OGUN DIGICLASS

CLASS: SECONDARY SCHOOL

SUBJECT: PHYSICS

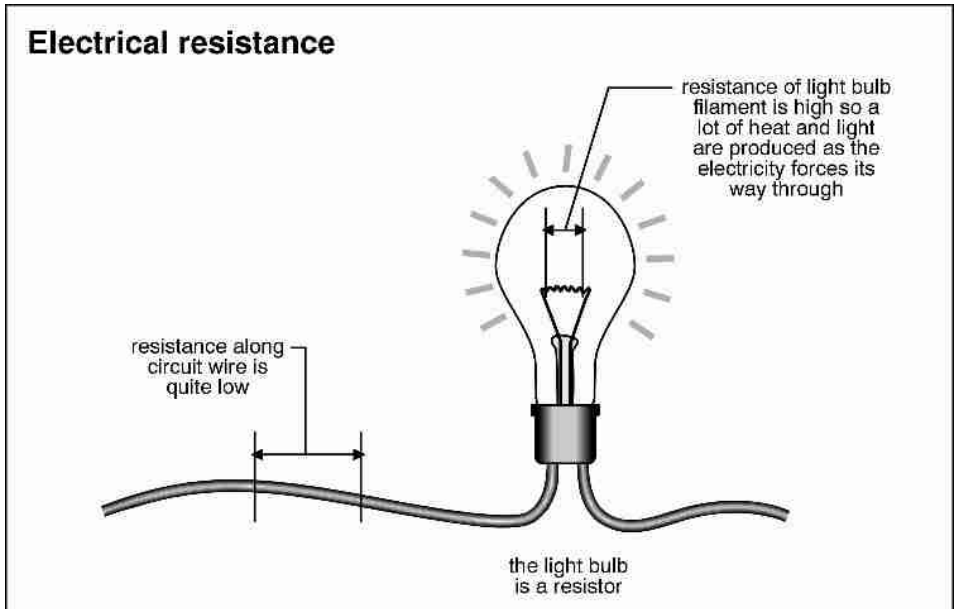
TOPIC: Resistivity and Conductivity

Lesson Objective

- Explain electrical resistance
- State factors affecting electrical resistance.
- Derive the equation connecting resistance and the factors.
- Explain resistivity and conductivity.
- Solve mathematical problems on resistivity and conductivity

Electrical Resistance

Resistance can be defined as the opposition to the flow of charges(electrons) or current. Unit is in ohms(Ω). Insulators are bad conductors and therefore have high electrical resistance.



Factors Affecting Electrical Resistance of a Conductor

Length of conductor – direct variation

i.e $R \propto L$

Area of conductor – inverse variation

i.e $R \propto 1/A$

Temperature – direct variation

i.e $R \propto T$

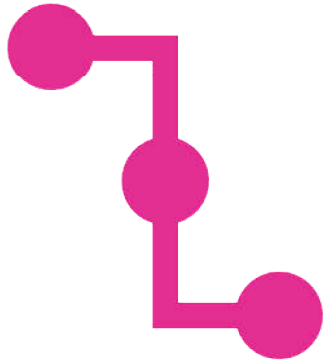
Type of material. i.e the substance.

THE CONNECTING EQUATION

Combine the first 3 factors in an equation form, we have that if Temp(T) in kept constant

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

$$R \propto \frac{L}{A} \qquad R = \frac{PL}{A}$$



Where P = constant of proportionality known as the RESISTIVITY which is dependent in the nature of the material.

