UDAAN 3.0

PHYSICS

ELECTRICITY

Lecture No.- 03

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Today's Targets

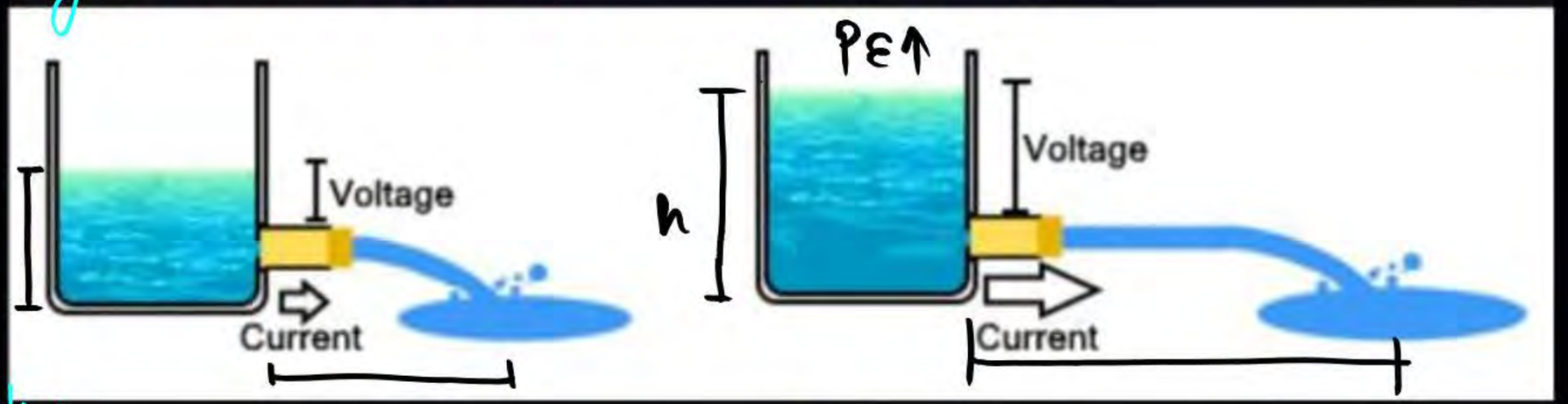
1. OHM'S LAW
2. RESISTANCE
3. VERIFICATION OF OHM'S LAW
4. FACTORS AFFECTING RESISTANCE
5. DIFFERENCE BETWEEN R & ρ
6. RESISTIVITY OF ELECTRICAL SUBSTANCES

OHM'S LAW

It states that,"
Current flowing in a conductor is directly proportional to potential difference applied across the ends of the conductor, at constant temp."

