Experiment No. 5
Variation of resistance with temperature

Objective:

To investigate the variation of the resistance of metals with temperature and to measure the temperature coefficient of resistance for copper.

Equipment:

Glass Beaker.
Metal resistance (coil of long wounded wire coated with mica)
Heating arrangement to heat the resistor.
Thermometer (0 - 100 $C^{o)}$.
Ohmmeter.

Theory:

The resistivity of a metal varies linearly with temperature (to first order approximation and when the temperature change is very small) according to,

$$\rho = \rho_o \left[1 + \alpha (T - T_o) \right]$$

Where ρ is the resistivity at temperature T, ρ_o is the resistivity at some reference temperature T_o (taken to be 20 ^oC or room temperature).
The resistance ($R = \rho L / A$) can be thus expressed as

$$R = R_o \left[1 + \alpha (T - T_o) \right] \quad \Rightarrow R = R_o + R_0 \alpha (T - T_o)$$

$$R = R_o + R_o \alpha \Delta T$$

R is the resistance at temperature T.

R_o is the resistance at reference temperature T_0.

The coefficient α is called the temperature coefficient of resistance, and clearly, is given by the rate at which the resistance changes with temperature for a particular material and is usually quite constant over a wide range of temperature, it is defined as and since

$$\Delta R = R_o \alpha \Delta T$$

$$\alpha = \frac{(R - R_0)}{R_o (T - T_0)} = \frac{1}{R_o} \cdot (slope\ of\ R\ vesus\ T) \qquad \Rightarrow \alpha = \frac{S}{R_o}$$

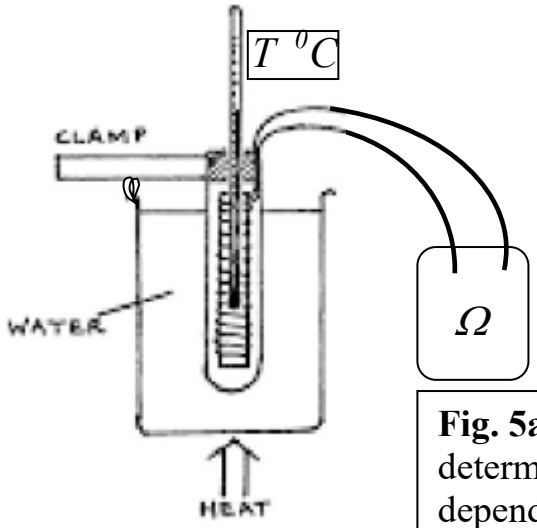

Fig. 5a: Apparatus used to determine the resistance dependence on temperature and the temperature coefficient of resistance α. Water beaker, wounded wire resistor, thermometer, Ohmmeter, heating source.

PROCEDURE:

1. Set up the apparatus as shown in the diagram above in Fig 5a.

2. Use the thermometer to note the temperature of the water, which we assume to be the same as the temperature of the coil.

3. Record the resistance of the coil of wire using the ohmmeter.

4. Heat the beaker and for each 10 °C rise in temperature record the resistance and temperature using the ohmmeter and the thermometer, and fill the table in the lab. report which follows.

5. Plot a graph of resistance R against temperature T.

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Name: …… Day and Date: …..……..…

Student's No.: …….. Sec: ……..……..

Partners Names: …….....

Data and Calculation:

T (^oC)	R(T) (Ω)

(1) Reference temperature $T_0 = 0\ ^oC$,

(2) Room temperature = ……. ^oC,

(3) Resistance R at room temperature
R_{room} …….. Ω

(4) Plot R vs. T.

(5) Use the graph to determine R_0, the value of resistance at $T_o = 0$,

R_0 = …….. Ω

(6) Determine **T** the temperature at which the resistance vanishes (when R=0)

……..

(This is the absolute zero **0K = -273 ^{o}C**)

(7) Find the error in in this temperature if its **accepted value** is: **-273 ^{0}C**

(8) Find the slope **S** of your graph.

Slope = S =

(9) Find the coefficient α

(10) Find the percentage error in α knowing its known value to be 0.0039 for the wire used.

$$R = R_o + R_0 \alpha \Delta T$$

Slope =

R_0 =

Question: **Exp.5: Variation of R with T:**

The resistance of a coil at different temperatures is plotted in Fig. 5b

1- Find the resistance at room temperature T_0= 25 °C

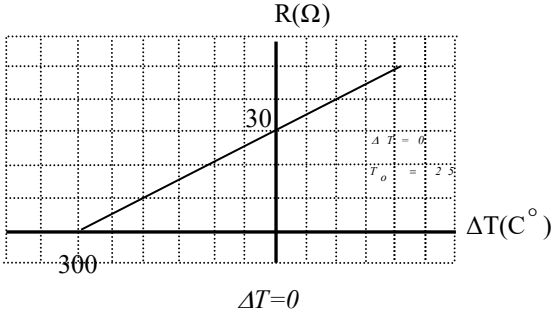

Fig.5b

2- Find the temperature coefficient of resistivity α