# KABARAK UNIVERSITY

## UNIVERSITY EXAMINATIONS

### 2010/2011 ACADEMIC YEAR

### FOR THE DEGREE OF BACHELOR OF SCIENCE IN EDUCATION SCIENCE

**COURSE CODE:** **PHYS 110**

**COURSE TITLE:** **ELECTRICITY AND MAGNETISM**

**STREAM:** **SESSION I**

**DAY:** **MONDAY**

**TIME:** **2.00 – 4.00 P.M**

**DATE:** **29/11/2010**

---

**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**

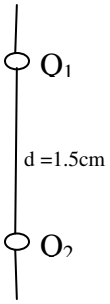
**QUESTION 1 (30 marks)**

a) i) Name two types of electric charges **(1mark)**

ii) Explain why conductors cannot be charged by friction. **(1mark)**

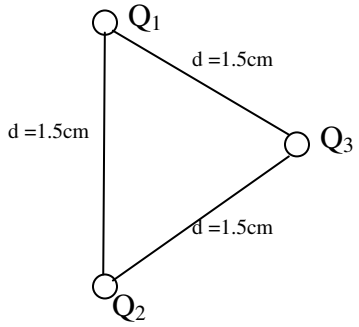
b) i) State the principle of superposition **(1mark)**

ii) The diagram below shows two charges $q_1$ and $q_2$ held at a fixed distance d apart.




I. Find the strength of the electric force that acts on $q_1$, given that $q_1 = q_2 = 4.3\mu C$ and $d = 1.5cm$ **(3marks)**

II. A third point charge $q_3 = 4.3\mu C$ is brought in and placed as shown. Find the strength of electric force on $q_1$ now **(3marks)**

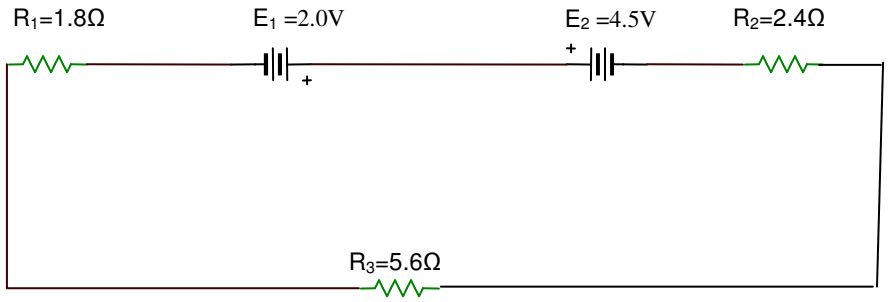



c) Show how Coulomb's law can be deduced from Gauss' law **(3marks)**

d) 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. **(2marks)**

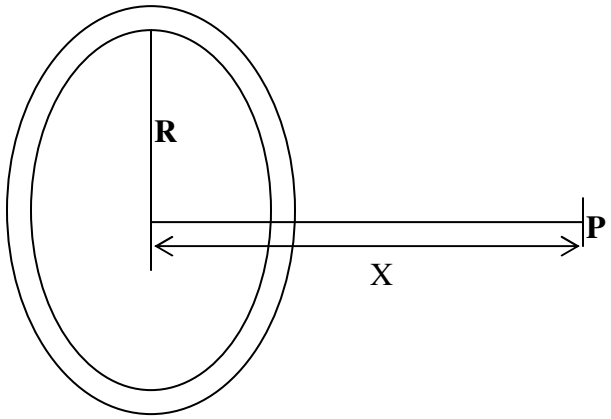
e) i) State Kirchhoff's voltage law. **(1mark)**

ii) Calculate the current in the given circuit **(3marks)**




f) Define Lorentz force and give its mathematical expression? **(2marks)**

g) 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 **(4marks)**

ii). Show that if X>>R, the ring become like a point charge. **(2marks)**

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

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. **(2marks)**

**QUESTION 2 (20 marks)**

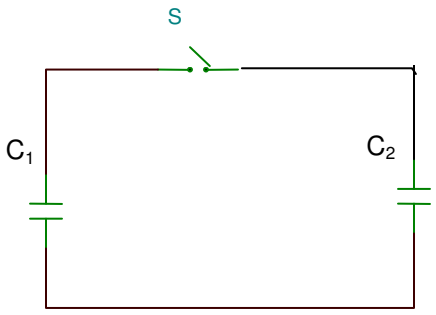
a) Define the following terms **(3marks)**

i). Flux of a vector field
ii). Negative flux
iii). Gaussian surface

b) i) Show how Coulomb's law can be deduced from Gauss' law **(3marks)**

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

c) A 2.5μF 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) **(3marks)**
ii). What is the energy stored after the switch is closed **(3marks)**

