

CIRCUITS DAY 1: CURRENT & RESISTANCE

WARMUP Charges Finally Move

The demo: a battery, a bulb, two clip leads. Snap the last clip on and the bulb lights; unclip anywhere and it dies — whatever flows must flow around the ENTIRE loop. If 12 C of charge passes any point of the loop in 6.0 s at a steady rate, the current is $I =$ _____. What familiar kinematics pair does $I = dq/dt$ mirror?

CURRENT, RESISTANCE, OHM

Current: $I = dq/dt$ (amperes = C/s); $Q = \int I dt$ — rate and accumulation, week one's machine.

Resistance from geometry: $R = \rho L/A$ — long and thin resists; short and fat conducts. ρ is the material's resistivity ($\Omega \cdot m$).

$V = IR$ — Ohm's law: volts pushed per ampere drawn.

WE DO Exercise 1: Rate and Total

A wire carries a steady 2.0 A. **(a)** Charge passing in 6.0 s: $Q =$ _____. **(b)** If instead $I(t) = 0.5t$ A, the charge in those 6.0 s is $Q = \int I dt =$ _____ (integrate!).

RESISTANCE AND OHM

WE DO Exercise 2: Build a Resistor

A copper wire ($\rho = 1.7 \times 10^{-8} \Omega \cdot \text{m}$) is $L = 10 \text{ m}$ long with cross-section $A = 1.0 \times 10^{-6} \text{ m}^2$. $R = \rho L/A = \underline{\hspace{2cm}}$ Ω . Then: the same wire stretched to double length (volume fixed, so A halves) — what happens to R ?

YOU DO Exercise 3: Ohm Three Ways

(a) A 6.0Ω resistor across 12 V draws $I = \underline{\hspace{2cm}}$. (b) A resistor drawing 0.5 A at 12 V has $R = \underline{\hspace{2cm}}$.
(c) A 4.0Ω resistor carrying 3.0 A drops $V = \underline{\hspace{2cm}}$.

CALC Exercise 4: Non-Uniform Current

A discharging circuit carries $I(t) = 4e^{-(t/3)} \text{ A}$. Set up and evaluate $Q = \int_0^\infty I \, dt$. (Antiderivative of $e^{-(t/\tau)}$ is $-\tau e^{-(t/\tau)}$ — the full area under a decaying exponential is $I_0 \tau$.)

PAPER PRACTICE

PRACTICE PROBLEMS

P1 Definition

30 C passes a point in 12 s at a steady rate. Find I .

P2 Geometry

Nichrome wire: $\rho = 1.1 \times 10^{-6} \Omega \cdot \text{m}$, $L = 2.0 \text{ m}$, $A = 1.0 \times 10^{-6} \text{ m}^2$. Find R .

P3 Ohm Chain

A 30Ω resistor sits across a 120 V outlet. Find the current, then the charge that flows in one minute.

P4 The Stretch Test

A wire of resistance 8.0Ω is stretched to triple length (volume fixed, so A drops to $A/3$). Find the new resistance — and state the general rule: stretching by factor n multiplies R by _____.