



EMBU UNIVERSITY COLLEGE
(A CONSTITUENT COLLEGE OF THE UNIVERSITY OF NAIROBI)

TRIMESTER EXAMINATIONS 2013/2014

SECOND YEAR EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE

SPH 203: STRUCTURE AND PROPERTIES OF MATTER

DATE: AUGUST 4, 2014

TIME: 11.00AM – 1.00PM

INSTRUCTIONS:

Answer Question ONE and ANY Other TWO Questions.

$$e = 1.6 \times 10^{-19} \text{ C}$$

$$\epsilon_0 = 8.86 \times 10^{-12}$$

$$m = 9.1 \times 10^{-31} \text{ Kg}$$

$$R = 8.32 \text{ J/molK}$$

$$h = 6.6 \times 10^{-34} \text{ JS}^{-1}$$

$$\rho_{\text{water}} = 1000 \text{ Kg/m}^3$$

$$c = 3.0 \times 10^8 \text{ m/s}$$

$$g = 9.81 \text{ m/s}^2$$

Coefficient linear expansion of steel is equal to $11 \times 10^{-6} \text{ } ^\circ\text{C}$

Y for steel is $2 \times 10^{11} \text{ N/m}^2$.

QUESTION ONE

- a) i) What is the difference between an atom and an elementary particle? Give an example of each (3 marks)
- ii) What is the difference between mean velocity and root mean square velocity of a gas particle? (2 marks)
- iii) Distinguish between surface tension and surface film. (2 marks)

- iv) What is the difference between a perfectly elastic body and a perfectly plastic body?
(2 marks)
- b) A mass of 2 kg produces an extension of 1 mm in a wire 3 m in length and 1mm in diameter. Calculate the young modulus of the wire. (3 marks)
- c) Calculate the longest wavelength than can be analyzed by a rock salt crystal of spacing $d= 2.82 \text{ \AA}$ in the first order. (2 marks)
- d) A mass of gas occupies 100 cm^3 at a temperature of 50°C . At what temperature will its volume become double if the pressure is kept constant? (3 marks)
- e) Briefly discuss the zeroth law of thermodynamics. (3 marks)
- f) Sketch the classical distribution of finding a particle at a particular position in an oscillator potential. (3 marks)
- g) What is absolute zero temperature? (2 marks)
- h) What is the difference of pressure between the inside and outside of a spherical drop of water of radius 1 mm? (3 marks)

QUESTION TWO

- a) Consider a perfect gas stored in a cube of side l cm with perfectly elastic walls, mass of each gas particle is m , number of particles present in the gas is n and that there is a particle having a velocity C_1 in the cube. Show that pressure P exerted by the gas is given by:-

$$P = \frac{mnc^2}{3v} \quad (10 \text{ marks})$$

- b) Determine the average value of kinetic energy of molecules of an ideal gas at 273K and at 373K. What is the kinetic energy per mole of an deal gas at these temperatures?
(10 marks)

QUESTION THREE

- a) Describe five features of Bohr's atomic model. (10 marks)
- b) Show that for large values of principal quantum numbers, the frequencies of an electron rotating in adjacent energy levels of hydrogen atom and the radiated frequencies for a transition between these levels all approach the same value. (7 marks)
- c) Discuss three assumptions of kinetic theory of ideal gases. (3 marks)

QUESTION FOUR

- a) What is surface tension? (2 marks)
- b) Consider four molecules A, B, C and D in a liquid as follows: - A: lies inside the liquid, B: lies just before the surface, C: lies at midway of surface and D just lies above the surface. Explain how surface tension arises using the molecules. (10 marks)
- c) A sphere of water of radius 1 mm is sprayed into one million drops all of the same size. Find the energy used in doing so. (8 marks)

QUESTION FIVE

- a) Explain the concept of wave particle duality. (4 marks)
- b) Consider a particle of mass m moving along x -axis between two rigid walls A and B at $x = 0$ and $x = a$ in a one dimensional box. Show that the energy of the particle is given by:- (10 marks)

$$E_n = \frac{n^2 h^2}{8ma^2}$$

- c) A steel wire 2 mm in diameter is just stretched between two fixed points at a temperature of 20°C . Determine its tension when temperature falls to 10°C . (6 marks)

-END-