KABARAK UNIVERSITY

UNIVERSITY EXAMINATIONS

2008/2009 ACADEMIC YEAR

FOR THE DEGREE OF BACHELOR OF COMPUTER SCIENCE

COURSE CODE: PHYS 110

COURSE TITLE: ELECTRICITY AND MAGNETISM

STREAM: Y1S1

DAY: WEDNESDAY

TIME: 2.00 – 4.00 P.M.

DATE: 11/08/2010

INSTRUCTIONS:

Instructions

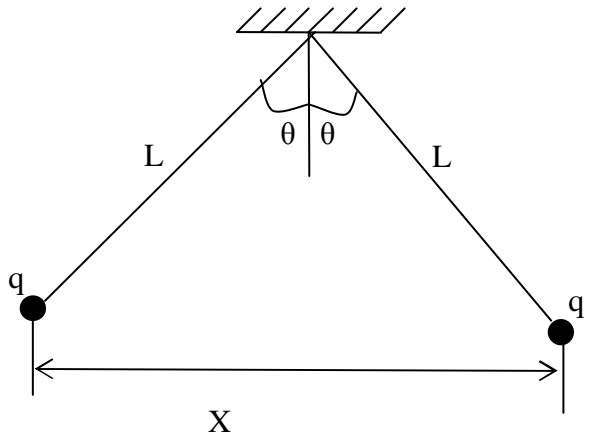
- *Answer Question **ONE** and any other **TWO** Questions. Question One carries **30marks** while each of the other Two Questions carry 2**0marks**.*
- ***The following constants may be useful***
  - Permeability of free space $\mu_0 = 4\pi \times 10^{-7} Wb/A$
  - Permittivity of free space $\varepsilon_0 = 8.85 \times 10^{-12} C^2/NM^2$
  - 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) Name two types of electric charges (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) Two similar tiny balls of mass (m) are hung from silk threads of length (L) and carry equal charges (q) as shown.



Assume that θ is so small that tanθ can be replaced by its approximate value equal to sinθ

I) To this approximation, show that for equilibrium

$$X = \left(\frac{q^2 L}{2\pi\varepsilon_0 mg} \right)^{\frac{1}{3}}$$ (4mks)

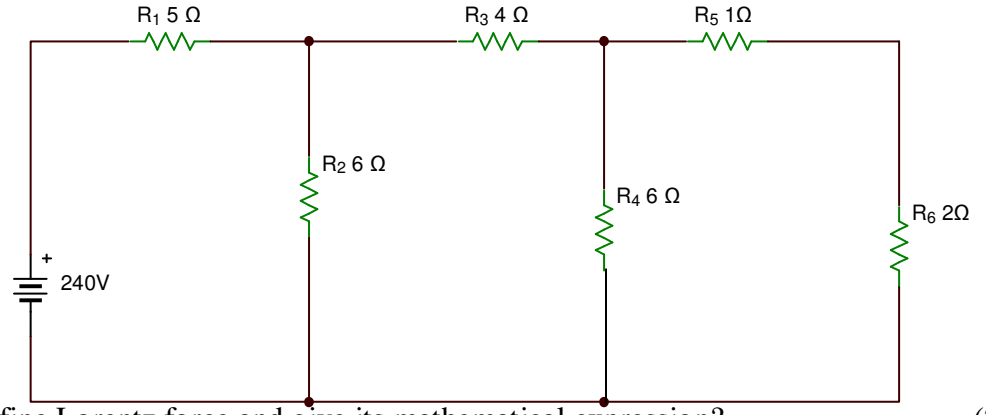
Where X is the distance between the two balls

II) If L= 122cm, m=11.2g and X=4.7cm, what is the value of q? (2mks)

(c) A rectangular block of Iron has dimensions 1.6cm by 1.6cm by 25cm. Find the conductance of the block between the two square ends. (2mks)

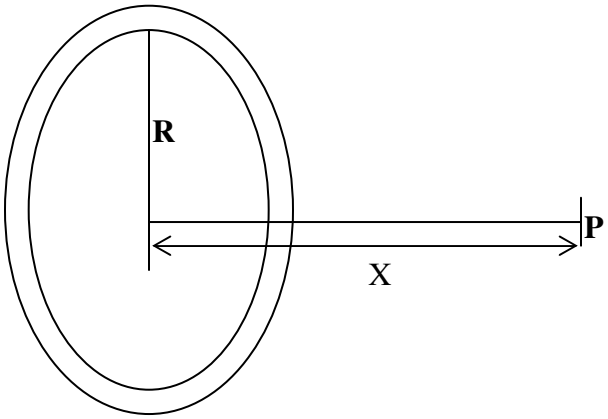
(d) i) State Kirchhoff's current law. (1mk)

ii) Determine the voltage across R_6 in the given circuit (3mks)



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

(f) Consider a thin ring of radius (**R**) carrying a uniform linear charge density (**λ**) around its circumference as shown



i). Derive an expression for the electric field (**E**) at a point (**P**) a distance (**X**) from the plane of the ring along its central axis (5mks)

ii). Show that if X>>R, the ring become like a point charge. (3mks)