Voltage ∝ Current

$V \propto I$



$V \propto I$

$V = IR$

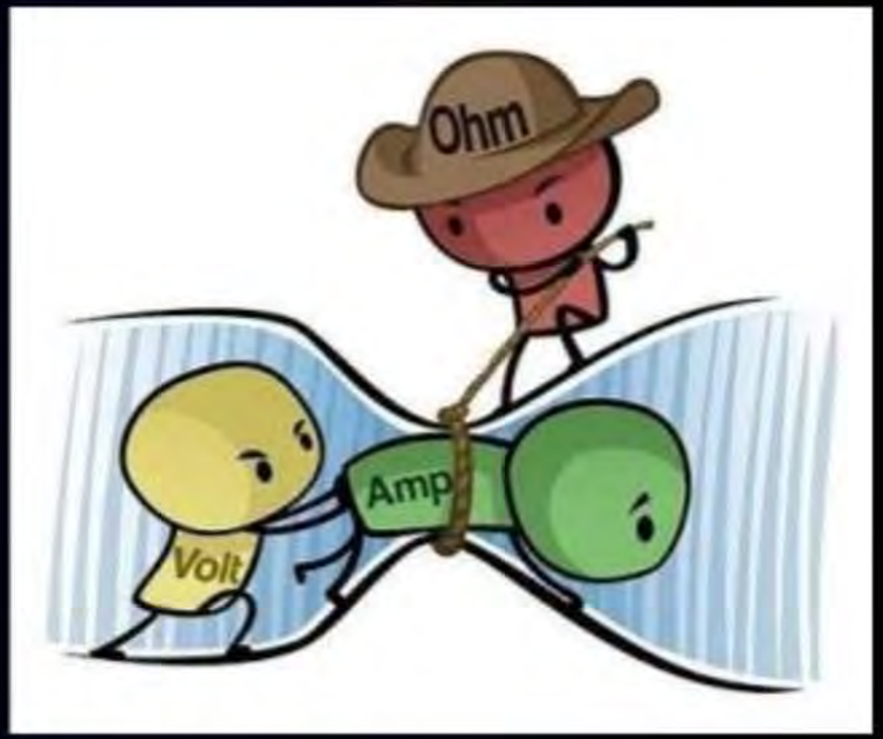
Voltage Current Constant → Resistance

RESISTANCE ⇒ प्रतिरोध

→ It is the opposition offered by the conductor in the flow of current.

→ 'R'

→ Ohm or Ω



VERIFICATION OF OHM'S LAW

BATTERY ELIMINATORS

RESISTANCE BOX

VOLTMETER

AMMETER

PLUG KEY

RHEOSTAT

CONNECTING WIRE

Simple

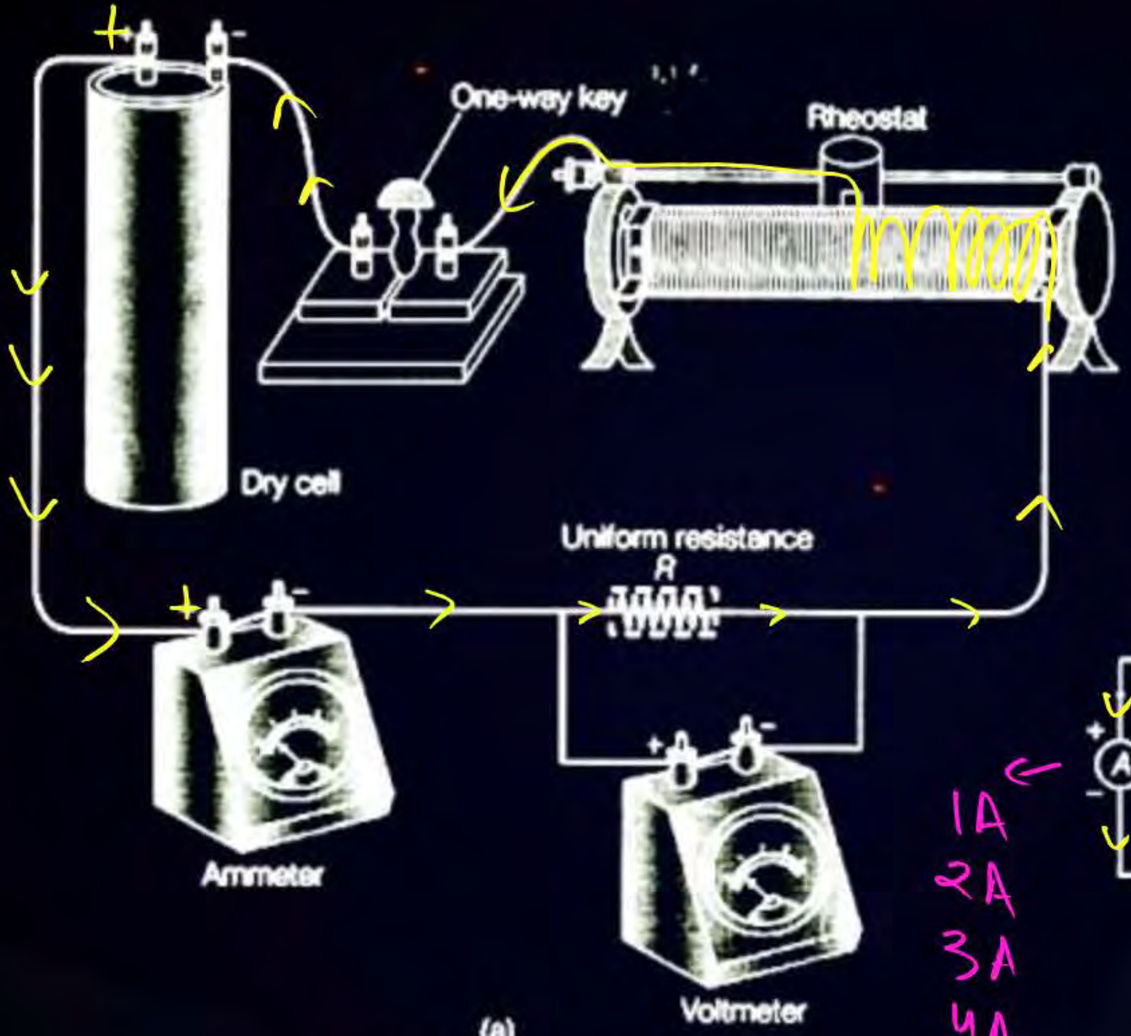
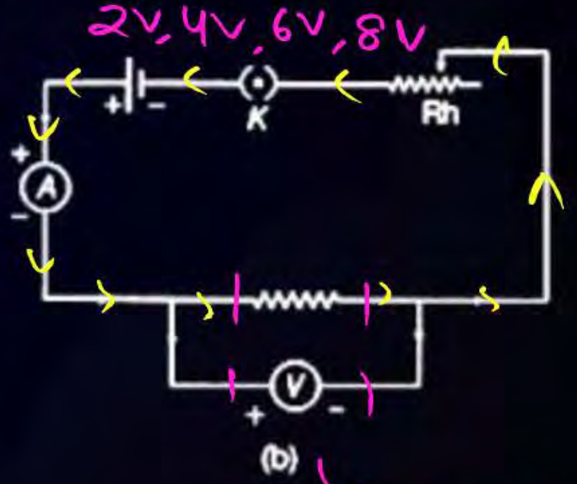


