TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Applied & Health Sciences

DEPARTMENT OF MATHEMATICS & PHYSICS

UNIVERSITY EXAMINATION FOR DEGREE OF:

BACHELOR OF TECHNOLOGY IN ANALYTICAL CHEMISTRY

APS 4103: PHYSICS FOR CHEMISTS

END OF SEMESTER EXAMINATION
SERIES: APRIL 2015
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 **THREE** printed pages

Take

$$\varepsilon_o = 8.85\times10^{-12}\,Fm^{-1}$$

$$K = \frac{1}{4\pi\varepsilon_o} = 9\times10^{9}\,Nm^{2}C^{-2}$$

$$g = 9.8ms^{-2}$$

Mass of electron = 1.6×10^{-19}C
Permeability of free space, μo = 4Π x 10-7 Hm-1
Universal gravitational constant G = $6.63 \times 10^{-11}Nm^2g^{-2}$

Question One (Compulsory)

a) Use dimensional analysis to check if the following equation is valid:

$$V^2 = 2ax$$

where V is the velocity , a is the acceleration and x is the displacement

(3 marks)

b) (i) Differentiate between velocity and speed **(1 mark)**

(ii) An object is dropped into a well and hits the water 2 seconds after being released. How deep is the well **(3 marks)**

(iii) If the velocity of a particle changes by the same amount for each similar time interval what can you say about the acceleration **(1 mark)**

c) Find the equivalent resistance of the following combinations of resistors:

(i) Parallel arrangement of 3Ω, 2Ω and 5Ω resistor **(2 marks)**

(ii) Series combination of 3 Ω and 4 Ω resistor in parallel with a 5 Ω resistor **(2 marks)**

d) Explain the term half life as used in discharging of a capacitor **(1 mark)**

e) (i) Show that for a linear conductor or electric current, resistivity j, is given by:

$$\tau = \frac{RA}{L}$$

where R is the resistance and L is the length of the conductor **(3 marks)**

(iii) Distinguish between ohmic and non-ohmic conductors **(1 mark)**

f) A 2.00μF and a 4.00μF capacitors are connected to a 60.0v battery. How much charge is supplied by the battery in charging the capacitors when the wiring is in series **(3 marks)**

g) (i) State Ohm's Law **(1 mark)**

(ii) Show that the effective resistance R of three resistors connected in parallel is given as:

$$R_T = \frac{R_1 R_2 R_3}{R_1 R_2 + R_2 R_3 + R_1 R_3}$$

(4 marks)

h) The charges in figure 1 below are placed at the corners of an equilateral triangle of side a

Figure 1

Show that the force experienced by charge Q1 is given by:

$$F = \frac{a^3\ kQ^3}{a^2}$$

if all the charges are identical **(6 marks)**

Question Two

a) What do you understand by the term capacitance? **(2 marks)**

$$C1 = 2\mu F,\ C_2 = C_3 = 0.5\mu F$$

b) In the circuit below, and v = 6v

Figure 2

(i) Determine the charge in each capacitor **(3 marks)**
(ii) Calculate the potential difference across each capacitor **(4 marks)**

c) A steady uniform current of 5mA glows axially along a metal cylinder of cross sectional area $0.02mm^2$, length 5m and resistivity $3 \times 10^{-5}\Omega m$. Calculate:

(i) The potential difference across the ends of the cylinder **(4 marks)**
(ii) The rate of heat production **(3 marks)**

d) State the TWO Kirchhoff's Laws **(4 marks)**

Question Three

a) Define the following terms and give the dimensions:
(i) Distance
(ii) Displacement
(iii) Acceleration
(iv) Friction **(8 marks)**

b) Derive Newton's second law **(3 marks)**

c) A 600N object is to be given an acceleration of $0.7ms^{-2}$. How large an unbalanced force must act upon it? **(3 marks)**

d) Two masses of 0.5kg and 0.25kg are connected by a light inextensible string, which passes over a smooth light pulley. If the system is released from rest with the string taut, find the acceleration of each mass and distance travelled in 1 second from rest **(6 marks)**

Question Four

a) (i) State Coulomb's Law for the electrostatic force between two point charges **(2 marks)**

(ii) Three positive charges lie along the same line as shown in figure 2. Derive an expression for the force acting on Q2 **(2 marks)**

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b) A 10μF capacitor is charged for a 30V supply and then connected across an uncharged 50 μF capacitor. Calculate the:

(i) Final potential difference across the combination **(4marks)**

(ii) Initial and final energies **(4 marks)**

c) Consider two charges Q_1 and Q_3 separated initially by a distance r. If the charge Q_2 is moved towards Q_1 such that the new separation distance is r, show that the work done in moving the charge Q_2 is given by:

$$W = \frac{Q_1 Q_2}{4\pi\varepsilon_O}\frac{1}{r} - \frac{1}{r_1}$$

(6 marks)