Physicsaholics

DPP – 2 (Current Electricity)

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Q 1. A rectangular metal block has dimensions 3cm × 1cm × 1cm. The ratio of the resistance measured between the two opposite rectangular faces to that measured between the two square faces of the block is:
(a) 1:3 (b) 1:9
(c) 3:1 (d) 9:1

Q 2. The resistance of a wire of uniform diameter d and length L is R. The resistance of another wire of the same material but diameter 2d and length 4L will be:
(a) 2R (b) R
(c) R/2 (d) R/8

Q 3. The resistance of a wire of length 300m and cross-section area 1.0 mm^2 made of material of resistivity $1.0 \times 10^{-7}\,\Omega$m is:
(a) 2Ω (b) 3Ω
(c) 20Ω (d) 30Ω

Q 4. Calculate the resistivity of the material of a wire 1 m long , 0.4 mm in diameter and having a resistance 2Ω:
(a) 300 Ωm (b) 2.51×10^{-7} Ωm
(c) 2×10^{7} Ωm (d) 1×10^{-15} Ωm

Q 5. A wire has a resistance of 10 ohm. Its resistance if it is stretched by one-tenth of its original length is:
(a) 12.1 Ω (b) 7.9 Ω
(c) 11 Ω (d) 9 Ω

Q 6. A wire of 10Ω resistance is stretched to thrice its original length. What will be its new resistivity:
(a) Three times of initial resistivity
(b) one-third of initial resistivity
(c) Equal to initial resistivity
(d) None of these

Q 7. If n, e, τ and m respectively represent the density, charge relaxation time and mass of the electron, then the resistance of a wire of length l and area of cross-section A will be:
(a) $\frac{ml}{ne^2\tau A}$ (b) $\frac{m\tau^2 A}{ne^2 l}$

(c) $\frac{ne^2\tau A}{2ml}$ (d) $\frac{ne^2A}{2m\tau l}$

Q 8. On increasing the temperature of a conductor, its resistance increases because:
(a) Relaxation time decreases
(b) Mass of the electrons increases
(c) Electron density decreases
(d) None of the above

Q 9. The resistance of a wire is 5 ohm at 50 ℃ and 6 ohm at 100 ℃. The resistance of the wire at 0 ℃ will be:
(a) 1 ohm (b) 2 ohm
(c) 3 ohm (d) 4 ohm