Fig. 1 (a) Arrangement diagram
(b) Circuit diagram

	V_1			V_2
V	2	4	6	8
I	1	2	3	4
	I_1			I_2



2V, 4V, 6V, 8V

1A
2A
3A
4A

2V, 4V, 6V, 8V

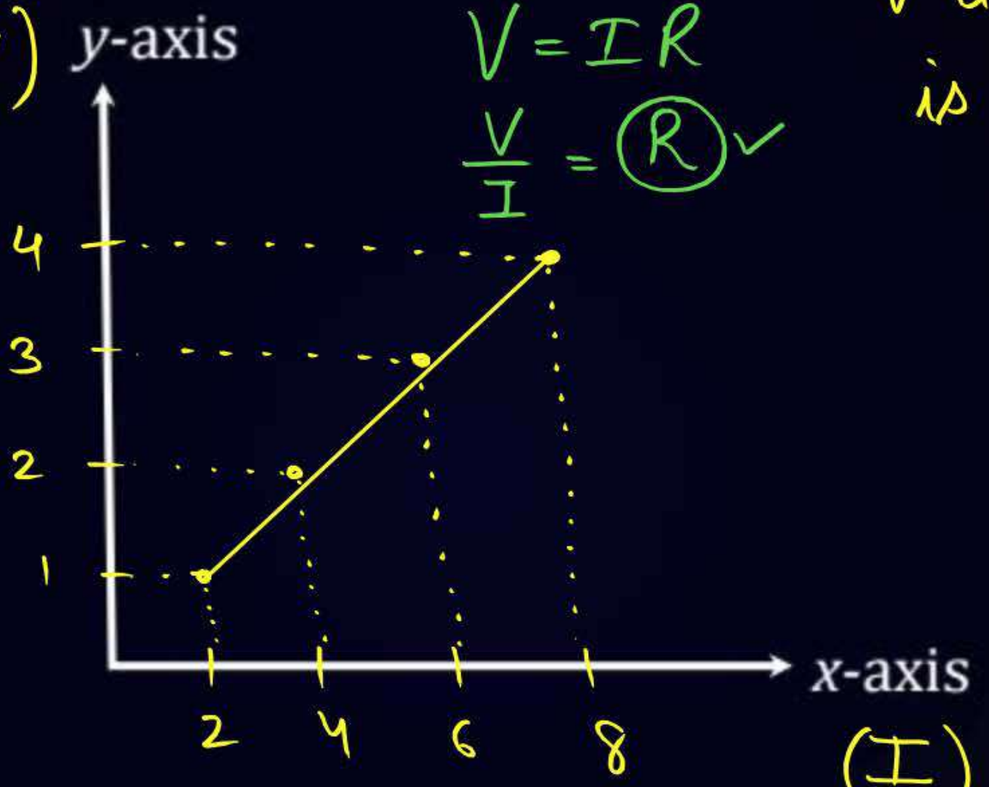
V-I CHARACTERISTIC CURVE/GRAPH

$$* \text{ slope } (V\text{-}I) = \frac{\Delta y}{\Delta x}$$

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

$$= \frac{V_2 - V_1}{I_2 - I_1}$$

$$= \frac{8-2}{4-1} = \frac{6}{3} = 2\,\Omega$$



$$V = IR$$

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

V and I का Graph is a straight line