(g) 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 $3.6\times10^{-24}\,J/T$ is in a uniform magnetic field of 450T at an angle of 30°. Calculate the magnetic torque on the electron. (2mks)

QUESTION 2 (20 marks)

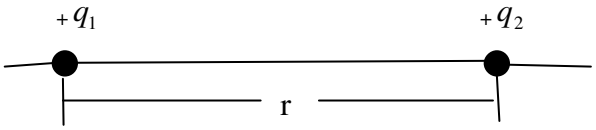
(a) Define flux of a vector field and give circumstances under which flux is positive or negative. (2mks)

(b) i) State Gauss' law in words. (1mk)

ii) A long cylindrical solid insulator of length (L) and radius (R) has charge per unit volume (ρ). Find the expression of electric field (**E**) inside and outside the cylinder and sketch the variation of (**E**) against (r) for $0<R\leq r$ and for r>R (5mks)

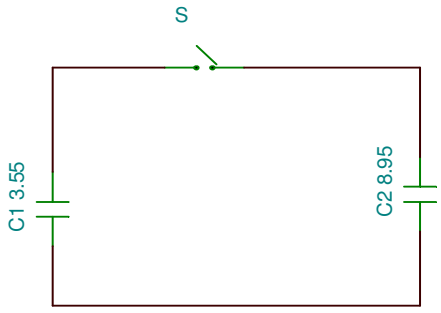
(c) i) Define electric potential (1mk)

ii) Calculate the expression for the potential energy of the system of two point charges shown (3mks)



Assuming q_2 moves away from or towards q_1 along the line connecting the two charges taken to be the X axis. (3mks)

d) A 3.55μF capacitor C_1 is charged to a potential difference $V_0 = 6.30V$, using a battery. The charging battery is then removed, and the capacitor is connected as shown in Figure below to an uncharged 8.95μF 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)

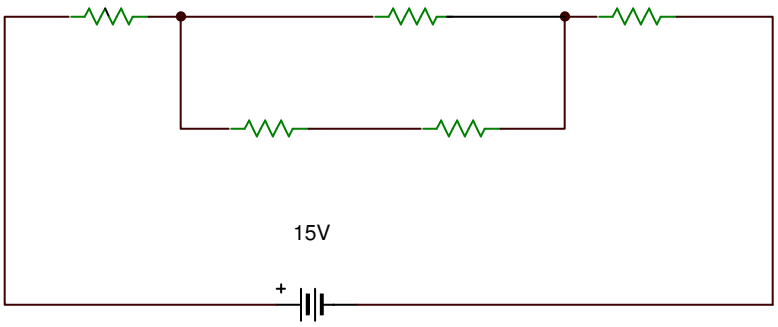
ii). What is the energy stored after the switch is closed (3mks)

QUESTION 3 (20 marks)

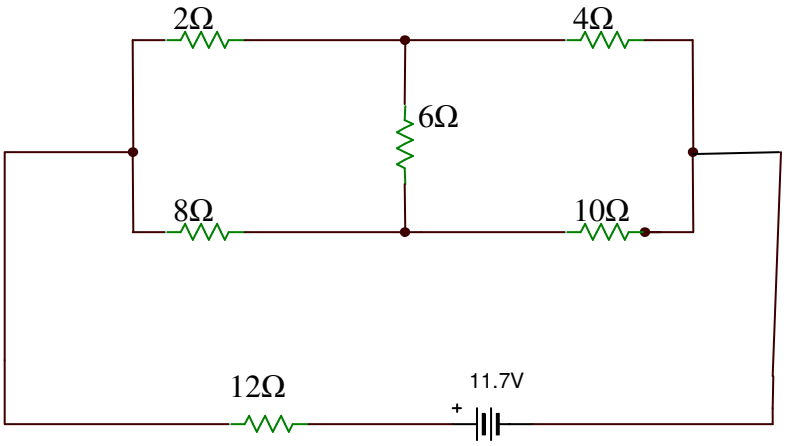
(a) i) What is a potentiometer? (1mk)

ii) State two uses of potentiometers (2mks)

(b) Find the equivalent resistance in the given resistor network circuit assuming that each resistor is 2Ω and hence calculate the total current in the circuit (4mks)



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



d) Consider a wheat-stone bridge circuit of resistors R_1, R_2, R_X and a variable resistor R_S connected in that order in the clockwise network loop, with a galvanometer between one diagonal and a source of e.m.f. in the other diagonal Show that at null condition,

$$R_X = R_S\left(\frac{R_2}{R_1}\right)$$ (3mks)

e) Derive the expression of finding the electric potential difference at a point (P) a distance (Z) along the axis of a uniform ring of radius (R) carrying total charge Q.(5mks)

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) Define the following terms (2mks)

i). Electromagnetic induction

ii). Magnetic flux

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

(c) i) Define inductance (1mk)

ii) Calculate the inductance of a solenoid containing 400 turns if the length of the solenoid is 25cm and its cross sectional area is $2cm^2$. (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 8H and resistor of 10Ω is connected to the terminals of a battery of e.m.f. 15V 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)