

Roll No.

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 ?

P. T. O.

- (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 μ_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_α 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 H^1Br^{79} consists of a series of lines spaced 17 cm^{-1} . Find the internuclear distance of H^1Br^{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 N_2 , O_2 , 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 N/m and its reduced mass is 1.62×10^{-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