$$\therefore P = \frac{RA}{L}$$

where A = area of the material in square metres

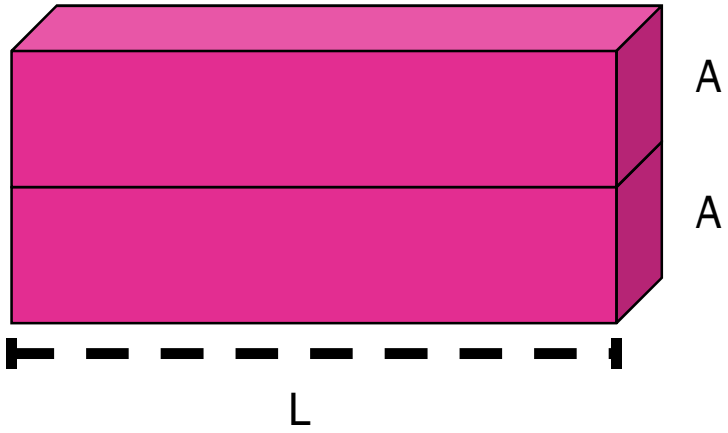
L = the length in metres

R = the resistance in ohms Ω

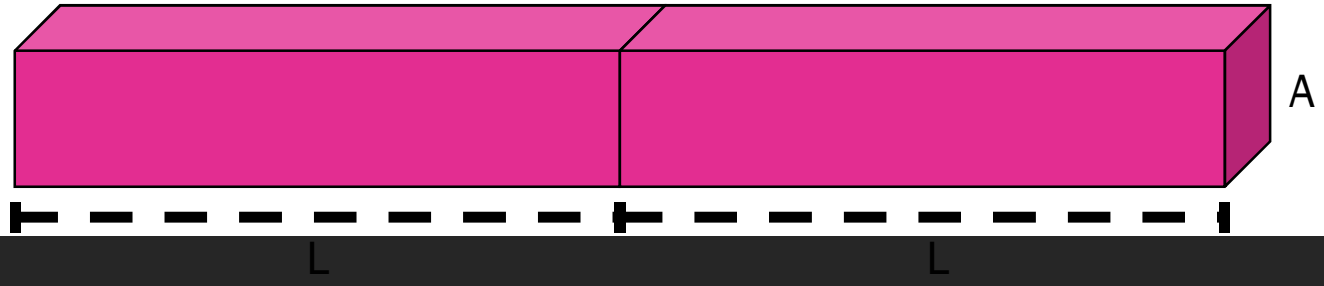
$$\therefore P = \frac{RA}{L} = \frac{\Omega \times m^2}{m} = \Omega\ m.$$

Resistivity vs Conductivity

A larger area = a better conductor
two areas conduct twice as well as one



A longer length = a better resistor
Two lengths will have twice the resistance



Example:

Find the resistance of a wire of length 0.65m radius 0.2mm and resistivity 3×10^{-6} ohm metre

Solution: $R = \frac{PL}{A} = \frac{PL}{\pi r^2}$

$$= \frac{3 \times 10^{-6} \times 0.65}{\pi \left(\frac{0.2}{1000} \times \frac{0.2}{1000}\right)}$$

$$= \frac{3 \times 10^{-6} \times 0.65}{\pi (2 \times 10^{-4})^2} =$$

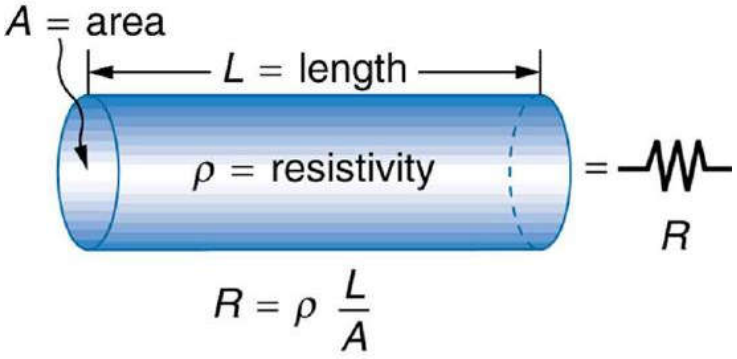
15.5ohms

RESISTIVITY (P)

This is defined as the resistance of a unit length of material unit cross-sectional area.

The unit is in ohm-metre (Ω m)

The greater the resistivity of a wire, the poorer it is as an electrical conductor. Because of this, conductivity is used to specify the current-carrying ability of a material.

