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, Pachen Bach 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. 16

7. (a) The far infra-red spectrum of H^1Br^{79} consists of a series of lines spaced 17 cm^{-1}. Find the inter nuclear distance of H^1Br^{79}. ($h = 6.63 \times 10^{-34}$ J s, $c = 3 \times 10^8$ m/s & $N_A = 6.023 \times 10^{23}$ 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 $^{17}O - {}^{16}O$ 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}. ($h = 6.63 \times 10^{-34}$ J s) 4

9. Discuss the fine structure of Infrared bands of diatomic molecules. Why they are all degraded towards longer wavelength ? 16
