EASTERN UNIVERSITY, SRI LANKA

SECOND EXAMINATION IN SCIENCE - 2001/2002

(APRIL 2002)

REPEAT

PH 201 ATOMIC PHYSICS AND QUANTUM MECHANICS

Time: 02 hours.

Answer ALL Questions

You may assume the following information

(i) charge of electron $e = 1.602 \times 10^{-19} C$

(ii) mass of electron $m_e = 9.109 \times 10^{-31} kg$

(iii) Planck's constant $h = 6.26 \times 10^{-34} Js$

(iv) permitivity in free space $\varepsilon_0 = 8.854 \times 10^{-12} C^2 N^{-1} m^2$

(v) $1eV = 1.602 \times 10^{-19} \mathrm{J}$

SECTION A

1. Write down the postulates of Bohr's theory for hydrogen atom. Obtain an expression for wavelength of radiation when electron in hydrogen like atom jumps from a "outer orbit " to a "inner orbit" in terms of quantum numbers and Rydberg constant R_H

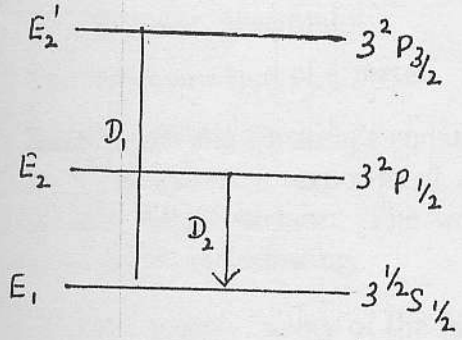
   The negative μ - meson has a charge equal to that of an electron but a mass about 207 times as great. Consider a hydrogen-like atom consisting of a proton and a μ - meson.

   (i) What is the ground state energy?

   (ii) What is the radius of the $n = 1$ Bohr orbit?

   (iii) What is the wave length of the radiation emitted in the transition from the $n = 2$ state to the $n = 1$ state?

2. What do you mean by Zeeman effect?
   Energy level diagram of D_1, D_2 lines of Na atom is given below in the diagram. The symbols have their usual meanings.



   (i) Draw possible spliting energy levels in the presence of magnetic field B.

   (ii) Draw possible transitions between these levels which obey selection rules.

   (iii) Calculate energy difference between these levels in terms of Bohr magneton μ_B and the magnetic field B and indicate in your diagram.

You may assume the following:
Lagendre factor

$$g_j = 1 + \frac{j(j+1) + s(s+1) - l(l+1)}{2j(j+1)}$$

Selection rules: allowed transitions

$$\triangle l = \pm 1$$

$$\triangle j = 0, \pm 1$$

$$\triangle m_j = 0, \pm 1$$

others will be prohibited.

SECTION B

3. What do you mean by Photoelectric effect? Define the following terms in Photoelectric effect.

   (i) threshold frequency

   (ii) stopping potential

   (iii) work function of a metal

   Write down the Einstein's equation for Photoelectric effect.
   In a Photoelectric experiment a light of wavelength $200nm$ falls on an aluminium surface. The work function of aluminium is $4.20eV$. Determine the following.

   (i) the kinetic energy of the fastest electron

   (ii) the stopping potential

   (iii) threshold wavelength

4. (a) Show that the change in wavelength of a photon subject to Compton scattering by an electron is given by

$$\triangle\lambda = \frac{h}{m_0 c}(1 - cos\theta)$$

the symbols have their usual meanings.
Show that the ratio of the kinetic energy of the recoil electron to the energy of the incident photon of wavelength λ is given by

$$\frac{\Delta\lambda}{\lambda + \Delta\lambda}$$

(b) Write down the time-independent Schrodinger's equation in a rectangular cartesian coordinate system for a particle of mass m and the energy E moving in a potential V. By solving this equation find the wave function of a particle with zero potential energy.