KABARAK UNIVERSITY

UNIVERSITY EXAMINATIONS

2010/2011 ACADEMIC YEAR

FOR THE DEGREE OF BACHELOR OF COMPUTER SCIENCE

COURSE CODE: PHYS 110

COURSE TITLE: ELECTRICITY AND MAGNETISM

STREAM: Y1S1

DAY: TUESDAY

TIME: 9.00 –11.00 A.M.

DATE: 07/12/2010

INSTRUCTIONS:

Instructions

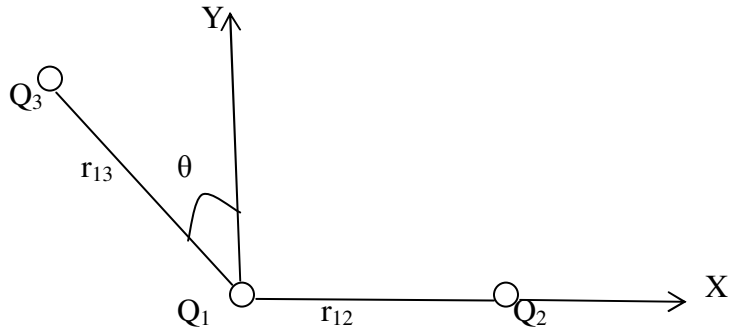
- *Answer Question **ONE** and any other **TWO** Questions. Question One carries **30marks** while each of the other Two Questions carry **20marks**.*
- ***The following constants may be useful***
  - Permeability of free space $\mu_0 = 4\pi \times 10^{-7} Wb / A$
  - Permittivity of free space $\varepsilon_0 = 8.85 \times 10^{-12} C^2 / NM^2$
  - Resistivity of Iron $\rho = 9.68 \times 10^{-8} \Omega m$
  - Acceleration due to gravity $g = 9.8 m / s^2$

PLEASE TURN OVER

QUESTION 1 (30 marks)

a) i) Differentiate between conductors and insulators **(1mk)**
ii) Explain why conductors cannot be charged by friction. **(1mk)**

b) i) State Coulomb's law in words and give its mathematical expression **(2mks)**
ii) The diagram below shows three charged particles held in place.

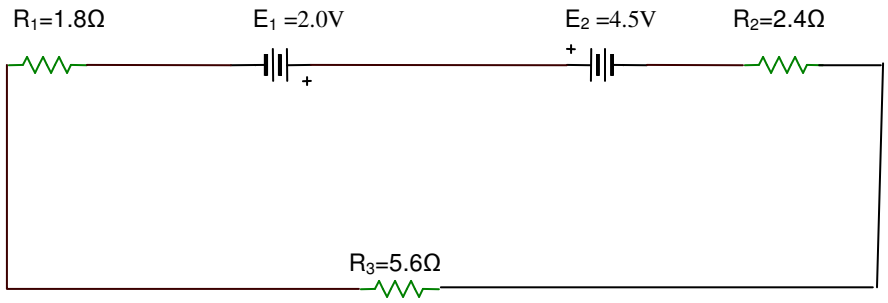


Given that $Q_1 = -2.0\mu C$, $Q_2 = +4.8\mu C$, $Q_3 = -2.4\mu C$, $r_{12} = 20cm$, $r_{13} = 10cm$ and $\theta = 30^0$ Calculate;

I) the resultant force on Q_1 due to the other two charges **(4mks)**
II) The direction of this resultant force **(2mks)**

c) A rectangular block of Iron has dimensions 2.5cm by 2.5cm by 20cm. Find the resistance of the block between the two square ends. **(2mks)**

d) i) State Kirchhoff's voltage law. **(1mk)**
ii) Calculate the current in the given circuit **(3mks)**



e) Define Lorentz force and give its mathematical expression? **(2mks)**

f) State three characteristics of electric field lines **(3mks)**

g) Consider a rod of length (**L**) carrying a uniform linear charge density (**λ**) and total charge (Q).Derive the expression of the electric field (**E**) at a point (**P**) along the x-axis of the rod distance (**d**) from a chosen origin **(5mks)**

h) i) State and explain two factors that affect the magnitude of torque experienced by a current carrying wire in a magnetic field. **(2mks)**

ii) An electron with magnetic dipole moment $2.4\times10^{-24}\,J/T$ is in a uniform magnetic field of750T at an angle of 30°. Calculate the magnetic torque on the electron**.** **(2mks)**

QUESTION 2 (20 marks)

a) i) Define flux of a vector field and give circumstances under which flux is positive or negative. **(2mks)**

ii) A cylinder of radius (R) is immersed in a uniform electric field ($\vec{E}$) with its axis parallel to the field. Find the electric flux (Φ_E) for the surface. **(4mks)**

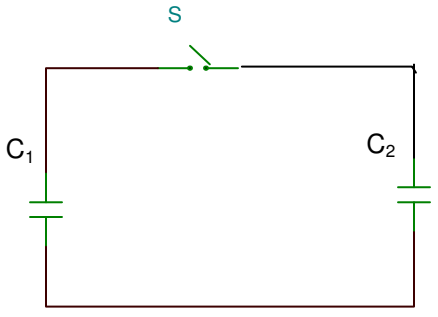
b) i) State Gauss' law in words and give its mathematical expression. **(2mks)**

ii) Consider a conducting sphere of radius (R) carrying charge per unit volume (ρ), derive the expression of finding electric field ($\vec{E}$) a distance r for r<R and for r>R. **(4mks)**

c) i) Define electric potential difference **(1mk)**

ii) Calculate the expression for the electric potential difference at a point (P) a distance (Z) along the axis of a uniform ring of radius (R) and total charge (Q). **(3mks)**

d) A 3.5μF capacitor C_1 is charged to a potential difference $V_0 = 12V$, using a battery. The charging battery is then removed, and the capacitor is connected as shown in Figure below to an uncharged 8.0μF capacitor C_2. After the switch S is closed, charge flows from C_1 to C_2 until equilibrium is established, with both capacitors at the same potential difference V.



