EASTERN UNIVERSITY, SRI LANKA

SECOND EXAMINATION IN SCIENCE – 2013/2014

FIRST SEMESTER (February/March 2016)

PH 201 ATOMIC PHYSICS AND QUANTUM MECHANICS

me: 02 hour.

nswer ALL Questions

---

u may find the following information useful

Charge of electron $e = 1.602 \times 10^{-19} C$

Mass of electron $m = 9.109 \times 10^{-31} kg$

Planck's constant $h = 6.63 \times 10^{-34} Js$

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

$1\,eV = 1.602 \times 10^{-19} J$

$c = 3 \times 10^8 ms^{-1}$

01.

(a) State the postulates of Bohr regarding his atomic model and henc the electron energy of the n^{th} orbit is expressed by

$$E_n = -\left[\frac{me^4}{2\hbar^2(4\pi\varepsilon_0)^2}\right]\frac{1}{n^2}$$

where the symbols have their usual meaning.

i. Calculate the value of the Rydberg constant, assuming that wavelen is 6563 Å.

ii. Determine the wavelengths of the first two lines of the Pachen series

(b) State and explain Pauli's exclusion principle as applied to electrons i the basis of this principle write down the electron configuration for employing modern symbolism and explain it.

02.

(a) Differentiate Russel-Saunders (or *LS*) coupling scheme from *jj* coupling s

(b) Explain briefly the nature of the Zeeman effect in a magnetic field.

The sample of atomic hydrogen is placed in a weak magnetic field of st the hydrogen atom makes the transition from state $n = 2$ to $n = 1$ and emission of three spectral lines, show that the frequency of these three sp are approximately given by

$$\nu_1 = \nu_0 - \frac{eB}{4\pi m}$$

$$\nu_2 = \nu_0$$

$$\nu_3 = \nu_0 + \frac{eB}{4\pi m}$$

where ν_0 is the frequency of the radiation emitted by the transition in the the magnetic field, and the other symbols have their usual meaning.

xplain the experimental setup to observe photoelectric effect. Hence, define the llowing terms in photoelectric effect.

i. threshold frequency
ii. stopping potential
iii. work function of a metal

rite down Einstein's equation adopted in photoelectric effect and show how it plains the main characteristics of the effect. Hence, outline how to determine the anck's constant and the work function of a given metal using the above perimental setup.

a photoelectric experiment a light of wavelength 200 nm falls on an aluminium rface. The work function of aluminum is 4.20 eV. Determine the following

i. the kinetic energy of the fastest electron
ii. the stopping potential
iii. threshold wavelength

State and write down the expression for the Heisenberg uncertainty principle which efers to the simultaneous determination of time-energy and position-momentum of a particle.

A particle of mass m and energy E is moving in a potential V inside an infinite square potential well of width a, described by

$$V = 0, \quad \text{for } 0 \leq x \leq a$$
$$V \to \infty, \quad \text{for } x > a \text{ and } x < 0.$$

i. Write down the time-independent Schrödinger equation in a rectangular Cartesian co-ordinate system, for the motion of the particle.
ii. State clearly the boundary conditions and normalization condition for the wave function ψ.
iii. Using the above conditions, show that the wave function of the particle is given by $\psi = \sqrt{\frac{2}{a}} \sin\left(\frac{n\pi}{a}\right) x$.