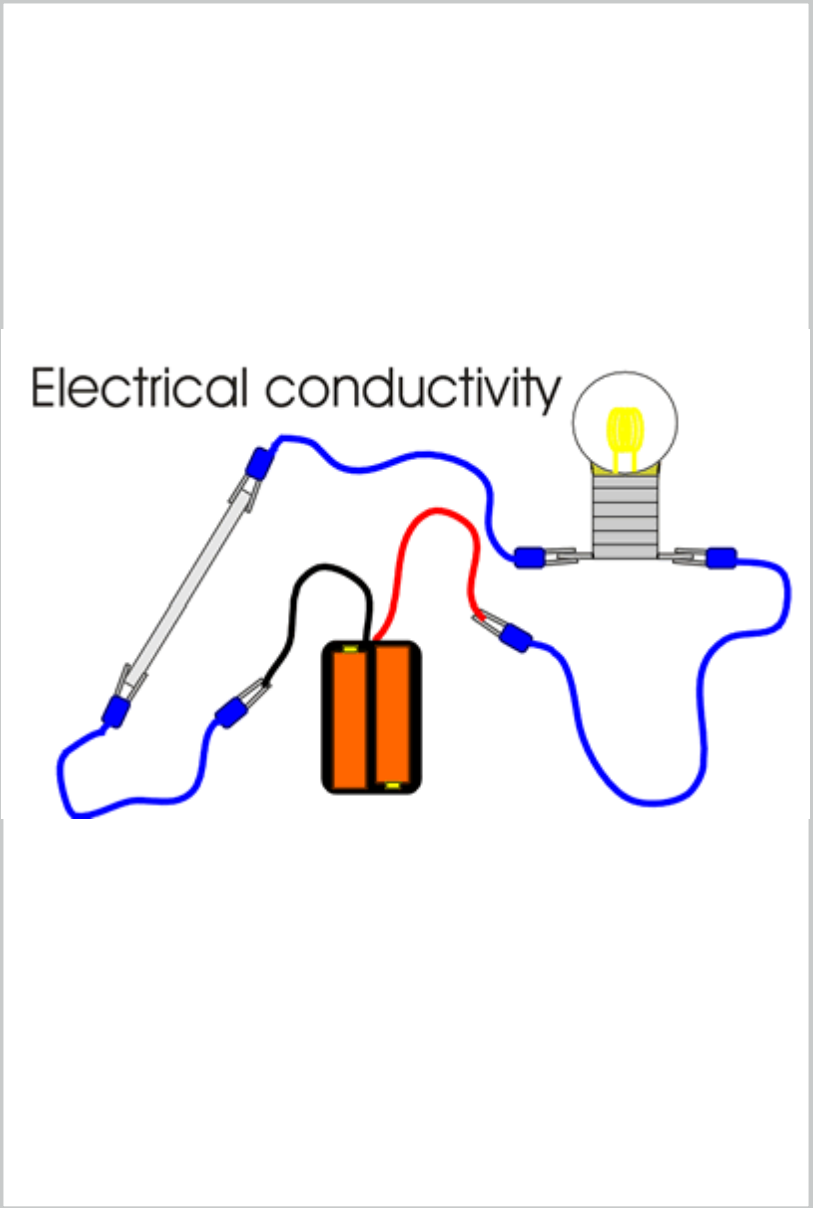


The greater the conductivity, the more easily can current flow through the material.

Thus, material of high conductivity also have low Resistivity.

Conductivity is therefore the reciprocal of the Resistivity of a material.

