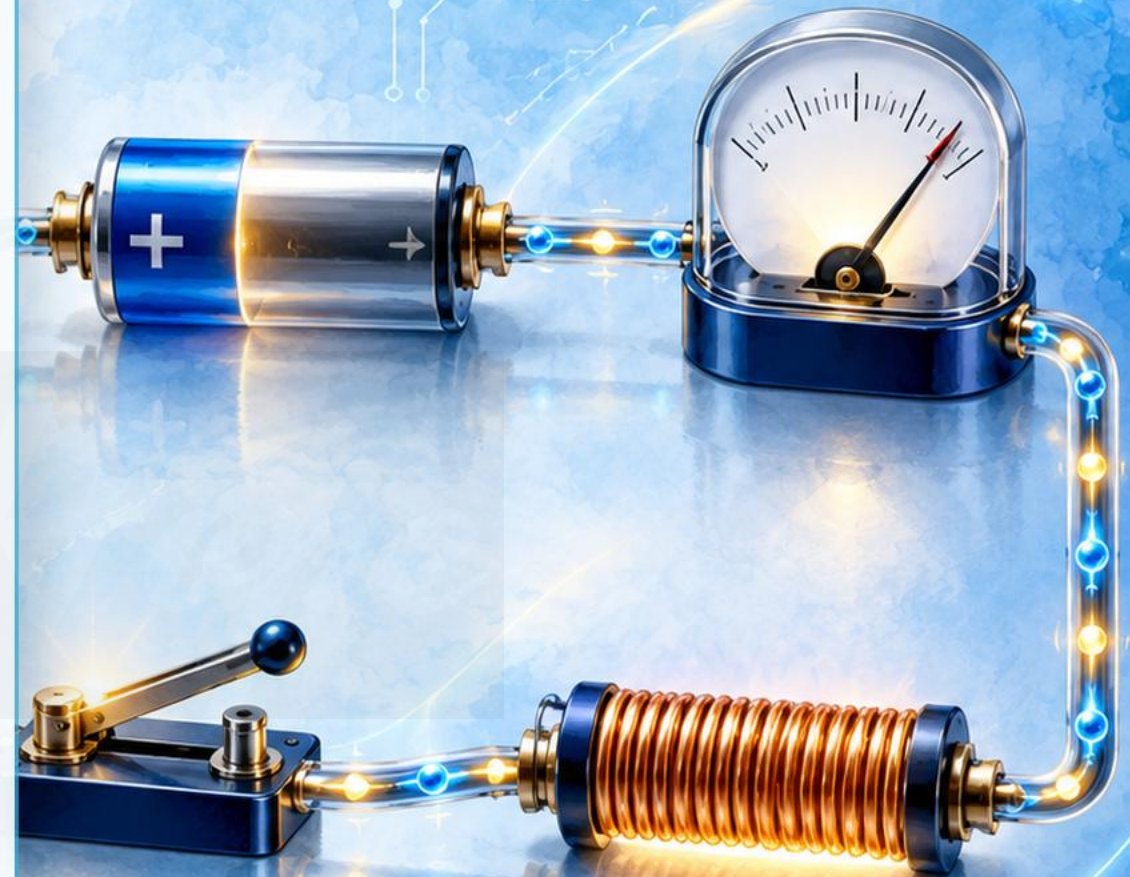


PHYSICS • CLASS 12

CHAPTER 3

Current Electricity

NCERT SOLUTIONS



MAXIMUM BATTERY CURRENT — EXERCISE 3.1

Q. A car storage battery has an emf of 12 V and internal resistance 0.4Ω . What is the maximum current that can be drawn from it?

External resistance decreases $\rightarrow$ total resistance decreases $\rightarrow$ current increases

Answer:

The current is largest when the external resistance is zero. The battery's internal resistance still limits it.

$$\mathcal{E} = 12 \text{ V}; \quad r = 0.4 \Omega.$$

$$I = \frac{\mathcal{E}}{R + r}.$$

$$\text{For } R = 0: \quad I_{\max} = \frac{\mathcal{E}}{r} = \frac{12}{0.4}$$

$$I_{\max} = 30 \text{ A}$$

This is the ideal short-circuit current predicted by the given model.

