MENGO SENIOR SCHOOL

DEPARTMENT OF PHYSICS

B.O. T I PHYSICS 501/2 EXAM, 2004

SENIOR SIX

TIME: 2 HOURS

INSTRUCTIONS:

- *Attempt any **four** questions*
- *All questions carry equal marks*

1. a) Distinguish between surface charge density and electric field intensity on the surface of an isolated spherical conductor.

   b) Show that the electric field strength on the surface of an isolated conducting spherical shell with total charge Q is given by

   $$\frac{\text{Charge density}}{\text{Permitivity of air}}$$

   c) A charged oil drop remains stationery when situated between parallel and horizontal metal plates 20mm apart and a p.d of 1000V applied to the plates.
   Find the mass of this drop given that it's charge is 1×10^{-12} MC.

   d) Point charges $q_1 = -2$MC and $q_2 = 3$MC are arranged in air as show below.

   Calculate the electric force on a unit positive charge place at P.

2. a) Explain the use of an insulator between capacitor plates.

   b) Show that the capacitance of two parallel plates with common area A and separated by a distance d apart by a material of permitivity E is given by

   $$\frac{EA}{d}$$

c) In the figure below, C_1, C_2, C_3 are capacitors of capacitance 3MF, 2MF, 2MF respectively.

i) Find the energy stored in a full charged C_2 if K is open.

ii) Find the total energy stored in the capacitors when K is closed.

iii) Draw a circuit diagram using C_1, C_2, C_3 and 50V d.c supply that will give maximum full charge and find this charge.

3. a) (i) State Kirchoff's laws for electric circuit networks.
(ii) Explain why the p.d across cell terminals isn't always equal to it's E.m.f.

b) In the circuit shown below, find

(i) the current I in the circuit.

(ii) the power dissipated in the 4Ω resistor.

c) It's required to make a heating element which dissipates 550W when connected to a 240V mains.

(i) Calculate the resistance of the wire needed.

(ii) The element is made of nichrome whose resistivity is $11x10^{-7}\Omega m$. If the width of this nichrome is 2mm and its thickness is 0.05mm, calculate its length.

d) i) State Ohm's law for electrical resistance.

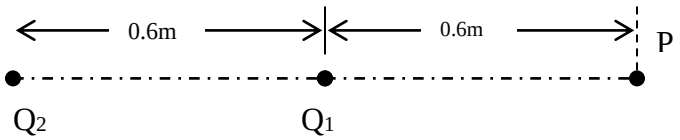
ii) Draw the I-V characteristic for neon gas.

4. a) (i) Write down expressions of the electric potential and electric field intensity at a point r meter away from the surface of a charged sphere of radius "a"m.

(ii) On the same sketch, illustrate the variation of potential and intensity along the radius of a charged conducting sphere to infinity.

b) Outline Faraday's ice pail experiment and point out deductions you can draw from it.

c) The figure below shows charges Q_1 and Q_2 placed along a straight line in air.



If Q_1 = 0.4MC and Q_2 = 12MC

(i) Calculate the field strength at point P.

(ii) Find the location of a point between Q1 and Q_2 at which the electric potential is zero.

d) A 5MF capacitor is charged to a p.d of 100V and then disconnected from the supply. Its terminals are then joined to another uncharged capacitor of capacitance 10MF.

Calculate the total energy stored in the combination.

5. a) (i) Define resistivity and write down it's units.

(ii) Explain the mechanism of electrical heating when a current passes through a wire of uniform material.

b) (i)

In trying to determine the resistance of a wire x, Mulinde and Brenda connected the above circuit. They connected x in series with a coil immersed in 1kg of water at 20^{o}C. When K_1 is closed and K_2 open, the water reached its boiling point in 10 minutes. When K_1 and K2 are both closed the water reaches it's boiling point in 6 minutes. Neglecting heat losses, calculate the resistance of wire x.

(ii) A battery of internal resistance r and e.m.f E is connected across a variable resistor R. On the same axes show the variation graphs for efficiency and the power output of the circuit.

(c) Derive the expression for the effective resistance of three resistors connected in

i) Parallel

ii) Series.