



# EMBU UNIVERSITY COLLEGE

(A Constituent College of the University of Nairobi)

2015/2016 ACADEMIC YEAR

SECOND SEMESTER EXAMINATION

FIRST YEAR EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE  
(ANALYTICAL CHEMISTRY) AND BACHELOR OF SCIENCE (INDUSTRIAL  
CHEMISTRY)

SCI 101: ELEMENTS OF PHYSICS

DATE: APRIL 14, 2016

TIME: 8:30-10:30

INSTRUCTIONS:

Answer Question ONE and ANY other two Questions

**Constants:**

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

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

$$m_e = 9.1 \times 10^{-31} \text{ kg}$$

$$\text{Plank's constant } h = 6.6 \times 10^{-34} \text{ JS}$$

$$\epsilon_0 = 8.86 \times 10^{-12} \text{ C}^2/\text{Nm}^2$$

QUESTION ONE

- a) You are provided with the following vectors  $\vec{x} = 3.0\hat{i} - 4.0\hat{j}$  and  $\vec{y} = -2.0\hat{i} - 3.0\hat{k}$  using  $\vec{x}$  and  $\vec{y}$  differentiate between a vector product and a scalar product. (4 Marks)
- b) A particle of mass 3 kg starts from rest and moves under a force of  $4\hat{i} + 8\hat{j} + 10\hat{k}$  N. find its position after 3 seconds. (4 Marks)
- c) Giving an example, explain Huygen's principle. (4 Marks)
- d) A wave is propagated with a speed  $v$ , through a medium. The frequency of the wave is  $f$ , and it has a period  $T$ . Derive the wave equation. (3 Marks)
- e) What are the conditions required for interference of waves to occur? (3 Marks)

- f) A satellite exploring Jupiter transmits data to the Earth as a radio wave with a frequency of 200 MHz. How long does the signal take to travel 800million kilometers from Jupiter to Earth? (3 Marks)
- g) What are the properties of matter waves? (2 Marks)
- h) What are the assumptions that were made in developing Bohr's atomic model? (2 Marks)
- i) A spectral line of wavelength  $4 \times 10^{-5}$ cm in the spectrum of light from a star is found to be displaced from its normal position towards the red end of spectrum by  $10^{-6}$  cm. Find the velocity of the star in the line of sight. (3 Marks)
- j) Using a diagram explain the propagation of electromagnetic waves in space. (2 Marks)

### QUESTION TWO

- a) Consider an atom of hydrogen and find the following of its characteristics.
- Velocity of electron in ground state. (2 Marks)
  - Radius of Bohr's orbit in ground state. (2 Marks)
  - Time taken by the electron to traverse the first Bohr orbit. (2 Marks)
  - Rydberg's constant. (2 Marks)
- b) Two waves whose frequencies are the same but amplitudes,  $a$ , and  $3a$ , respectively are superimposed over each other. The amplitudes of the resulting wave is  $A$ . find the maximum value of  $A$ . (4 Marks)
- c) Consider a particle of mass  $m$  which is located at a point  $P$  with a linear momentum of magnitude  $\vec{P}$ . Show that the torque,  $\tau$ , of the particle with respect to a fixed point  $O$  is given by:

$$\tau = \frac{dL}{dt} = 0 \quad (8 \text{ Marks})$$

### QUESTION THREE

- a) Ethanol of density  $791\text{kg/m}^3$  flows smoothly through a horizontal pipe that has different cross sectional areas from  $A_1 = 1.20 \times 10^{-3} \text{ m}^2$  to  $A_2 = A_1/2$ . The difference in pressure between the wide and the narrow sections of the pipe is  $4120\text{Pa}$ . find the volume flow rate,  $R_v$ , of ethanol. (10 Marks)



- b) A car accelerates from rest at a constant rate  $a_1$  for some time after which it decelerates at a constant rate  $a_2$  to come to rest. If the total time lapse is  $t$  seconds, calculate:
- i) Maximum velocity reached (5 Marks)
  - ii) Total distance travelled (5 Marks)

#### **QUESTION FOUR**

- a) A railway engine of mass 5 tons travels along a level track at 75 km/h and collides with a wagon of mass 15 tons travelling in the opposite direction at 20 km/h. After the impact the engine is seen to be travelling in the same direction as before with a speed of 3 km/h. Find the speed of the wagon. (8 Marks)
- b) The diameter of the first ring of a zone plate is 1 mm. If the plane waves of wavelength  $5000 \times 10^{-10}$  m fall on the plate, find the position of a screen to focus on the brightest spot. (5 Marks)
- c) A force of  $4i + 8j + 10k$  N acts on a particle of mass 6 kg. If the particle starts from rest, calculate:
- i) Maximum velocity reached (4 Marks)
  - ii) The position of the particle after 6s. (3 Marks)

#### **QUESTION FIVE**

- a) A uniform rod of 4m length and weighing 15 kg is supported in a horizontal position on a fulcrum with weights of 20 kg and 25 kg suspended from its ends. Find the position of the fulcrum. (7 Marks)
- b) A block of wood of mass 4.5 kg hung from a cord. A bullet of mass 9.5 g collided into the block coming quickly to rest. They both swung a vertical distance of 6.3 cm before the pendulum came momentarily to rest at the end of the arch. Find the speed of the bullet prior to the collision. (6 Marks)
- c) Briefly explain the structure of a ruby laser light (7 Marks)

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