Vision

To be the centre of excellence in the field of technical education.

Program Code:- First Semester – All Program

Course Name:- Basic Science (PHYSICS)

Course Code : - BSC (22102)

Course coordinator: Mr. S. K. Rawat

Course Name:- Basic Science (PHYSICS)

Unit No:2

Unit Name: Specific resistance & conductance.

Unit Outcomes (UO2d): Apply laws of series and parallel combination in the given electric circuits.

Learning Outcomes (LOs):

LO6: Student will be able to solve problems on specific resistance.

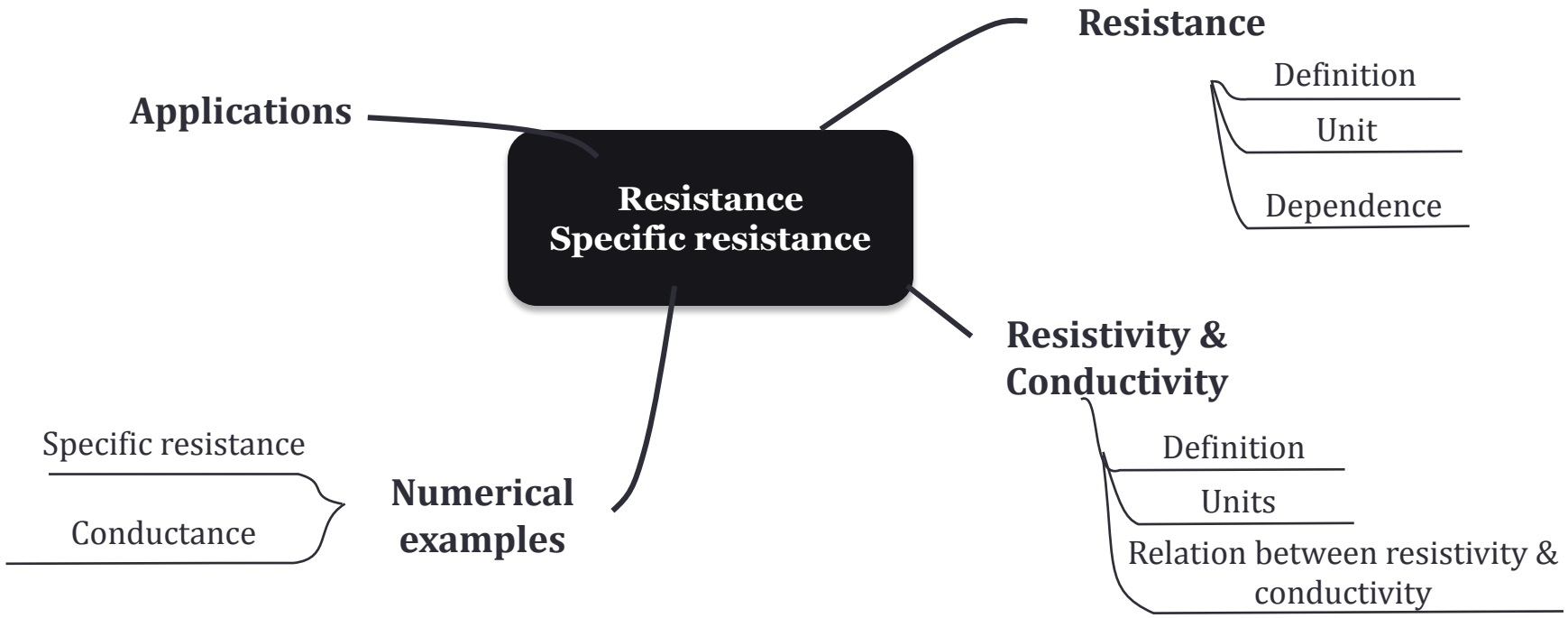
CONTENT

- Electric current
- Electric potential
- Ohm’s law

LEARNING OBJECTIVES

- Student will be able to solve problems on specific resistance.

Concept Map


Resistance
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Resistance

Resistance

It is the property of a conductor to resist the flow of charges across it. Or

The opposition offered to flow of current by the conductor.

According to Ohm's law, $R = V/I$

One Ohm

If the potential difference across the two ends of a conductor is 1 V and the current through it is 1 A, then the resistance R, of the conductor is 1 Ω. i.e., $1ohm = \frac{1volt}{1ampere}$

Factors on which resistance depends

Practically, it has been observed that the resistance of the conductor depends on –

(i) length of conductor,

(ii) area of cross-section, and

(iii) the nature of its material.

