



ED-602

M.Sc. 3rd Semester
Examination, March-April 2021

PHYSICS

Paper - II

Atomic and Molecular Physics

Time : Three Hours] [*Maximum Marks* : 80

Note : Answer **all** questions. The figures in the right-hand margin indicate marks.

Unit-I

1. (a) (i) Explain the effect of spin-orbit interaction on the structure of a spectral line. Discuss the fine structure of $H\alpha$ line. 10

(ii) An electron have quantum number $l = 2$, determine the possible values of the components of angular momentum along a specified direction. 6

OR

(b) (i) Explain penetrating and non-penetrating orbits for a single valence electron. 12

DRG_65_(3)

(Turn Over)

(2)

- (ii) Calculate the spin-orbit interaction splitting of a level corresponding to $n = 2$ and $l = 1$ of hydrogen atom. 4

Unit-II

2. (a) (i) State, explain and deduce Pauli's principle. What is its physical significance? 8
- (ii) Explain two electron systems. 8

OR

- (b) What is L-S and J-J coupling? Deduce the interaction energy for it. 16

Unit-III

3. (a) Define normal and anomalous Zeeman effect. Derive g factor and interaction energy for anomalous Zeeman effect with suitable splitting diagram. 16

OR

- (b) (i) Explain Paschen-Back effect and spin-orbit correction for it. 10
- (ii) Compute the Zeeman pattern components for ${}^2D_{5/2} - {}^2P_{3/2}$ transition. 6

(3)

Unit-IV

4. (a) Explain rotational spectra of diatomic molecule. Deduce rotational energy of it with rotational energy level diagram. 16

OR

- (b) (i) Explain diatomic molecule as 'symmetric top'. Deduce expression for the rotational energy levels of a symmetric top molecules. 12
- (ii) The wave numbers of the lines in a band are given by $\nu = 1000(2n - 1)$ for n positive and by $\nu = -1000(2n + 1)$ for n negative. Calculate the moment of inertia of the emitter molecule of the spectrum. 4

Unit-V

5. (a) (i) Derive expression for vibrational frequency and force constant of anharmonic oscillator. 10
- (ii) Explain vibrational Raman Spectra. 6

OR

- (b) (i) Explain energy level diagram of a diatomic molecule as anharmonic oscillator. 14
- (ii) With exciting line 2536 \AA a Raman line for a sample is observed at 2612 \AA . Calculate the Raman shift in cm^{-1} . 2