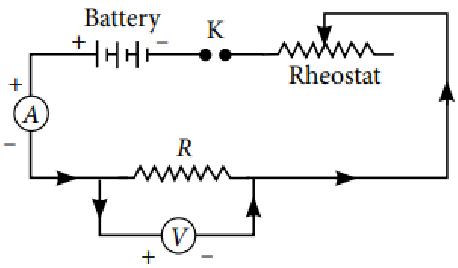
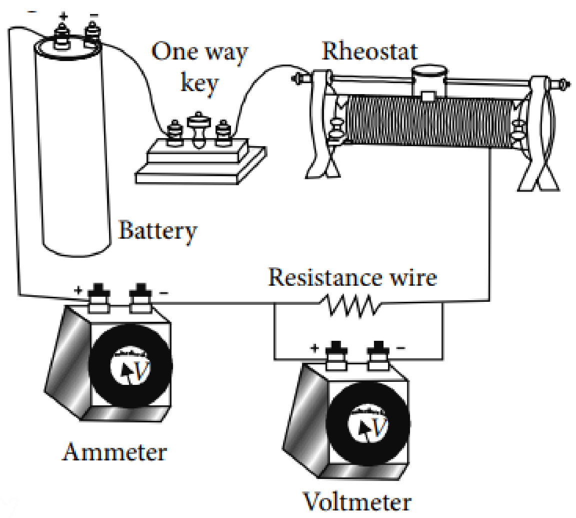
Experiment - 11 : To find Resistance of a given wire using Ohm's law.

Construction

To use ohm's law, we require the following apparatus. A resistance wire, a voltmeter and an ammeter of appropriate range, a battery, a rheostat, a one-way key and connecting wires. Connect the elements as shown in the circuit diagram below.



The arrangement would look like the one below.



Theory

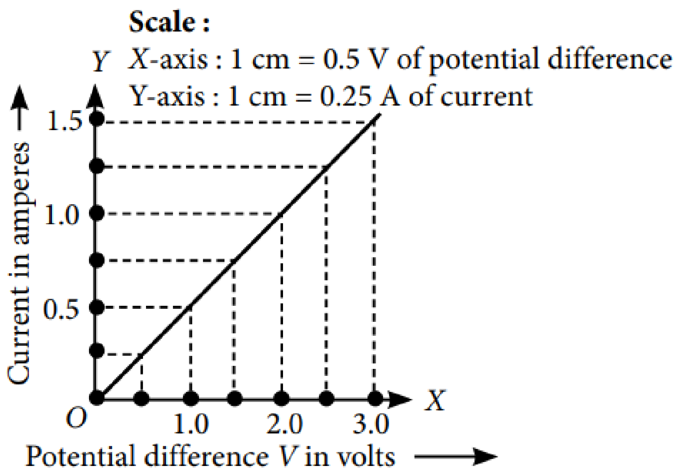
When a current I flows through a conductor of resistance R and V be the potential difference across the resistance, then according to Ohm's law, $V \propto I$ or $V = I \cdot R$
The constant of proportionality is known as resistance.

$$R = \frac{V}{I}$$

The R depends on the material of the wire, its length and cross-sectional area. In S.I. units, V is measured in volt and I in ampere, then R is measured in ohm. While making connections, ensure the positive marked terminals of ammeter and voltmeter are joined towards the positive terminal of the battery.

By adjusting the rheostat, the net resistance and hence the current can be varied. Note various observations of current and potential difference across the resistance and plot the graph.

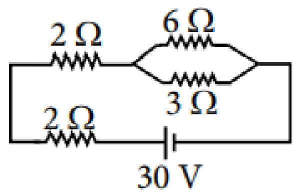
The sample graph of V vs I is shown below:



MCQs Corner

Experiment – 11

48. The current taken from the 30 V supply and the current through the 6 Ω resistor are respectively.



(a) 5 A, $\frac{5}{6}$ A (b) 5 A, $\frac{5}{3}$ A

(c) 6 A, $\frac{5}{6}$ A (d) 6 A, 2 A

49. If a copper wire is stretched to make it η = 0.1% longer, then the percentage change in its resistance is

(a) 0.1 % (b) 0.2 % (c) 0.3 % (d) 0.4 %

50. The temperature coefficient of resistance of a wire is 1.25×10^{-3}/°C. At 300 K, its resistance is 1 Ω. The temperature at which its resistance becomes 2 Ω is

(a) 800°C (b) 827°C (c) 1100°C (d) 1127°C

Answer Key

48. (b) 49. (b) 50. (b)

Hints & Explanation

48. (b) : 6 Ω and 3 Ω in parallel make $\left(\frac{6\times 3}{6+3}\right)\Omega = 2\ \Omega$

The net resistance of the circuit is (2 + 2 + 2)Ω = 6 Ω

$$\Rightarrow \quad I_{\text{Battery}} = \frac{30\ \text{V}}{6\ \Omega} = 5\ \text{A}.$$

The 5 A current in the main circuit will divide in the inverse ratio of resistances, while splitting in the 6 Ω and 3 Ω parallel combination.

$$\Rightarrow \quad I_{6\Omega} = 5\text{A} \times \left(\frac{3\Omega}{3\Omega+6\Omega}\right) = 5\text{A} \times \frac{1}{3} = \frac{5}{3}\ \text{A}$$

49. (b) : $R = \frac{\rho \cdot l}{A}$

$\ln R = \ln \rho + \ln l - \ln A$

$$\frac{dR}{R} = 0 + \frac{dl}{l} - \frac{dA}{A} \qquad \ldots\text{(i)}$$

Now $V = l{\cdot}A$ and volume is constant

$\ln V = \ln l + \ln A$

$$\frac{dV}{V} = \frac{dl}{l} + \frac{dA}{A} \Rightarrow 0 = \frac{dl}{l} + \frac{dA}{A} \qquad \ldots\text{(ii)}$$

Adding (i) and (ii), we get

$$\frac{dR}{R} = \frac{2dl}{l} \quad (\text{As } \eta = 0.1\ \%,\ dl = 0.1\ \%)$$

$$\Rightarrow \quad \frac{dR}{R} = 2 \times 0.1\% = 0.2\ \%$$

50. (b) : $R = R_0(1 + \alpha\Delta T)$

$2\ \Omega = 1\ \Omega(1 + (1.25 \times 10^{-3})\Delta T)$

$\Rightarrow 2 = 1 + (1.25 \times 10^{-3})\Delta T$

$$\Delta T = \left(\frac{1}{1.25\times 10^{-3}}\right)^\circ\text{C} = 800^\circ\text{C}$$

Now, $T_f = T_0 + \Delta T$.

Here $T_0 = 300\ \text{K} = 27^\circ\text{C} \Rightarrow T_f = 27^\circ\text{C} + 800^\circ\text{C} = 827^\circ\text{C}$