TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF APPLIED AND HEALTH SCIENCES

MATHEMATICS &PHYSICS DEPARTMENT

UNIVERSITY EXAMINATION FOR:

BACHELOR OF SCIENCE IN ELECTRICAL &ELECTRONICS ENGINEERING,BUILDING &CIVIL ENGINEERING,MECHANICAL &AUTOMOTIVE ENGINEERING,MATHEMATICS &COMPUTER SCIENCE,STATISTICS & COMPUTER SCIENCE, FOOD &QUALITY ASSURANCE AND BACHELOR OF TECHNOLOGY IN INFORMATION TECHNOLOGY (BSEE,BSCE,BSME,BSSC,BMCS,BSFQ,BTIT)

APS 4102/SPH 2171/SPH 2174: PHYSICS II/PHYSICS FOR ENGINEERS II

END OF SEMESTER EXAMINATION

SERIES: MAY 2016

TIME: HOURS

DATE: MAY 13, 2016

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass and student ID

T*his paper consists of* ***FIVE*** *questions. Attempt Question* ***ONE*** *and any other* ***TWO*** *questions.*

-Do not write on the question paper.

- Mathematical tables and scientific calculators may be used

-The following constants may be useful:

Gravitation acceleration, $g = 9.89\ m/s^2$
Permittivity in vacuum, $\varepsilon_0 = 8.85 \times 10^{-12} FM^{-1}$
Electron charge, $e = 1.6 \times 10^{-19}\ C$
Mass of an electron $M_e = 9.11 \times 10^{-31}\ kg$
Mass of an electron $M_p = 1.67 \times 10^{-27}\ kg$
Universal gravitational pull $G = 6.67 \times 10^{-11}\ N/kg$

QUESTION ONE (30 MRKS)

a) (i) State Coulomb's law of electrost**ati**cs and hence express its mathematical form giving the meaning of all symbols used. (3mrks)

(ii) A positively charged particle and an equivalent negatively charged particle are separated by a distance of **5.5 x 10^{-11}M**. Calculate the electrostatic force of attraction between them if each particle carries a charge of **1.3 x 10^{-9} C.** (3mrks)

(iii) Sketch a diagram to show the electric field lines between a positively charged particle interacting with negatively charge**.** (2mrks)

b) A number of charged particles are placed close together such that they interact with each other. If the charges are Q_1, Q_2, Q_3 ...Q_n, what will be the force experienced by charge Q_3 due to the other charges. (5mrks)

c) (i) Define the term electromotive force. (2mrks)

(ii) Study the circuit in figure 1.Calculate the Current through resistor R_5. (5mrks)

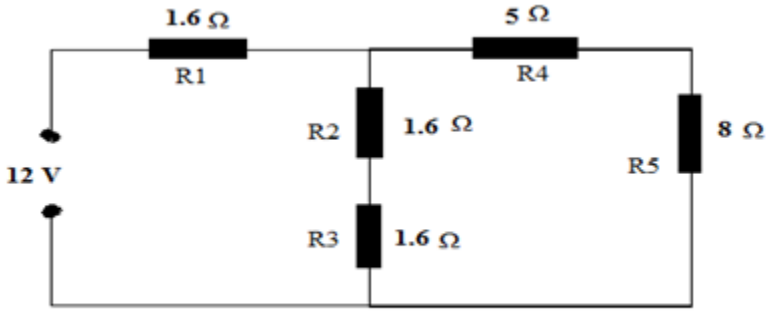


Figure 1 Circuit connected with resistors

d) (i) Define the term radioactivity**.** (1mrk)

(ii) List any three radioactive decay particles generated during a radioactive decay process and given two properties of each. (3mrks)

(iii) Calculate the atomic weight of a Lithium element if it has an atomic number, 6 with atomic abundances of 7.5% of isotope Li-6 of **6.015122** a.m.u and 92.5% abundance of Li-7 of **7.016003** a.m.u (3mrks)

e) Differentiate between capacitance and a dielectric as used in electrostatics. (3mrks)

