TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Applied & Health Sciences

DEPARTMENT OF MATHEMATICS & PHYSICS

UNIVERSITY EXAMINATION FOR:

BACHELOR OF TECHNOLOGY IN ANALYTICAL CHEMISTRY (BTAC 13S)

APS 4103: PHYSICS FOR CHEMISTS

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 **THREE** questions

Maximum marks for each part of a question are as shown

This paper consists of **FOUR** printed pages

	ε_o	
Take:	=	$8.85 \times 10^{-12}\ Fm^{-1}$
		$\frac{1}{4\pi\varepsilon_o} = 9\times10^9\ Nm^2C^{-2}$
	k =	
	g =	$9.8 ms^{-2}$
Electron charge	=	$1.6 \times 10^{-19} C$
Mass of electron	=	9.11×10^{-31} kg
	μ_o	$4\pi \times 10^{-7}\ Tm/A$
	=	
Proton Mass	=	1.7×10^{-27}kg

	$1\mu C$		
		=	10^{-6}C
	$1\mu C$		
		=	10^{-9}C
	1eV	=	1.6×10^{-19}J
Universal gravitational constant	G	=	6.63×10^{-11} Nm^2kg^2

Question One (Compulsory)

a) Define the following terms:
- **(i)** Momentum
- **(ii)** Impulse
- **(iii)** Coefficient of restitution **(3 marks)**

b) Consider two masks m_1 and m_2 arranged as shown. Assume that the string is massless and that the pulley is frictionless. If the tale is horizontal.

m_1

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

$$T = \left(\frac{m_1 \ m_2}{m_1 + m_2} \right) g$$

where g is eh acceleration 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)**

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

(II) In the circuit below, $C_1 = 2$ and V = 6V.

C_1

(i) Compute 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 $3 \times 10^{-5}\ \Omega m$. Calculate:
(i) The potential difference between the ends of the cylinder. **(3 marks)**
(ii) The rate of heat production in the cylinder. **(2 marks)**

Question Two (15 marks)

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

b) A 15.2kΩ 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 from zero to 5.0V in 1.28 μs.

(i) Calculate the time constant of the circuit **(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 (15 marks)

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 with 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 $10 \times 10^5\ ms^{-1}$ into a region where it is subjected to an acceleration of $2 \times 10^{12}\ ms^{-1}$ 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 (15 marks)

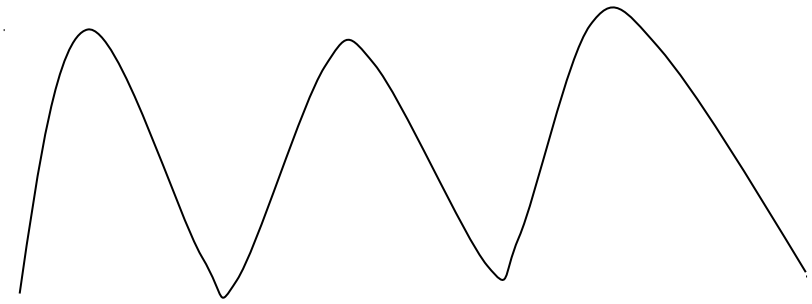
a) State Kirchoff's Laws. **(2 marks)**

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

$$P_T = \frac{R_1 \ R_2 \ R_3}{\left(R_1R_2 + R_2R_3 + R_1R_3\right)}$$

(4 marks)

c) Consider the circuit below:



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

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

Question Five (15 marks)

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

$$W = \frac{Q_1Q_2}{4\pi\varepsilon_o}\left(\frac{1}{r} - \frac{1}{r^1}\right)$$

Three positive charges lie along the same line as shown in the figure below. Derive an expression for the force acting on Q_2.

(4 marks)

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

Q_2

Show that the force experienced by charge Q_1 is given by the expression:

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

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

d) 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 in moving Q_2 is given by:

$$W = \frac{Q_1 Q_2}{4\pi\varepsilon_o}\left(\frac{1}{r} - \frac{1}{r^1}\right)$$

(6 marks)