Resistivity And Its Dependence On Temperature

Resistance is defined as the opposition offered by the atom of the conductor to the flow of electric current is called resistance in ohm's law. In this article, we will learn about resistivity and its dependence on temperature.

It has been experimentally seen that the resistance of a conductor is directly proportional to its length 'L' and inversely proportional to its area of cross-section 'A',

Mathematically,

$$R \propto L$$

$$R \propto 1/A$$

$$R \propto L/A$$

$$R = \rho(L/A)$$

Where 'p' is the constant of proportionality and is called "Resistivity" or "Specific Resistance" of the conductor.

What is Resistivity?

"The resistance of a meter cube of a material is called Resistivity."

Unit of resistivity

The SI unit of resistivity is Ohm-meter (Ωm).

What is the difference between resistance and resistivity?

- Unit of resistance of 'Ohm' while that of resistivity is 'Ohm-meter'
- Resistance depends on the nature, temperature, and geometry of the wire while resistivity depends on nature and temperature only

What is Conductance?

"The reciprocal of resistance is called Conductance"

Mathematically.

Conductance =G=1/R

What is the Unit of Conductance?

The SI unit of conductance is "mho" or "Siemen".

What is Conductivity?

"The reciprocal of resistivity is called Conductivity."

It is denoted by ' σ'

$$\sigma = 1/\rho$$

What is the Unit of Conductivity?

The SI unit of conductance is "mho-m^{-1}"

Effect of temperature on resistance

The resistance of a conductor is due to the collisions of electrons with the atoms of the conductor.

As the temperature of the conductor rises, the K.E. of the atoms increases and they vibrate with greater amplitude. Hence the probability of their collision with free electrons also increases. So the electrons find it more difficult to pass through them.

Thus the current in the circuit, which is due to the flow of electrons, decreases and we say that the resistance of the conductor has been increased.

Temperature coefficient of resistance:

"The fractional change in resistance per Kelvin is called Temperature co-efficient of Resistance.

It is denoted by ' α'.

Suppose

R_o= Resistance of conductor at 0°C.

R_t = Resistance of conductor at t°C.

(R_t-R_o)= Change in resistance.

Experimentally, it has been found that the change in resistance is directly proportional to the original resistance and the rise in temperature.

Mathematically,

$$R_t - R_o \propto R_o$$

$$R_t - R_o \propto t$$

$$R_t - R_o \propto R_o\, t$$

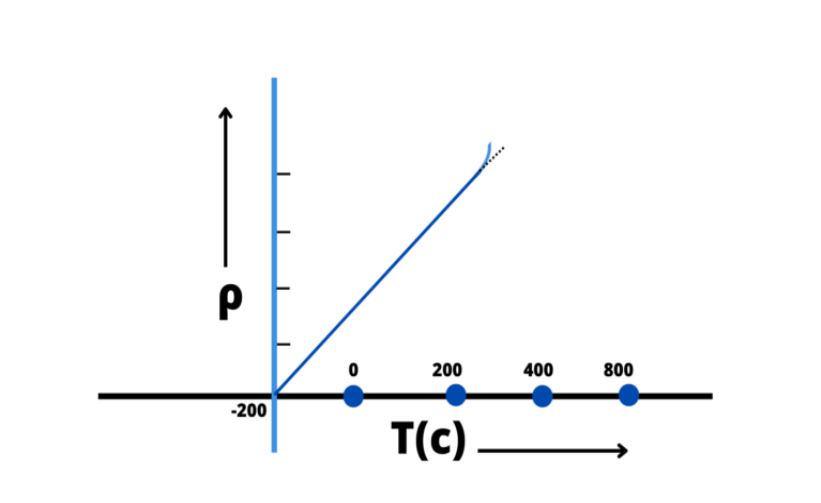
$$R_t - R_o = \alpha\, R_o\, t$$

$$\alpha = R_t - R_o / R_o$$

Since resistivity is directly proportional to the resistance, therefore in terms of resistivity can be expressed as:

$$\alpha = \rho_t - \rho_o / \rho_o t$$

‘ α ‘is called the “**Temperature co-efficient of Resistivity**“



Temperature coefficient of resistivity:

“The fractional change in resistivity per Kelvin is called Temperature co-efficient of Resistivity.”

Unit:

The SI unit of temperature coefficient of resistivity ‘ α ‘ is K^{-1}

Differentiating metals:

Two or more metals may have the same resistivity but different values of α

Thus α can be used in differentiating between two metals.

Negative temperature coefficients:

Resistances of some substances like germanium, silicon, etc, decrease with an increase in temperature.

Thus these substances have negative temperature coefficients