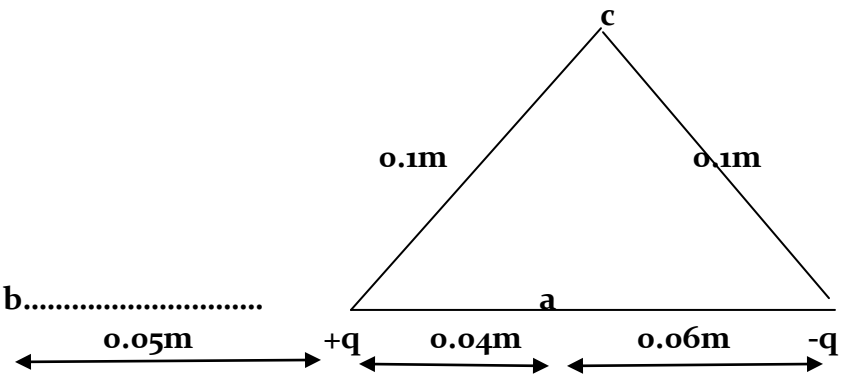
QUESTION TWO (20 MRKS)

a)) An electron $q = -e$ placed near a charged body experiences a force in the +y direction of magnitude 3.6 x 10^{8}N:

(i) What is the electric field at that location? **(3 marks)**

(ii) What would be the force exerted by the same charged body on an alpha particle (q = *+2e)* placed at the location formerly occupied by the electron? Take *e* = +1.602 x 10^{-19}C **(3 marks)**

b) Two points charges q_1 and q_2 of 8 x 10^{-9}C and -8 x 10^{-9}C respectively are placed o.lm apart as shown. Find the electric fields at point a, b and c. (5 **marks)**



c) Show that the capacitance C, for a spherical capacitor consisting of a conducting sheet of radius "**b**" and charge "**Q**" concentric with a smaller conducting sphere of radius "**a**" and charge "**Q**" can be expressed by;

$$C = \frac{ab}{k(b-a)}$$ (3mrks)

d) (i) State three factors that affect capacitance of a capacitor. (3mrks)

(ii) A parallel plate air filled capacitor has its plate area, A given as **2.5cm²** with separation distance between the plates as **1.1mm.** Determine its capacitance assuming **ε,** for air is equal to **ε** in a vacuum. (3mrks)

QUESTION THREE (20 MRKS)

a) (i) State Kirchoff's laws. (2mrks)

(ii) Consider a cylindrical copper metal conductor of dimensions shown in figure 2.

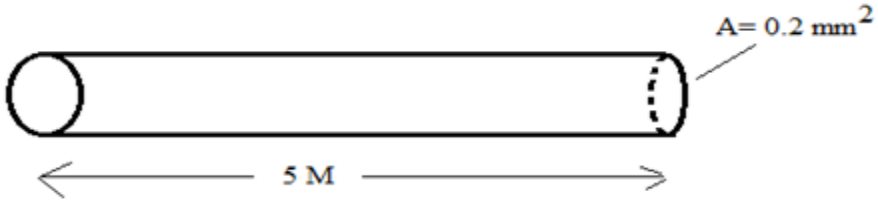


Figure 2: Cylindrical copper metal conductor

If it has a resistivity of **3.0 x 10⁻⁵ ΩM⁻¹**, determine the potential difference between the ends of the cylinder if a steady current of **5mA** flows in the conductor. (3mrks)

b) In the circuit shown in figure 3, E_1 = **2.1V**, E_2 = **6.3V** and E_3 = **6.3V**, find the currents I_1, I_2 and I_3 respectively. (7mrks)

