



MURANG'A UNIVERSITY COLLEGE

(A constituent college of Jomo Kenyatta University of Agriculture and Technology)

FIRST YEAR SECOND SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN MATHEMATICS AND COMPUTER SCIENCE

SPH 2172: PHYSICS

APRIL 2015

INSTRUCTIONS TO CANDIDATES

1. Answer question **ONE** and any other **TWO**
2. All working must be clearly shown on the answer booklet
3. Do not answer more than three questions
4. Start each question on a fresh page
5. Use of Mobile phones is prohibited in examination rooms
6. Indicate on the table in the front page of the answer booklet the questions you attempted
7. Electronic calculators may be used

Useful constants

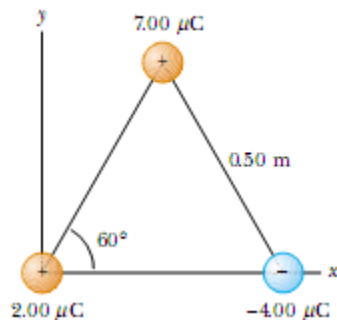
- Charge of an electron = $1.6 \times 10^{-19}\text{C}$
- Permeability of free space, $\mu_0 = 4\pi \times 10^{-7} \text{ Tm/A}$
- Permittivity of free space, $\epsilon_0 = 8.85 \times 10^{-12} \text{ F/m}$
- Mass of a proton, $m_p = 1.7 \times 10^{-27} \text{ kg}$ or 1.0073 a.m.u
- Mass of a neutron $m_n = 1.0084 \text{ a.m.u}$
- 1 a.m.u = 931MeV
- Mass of an electron, $m_e = 9.1 \times 10^{-31} \text{ kg}$
- Resistivity of tungsten $\alpha = 4.5 \times 10^{-3}/^\circ\text{C}$
- Planck's constant $h = 6.63 \times 10^{-34} \text{ Js}$
- Speed of electromagnetic waves in a vacuum $c = 3.0 \times 10^8 \text{ m/s}$

QUESTION 1 (30 MARKS)

- a) Define the following terms [3mks]
- Electric field
 - Binding energy
 - resistance
- b) Distinguish between insulators, conductors and semiconductors. [3mks]
- c) Show that the capacitance of a parallel plate capacitor is given by $C = \frac{\epsilon_0 A}{d}$
where A is the area of overlap of the plates and d is the distance of separation of the plates. [5mks]
- d) State Coulomb's law. [2mks]
- e) The electron and proton of a hydrogen atom are separated by a distance of approximately $5.3 \times 10^{-11} \text{m}$. Find the electric force between the two particles. [3mks]
- f) Calculate the magnitude of emf induced in a coil of inductance 18H by a current changing at the rate of 4A/s. [3mks]
- g) A magnetic pole has a rectangular section having dimensions 400mm by 200mm. If the total flux emerging from the pole is $200 \mu \text{Wb}$, determine the flux density. [3mks]
- h) State two industrial uses of x-rays. [2mks]
- i) Determine the binding energy in electron volts (eV) of an element ${}^6_2\text{X}$ if its nucleus has mass of 6.0074 a.m.u. [4mks]
- j) State and explain two applications of radioactive emissions. [2mks]

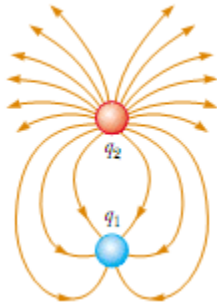
QUESTION 2

- a) Three point charges are located at the corners of an equilateral triangle as shown. Calculate the resultant electric force on the $7.00 \mu \text{C}$ charge. [8mks]

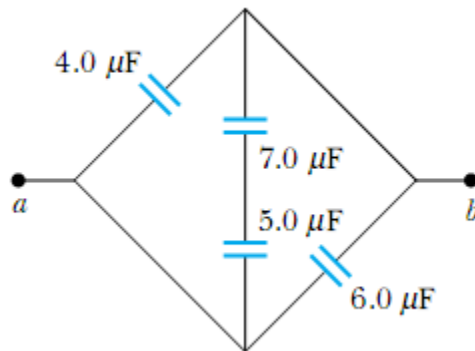


- b) The figure below shows electric field lines for two point charges separated by a small distance.