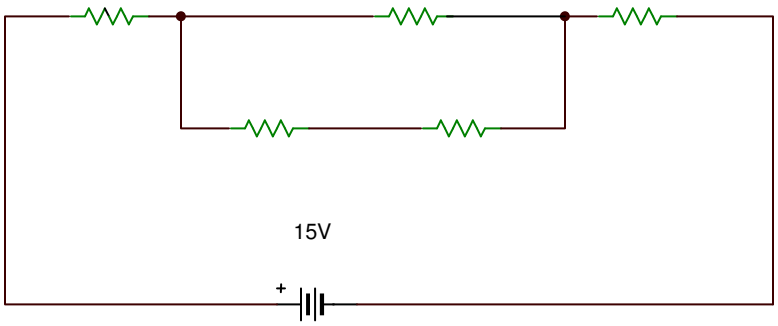
i). Calculate the common potential difference (V) **(2mks)**

ii). What is the energy stored after the switch is closed **(2mks)**

QUESTION 3 (20 marks)

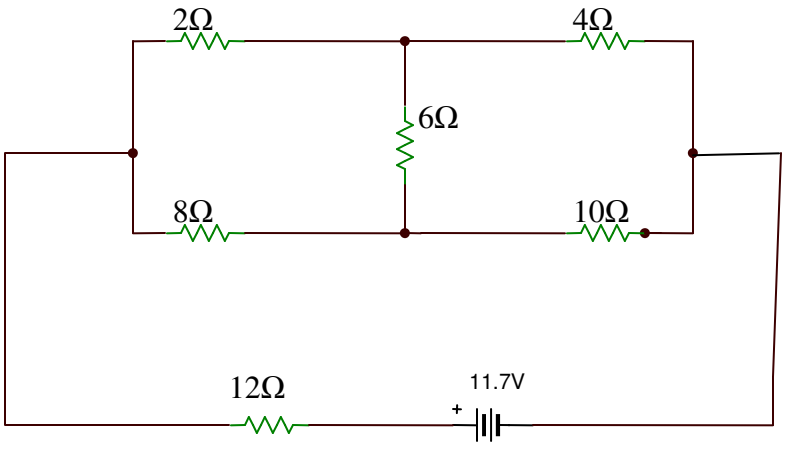
a) i) What is a potentiometer? **(1mk)**
ii) State two uses of potentiometers **(2mks)**

b) Consider the given resistor network circuit.



Assuming that each resistor is 5Ω, Calculate;
i). Total resistance **(2mks)**
ii). the total current in the circuit **(2mks)**

c) Find the current in different branches in the given circuit **(5mks)**



d) Derive the expression of charge (Q) at any time (t) of a capacitor during the discharging phase, hence show that time constant (τ) during this phase is 37% of maximum value. **(5mks)**

e) State three effects of dielectrics on capacitors. **(3mks)**

QUESTION 4 (20 marks)

a) i) What is magnetic field? **(1mk)**

ii) State two differences and two similarities between magnetic force and electric force. **(4mks)**

b) i)Consider a segment of conductor of length (L), cross sectional area (A), carrying current (I) placed in a uniform magnetic field ($\vec{B}$), derive the expression of magnetic force F_B experienced by the wire segment. **(5mks)**

ii) A straight horizontal segment of copper wire carries a current $I = 28A$. What are the magnitude and direction of magnetic field needed to balance its weight? Given that it's linear mass density is $46.6g/m$. **(4mks)**

c) Consider a proton of charge $1.6\times10^{-19}C$ being moved at a velocity of $3.2\times10^{7}m/s$ in a uniform magnetic field of $1.2\times10^{-3}T$ at an angle of 30°.

i). Find the magnitude of magnetic force experienced by the proton **(3mks)**

ii). What will be the acceleration of the proton given that its mass is $1.67\times10^{-27}Kg$ **(3mks)**

QUESTION 5 (20 marks)

a) State Lenz's law in words and give its mathematical expression. **(2mks)**

b) State and explain two factors that affect the magnitude of induced electromotive force **(2mks)**

c) i) Define inductance **(1mk)**

ii) A solenoid containing 8000 turns and length of 40cm has a cross sectional area of $2cm^2$. Calculate the self induced e.m.f. in the solenoid if the current in it is changing at a rate of $50A/s$ **(2mks)**

d) Consider a series RL circuit connected to a d.c. source. Derive the expression of finding energy in the circuit. **(5mks)**

e) An RL circuit with an inductor of inductance 4H and resistor of 10Ω is connected to the terminals of a battery of e.m.f. 12V and negligible internal resistance. Find

i). The initial rate of increase of current in the circuit **(2mks)**

ii). The rate of increase at the instant when the current is 0.5A **(2mks)**

iii). The current 0.5s after the circuit is closed **(2mks)**

iv). The final steady state current **(2mks)**