Subject - Physics Chapter-1 Class X

(Electricity)

Ohm's Law :- According to Ohm's law —

"At constant temperature, the current flowing through a conductor is directly proportional to the potential difference across its ends."

$$V \propto i$$

$$\Rightarrow \boxed{V = iR} \quad \Rightarrow \quad R = \frac{V}{i}$$

V = Potential difference
i = Current
R = Resistance

(i) The current is directly proportional to potential difference.

(ii) The current is inversely proportional to resistance.

Note:- The strength of electric current in a given conductor depends on two factors :-

(i) potential difference across the ends of the conductor.

(ii) Resistance of the conductor.

Resistance :- The property of a conductor due to which it opposes the flow of current through it is called resistance.

$$\boxed{R = \frac{V}{i}}$$

(i) The resistance of a conductor depends upon length, thickness, nature of materials and temperature of the conductor.

(ii) The SI unit of resistance is "Ohm" (Ω).

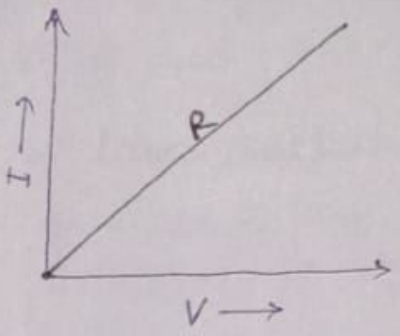
(iii) It is denoted by 'R'.

1 Ohm :- 1 ohm is the resistance of a conductor such that when a potential difference of 1 volt is applied to its ends, a current flows (1 ampere) through it.

Graph between V and I.

Current is directly proportional to the potential difference. So the graph between V and I is a straight line.

$V \propto I$



Conductor :- Those substances which have very low electrical resistance are called good conductors.

Ex- Copper, Iron, Aluminium etc.

Resistors :- Those substances which have comparatively high electrical resistance, are called resistors.

Insulators :- Those substances which have infinitely high electrical resistance are called insulators.
Ex- Dry Wood is good insulators.

- **Factors affecting the resistance of a conductor–**
The electrical resistance of a conductor depends on the following factors :-

1. **Effect of length of the conductor–**
The resistance of a conductor is directly proportional to its length.

$$R \propto L \quad \Rightarrow \quad \frac{R_1}{R_2} = \frac{L_1}{L_2}$$

where –
R_1 & R_2 = Initial and final resistance of wire
L_1 & L_2 = Initial and final length of wire

2. **Effect of Area of Cross-Section of the conductor–**
The resistance of a conductor is inversaly proportional to its area of cross-section.

$$R \propto \frac{1}{A}$$

where, A = Area of cross-section
R = Resistance

$$\Rightarrow \quad \frac{R_1}{R_2} = \frac{A_2}{A_1}$$

R_1 & R_2 = initial and final resistance of the conductive wire
A_1 & A_2 = initial and final cross-sectinal area.

3. Effect of Temperature :-

The resistance of all pure metals increases on raising the temperature; and decreases on lowering the temperature.

4. Effect of the nature of Material :-

The resistance are different for different types of materials.

Note :- The resistance of nichrome wire is about 60 times more than that of copper wire.

- **Resistivity :-**

We know that -

(i) The resistance of a given conductor is directly proportional to its length.

$$R \propto l \quad \text{——— (i)}$$

(ii) The resistance of a given conductor is inversaly proportional to its area of cross-section.

$$R \propto \frac{1}{A} \quad \text{——— (ii)}$$

By combining equation (i) and (ii)

$$R \propto \frac{l}{A} \Rightarrow \boxed{R = \frac{\rho \times l}{A}}$$

$$\Rightarrow \boxed{\rho = \frac{R \times A}{l}}$$

Where,

ρ = Resistivity of material

If ~~R = 1Ω~~, $l = 1\,m$ and $A = 1\,m^2$

Then $$\rho = \frac{R \times A}{l} = \frac{1 \times 1}{1} = 1\ \Omega \cdot m$$

$$\Rightarrow \boxed{\rho = R}$$

"The resistivity of a substance is numerically equal to the resistance of a rod of that substance which is 1m long and 1 square metre in cross-section."

(i) The unit of resistivity is Ω·m.

(ii) Resistivity of a substance does not depend on its length or thickness, it depends on the nature of the substance and temperature.

(iii) Silver metal is the best conductor of electricity.

(iv) We use copper and aluminium wires for the transmission of electricity because copper and aluminium have very low resistivity.

(v) The resistivities of alloys are much more higher than those of the pure metals.

(vi) The heating elements of electrical heating appliance such as electric iron, toaster etc. are made of an alloy rather than a pure metal.

Question

Que 1. Distinguish between good conductors, insulators and resistors.

Que 2. What is Ohm's law? Explain how it is used to define the unit of resistance?

Que 3. What is resistance of wire?

Que 4. Define resistivity. Write an expression for the resistivity of a substance.

Que 5. Distinguish between resistance and resistivity.

Que 6. A simple electric circuit has a 24 V battery and a resistor of 60 ohms. What will be the current in the circuit? The resistance of the connecting wires is negligible.

Que 7. A copper wire length of 2 m and area of cross section $1.7 \times 10^{-6}\ m^2$ has a resistance of $2 \times 10^{-2}\ \Omega$. Calculate the resistivity of wire.

Que 8. A 6 Ω resistance wire is doubled up by folding. Calculate the new resistance of the wire.

Que 9. A piece of wire of resistance 20 Ω is drawn out so that its length is increased to twice its original length. Calculate the resistance of wire in the new situation.