Registration No.:

Total Number of Pages: 02

Course: M.Sc.I
Sub_Code: FPYC1001

10th Semester Regular Examination: 2024-25
SUBJECT: Atomic and Molecular Physics
BRANCH(S): M.Sc.I(AP)
Time : 3 Hours
Max Marks : 70
Q.Code : S008
Answer Question No.1 (Part-I) which is compulsory, any five from rest (Part-II)
The figures in the right hand margin indicate marks.

Part-I

Q1 Answer the following questions : **(2 x 10)**

a) Show that the most probable value of r for 1s electron in Hydrogen atom is the Bohr's radius a_0.

b) What are orbitals? How many nodes are there in 3s orbital?

c) Why excitation potential for the spectra of ions greater than that of neutral atoms in spectra of alkali atoms?

d) What is Lande interval rule?

e) What are the two useful information got from the knowledge of centrifugal distribution constant D?

f) Distinguish between symmetric top and asymmetric top molecule in respect to their energy level.

g) Write down the spectroscopic terms for the following cases
(i) L = 1, S = 1/2 (ii) L = 3, S = 3

h) Write the energy of vibrational-rotational spectra. Find the ground state energy of vibrational-rotational spectra.

i) With exciting line 4358 Å, a sample gives Stokes line at 4458 Å. Find the wavelength of the anti-Stokes line.

j) What are Fortrat diagrams? In a representative Fortrat diagram show the P-branches and R-branches.

Part-II

Long Answer Type Questions (Answer Any five)

Q2 a) What is hyperfine interaction? Derive an expression for the change in energy of one electron atom due to hyperfine interaction. **(5 + 5)**

b) Calculate the hyperfine splitting for $2_{P_{3/2}}$ state of Hydrogen atom if the hyperfine constant is 0.047 cm^{-1}.

Q3 What is central field approximation? Use it to obtain the energy spectrum of Helium atom. Calculate the screening constant for Helium atom in its ground state. On the basis of this theory schematically represent the Helium spectrum. **(10)**

Q4 **a)** What are the main features of alkali spectra and discuss the effect of spin orbit coupling on them. **(5 + 5)**

b) Considering L-S coupling, compute the possible terms for a configuration with three non-equivalent optically active electrons 2p 3p 4d.

Q5 **a)** Describe the principal features of the rotational band spectrum of a diatomic molecule. **(5 + 5)**

b) Estimate the energy difference between the rotational levels J = 0 and J = 1 of Hcl molecule if its moment of inertia is 2.66 X 10^{-47} Kgm^2.

Q6 What do you mean by normal modes of vibration of a molecule? Give an account of symmetry of normal modes of molecular vibration using group theory. **(10)**

Q7 Give the complete theory of vibrational-rotational spectrum of diatomic molecule. **(10)**

Q8 Write short answer on any TWO: **(5 + 5)**

a) Angular and radial distribution functions
b) Born-Oppenheimer approximation
c) Centrifugal Distortion
d) Frank-Condon principle