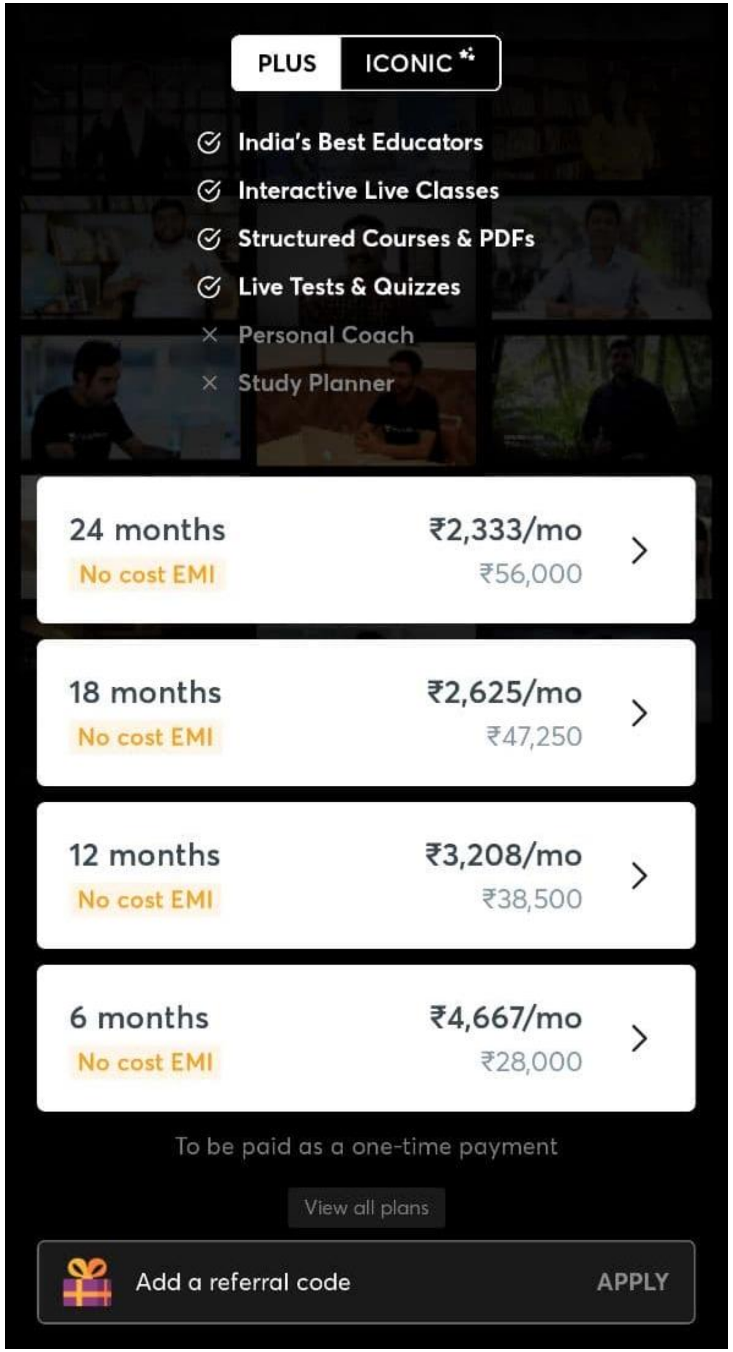
Q 10. The resistance of a semiconductor material (germanium or silicon) ________ with rise in temperature.
(a) increases (b) decreases
(c) Remains the same (d) first increases then decreases

Q 11. A nichrome wire of length 100cm and radius 0.36 mm has a resistance of 1.5 ohm. Calculate the conductivity of nichrome (in mho):

