MENGO SENIOR SCHOOL

BEGINNING OF TERM 2 EXAMS 2003

S.6 PHYSICS P510/2

TIME: 2:30 HOURS

INSTRUCTIONS:
-Attempt any five questions
-All questions carry equal marks

1(a) What do you understand by the following terms:
(i) Electromotive force
(ii) Internal resistance of a battery

(b) An 80m copper wire of diameter 1mm is joined end to end with a 50m iron wire of the same diameter as shown below:

Iron wire

Copper wire

A current enters the loop at Q and leaves at P. Given that the resistivities of copper and Iron are 1.7×10^{-8} m and 10×10^{-8} m respectively, find:

(i) The effective resistance of the loop
(ii) The electric field intensity in the copper wire.
(iii) The currents through the respective wires.

(c) Using the atomic model, explain completely why metals become hot when a current flows through them for some time.

(d) In an experiment with a metre bridge, the unknown X is kept in the right hand gap and is gradually heated.

When its temperature is 30^0C, the balance point is 51.5cm from the left hand end of the slide wire.

When the temperature is 100^0C, the balance point is 54.6cm from that end. Calculate the balance length when x is cooled to 0^0C.

2. A battery of e.m.f E and Internal resistance r is connected across a variable resistor R.

(i) Deduce the condition for the maximum power dissipated by the battery.
(ii) Sketch a graph to show the variation of the power dissipated with R.

(b)(i) Assuming that the resistivity of copper is half that of aluminium and that the density of copper is three times that of aluminium. Find the ratio of the masses of copper and aluminium cables of equal resistance and length.

(ii) A wire has a resistance of 10Ω at 20^0C and 13.1Ω at 100^0C obtain a value for its temperature coefficient of resistance.

(c) When the current passing through a nichrome wire is very small, the resistance is found to be 50.9 at 20^0C. In use the current through the wire is 4.17 A on a 240v supply. Calculate:

(i) The rate of energy conversion by the wire.
(ii) The steady temperature reached by the wire when in use
(t.c.r of Nichrome is $1.7 \times 10^{-4}/^0$C)

3(a) Define the terms virsual angle and angular maginification as applied to optical instruments.

(b)(i) Describe with aid of a simple telescope made up of a converging and a diverging lens when used in normal adjustment.

(ii) State one limitation of this type of telescope.

(c) A telescope consists of a converging and diverging lens of focal length 150cm and 30cm respectively.
When it is used to read a scale 15cm from the objective, the final image is formed 60cm from the eye piece.
Find the separation of the lenses.

(d) A ray of monochromatic light eneters one face of a 60^0 glass prism and is totally internally reflected at the next face.

(i) Draw a diagram to show the path of the ray through the prism.
(ii) Calculate the angle of incidence at the first face if the refractive index of glass is 1.53 and the angle of incidence at the second face is 42^0.

4(a)(i) Derive the balance condition for the wheat stone bridge circuit.

(ii) List down three limitations of a bridge circuit.

(b)(i) Define the term temperature coefficient of resistance of a material of wire.

(ii) Describe an experiment to determine the temperature coefficient of resistance of a material of wire using a bridge circuit.

(c)(i) A coil of wire immersed in a water ice mixture has a resistance of 5 and a bridge circuit is balanced when this coil is connected across the left hand gap.

When the temperature of the coil is increased to 100^0C, it is found necessary to connect a resistance of 100 in parallel with the coil in order for the bridge to balance again without adjusting the jockey at all.

Calculate the temperature coefficient of resistance of the material of this coil.

(iii) The table below shows the resistance of a nichrome wire at various temperatures.

Temp/^{0}C	75	120	150	250	300
Resistance/	103	103.8	1004.4	105.9	106.8

Plot a suitable graph and use the graph to determine the t.c.r of nichrome.

5(a)(i) Define the term resistivity of a material.

(iii) Describe giving full experimental details how you can determine the resistivity of a material of wire using a simple meter bridge.

(b)(i) In an experiment to determine the resistivity of a material of wire, the following results were obtained when a wire of diameter 0.40mm was connected across the left hand gap of a simple metre bridge with a 2 resistor in the right hand gap.

Length of wire x/cm	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8
Balanced L.H. side L/cm	17.3	30.0	38.9	46.1	51.7	56.5	60.2	63.4

By a graphical; method determine the resistivity of the material of this wire.

(ii) Two coils P and Q are placed in the gaps of metre bridge. A balance point is found when the jockey is 35.5cm from the end joined to P. When Q is shunted with a resistance of 10 the balance point is moved through a distance of 15.5cm. Find the value of the resistances of P and Q.

6(a)(i) State kirchhoff's laws for electrical circuit networks.

(ii) The circuit below shows two cells E_1 and E_2 of internal resistance 3 and respectively across which is an 8 resistor.

(i) Find the magnitudes of the currents I_1 and I_2 shown in the diagram.

(ii) What is the p.d across the 8 resistor.

(b)(i) State ohm's law for a conductor.

(ii) A fuse wire has length l and radius r. The wire melts if the current through it exceeds 5A. The wire is now replaced by another one of the same material and lengths but of radius 2r. Find the current beyond which the second of heat loss is proportional to the surface area.

(c) A wire of diameter d, length l and resistivity forms a loop. A current enters and leaves the loop at points P and Q respectively as show below.

Show that the resistance R of the wire is given by.

$$R = \frac{4 \times (l-x)}{D^2 l}$$

(d) Sketch the I-V characteristics for:
(i) A junction diode
(ii) Neon gas

7(a) Define the terms below as applied to capacitors.

(i) Dielectric constant
(ii) Capacitance

(b)(i) Derive an expression for the energy stored in a capacitor of capacitance C charged to a p.d V.
(N.B be well detailed)

(ii) A capacitor of capacitance C is fully charged by a 200V supply. Its then discharged through a small coil of a resistance wire embedded in a thermally insulated block of specific heat capacity 2.5×10^2 J/Kg/k and mass 0.4kg. If the temperature of the block rised by 0.1k, what is the value of C and state any assumptions made.

(c)(i) A capacitor filled with a dielectric is charged and then discharged through a milliammeter.
The dielectric is then withdrawn half way and the capacitor is charged to the same voltage as before and again discharged through the milliameter again. Show that the relative permitivity, E of the dielectric is given by:

$$E = \frac{I}{2I^1 - I}$$

Where I and I^1 are the readings of the milliameter respectively.

(iii) Derive an expression for two capacitors connected in series.

END