

EASTERN UNIVERSITY, SRI LANKA
THIRD YEAR FIRST SEMESTER EXAMINATION IN SCIENCE -
2021/2022
(Sep/Oct - 2024)
PH 3021-ATOMIC PHYSICS

Time : 01 hour

Answer All Questions

You 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 $\epsilon_0 = 8.854 \times 10^{-12} C^2 N^{-1} m^2$

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

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

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

$$E_n = - \left[\frac{me^4}{2\hbar^2(4\pi\epsilon_0)^2} \right] \frac{1}{n^2}$$

where the symbols have their usual meaning.

Calculate the value of the Rydberg constant, assuming that the wavelength of H_α line is 6563 \AA . Hence, determine the wavelengths of the first two lines of the Paschen series?

(60 marks)

(b) Explain the physical significance of the four quantum numbers, which characterize the eigen states of the electron in a hydrogen atom. Write down the allowed values for each quantum numbers?

(20 marks)

(c) Write brief description on the following coupling schemes:

(i) Russel-Saunders (or *LS*) coupling

(ii) *jj* coupling

(20 marks)

2.

(a) What is meant by *Zeeman effect*?

Explain how the *normal longitudinal Zeeman effect* and *normal transverse Zeeman effect* are observed when a spectral line is viewed using a high resolution spectrometer, in presence of an applied magnetic field.

(30 marks)

(b) Explain the effect of magnetic field on energy levels of an atom in *Zeeman effect* based on quantum theory and obtain an expression for *Zeeman shift*.

(50 marks)

(c) The *Zeeman components* of a 500 nm spectral line are 0.0116 nm apart when the magnetic field is 1.00 T . Find the ratio of e/m for the electron.

(20 marks)