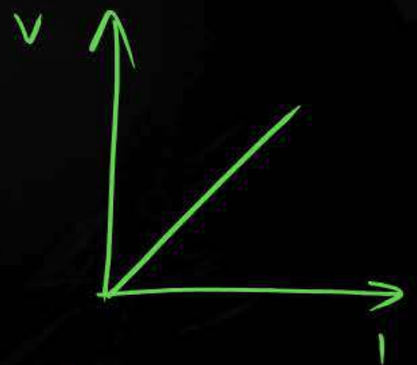
"linear graph"

$$y \propto x$$

$$V \propto I$$

hence, ohm's law is Verified.

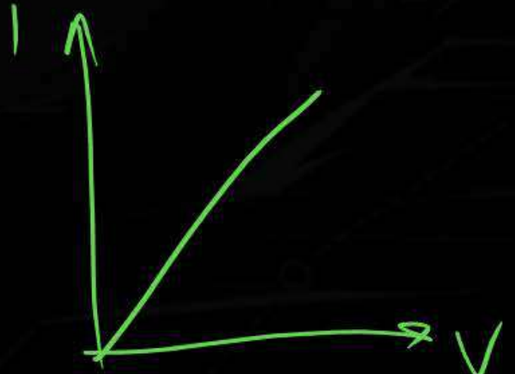
NOTE – Slope of 'V-I' graph gives 'R'



$$\text{Slope} = \frac{\Delta y}{\Delta x}$$

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

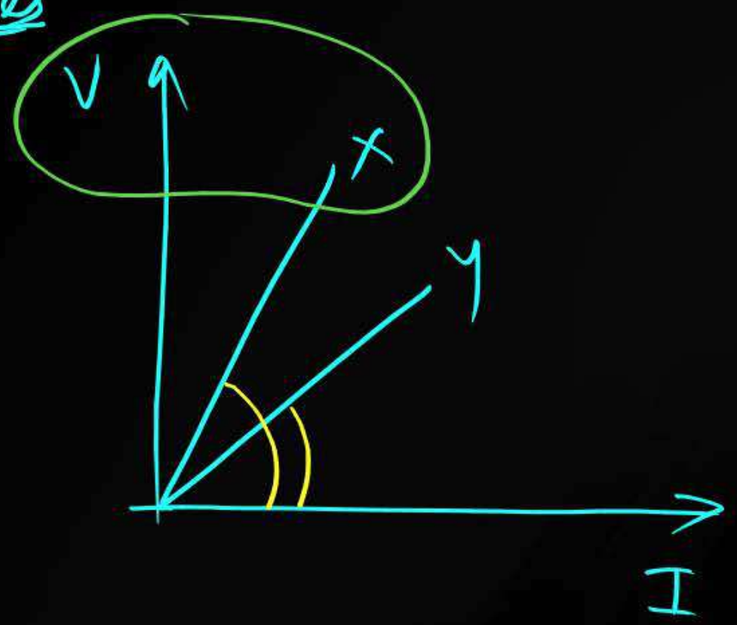
– Slope of 'I-V' graph gives '$\frac{1}{R}$'



$$\text{Slope} = \frac{\Delta y}{\Delta x}$$

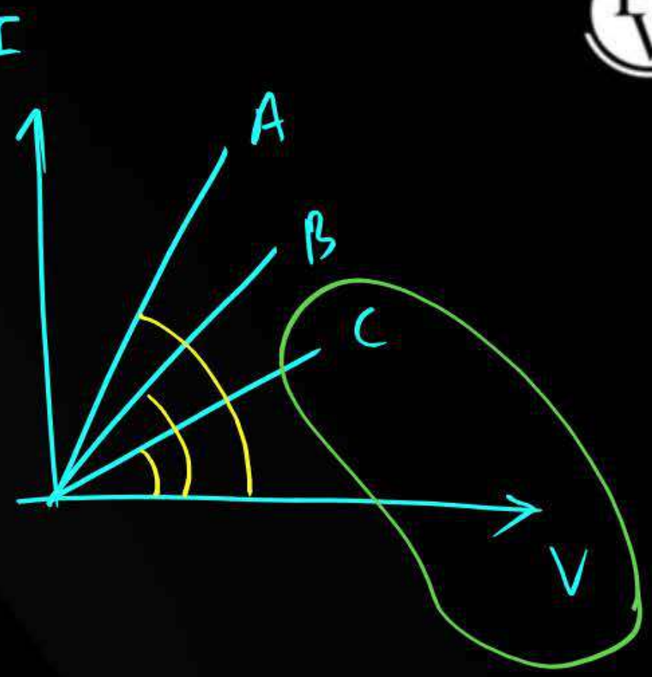
$$= \frac{\Delta I}{\Delta V} = \frac{1}{R}$$

