



# EMBU UNIVERSITY COLLEGE

(A Constituent College of the University of Nairobi)

2015/2016 ACADEMIC YEAR

SECOND SEMESTER EXAMINATION

SECOND YEAR EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE

SPH 203: STRUCTURE AND PROPERTIES OF MATTER

DATE: APRIL 6, 2016

TIME: 08:30-10:30

**INSTRUCTIONS:**

Answer Question ONE and ANY Other TWO Questions

**Constants:**  $e = 1.6 \times 10^{-19} \text{ C}$   $m_e = 9.1 \times 10^{-31} \text{ Kg}$   
 $h = 6.6 \times 10^{-34} \text{ Js}$   $c = 3.0 \times 10^8 \text{ ms}^{-1}$   
 $\epsilon_0 = 8.86 \times 10^{-12}$   $K = 1.38 \times 10^{-23} \text{ J/K}$

**QUESTION ONE**

- a) What is the purpose of an atomic model? (2 Marks)
- b) Explain two drawbacks of Rutherford atomic model. (4 Marks)
- c) An electron is occupying the ground state of the hydrogen atom. Find its velocity. (3 Marks)
- d) What are state variables? Give an example in the case of an ideal gas. (2 Marks)
- e) Calculate the root mean square speed of dust particles of mass  $4 \times 10^{-17} \text{ kg}$  in air at  $0^\circ\text{C}$  and at 1 atmospheric pressure. (3 Marks)
- f) Differentiate between stress and deformation. (2 Marks)
- g) A beam of x-rays of  $\lambda = 0.842 \text{ \AA}$  is incident on a crystal at a grating angle of  $8^\circ 35'$  when the first order Bragg's reflection occurs. Calculate the glancing angle for the third order reflection. (4 Marks)

- h) Determine the difference of pressure between the inside and outside of a spherical drop of water at radius 1 mm. surface tension = 0.073 N/m. (3 Marks)
- i) A steel wire was loaded with a force F, which caused it to triple its length. If its area of cross section was  $1\text{ cm}^2$  and the young modulus was  $2 \times 10^{11}\text{ Nm}^{-2}$ , find the value of F. (3 Marks)
- j) Using an example explain an irreversible process in nature. (4 Marks)

### QUESTION TWO

- a) Consider an infinite potential well whose potential energy, U, is defined as a function of spatial coordinate x as

$$U(x) = \begin{cases} \infty & \text{for } x < 0, \\ 0 & \text{for } 0 \leq x \leq a, \\ \infty & \text{for } x > a \end{cases}$$

Show the possible solution of Schrodinger equation (14 Marks)

- b) A gas occupying 1 liter at 80 cmHg is expanded adiabatically to  $1190\text{ cm}^3$ . If the pressure falls to 60 cmHg, find the value of  $\gamma$ . (6 Marks)

### QUESTION THREE

- a) Briefly explain the classical probability distribution as applied to the correspondence principle. (10 Marks)
- b) Calculate the surface temperature in  $^{\circ}\text{C}$  of the sun and moon given that  $\lambda_m = 4573$  and  $14\ \mu$  respectively where  $\lambda_m$  is the maximum intensity of emission. (10 Marks)

### QUESTION FOUR

Using examples, explain the particle wave duality of light. (20 Marks)

### QUESTION FIVE (20 MARKS)

A gas of mass m g, was enclosed in a perfectly insulated container at a pressure, P, temperature, T, and a volume, V. It was made to expand by moving the piston outwards. Show that for a unit mass of gas the work done by the gas is given by:

(20 Marks)

$$W = \frac{R}{\alpha - 1} (T_1 - T_2)$$

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