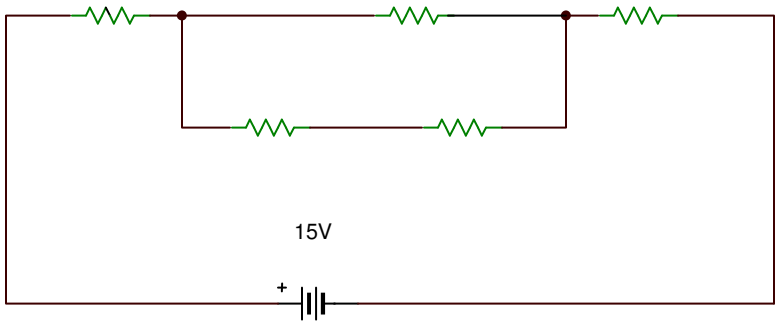
d) State three effects of dielectrics on capacitors**.** **(3marks)**

**QUESTION 3 (20 marks)**

a) i) What is a potentiometer? **(1mark)**

ii) State two uses of potentiometers **(2marks)**

b) Consider the given resistor network circuit.

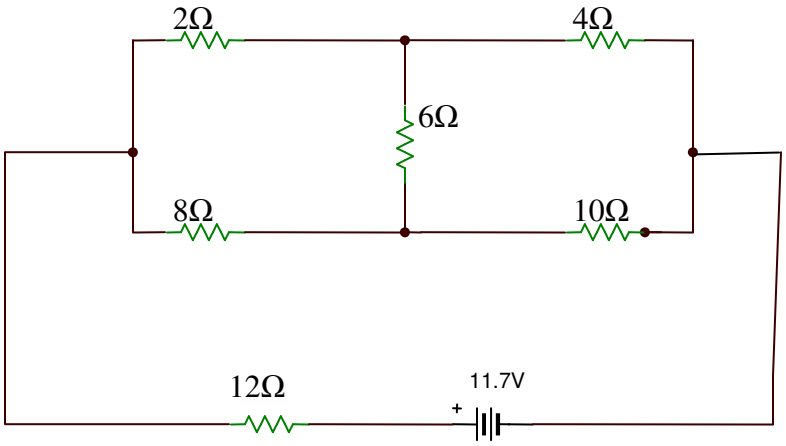



Assuming that each resistor is 2Ω, Calculate;

**i).** Total resistance **(2marks)**

ii). the total current in the circuit **(2marks)**

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



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,

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

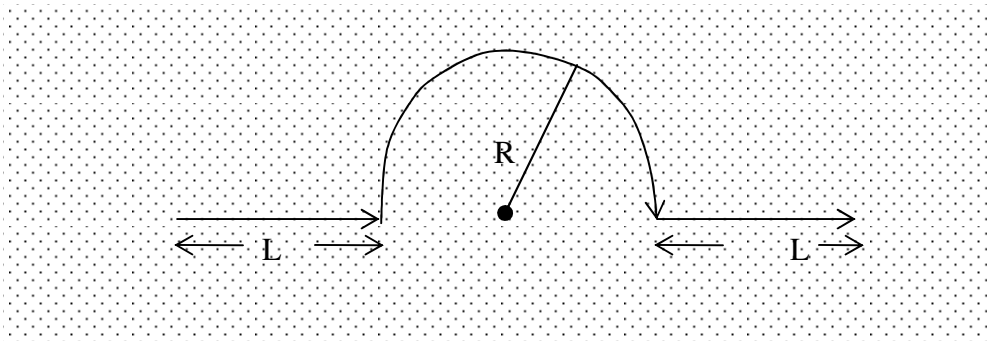
e) Derive the expression of finding the electric potential difference at a point (P) a distance (Z) along the axis of a uniform ring of radius (R) carrying total charge Q. **(5marks)**

**QUESTION 4 (20 marks)**

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

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

b) i) The diagram below shows a wire segment placed in a uniform magnetic field $(\vec{B})$ that point out of the plane of the diagram.




If the wire carries a current $(I)$, from left to right as shown, derive the expression of the resultant magnetic force $(\overrightarrow{F_B})$ experienced by the wire. **(5marks)**

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 $46.6g/m$. **(4marks)**

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 **(3marks)**

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

**QUESTION 5 (20 marks)**

a) Define the following terms **(2marks)**

i). Electromagnetic induction

ii). Magnetic flux

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

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

ii) Calculate the inductance of a solenoid containing 10,000 turns if the length of the solenoid is 25cm and its cross sectional area is $2cm^2$. **(2marks)**

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

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 **(2marks)**

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

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

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