TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Applied & Health Sciences

DEPARTMENT OF MATHEMATICS & PHYSICS

UNIVERSITY EXAMINATION FOR THE BACHELOR OF TECHNOLOGY IN APPLIED CHEMISTRY
(BTAC 12J)

APS 4102: PHYSICS FOR CHEMISTS

END OF SEMESTER EXAMINATION
SERIES: APRIL 2013
TIME: 2 HOURS

Instructions to Candidates:
You should have the following for this examination
- *Answer Booklet*

This paper consist of **FIVE** questions in **TWO** sections **A** & **B**
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

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

$k = 1/(4\pi\varepsilon_o) = 9\times109 Nm^2/C^2$

$G = 9.8ms^{-2}$

Electron charge = $1.6\times10^{-19}C$

Mass of Electron = $9.11\times10^{-31}kg$

Permeability constraint = $M_o = 4\pi\times10^{-7}Tm/A$

Proton Mass = $1.7\times10^{-27}\,kg$

$1\mu C = 10^{-6}\,C$

$1\mu c = 10^{-9}\,C$

$1eV = 1.6\times10^{-19}\,J$

Universal constant = $G = 6.63\times10^{-11}\,Nm^2kg^{-2}$

SECTION A (COMPULSORY)

Question One

a) Define the following terms:

(i) Momentum **(1 mark)**

(ii) Impulse **(1 mark)**

(iii) Coefficient of restitution **(1 mark)**

b) Consider a block of mass M_1 attached to a massless string that passes over a pulley hung by another mass M_2. Mass M_1 is placed on a horizontal frictionless table as shown below.

m_1

Show clearly that the tension T acting on the massless string is given by:

$$T = \left(\frac{M_1M_2}{M_1+M_2}\right)g$$

Where g is the acceleration on due to gravity on the earth's surface. **(5 marks)**

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

(ii) Other than temperature, explain two other factors that influence resistance of a linear conductor of electric current. **(2 marks)**

d) (i) Define capacitance. **(2 marks)**

(ii) In the circuit below, $C_1 = 2uF,\ C_2 = C_3 = 0.5\mu F$ and V = 6V

C_1

(I) Compare the charge in each capacitor. **(3 marks)**
(II) Calculate the potential difference across each capacitor. **(4 marks)**

e) A steady uniform current of 5mA flows axially along a metal cylinder of cross-sectional area $0.2mm^2$, length 5m and resistivity 3×10^{-5} Ωm Calculate:
(i) The potential difference between the ends of the cylinder. **(3 marks)**
(ii) The rate of heat production. **(2 marks)**

SECTION B (Answer any TWO questions from this section)

Question Two

a) What do you understand by the term time constant of a discharging capacitor? **(1 mark)**

b) A 15.2k Ω resistor and a capacitor C, are connected in series and a 13.0V potential is suddenly applied to the circuit. The potential difference across the capacitor rises to 5.0V in 1.28 μS .
(i) Calculate the time constant **(5 marks)**
(ii) Calculate the capacitance of the capacitor **(3 marks)**
(iii) Determine the half life of the capacitor **(3 marks)**

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

Question Three

a) (i) State Newton's laws of motion. **(3 marks)**

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

b) When is a body said to move in uniform acceleration? **(2 marks)**

c) (i) A ball is thrown vertically into the air at $50ms^{-1}$. How high will it rise and how long will it take to reach that height? **(3 marks)**

(ii) A particle is fired with a constant velocity of 10×10^5mls into a region where it is subjected to an acceleration of 2×10^{12} ms^{-1} directed opposite to the initial velocity. How far does the particle travel before coming to rest? How long does the particle remain at rest? **(4 marks)**

Question Four

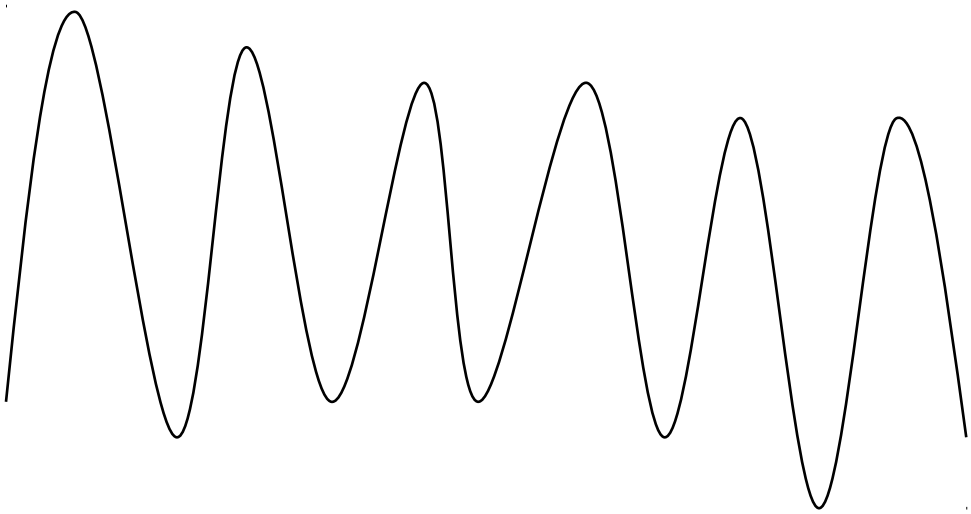
a) State Kirchhoff's Laws.

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

$$R_1 = \frac{R_1 \; R_2 \; R_3}{\left(R_1 R_2 + R_2 R_3 + R_1 R_3\right)}$$

(4 marks)

c) Consider the circuit below:



(i) Find the equivalent resistance of the combination of resistors in the circuit. **(5 marks)**

(ii) Compute current I if the applied voltage is 6V. **(4 marks)**

Question Five

a) Three positive charges lie along the same lien as shown in figure below. Derive an expression for the force acting on Q_2. **(4 marks)**

b) The charges below are placed at the corner of an equilateral triangle of side a.

Figure 4

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

$$F = \frac{\sqrt{3}\, KQ^2}{a^2}$$

If the charges are identical. **(5 marks)**

c) Consider two charges Q_1 and Q_2 separated by a distance r_1. If the charge Q_2 is moved towards Q_1 such that the new separation distance r_1 show that the work done is moving Q_2 is given by:

$$2 = \frac{Q_1\, Q_2}{4\pi\varepsilon_o}\left[\frac{1}{r} - \frac{1}{r^1}\right]$$

(6 marks)