Precise measurements shows that resistance of a uniform metallic conductor is directly proportional to its length (l) and inversely proportional to the area of cross-section (A). i.e., $R \propto l$ and $R \propto 1/A$

Combining above equation, we get $R \propto l/A$

or $R = \rho l/A$

where ρ (rho) is a constant of proportionality and is called the specific resistance or resistivity of conductor

Attempt Set 1 MCQs

Question No	Question No. 1	Question No. 2	Question No. 3
Statement of Question	At constant temperature, the resistance of a material is _____ length of the material.	If the length and area of cross-section of a wire are doubled, then its resistance.	A length of wire has a resistance of 10 ohms. What is the resistance of a wire of the same material three times as long and twice the cross-sectional area?
Level of Question	Remembering	Understanding	Applications
Option (a)	directly proportional to	becomes four times	30 ohms
Option (b)	independent of	becomes sixteen times	20 ohms
Option (c)	inversely proportional to	remains the same	15 ohms
Option (d)	equal to	becomes two times	7 ohms
Correct Option	**directly proportional to**	**remains the same**	**15 ohms**

START

Resistivity

As resistance depends on nature of the material and temperature, therefore resistance of different materials of same dimensions will be different. Hence resistivity is characteristics property of the material.

As we know $R = \rho l/A$ $\quad\quad$ $\therefore\ \rho = RA/l$

Thus if A = 1 and $l = 1,$ then $\rho = R$

Definition: Resistivity of material is defined as the resistance of material of unit length having unit area of cross section.

Unit: As we know $\rho = RA/l$ $\quad\quad$ In terms of unit, $\rho = 1\Omega \times \frac{1m^2}{1m} = 1\Omega\text{m}$

The SI unit of resistivity is Ωm.

Conductance and Conductivity

Conductance of a conductor is a measure of ease with which the current will flow through it and is the reciprocal of resistance.

The conductance is denoted by symbol G. i.e., $G = 1/R$

SI Unit: mho or Siemens.

Conductivity depends on resistivity of the material. It is the property of material which easily allows flow of current through it.

Conductivity is the reciprocal of the resistivity of the material. i.e., As $\sigma = 1/\rho$

SI Unit: As $\sigma = 1/\rho$, therefore unit of $\sigma = 1/\Omega m$

SI unit of conductivity is Siemens/metre or 1/(ohm metre)

Numerical Examples

The resistance of a copper wire of 5 m long is 0.5 Ω. If the diameter of wire is 0.045 cm, determine its specific resistance.

Given: $l = 5\,m$, $R = 0.5\,\Omega$ and $d = 0.045cm$

Find: ρ

Formula: $A = \frac{\pi}{4} \times d^2$ and $\rho = R \times \frac{l}{A}$

Solution:

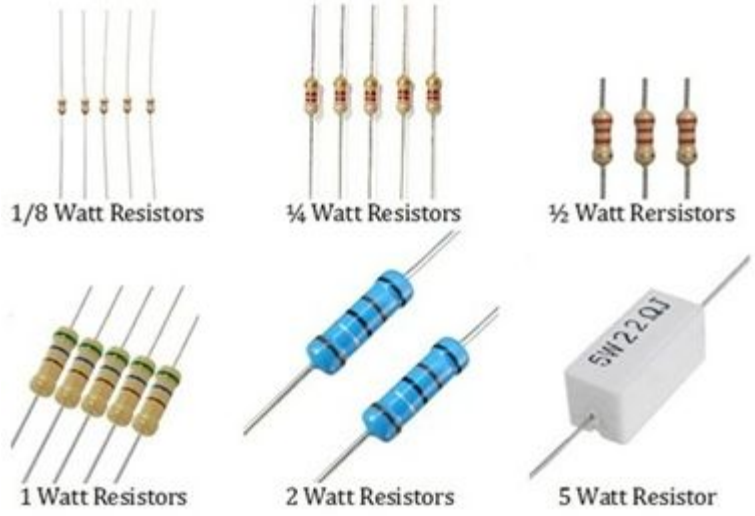
As area of cross-section is $A = \frac{\pi}{4} \times d^2 = \frac{\pi}{4} \times (0.045 \times 10^{-2})^2 = 1.6 \times 10^{-7} m^2$

The specific resistance is calculated as $\rho = R \times \frac{l}{A} = 0.5 \times \frac{1.6 \times 10^{-7}}{5} = 16 \times 10^{-9} \Omega m$

Ans: Thus, the specific resistance is $16 \times 10^{-9} \Omega m$

Applications

- By keeping resistivity constant, the resistance of the material can be increased by increasing the length, or decreasing the cross sectional area. For example the different resistors used in electronic circuits.
- Depending upon the value of specific resistance, materials can also be classified as Electrolytes, Insulators, Metals, Semiconductors & Superconductors



Attempt Set 2 MCQs

Question No	Question No. 1	Question No. 2	Question No. 3
Statement of Question	SI unit of conductance is _____.	_____ is the reciprocal of resistance.	If the resistance of a material 2 m long and 2 m2 in area of cross-section is 1.6 × 10-8 Ω, then its resistivity is
Level of Question	Understanding	Understanding	Application
Option (a)	Siemens	Conductance	3.2 × 10-8 Ω-m
Option (b)	volt	Conductivity	1.6 × 10-8 Ω-m
Option (c)	ohm	Resistivity	0.64 × 10-8 Ω-m
Option (d)	farad	Specific resistance	0.16 × 10-8 Ω-m
Correct Option	**Siemens**	**Conductance**	**0.64 × 10-8 Ω-m**

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