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 Hα 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

(*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

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 Å a Raman line for a sample is observed at 2612 Å. Calculate the Raman shift in cm^{-1}. 2

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