UNIVERSITY OF EMBU

2016/2017 ACADEMIC YEAR

SECOND SEMESTER EXAMINATION

SECOND YEAR EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE AND BACHELOR OF EDUCATION SCIENCE

SPH 203: STRUCTURE AND PROPERTIES OF MATTER

DATE: APRIL 5, 2017 **TIME: 8:30-10:30 AM**

INSTRUCTIONS:

Answer Question ONE and ANY Other TWO Questions.

Constants:

$g = 9.81\ ms^{-2}$	$k = 1.38 \times 10^{-23}\ J/K$
$c = 3.0 \times 10^{8}\ m/s$	$e = 1.6 \times 10^{-19}\ C$
$m_e = 9.1 \times 10^{-31}\ kg$	$h = 6.6 \times 10^{-34}\ JS$
$\varepsilon_o = 8.86 \times 10^{-12}\ C^2/Nm^2$	$\mu_o = 4\pi \times 10^{-7}\ Wbm^{-2}$
Ionization of hydrogen atom = 13.6 eV	Surface tension of water = $0.072\ Nm^{-1}$

QUESTION ONE (30 MARKS)

a) Calculate the root mean square speed of small particles of mass 4×10^{-17} kg in air at $0\ ^0C$ and 1 atm pressure. (2 marks)

b) A circular wire ring of radius 3 cm was placed on a flat surface of a liquid and then raised. The force required to raise the film was equal to 3. 03 g mass more before the film broke than after it broke. Determine the surface tension of the liquid. (4 marks)

c) Explain the concept of state variables of a system of a gas by giving relevant examples. (4 marks)

d) Differentiate between extensive and intensive thermodynamic systems. (3 marks)

e) Find the force required to stretch a steel wire to double its length if its area of cross-section is $1cm^2$ and its young modulus is $2 \times 10^{11}\ N/m^2$. (2 marks)

f) Find the value of plank's constant h, if photoelectrons ejected from a surface of a certain metal by light of frequency 2.2 x 10^{15} Hz are fully retarded by a reverse potential of 6.6 V and those ejected by light of frequency 4.6 x 10^{15} Hz are stopped by a reverse potential of 16.5 V. (4 marks)

g) Briefly describe a quasi-statistic process. (4 marks)

h) Find the eigen values of the matrix given as: $\begin{pmatrix} 1 & 0 \\ 0 & 2 \end{pmatrix}$ (4 marks)

i) Give the physical interpretation of the wave function Ψ for an electromagnetic wave system. (3 marks)

QUESTION TWO (20 MARKS)

a) Determine the time taken by an electron to traverse the first Bohr's orbit in a hydrogen atom. (6 marks)

b) Explain the classical probability distribution of the correspondence principle. (9 marks)

c) Using a square matrix A, explain and show its eigen values and their corresponding eigen vectors. (5 marks)

QUESTION THREE (20 MARKS)

Consider a perfect gas enclosed in a cube of side *l* which has perfectly elastic walls. Let each gas molecule have a mass, m, and the number of molecules present in the cube be n. Suppose the molecules move with a speed c_1, find:

a) The total force exerted by all the n molecules on one face of the cube. (13 marks)

b) Show that the pressure exerted by the ideal gas on the cube walls is given by:

$$P = \frac{1}{3}\rho c^2$$ (7 marks)

QUESTION FOUR (20 MARKS)

a) A beam of x- rays of wavelength $\lambda = 8.42 \times 10^{-11}$ m was incident on a crystal plane at a glancing angle of 8°35' when the first order Bragg's reflection occurs. Calculate the glancing angle for the third order reflection. (7 marks)

b) A single electron orbits around a stationary nucleus of charge +Ze. It requires 47.2 eV to excite the electron from the second Bohr's orbit to the third. Suppose Z is a constant:

i. By obtaining the value of Z, find the energy required to excite the electron from the third to the fourth orbit.

(8 marks)

ii. Find the wavelength of the electromagnetic radiation required to remove the electron from first Bohr's orbit to infinity. (5 marks)

QUESTION FIVE (20 MARKS)

a) By giving an example briefly explain the use of the zeroth law of thermodynamics to measure temperature. (7 marks)

b) A steel wire of 2 mm diameter is stretched between two fixed points at a temperature of 20 °C. Find its tension when the temperature falls to 10 °C. (6 marks)

c) By use of the properties of a particle and those of a wave elaborate on the wave – particle duality of radiation. Give examples (7 marks)

END