- i. Determine the ratio $\frac{q_1}{q_2}$ [2mks]
- ii. What are the signs of q_1 and q_2 . [1mk]

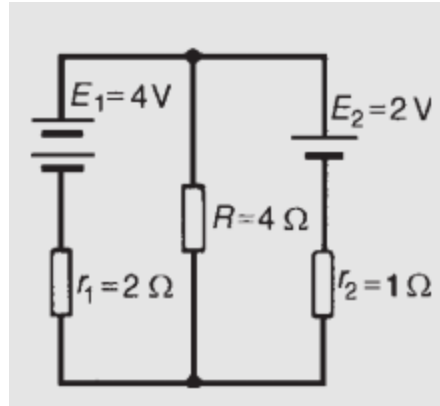


- c) Two capacitors when connected in parallel give an equivalent capacitance of 9pF and an equivalent capacitance of 2pF when connected in series. What is the capacitance of each capacitor? [6mks]
- d) Find the equivalent capacitance between points a and b in the combination of capacitors shown in the figure below. [3mks]



QUESTION 3

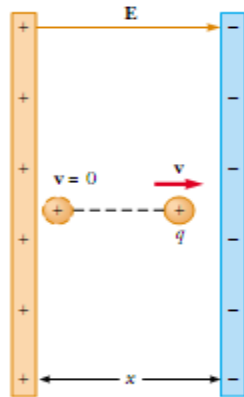
- a) A certain light bulb has a tungsten filament with a resistance of 19Ω when cold and 140Ω when hot. Assume that the resistivity of tungsten varies linearly with temperature even over the large temperature range involved here, and find the temperature of the hot filament. Assume the initial temperature is 20°C and resistivity of tungsten $\alpha = 4.5 \times 10^{-3} / ^\circ \text{C}$. 4mks
- b) Name and state Kirchhoff's rules. [2mks]
- c) In the circuit figure below, determine the current in each resistor. [10mks]



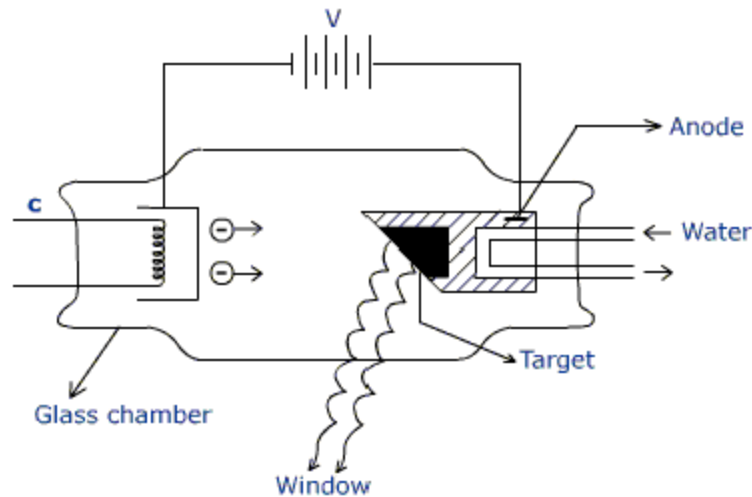
- d) State four factors that affect the force on a current carrying conductor. [4mks]

QUESTION 4

- a) Define inductance and from the definition distinguish between mutual and self inductance. 3mks
- b) A positive charge is released from rest in a uniform electric field set up between two oppositely charged metal plates as shown in the figure below. Describe its motion. [4mks]



- c) The figure below shows a modern x- ray tube.



- i) Which metals are used as a target and why? [2mks]
- ii) Why is the tube evacuated? [1mk]
- iii) Explain how x-rays are produced in the tube. [3mks]
- d) Find the potential difference through which electrons must be accelerated in order to have x-rays of wavelength 0.0024m. [3mks]
- e) Compute the internal resistance of an electrical generator which has an emf, $E = 120\text{V}$ and a terminal voltage $V = 110\text{V}$ when supplying a current $I = 20\text{A}$. [4mks]

Question 5

- a) Two point charges Q_1 and Q_2 are 3m apart and their combined charge is $q = 20\mu\text{C}$. If one repels the other with a force $F = 0.075\text{N}$, what are their values? [6mks]
- b) The electron beam in a TV tube accelerates an electron from rest through a potential difference of about 20kV. Suppose conservation of energy,
 - i) What is the speed of the electron when they reaches the screen? [6mks]
 - ii) What is the wavelength of the x-rays produced by the electron on impact with the screen? [4mks]
- c) Write down Ohm's law for a closed DC circuit. Give the name and SI unit units of each symbol used. [4mks]