

LAWS OF RESISTANCE

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LAWS OF RESISTANCE

- **The resistance of the conductor varies directly with its length.**
- **The resistance of the conductor is inversely proportional to its cross sectional area.**
- **The resistance of the conductor depends on the material with which it is made of.**
- **It also depends on the temperature of the conductor.**

LAWS OF RESISTANCE

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

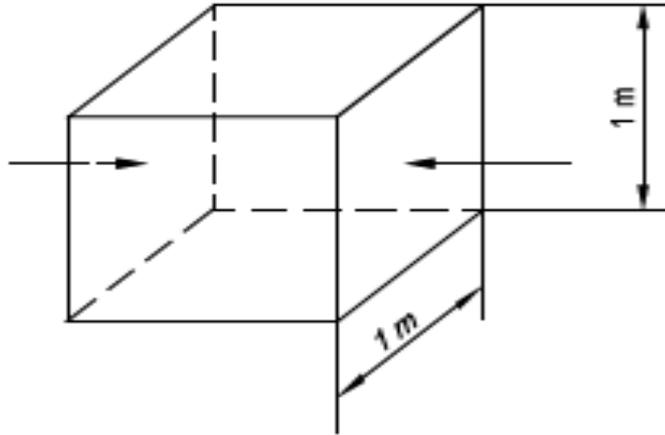
$$R = \frac{\rho l}{A}$$

RESISTIVITY

- $\rho = \frac{RA}{l}$
- ρ is a constant depending on the nature of the material of the conductor and is known as its specific resistance or resistivity.
- unit of resistivity is ohm-metre ($\Omega\text{-m}$).

RESISTIVITY

- It is the resistance between the opposite faces of a meter cube of that material.



SPECIFIC RESISTANCE

- **Copper** **$1.72 \mu\Omega \text{ cm}$** **$1.72 \times 10^{-8} \Omega\text{m}$**
- **Silver** **$1.64 \mu\Omega \text{ cm}$** **$1.64 \times 10^{-8} \Omega\text{m}$**
- **Eureka** **$49 \mu\Omega \text{ cm}$** **$49 \times 10^{-8} \Omega\text{m}$**
- **Iron** **$9.8 \mu\Omega \text{ cm}$** **$9.8 \times 10^{-8} \Omega\text{m}$**
- **Aluminium** **$2.8 \mu\Omega \text{ cm}$** **$2.8 \times 10^{-8} \Omega\text{m}$**

SPECIFIC RESISTANCE

- **Nickel** **$7.8 \mu\Omega \text{ cm}$** **$7.8 \times 10^{-8} \Omega m$**
- **Nichrome** **$108.5 \mu\Omega \text{ cm}$** **$108.5 \times 10^{-8} \Omega m$**
- **Tungsten** **$5.5 \mu\Omega \text{ cm}$** **$5.5 \times 10^{-8} \Omega m$**

CONDUCTANCE

- **The property of a conductor which conducts the flow of current.**
- **It is the reciprocal of resistance**

$$\text{Conductance (G)} = \frac{1}{R}$$

- **Unit – Mho or Siemen**
- **Good conductors have large conductance and good insulators have low conductance**

CONDUCTIVITY

- It is the reciprocal of resistivity of a conductor
- It is also known as specific conductance
- Denoted by σ

$$\sigma = G \frac{l}{A}$$

- Unit of conductivity is siemens/metre (S/m).

TEMPERATURE COEFFICIENT OF RESISTANCE

- **Most conductive materials change specific resistance with changes in temperature.**
- **The resistance-change factor per degree Celsius of temperature change is called the temperature coefficient of resistance.**

TEMPERATURE COEFFICIENT OF RESISTANCE

- Let a metallic conductor having a resistance of R_0 at 0°C be heated of $t^\circ\text{C}$ and let its resistance at this temperature be R_t .
- Increase in resistance

$$\Delta R = R_t - R_0$$

TEMPERATURE COEFFICIENT OF RESISTANCE

- Increase in resistance depends,
 - directly on its initial resistance
 - directly on the rise in temperature
 - on the nature of the material of the conductor

$$R_t - R_0 \propto R \times t$$

TEMPERATURE COEFFICIENT OF RESISTANCE

- $R_t - R_o = \alpha R_o t$
- where α (alpha) is a constant and is known as the temperature coefficient of resistance of the conductor.

$$\alpha = \frac{\Delta R}{R_o t}$$

TEMPERATURE COEFFICIENT OF RESISTANCE

- **Temperature coefficient of a material may be defined as the increase in resistance per ohm original resistance per °C rise in temperature.**

$$R_t = R_o (1 + \alpha t)$$

POSITIVE TEMPERATURE COEFFICIENT

- **If the value temperature coefficient is positive, then the value of resistance increases with increase in temperature.**
- **The temperature/resistance graph is a straight line**
- **Pure metals typically have positive temperature coefficients of resistance.**

ZERO TEMPERATURE COEFFICIENT

- If there is approximately no change in resistance with temperature, we can consider the value of this coefficient as zero.
- Example : Manganin, Eureka and Constantan

NEGATIVE TEMPERATURE COEFFICIENT

- **If the value temperature coefficient is negative, then the value of resistance decreases with increase in temperature.**
- **Decrease the resistance of electrolytes, insulators (such as paper, rubber, glass, mica etc.) and partial conductors such as carbon, Silicon.....**

**Resistance of wire of length is 100 ohm,
resistance of the wire of same thickness but
tripled the length is...**

$$R_1 = \frac{\rho L}{A}$$

$$R_2 = \rho \frac{3L}{A}$$

$$= 3 \times \frac{\rho L}{A} = 3 \times R_1$$

$$= 3 \times 100$$

$$= 300 \Omega$$

If the diameter of a resistance wire is halved, then its resistance becomes:

$$R_1 = \frac{\rho L}{A}$$

- **Area of cross-section, $A = \pi r^2 = \frac{A}{4}$**

$$\begin{aligned} R_2 &= \rho \frac{L}{\frac{A}{4}} \\ &= \rho \frac{4L}{A} = 4 R_1 \end{aligned}$$

If a wire of resistance R is stretched to double of its length, then the new resistance will be

$$R_1 = \frac{\rho L}{A}$$

- **When the wire is stretched then, then its area will decrease automatically. But the volume of wire will be the same.**

$$L_2 = 2 \times L_1$$

$$A_2 = \frac{A_1}{2}$$

If a wire of resistance R is stretched to double of its length, then the new resistance will be

$$\begin{aligned} R_2 &= \rho \frac{2L}{\frac{A}{2}} \\ &= \rho \frac{4L}{A} \\ &= 4 \times R_1 \end{aligned}$$

THANK YOU