RESISTANCE & TERMINAL VOLTAGE — EXERCISE 3.2

Q. A 10 V battery with internal resistance $3\ \Omega$ is connected to a resistor. The current is 0.5 A. Find the resistor's resistance and the battery's terminal voltage when the circuit is closed.

Answer:

External resistance:

$$I = \frac{\mathcal{E}}{R + r}$$

$$R = \frac{\mathcal{E}}{I} - r = \frac{10}{0.5} - 3 = 20 - 3$$

$$R = 17\ \Omega$$

Terminal voltage:

$$V = \mathcal{E} - Ir = 10 - (0.5)(3)$$

$$V = 8.5\ \text{V}$$

$$\text{Check: } V = IR = (0.5)(17) = 8.5\ \text{V}$$

During discharge, part of the emf is used to drive current through the internal resistance. The terminal voltage is therefore less than the emf.

TEMPERATURE FROM RESISTANCE – EXERCISE 3.3

Q. A heating element has resistance $100\ \Omega$ at room temperature $27.0\ ^\circ\text{C}$. Find its temperature when its resistance becomes $117\ \Omega$. The temperature coefficient is $1.70 \times 10^{-4}\ ^\circ\text{C}^{-1}$.

Answer:

Use the resistance at room temperature as the reference.

$$R_0 = 100\ \Omega$$

$$R = 117\ \Omega$$

$$T_0 = 27.0\ ^\circ\text{C}$$

$$\alpha = 1.70 \times 10^{-4}\ ^\circ\text{C}^{-1}$$

$$R = R_0[1 + \alpha(T - T_0)].$$

$$T - T_0 = \frac{R - R_0}{\alpha R_0}.$$

$$T - 27 = \frac{117 - 100}{(1.70 \times 10^{-4})(100)} = 1000\ ^\circ\text{C}.$$

$$T = 27 + 1000.$$

$$\boxed{T = 1027\ ^\circ\text{C}.}$$

The calculated rise must be added to the starting temperature.

RESISTIVITY OF A WIRE — EXERCISE 3.4

Q. A negligibly small current passes through a wire of length 15 m and uniform cross-sectional area $6.0 \times 10^{-7} \text{ m}^2$. Its resistance is 5.0Ω . Find its resistivity at the temperature of the experiment.

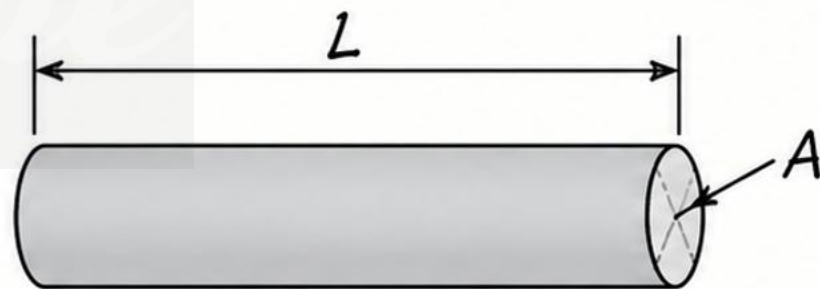
Answer: A very small current avoids appreciable heating, so the measured resistance corresponds to the experimental temperature.

$$L = 15 \text{ m}; \quad A = 6.0 \times 10^{-7} \text{ m}^2; \quad R = 5.0 \Omega.$$

$$R = \frac{\rho L}{A} \Rightarrow \rho = \frac{RA}{L}.$$

$$\rho = \frac{(5.0)(6.0 \times 10^{-7})}{15}.$$

$$\rho = 2.0 \times 10^{-7} \Omega \text{ m}.$$





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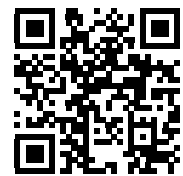


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