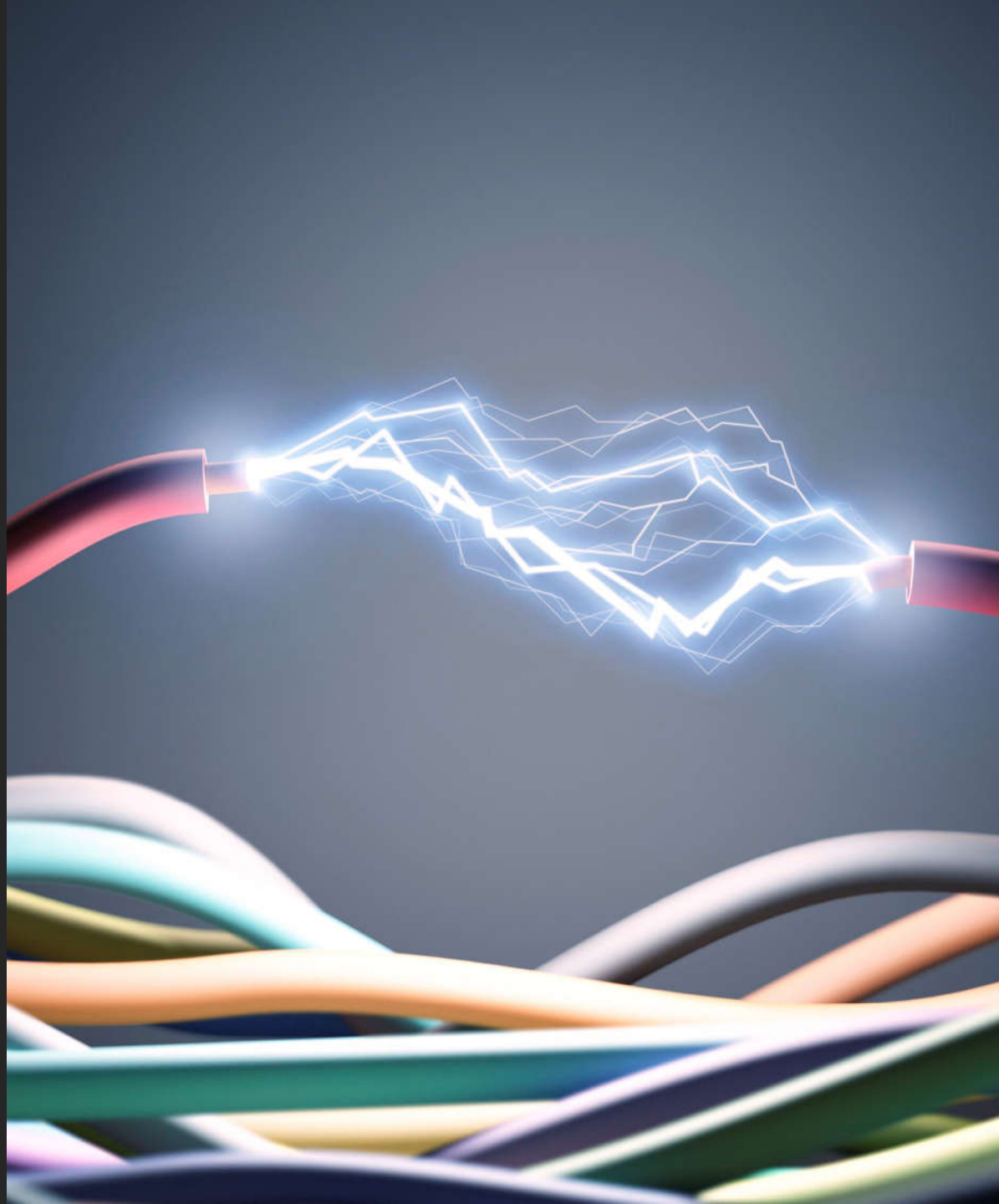
$$= \frac{1}{p}$$



ELECTRICAL CONDUCTIVITY

The extent to which a material will allow current to flow easily through it when a p.d is applied at a specified temperature.

what is $(\Omega m)^{-1}$?



Example

Calculate the length of a wire of diameter 0.6mm and resistivity $1.1 \times 10^{-6} \Omega m$ required to construct a standard resistor of resistance 35Ω.

Solution

l=?

d=0.6mm

r= d/2

= 0.6mm/2

= 0.3mm.

$\therefore A = \pi r^2 = \pi\ (0.3/1000 \times 0.3/1000)$

$= \pi(3 \times 10^{-4})^2$

$R = 35\Omega$

$P = 1.1 \times 10^{-6}\Omega$

From $R = \frac{PL}{A}$

i.e $Pl = RA$

$\therefore\ l = \frac{RA}{P} = \frac{35 \times \pi(3 \times 10^{-4})^2}{1.1 \times 10^{-6}}$

$= \frac{35 \times 22/7 \times 3x10^{-4} \times 3x10^{-4}}{1.1 \times 10^{-6}}$

$= \frac{5 \times 22 \times 9 \times 10^{-8} \times 10^{6}}{1.1}$

$= \frac{5 \times 22 \times 9}{1.1x10^2} = \frac{5 \times 22 \times 9}{1.1 \times 100} = \frac{5 \times 22 \times 9}{1.1 \times 10} = 9m$

ASSIGNMENT

1. State the factors affecting electrical resistance and write out the connecting equation for the resistivity of the material.
2. The resistance of a wire of length 100cm and diameter 0.3mm is found to be 3.0 Ω.

Calculate

I. The resistivity and

II. the conductivity of the wire