MURANG'A UNIVERSITY OF TECHNOLOGY

SCHOOL OF PURE AND APPLIED SCIENCE

DEPARTMENT OF APPLIED SCIENCE

UNIVERSITY ORDINARY EXAMINATION

2017/2018 ACADEMIC YEAR

FIRST YEAR **SECOND** SEMESTER EXAMINATION FOR DEGREE OF BACHELOR OF EDUCATION SCIENCE

APH 103 – ELECTRICITY AND MAGNETISM I

DURATION: 2 HOURS

DATE: 18TH APRIL, 2018

TIME: 2.00 – 4.00 P.M.

Instructions to Candidates:

1. Answer **Question 1** and **Any Other Two** questions.
2. Mobile phones are not allowed in the examination room.
3. You are not allowed to write on this examination question paper.

Useful Constants

- Permeability of free space $\mu_o = 4\pi x\ 10^{-17} Tm/A$
- Permittivity of free space $\varepsilon_o = 8.85\ x\ 10^{-12} F/m$
- Mass of a proton $M_p = 1.7\ x\ 10^{-27} kg$
- Mass of an electron $M_e = 9.1\ x\ 10^{-31} kg$
- Resistivity of tungsten $\propto = 4.5\ x\ 10^{-3}/°C$
- Planck's constant $h = 6.63\ x\ 10^{-34} JS$
- Speed of electromagnetic waves in a vacuum $C = 3\ x\ 10^{8}\ mls$

SECTION A – ANSWER ALL QUESTIONS IN THIS SECTION

QUESTION ONE

a) Define the following terms (2 marks)

   i. Electric field at a point

   ii. Electromotive force of a battery

b) Show that the capacitance of a parallel plate capacitor is given by $C = \frac{\varepsilon_0 A}{d}$ where A is the area of overlap of the plates and d is the separation of the plates (5 marks)

c) State Coulomb's law (2 marks)

d) The electron and proton of a hydrogen atom are separated by a distance of approximately 5.3 x 10^{-11}m. Find the electric force between the two particles (4 marks)

e) Calculate the magnitude of the induced emf in a coil of inductance 24H by a current changing at a rate of 8 A/S. (3 marks)

f) A magnetic pole has a rectangular section having dimensions 400mm by 200mm. if the total flux emerging from the pole is 200μWb, determine the flux density (3 marks)

g) Two light bulbs operate from 120V. One has a power of 25W and the other 100W. Which bulb has higher resistance? Which bulb carries more current? Clearly show how you arrived at your answers. (5 marks)

h) A current of 5A is passing through a 1000 turn coil wound on a circular magnetic circuit of radius 120mm. calculate

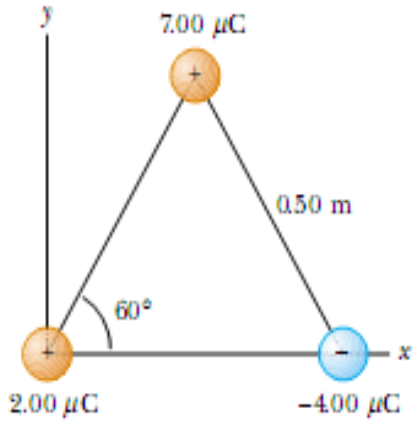
   i. The magnetomotive force (3 marks)

   ii. The magnetic field strength (3 marks)

SECTION B – ANSWER ANY TWO QUESTIONS IN THIS SECTION

QUESTION TWO

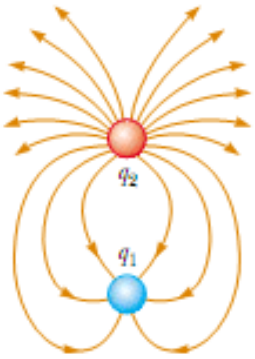
a) Three point charges are located at the corners of an equilateral triangle as shown. Calculate the electric force on the 7μC charge. Express your answer in unit vector form (8 marks)



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

i. Determine the ratio $\frac{q_1}{q_2}$ (2 marks)

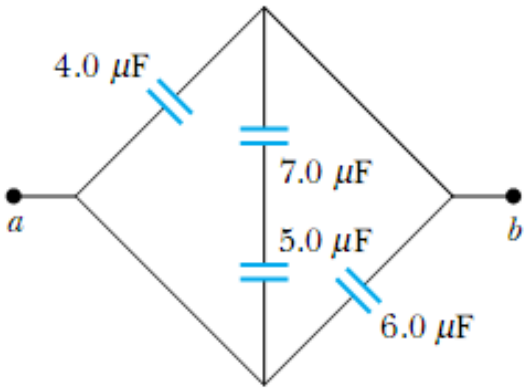
ii. What are the signs of q_1 and q_2 (1 mark)



c) Two capacitors when connected in parallel give an equivalent capacitance of 9pF and an equivalent capacitance of 2_pF when connected in series. What is the capacitance of each capacitor? (6 marks)

d) Find the equivalent capacitance between points a and b in the combination shown below

(3 marks)

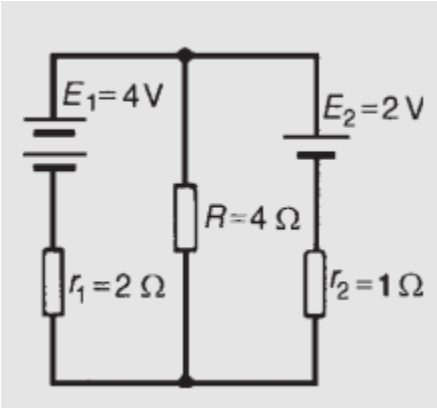


QUESTION THREE

a) A certain light bulb has tungsten filament with a resistance of 19Ω when cold and 140 Ω S when hot. Assume that the resistivity of tungsten varies linearly with temperature. Find the temperature of the hot filament. Assume the initial temperature is 20°C and resistivity of tungsten $\propto = 4.5\ x\ 10^{-3}/°C$ (4 marks)

b) Name and state Kirchhoff's rules (2 marks)

c) In the circuit below, determine the current in each resistor (10 marks)



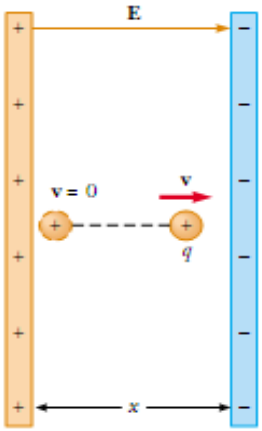
d) State four factors that affect the force on a current carrying conductor (4 marks)

QUESTION FOUR

a) Define inductance and from the definition distinguish between mutual and self inductance (3 marks)

b) How would you connect resistors so that the equivalent resistance is higher than the greatest individual resistance? Give an example involving three resistors (3 marks)

c) A positive charge is released from rest in a uniform electric field set up between two oppositely charged metal plates as shown below. Describe its motion (4 marks)



d) Compute the internal resistance of an electric generator which has an e.m.f. of 120V and a terminal voltage of 110V when supplying a current of 20A (4 marks)

e) Two point charges Q1 and Q2 are 3 m apart and their combined charge is q = 20μC. If one repels the other with a force of 0.075N, what are their values? (6marks)