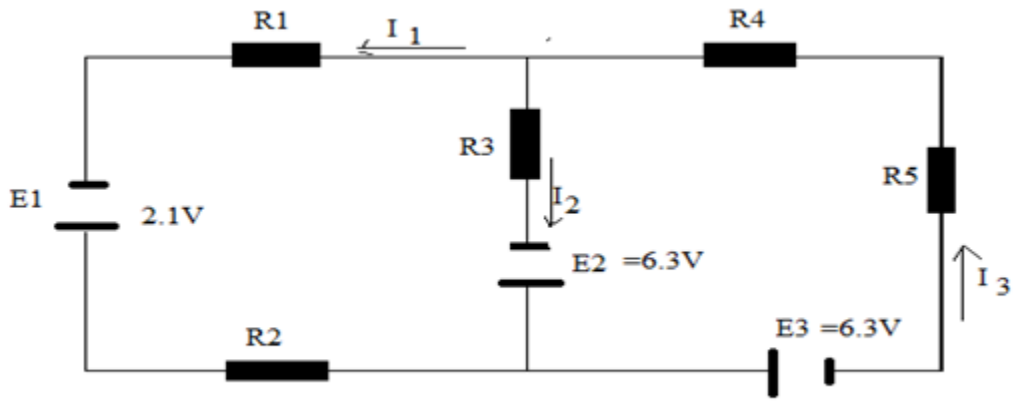


Figure 3: Circuit network containing voltage sources and resistors

c) (i) A wire loop of radius 10 cm has a resistance of **2Ω**. The plane of the loop is perpendicular to a uniform magnetic field that is at **0.10T/s**, find the magnitude of the induced current in the loop. (5mks)
(ii) Define the term magnetic force. (1mk)
(iii) State Amperes law of magnetism**.** (2mks)

QUESTION FOUR (20 MRKS)

a) A potential difference of 300V is applied to a 2μF capacitor and a 8 μF capacitor connected in series as shown in figure 4 below.

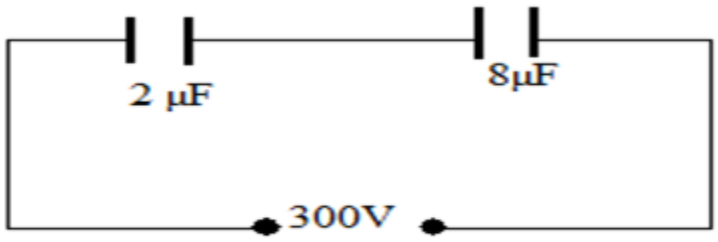


Figure 4: Capacitiors connected in series

(i) Calculate the potential difference across each capacitor. (3mrks)
(ii) If the positive plates of these capacitors are connected together while the negative plates are also connected together with no external voltage applied, determine;
(a) the charge across them. (2mrk)
(b) the potential difference across each capacitor. (2mrks)
(iii) If these capacitors are now connected such that their plates have opposite charged plates together, determine the potential and the charge across them. (4mrks)

b) An Android camera of a SUMSUNG J7 mobile phone gets its energy from a 150 μF capacitor. This camera requires 170V to fire when needed to operate. If the capacitor is charged by a 200V source through a 18KΩ resistor, how long must the photographer using the camera wait between any two flashes? (4mrks)

c) (i) What is electrostatic equilibrium? (2mrks)

(i) Explain any three characteristics of a conductor in electrostatic equilibrium. (3mrks)

QUESTION FIVE (20 MRKS)

a) Calculate the magnetic field of a long straight wire carrying a current of 10A at a distance of 8cm from the wire. (3mrks)

b) (i) The half-life of Radium element is equal to **1590** years. Find its decay constant, **λ.** Determine the number of nuclei in the one gram of radium. (4mrks)

(ii) List two applications of radioactivity. (2mrks)

c) Show that the electric field strength, **E**, due to a dipole, $\hat{p}$ of weak charges separated by a distance, r, is given by

$$E = \frac{2\hat{p}}{4\pi \varepsilon_0} \frac{1}{R^3}$$ (6mrks)

d) (i) Differentiate between an electric field and a magnetic field. (2mrks)

(ii) Define the following terms as used in radioactivity:

(a) Nuclear fusion. (1mrk)

(b) Nuclear fusion. (1mrk)

(c) Carbon dating. (1mrk)

END