Applied Physics
EEI (morning), C.S.I, M.Cad I

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10/04 | 2020

Ohm's Law: Resistance:

The current flowing through a conductor is directly proportional to the potential difference applied across its ends, provided the temperature and other physical conditions remain unchanged.

Thus,

Potential difference $\propto$ current

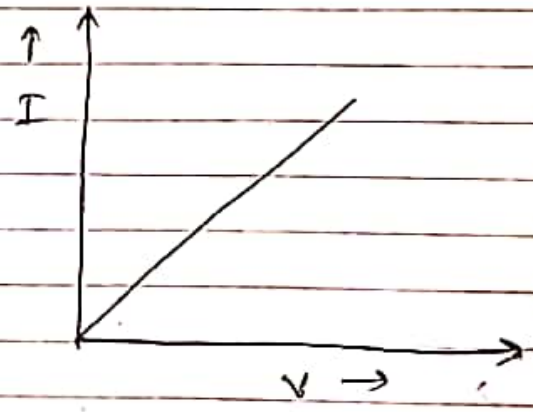
$$V \propto I$$

$$\boxed{V = RI}$$

The proportionality constant R is called the resistance of the conductor. Its value is independent of V and I but depends on the nature of the conductor, its length and area of cross-section and physical conditions like temperature etc. Ohm's law may also be expressed as-

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

The graph b/w the potential difference V applied across a conductor to the current I flowing through it is a straight line as shown in fig.



Resistance: The resistance of a conductor is the property by virtue of which it oppose the flow of charges through it.

It is equal to the ratio of the potential difference applied across the conductor to the current flowing through it. Thus.

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

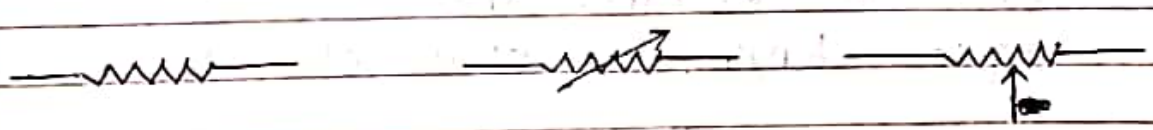
SI unit of resistance is ohm (Ω). If the potential difference (V) is 1 volt and current (I) is 1 ampere, then the resistance (R) is 1 ohm.

$$\therefore \quad 1 \text{ ohm} = \frac{1 \text{ volt}}{1 \text{ ampere}}$$

or $$1\,\Omega = 1\,VA^{-1}$$

Thus, the resistance of a conductor is said to be 1 ohm if a current of 1 ampere flows through it on applying a potential difference of 1 volt across its ends.

Any material that has some resistance is called a resistor. Pictorial symbols for resistors and meets are given in fig.



Fixed resistor Variable resistor Potential divider

Factors Affecting The Resistance : Resistivity.

At a constant temperature, the resistance of a conductor depends on the following factors.

(1) Length. The resistance R of a conductor is directly proportional to its length ie.

$$R \propto l$$

(2) Area of cross-section: The resistance R of a uniform conductor is ~~inves~~ inversely proportional to its area of cross-section A.

ie

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

(3) Nature of the material:

The resistance of a conductor also depends on the nature of its material. For example, the resistance of nichrome wire is 60 times that of a copper wire of equal length and area of cross-section.

Combining the above factors, we get

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

Where ρ is the constant of proportionality called resistivity or specific resistance of the material of the conductor.

It depends on the nature of the material of the conductor and on the physical conditions like temperature and pressure but it is independent of its size or shape.

Resistivity or specific resistance: If in the above equation, we take

$l = 1$ unit and $A = 1$ square unit

then $\boxed{R = \rho}$

Thus, the resistivity or specific resistance of a material may be defined as the resistance of a conductor of that material, having unit length and unit area of cross-section, or it is the resistance offered by the unit cube of the material of a conductor.

SI unit of resistivity: We can write

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

$$\therefore \text{SI unit of } \rho = \frac{\text{ohm} \times \text{meter}^2}{\text{meter}}$$

$$= \text{ohm meter } (\Omega\,m)$$

Thus, the SI unit of resistivity is ohm meter ($\Omega\,m$).