Assignment 1

Modern Physics(including Special Theory of Relativity)(PY251)

1. Derive an expression for the differential cross-section for energy transfer in elastic collision between a heavy charged particle and an electron.

2. A beam of protons of 5 MeV kinetic energy traverses a gold foil, one particle in 5×10^6 is scattered so as to hit a surface 0.5 cm^2 in area at a distance 10 cm from the foil and in a direction making an angle of 60° with the initial direction of the beam. What is the thickness of the foil?

3. When the electron in hydrogen atom jumps from second orbit to first orbit, a certain wavelength is emitted. When the electron jumps from the third orbit to first orbit, what is the new wavelength emitted in terms of the first wavelength?

4. What is the ratio of largest to shortest wavelengths in the Balmer series of the hydrogen spectrum?

5. In a hydrogen atom electron is jumped from the fifth orbit to first orbit. What is the recoil speed of the hydrogen atom in this process?

6. If the wavelength of the first member of the Balmer series in the hydrogen spectrum is 6564 $\mathring{A}$, what will be the wavelength of the second member of the Balmer series?

7. In the Bohr model of the hydrogen-like atom of atomic number Z the atomic energy levels of a single-electron are quantized with values given by

$$E_n = \frac{Z^2 m_e e^4}{8\varepsilon_0^2 h^2 n^2} \tag{1}$$

where m is the mass of the electron, e is the electronic charge and n is an integer greater than zero (principle quantum number)

What additional quantum numbers are needed to specify fully an atomic quantum state and what physical quantities do they quantify? List the allowed quantum numbers for n = 1 and n = 2 and specify fully the electronic quantum numbers for the ground state of the Carbon atom (atomic number Z = 6).