(a) 1.6×10^6 (b) 16×10^6
(c) 1.6×10^5 (d) 1.6×10^7

Answer Key

Q.1 b	Q.2 b	Q.3 d	Q.4 b	Q.5 a
Q.6 c	Q.7 a	Q.8 a	Q.9 d	Q.10 b
Q.11 a				



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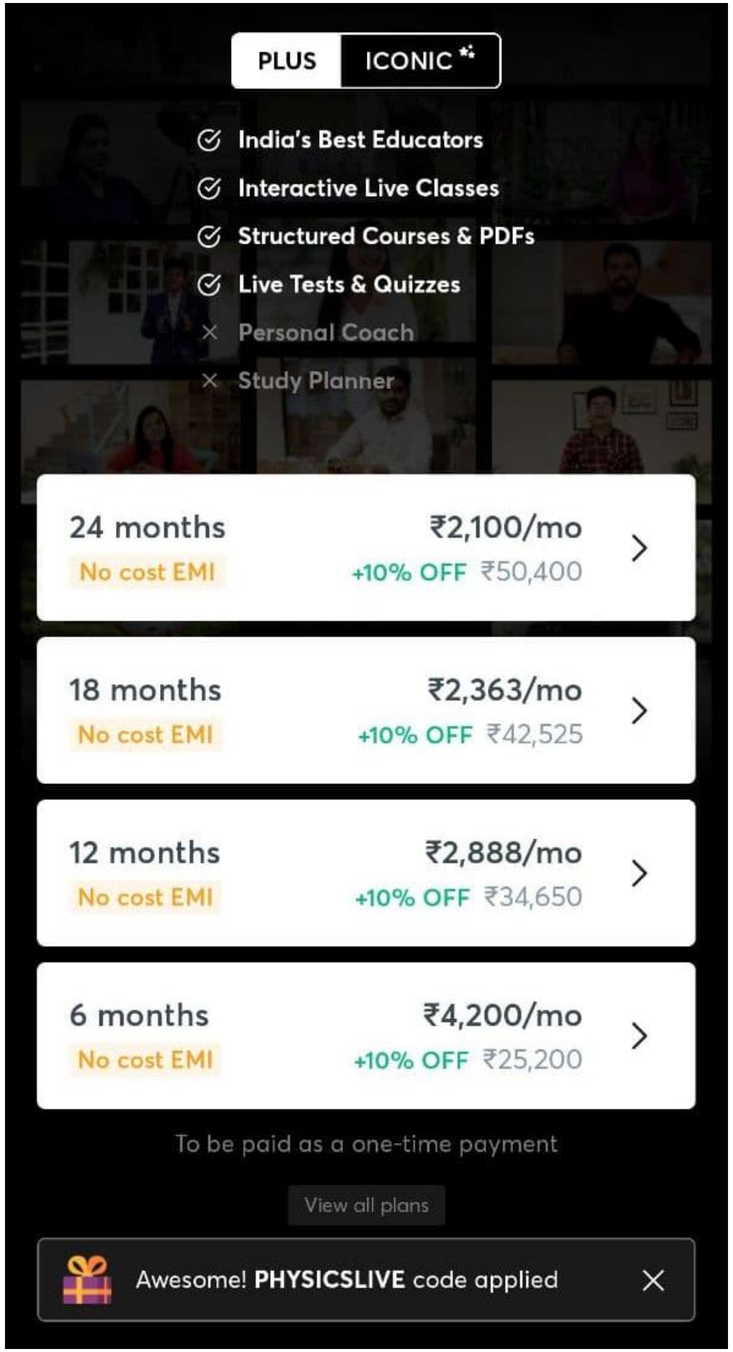

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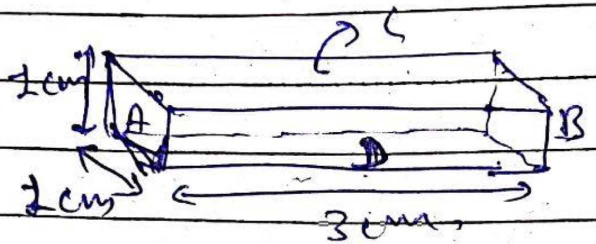
Written Solution

DPP-2 Current Electricity: Resistance and effect of temperature on resistance

By Physicsaholics Team

Solution: 1

3 cm × 1 cm × 1 cm



R_{AB} = Resistance between square faces

R_{CD} = Resistance between rectangular faces

$$\frac{R_{CD}}{R_{AB}} = \frac{\rho \frac{l_{CD}}{A_{CD}}}{\rho \frac{l_{AB}}{A_{AB}}} = \frac{l_{CD}}{A_{CD}} \times \frac{A_{AB}}{l_{AB}}$$

$$= \frac{1\text{ cm}}{1\text{ cm} \times 3\text{ cm}} \times \frac{1\text{ cm} \times 1\text{ cm}}{3\text{ cm}}$$

$$\boxed{\frac{R_{CD}}{R_{AB}} = \frac{1}{9}}$$

Ans. b

Solution: 2

$$R = \frac{\rho l}{A} \; ; \; A = \frac{\pi d^2}{4}$$

$$R = \frac{4\rho l}{\pi d^2} \; ; \text{ Now } d \rightarrow 2d, \; l \rightarrow 4l$$

so; $R' = \frac{4\rho(4l)}{\pi(2d)^2} = \frac{4\rho l}{\pi d^2} = R$

$$\boxed{R' = R}$$

Ans. b

Solution: 3

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

$$R = \frac{1\times10^{-7}\times300}{1\times(10^{-3})^2 m^2}$$

$$= \frac{10^{-7}\times300}{10^{-6}}\ \Omega$$

$$\boxed{R = 30\ \Omega}$$

Ans. d

Solution: 4

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

$$\rho = \frac{RA}{l} = \frac{2 \times \frac{\pi}{4}(0.4 \times 10^{-3})^2}{1}$$

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

$$= \frac{\pi}{2} \times 16 \times 10^{-8}$$

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

$$\rho = 25.12 \times 10^{-8}\ \Omega m$$

$$\rho = 2.51 \times 10^{-7}\ \Omega m$$

$$\boxed{\rho = 2.51 \times 10^{-7}\ \Omega m}$$

Ans. b

Solution: 5

$R = \frac{\rho l}{A}$ —① $\quad R = 10\,\Omega$ (given)

