TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Applied & Health Sciences

DEPARTMENT OF MATHEMATICS & PHYSICS

UNIVERSITY EXAMINATION FOR:

BACHELOR OF SCIENCE IN MATHEMATICS & COMPUTER SCIENCE

(BSMCS)

APS 4108: PHYSICS

END OF SEMESTER EXAMINATION
SERIES: DECEMBER 2013
TIME ALLOWED: 2 HOURS

Instructions to Candidates:
You should have the following for this examination

- *Mathematical tables*
- *Scientific Calculator*

This paper consist of **FIVE** 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

Where necessary use:

$$K = \frac{1}{4\pi\varepsilon_0} = 8.988\times10^{9}\, Nm^2/C^2$$

- Coulomb's Law constant

$$\varepsilon_0 = 8.854\times10^{-12}\, C^2/Nm^2$$

- Permittivity of free space,
- elementary charge, e = 1.602 x 10^{-19}C
- electron mass, m_e = 9.11 x 0^{-31}kg
- proton mass, m_p = 1.67 x 10^{-27}kg
- 1electron volt = 1.00v = 1.602 x 10^{-19}J

- 1 gauss = 10^{-4}T

Question One (Compulsory)

a) (i) A useful method of expressing very small or very large numbers is:
A. Arabic numerals
B. Roman numerals
C. Scientific notation
D. The metric system **(2 marks)**

(ii) Electric conductors behave differently from electric insulators because conductors have
A. net charge
B. free charge
C. induced charge **(2 marks)**

(iii) All of the following are base units of the SI system except:
A. Kilogram
B. Kelvin
C. Metre
D. Volt **(2 marks)**

(iv) The magnetic force on a current carrying wire between the poles of a magnet as shown in the figure points:

A. Upwards
B. Downward
C. Left
D. Right
E. Into the page
F. Out of the page **(2 marks)**

b) Draw electric field lines for:
(i) a single positive charge **(2 marks)**
(ii) two equal and opposite charges **(2 marks)**

c) Excess electrons are placed on a small lead sphere so that its net charge is -3.2 x 10^{-9}C. Find the number of excess electrons on the sphere. **(2 marks)**

d) Find the length of a copper wire of diameter 0.6mm that will give a resistance of 2.5 Ω (Resistivity of copper is 1.72 x 10^{-8} Ω m **(3 marks)**

$\varepsilon = NBA\omega \sin \omega t$

e) The output voltage from an AC generator is given by :

(i) If the AC generator has a square 12cm x 12cm armature coil with 480turns rotating at 720 rpm in a 0.5T magnetic field, how large is its peak voltage? **(4 marks)**

(ii) Find the root mean square voltage of the generator. **(3 marks)**

f) The terminal voltage of a battery is 7.5V with no load connected to it. When connected to a light bulb that draws a current of 0.5A, its terminal voltage drops to 6.2V:

(i) What is the resistance of the light bulb? **(3 marks)**

(ii) What is the internal resistance of the bulb **(3 marks)**

Question Two

a) State Coulomb's law **(2 marks)**

$q_1 = +3.0\mu c$

b) Three charges are arranged along the x-axis. Charges is at the origin and charge $q_2 = -5.0\mu c$ $-8.0\mu c$ is at x = 0.2m; charge q_3 =

(i) Where is q_3 located if the net force on q_1 is 7.0N in the negative x-axis? **(8 marks)**

(ii) Find the magnitude and direction of the electric field due to the three charges at a point 0.25m directly above q_3 **(10 marks)**

Question Three

$V_A = +20.0KV$

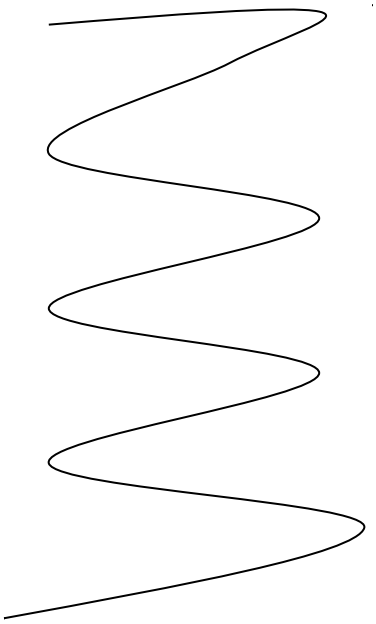
a) An electron moves from point A where the potential is to point B where the potential is $V_B = -40.0KV$ these potentials are due to other charges.

(i) What is the change in potential energy? **(3 marks)**

(ii) What change in kinetic energy does the electron experience? **(3 marks)**

(iii) Give the answer to (ii) above in electron volts and comment on the results. **(2 marks)**

b) The current below contains an arrangement of resistors connected to an ideal 30V battery that has no internal resistance.



(i) What pair of resistors is in series (if any) and in parallel (if any)? **(3 marks)**

(ii) What is the equivalent resistance connected to the battery **(6 marks)**

(iii) What is the voltage drop across the $4\ \Omega$ resistor **(3 marks)**

Question Four

a) Answer TRUE or FALSE**:**

(i) Two long wires with parallel currents repel each other **(2 marks)**

(ii) The magnetic force on a moving charged particle is always perpendicular to the magnetic field $\vec{B}$ **(2 marks)**

(iii) At any point in space, the electric field $\vec{E}$ is in the direction perpendicular to the electric force of a positively charged particle at that point. **(2 marks)**

b) A uniform magnetic field B causes protons to move in cyclotron orbits of radius 12cm at a frequency of 250 MHz (i.e. 250×10^6 revolutions per second)

(i) Show on the diagram above, the direction in which the protons circulate **(3 marks)**

(ii) At what speed v are the protons moving **(6 marks)**

(iii) How strong is the magnetic field $\vec{B}$ in testa? **(5 marks)**