TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Applied & Health Sciences

DEPARTMENT OF MATHEMATICS & PHYSICS

UNIVERSITY EXAMINATION FOR:

BACHELOR OF SCIENCE IN MARINE REOURCE MANAGEMENT

APS 4109: FUNDAMENTALS OF PHYSICS

END OF SEMESTER EXAMINATION

SERIES: APRIL 2014

TIME ALLOWED: 2 HOURS

Instructions to Candidates:

You should have the following for this examination

- *Mathematical tables*
- *Scientific Calculator*

This paper consist of **FOUR** questions

Answer question **ONE (COMPULSORY)** and any other **TWO** questions

Maximum marks for each part of a question are as shown

This paper consists of **FOUR** printed pages

Question One (Compulsory)

a) (i) Differentiate between fundamental and derived quantities. Give an example of each and the corresponding units. **(2 marks)**

(ii) Find by dimensional analysis an expression for electric potential. **(3 marks)**

b) A kitten of mass 0.6kg leaps at 30^{o} to the horizontal out of a toy truck of mass 1.2kg causing it to move over the horizontal ground at 4m/s. At what speed did the kitten leap? **(4 marks)**

c) (i) State Columb's Law **(1 mark)**

(ii) Figure 1 shows three charges, A, B and P in a line. The charge at A is positive, that at B is

negative and that at P is positive. The values are as shown. Calculate the force on the change at P $\left(\frac{1}{4}\pi\varepsilon_o = 9\times10^9\, Nm^2\right)$

due to A and B.

$1 \times 10^{-9}C$

d) Show that the expression for changing a capacitor through a resistor is given by:

$$Q = Qo\left(1 - e^{-t/RC}\right)$$

where the symbols have their usual meaning. **(5 marks)**

e) A stone of mass 0.6kg attached to a string of length 0.5m is whirled in a horizontal circle at a constant speed. If the maximum tension in the string is 30N before its breaks, calculate:

(i) The maximum speed of the stone **(3 marks)**

(ii) The maximum no. of revolutions per second it can make **(2 marks)**

$$y = 10\sin\left(200\pi t - \frac{\pi}{0.17}x\right)$$

e) Consider a ware represented by

Find:

(i) The speed of the ware **(3 marks)**

(ii) The period of the ware **(2 marks)**

Question Two

a) A ball A of mass 0.4kg moving with velocity 5m/s collides head on with ball B of mass 0.2kg moving with velocity 2m/s. After collision, A moves with velocity 6m/s

(i) Show that the collision obeys the law of conservation of momentum. **(5 marks)**

(ii) Is the momentum elastic or inelastic? Prove. **(5 marks)**

b) A body of mass 5kg is pulled up a plane inclined at an angle of 30^o to the horizontal by a force of 40N acting parallel to the plane. If the frictional force between the plane and the body is 10N, find the acceleration of the body. ($g = 9.8m/s^2$) **(5 marks)**

c) A ball is thrown vertically upwards at 10m/s from a bridge which is 15m above the river.

(i) What is the speed of the stone as it hits the river? **(3 marks)**

(ii) With what speed would it hit the river if it were thrown downwards at 10m/s ($g = 9.8m/s^2$) **(2 marks)**

Question Three

a) A car of mass 1.2 x 10^3 kg moves 300m up a road which is inclined to the horizontal at an angle α where $\alpha = \frac{1}{15}$ By how much does the potential energy increase? (Take g = 9.8m/s^2) **(1 mark)**

b) (i) Define critical angle. **(1 mark)**
(ii) What are the conditions necessary for total internal reflection? **(2 marks)**

(iii) Briefly describe THREE properties of wave nature of light. **(6 marks)**

(iv) State the laws of refraction. **(2 marks)**

c) Find the angle of refraction:
(i) When a ray of light travels from air to glass at a an angle of 40^o **(3 marks)**
(ii) When a ray travels from glass to air at an angle of 20^o (refractive index of glass with respect to air = 1.5) **(3 marks)**

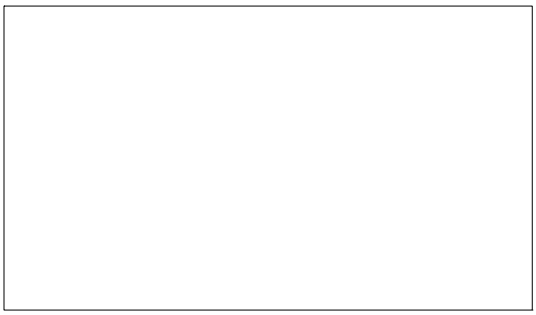
Question Four

a) (i) Two capacitors of capacitances 4 μF and 8 μF are charged to potential of 3V and 6V respectively. These two charged capacitors are then connected in parallel. Find the charge across each of the capacitors now. **(5 marks)**

(ii) In the figure 2 the energy stored in C4 is 27J. Calculate the total energy stored in the system. **(8 marks)**

b) Calculate the electrical conductivity of the material of a conductor of length 3m, area of cross-section 0.02mm^2 and having a resistance of 2 Ω **(2 marks)**

c) In the circuit shown in figure 3, the current in the 4 Ω resistor is 1.2A. Determine the potential difference between b and c. **(5 marks)**



Question Five

a) Show that the potential V at a distance r from a point charge Q in a medium of permittivity ε_0 is given by:

$$V = \frac{1}{4\pi\varepsilon_o}\frac{Q}{r}$$

(6 marks)

b) Find the potential at the centre of a 1m square having changes 1Q, – 2Q, 3Q and 2Q at its corners. $\left(Q = 1\times10^{-8} C \; \frac{1}{4\pi\varepsilon_0} = 9\,x10^{9}\, Nm^{2} \right)$

(4 marks)

c) ABCD is a square of 4cm side charges of 16 x 10^{-9}, -16x 10^{-9} and 32 x 10^{-9}C are placed at the points A, C and D respectively. Find the intensity of the electric field at B $\left({}^{1}\!/_{4\pi\varepsilon_o} = 9\times10^{9}\, units \right)$

(6 marks)

d) At certain instant, a piece of radioactive material contains 10^{12} atoms. The half-life of the material is 30 days. What time will elapse before 10^{4} atoms remain? **(4 marks)**