Islampur College

Department of Physics

Home Assignment for Internal Assessment

Sem: V (Major)

Paper Name: Atomic Physics

Paper Code: PHYSMAJ511

Submission Date: 20/11/2026

Submission Time: 1:00 PM-2:00 PM

Submission Room Number: 214

Full Marks: 20

Instructions to Students:

- Prepare the home assignment by answering all the questions given below. Write your answers neatly on A4-size paper. All questions and sub-questions are compulsory.

Problem 1. (a) What is population inversion in a laser? How can we achieve higher probability of stimulated emission as compared to that of spontaneous emission?
(b) Find the ratio of spontaneous emission to stimulated emission for a cavity of temperature 50 K and wavelength 10^{-5} m. [2+2+1]

Problem 2. (a) The ground-state wave function of a hydrogen atom is given by $\psi_{100} = \frac{1}{\sqrt{\pi a_0^3}} e^{-r/a_0}$. Show that the average distance of the electron from the nucleus is $1.5a_0$.
(b) For a hydrogen atom, verify that the radial probability distribution of a $1s$ electron has its maximum value at the Bohr radius.
(c) List the set of quantum numbers for n = 3; hydrogen atom. [2+2+1]

Problem 3. (a) What is JJ coupling? Why is it applicable only for heavy elements?
(b) Determine the possible values of L, S, and J under LS coupling for two atomic electrons with orbital quantum numbers $l_1 = 1$ and $l_2 = 2$. [1+2+2]

Problem 4. (a) Evaluate $[L_x^2 + L_y^2, L_z^2]$ and discuss the physical significance of the result obtained.
(b) Determine the normal Zeeman splitting of the cadmium red line 6438 Å when the atoms are placed in a magnetic field of 0.009 T.
(c) Explain which of the two elements, Na or Ba, exhibits the normal Zeeman effect. [2+1+1+1]