O}_2$ ,  $\text{H}_2$  will not. Why ? Will the molecule  $^{17}\text{O} - ^{16}\text{O}$  show a rotational spectra. 8

**UNIT – IV**

8. (a) Explain diatomic molecule as symmetric top. Deduce expression for the rotational energy levels of a symmetric-top molecule and discuss the structure of their vibrational bands. 12
- (b) Find the amplitude of vibration of HCl in the first excited vibrational level. The force constant  $k$  of the vibrating HCl molecule is  $480 \text{ N/m}$  and its reduced mass is  $1.62 \times 10^{-27}$ . ( $h = 6.63 \times 10^{-34} \text{ J s}$ ) 4
9. Discuss the fine structure of Infrared bands of diatomic molecules. Why they are all degraded towards longer wavelength ? 16