UNIVERSITY OF EMBU

2018/2019 ACADEMIC YEAR

SECOND SEMESTER EXAMINATIONS

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

SPH 203: STRUCTURE AND PROPERTIES OF MATTER

DATE: APRIL 9, 2019 **TIME: 11:00 AM – 1:00 PM**

INSTRUCTIONS:

Answer Question ONE and ANY Other TWO Questions.

Constants:

$c = 3.0\times10^{8}$ 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	$k = 1.38 \times 10^{-23} JK^{-1}$
$\mu_o = 4\pi \times 10^{-7}$ N/A.M	1 eV = 1.6×10^{-19} J
$m_n = 1.65 \times 10^{-27}$ kg	$g = 9.8\ ms^{-2}$
Density of steel = $7800\ kg\ m^3$	Surface tension of water= 0.075

Critical electric field strength that leads to break down in air is 3.0×10^6 N/C

QUESTION ONE (30 MARKS)

a) Compare Bohr's and Rutherford's postulates of an atomic model (3 marks)

b) Explain the basis on the differences between the liquid and gaseous phases of matter (4 marks)

c) In an experiment with a gas in vacuum, a pressure of 10^{-13} m of mercury was attained. Determine the number of molecules of gas per cubic meter at 293 K in the vacuum (3 marks)

d) Differentiate between fracture and deformation (2marks)

e) Determine the Debroglie wavelength of 10 k Ev neutron (4 marks)

f) A load 2 kg produces an extension of 1 mm in a wire 3m in length and 1 mm in diameter. Determine the Young's modulus of the wire (3 marks)

g) A wire in form of a ring of radius 3 cm was rested flat on the surface of a liquid and then raised. The pull required was 3.03 g more before the film broke than after. Calculate the surface tension of the liquid (3 marks)

h) Calculate the average energy of an oscillator if its frequency is 5.0×10^{14} and the temperature was 500 K (4 marks)

i) Find the greatest length of steel wire which if fixed at one end can hang without breaking (Breaking strength of steel is 7.8×10^{8} Nm^{-2} (3 marks)

j) Define the center of mass, r_{cm}, of two masses m_1 and m_2 which are distances r_1 and r_2 cm respectively with respect to the origin (1 mark)

QUESTION TWO (20 MARKS)

a) The potential energy function for the force between two atoms in a diatomic molecule can be expressed as follows:

$$V_{x=}\frac{a}{x^{12}}-\frac{b}{x^{6}}$$

(a and b are constants and x is the distance between the two atoms). Derive the expression for the force between the two atoms and show that the two atoms repel each other for x less than x_o and attract each other for x greater than x_o (10 marks)

b) A column of mercury of length 10 cm was contained in the center of a narrow horizontal tube of length 1 m soldered at both ends as shown in Figure 1. The air in both halves of the tube was at atmospheric pressure of 76 cm of mercury. (10 marks)

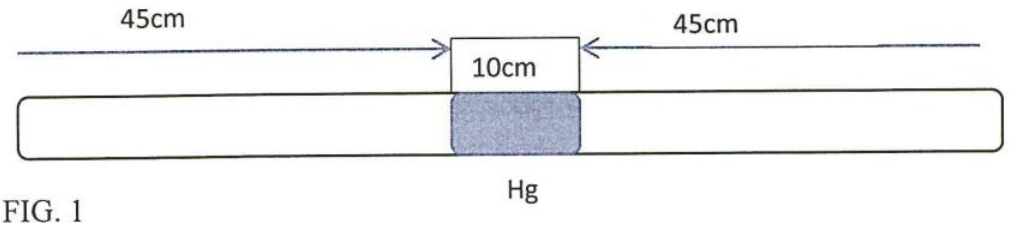

FIG. 1

Find the distance between the mercury column moved when the tube was placed vertically

(10 marks)

QUESTION THREE (20 MARKS)

a) Classify composites with respect to origin. For each class give an example

(6 marks)

b) Considering small variations of energy between one orbital of an atom and the next one, explain the correspondence principle

(7 marks)

c) Aan x ray analysis of a crystal was made with monochromatic x rays of wavelength 0.58×10^{-10} m. Bragg's reflections were obtained at angles of 6.45°, 9.15°and 13°. Determine the interplanar spacing of the crystal

(7 marks)

QUESTION FOUR (20 MARKS)

a) Using a diagram briefly explain an experiment that demonstrated the wave nature of an electron

(6 marks)

b) Determine the amount of energy that will be liberated if 1000 droplets of water each 5×10^{-9} m in diameter coalesce to form one big spherical drop.

(7 marks)

c) Find the eigen values of the matrix A given as

$$A = \begin{pmatrix} 1 & -3 & 3 \\ 3 & -5 & 3 \\ 6 & -6 & 4 \end{pmatrix}$$

(7 marks)

QUESTION FIVE (20 MARKS)

a) Briefly explain a macroscopic system with respect to a boundary, surrounding and the system itself

(8 marks)

b) By giving examples explain the nature of various modes which occur in phases transitions

(12 marks)

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