$l_1 = l + \frac{1}{10} \times l$

$l_1 = 1.1 l$

$(\text{Volume})_{\text{initial}} = (\text{Volume})_{\text{final}}$

$(A \times l) = (A_1 \times l_1)$

$A_1 = \frac{A \times l}{1.1 l} = \frac{A}{1.1}$

$R_1 = \frac{\rho l_1}{A_1}$ —②

$\frac{①}{②} = \frac{R}{R_1} = \frac{\rho l / A}{\rho l_1 / A_1} = \frac{l}{l_1} \frac{A_1}{A}$

$R_1 = \left(\frac{l_1}{l} \times \frac{A}{A_1}\right) R$

$R_1 = (1.1 \times 1.1) R$

$R_1 = 1.21 R$

$R = 1.21 \times 10$

$\boxed{R = 12.1\,\Omega}$

or

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

$R = \frac{\rho l}{A} \times \frac{l}{l} = \frac{\rho l^2}{V}$

Now $l_1 = 1.1 l$

then $R_1 = ?$

$\frac{R}{R_1} = \frac{l^2}{l_1^2} = \left(\frac{l}{l_1}\right)^2 = \left(\frac{l}{1.1 l}\right)^2$

$R_1 = (1.1)^2 R$

$R_1 = 1.21 R$

$R_1 = 1.21 \times 10$

$\boxed{R_1 = 12.1\,\Omega}$

Ans. a

Solution: 6

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

ρ = Resitivity

it depends on the material of wired used. And does not depend on length, area etc.

$\therefore \rho' = \rho$

Ans. c

Solution: 7

$$\therefore \rho = \frac{m}{ne^2\tau}$$

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

$$R = \frac{ml}{ne^2\tau A}$$

Ans. a

Solution: 8

$\because R \propto \frac{1}{\tau}$

τ = Relaxation time

& $\tau \propto \frac{1}{T}$ (T = Temperature)

$\therefore R \propto \frac{1}{\tau} \propto T$

so, when T ↑ ⇒ τ ↓ & R ↑

Ans. a

Solution: 9

$R = R_0(1 + \alpha \Delta T)$

R_0 = Resistance at Temperature $0°C$.

Now; when $T = 50°$; $R = 5\Omega$

& $T = 100° \Rightarrow R = 6\Omega$

$\therefore \quad 5 = R_0(1 + 50\alpha)$ —①

$6 = R_0(1 + 100\alpha)$ —②

$\frac{①}{②} = \frac{5}{6} = \frac{1 + 50\alpha}{1 + 100\alpha}$

$\Rightarrow \alpha = 1/200$

Put value of α in eqn ②

$6 = R_0\left(1 + 100 \times \frac{1}{200}\right)$

$\boxed{R_0 = 4\,\Omega}$

Ans. d

Solution: 10

for semiconductors

if Temp ↑ ⇒ Resistance ↓

Ans. b

Solution: 11

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

$$\rho = \frac{RA}{l}$$

ρ = Resistivity.

$\sigma = \frac{1}{\rho}$; σ = conductivity

$$\therefore \sigma = \frac{l}{RA}$$

$$= \frac{100 \times 10^{-2}}{1.5 \times \pi \times (0.36 \times 10^{-3})^2}$$

$$= \frac{1}{1.5 \times \pi \times (36 \times 10^{-5})^2}$$

$$= \frac{10^{10}}{1944 \pi}$$

$$\boxed{\sigma = 1.6 \times 10^{6} \text{ mho}}$$

Ans. a

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Chalo Niklo