Ques



$R_x > R_y$

Ques



$R_A < R_B < R_C$

Question

How much current will an electric bulb draw from a 220 V source, if the resistance of the bulb filament is 1200 Ω?

$I = ?$

$V = 220V$

$R = 1200\Omega$

$$I = \frac{V}{R} = \frac{220}{1200} = \frac{11}{60}\,A$$

Question

H.W.

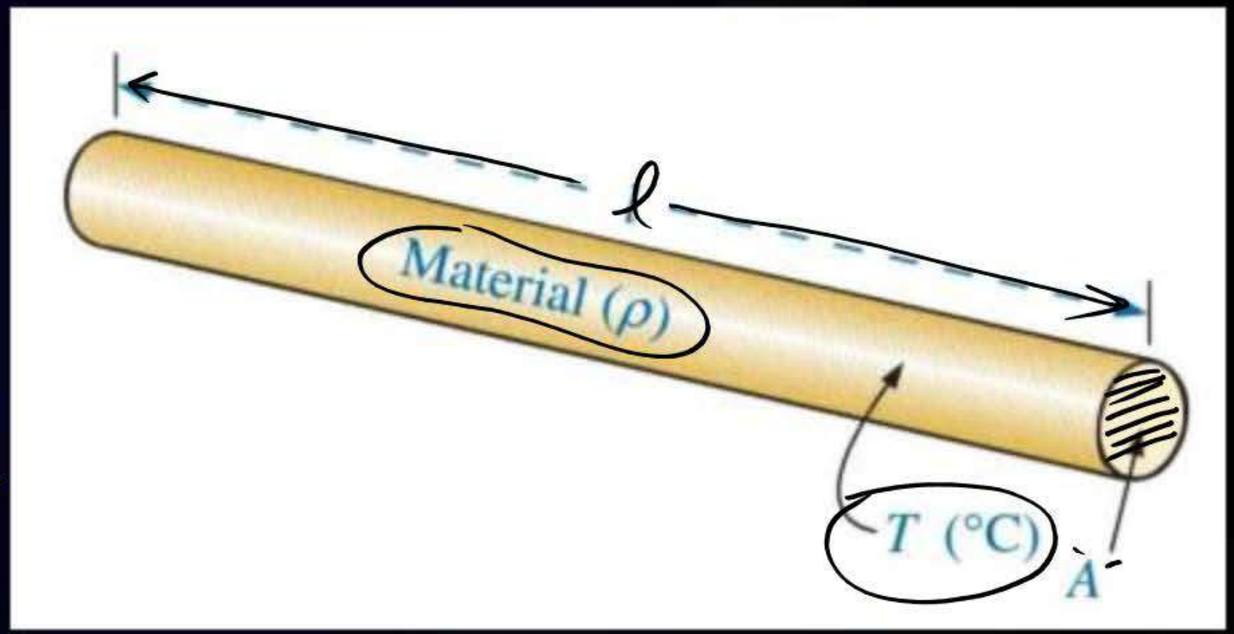
The values of current I flowing in a given resistor for the corresponding values of potential difference V across the resistor are given below. Plot a graph between V and I and calculate the resistance of that resistor.

I (amperes)	0.5	1.0	1.5	2.0	2.5
V (volts)	1.6	3.2	4.8	6.4	8.0

FACTORS AFFECTING RESISTANCE

$V = IR$
↳ Constant

1. length of the conductor (l) → 'm'
   ↑ $R \propto l$ ↑
2. Cross-sectional Area (A) → 'm^2'
   ↓ $R \propto \frac{1}{A}$ ↑ ↳ πr^2
3. Material of the conductor
   ↳ Resistivity (ρ) → 'ohm-m'
4. Temperature of the conductor ↑ R ↑



$R \propto l$

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

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

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

↓

'Constant'

* finding SI unit of 'ρ'

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

$$\Omega = \rho \frac{m}{m^2}$$

$\Omega m = \rho$

(Ohm-metre or Ωm)

DIFFERENCE BETWEEN

RESISTANCE

→ opposition of offered by the conductor in the path of current.

→ It depends on length, Area of Cross Section, Resistivity and Temperature

→ R

→ ohm

RESISTIVITY

→ property of a material to oppose the flow of Current

→ it depends on Temperature $T \uparrow \rho \uparrow$

→ ρ (Rho)

→ ohm-metre (Ωm)

RESISTIVITY OF ELECTRICAL SUBSTANCES

Material → Same
ρ → Same

ρ ↗ Very less ⇒ Conductor
ρ → Thik-Thak ⇒ Alloy
ρ ↘ Very high ⇒ Insulator

	Material	Resistivity (Ω m)
Conductors	Silver	1.60×10^{-8}
	Copper	1.62×10^{-8}
	Aluminium	2.63×10^{-8}
	Tungsten	5.20×10^{-8}
	Nickel	6.84×10^{-8}
	Iron	10.0×10^{-8}
	Chromium	12.9×10^{-8}
	Mercury	94.0×10^{-8}
	Manganese	1.84×10^{-6}
Alloys	Constantan (alloy of Cu and Ni)	49×10^{-6}
	Manganin (alloy of Cu, Mn and Ni)	44×10^{-6}
	Nichrome (alloy of Ni, Cr, Mn and Fe)	100×10^{-6}
Insulators	Glass	$10^{10} - 10^{14}$
	Hard rubber	$10^{13} - 10^{16}$
	Ebonite	$10^{15} - 10^{17}$
	Diamond	$10^{12} - 10^{13}$
	Paper (dry)	10^{12}

ρ ↓↓ (Conductors)
ρ ↑ (Alloys)
ρ ↑↑ (Insulators)

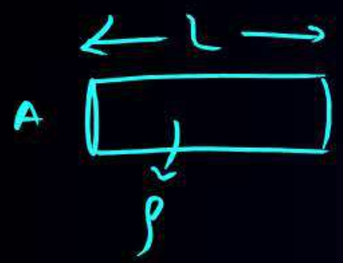
Question

Imp.

A wire of length L and resistance R is stretched so that its length is doubled and the area of cross-section is halved. How will it's

(1) resistance change (2) resistivity change.

Gen Case :-



$$R = \frac{\rho L}{A} \quad \ldots (1)$$

$$R' = \rho \frac{2L}{\frac{A}{2}}$$

$$R' = 4\left(\frac{\rho L}{A}\right) = 4R$$

i) $R' = 4R$

ii) ρ does not change with the change of dimensions.

Question

H.W

The resistance of a wire of 0.01 cm radius is 10 Ω If the resistivity of the material of the wire is 50×10^{-8} Ωm. find the length of the wire.

$r = 0.01\ cm \longrightarrow A = \pi r^2$

$R = 10\Omega$

$\rho = 50 \times 10^{-8}\ \Omega m$

$l = ?$

Question

The resistance of a metallic wire becomes 8 times when:

A. length is doubled $2R$

$\ell \uparrow \; R \uparrow$

B. length is tripled $3R$

C. length is doubled and radius is halved

2ℓ $\quad$ $r \to \frac{r}{2}$, $A \to \frac{A}{4}$

D. length is halved and radius is doubled

$r \to \frac{r}{2}$

$A = \pi r^2$

$A' = \pi\left(\frac{r}{2}\right)^2 = \frac{\pi r^2}{4} = \frac{A}{4}$

$R = \rho\frac{\ell}{A}$, $R' = \rho\frac{2\ell}{\frac{A}{4}} = 8\left(\rho\frac{\ell}{A}\right)$

$R' = 8R$

$A' = \frac{A}{4}$ ✓

Question

A resistance with a resistance R is connected to a battery with a voltage V to produce a current I. What would be the new current (in terms of I) if the voltage is doubled and resistance is halved?

A 4 I

B I/4

C 2 I

D I/2

एक उत्कृष्ट बात जो शेर से सीखी जा सकती है वह यह है कि मनुष्य जो कुछ भी करने का इरादा रखता है उसे पूरे दिल से और ज़ोरदार प्रयास के साथ करना चाहिए।


Thank
You