

B.5 Current and circuits

Practice Worksheet — name: _____ date: _____

FORMULAS FOR THIS TOPIC

ELECTRIC CURRENT $I = \frac{\Delta q}{\Delta t}$ POTENTIAL DIFFERENCE $V = \frac{W}{q}$ RESISTANCE $R = \frac{V}{I}$ RESISTIVITY $\rho = \frac{RA}{L}$ ELECTRICAL POWER $P = VI = I^2R = \frac{V^2}{R}$ RESISTORS IN SERIES $R_s = R_1 + R_2 + \dots$ RESISTORS IN PARALLEL $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$ EMF AND INTERNAL RESISTANCE $\varepsilon = I(R + r)$

SECTION A — MULTIPLE CHOICE

A1. Two identical resistors connected in parallel have combined resistance R_p . Connected in series, their combined resistance is:

- A R_p
- B $2R_p$
- C $4R_p$
- D $R_p/4$

A2. A battery of emf 12 V and internal resistance 0.50Ω delivers a current of 4.0 A. Its terminal potential difference is:

- A 12 V
- B 10 V
- C 14 V
- D 8.0 V

A3. The current through a filament lamp doubles when the potential difference across it is tripled. The lamp is:

- A Ohmic, because current increases with voltage
- B Non-ohmic, because resistance has increased with temperature
- C Non-ohmic, because resistance has decreased with temperature
- D Ohmic, because the filament obeys $P = VI$

SECTION B — SHORT ANSWER

B1. A copper wire of length 2.0 m and cross-sectional area $1.0 \times 10^{-6} \text{ m}^2$ has resistivity $1.7 \times 10^{-8} \Omega\text{m}$. Calculate its resistance, and the new resistance if the wire is stretched (at constant volume) to twice its length. [4 marks]

B2. Explain why the emf of a cell exceeds its terminal potential difference when a current flows, and state when they are equal. [3 marks]

B3. Three resistors — $6.0\ \Omega$ and $3.0\ \Omega$ in parallel, in series with $4.0\ \Omega$ — are connected to a $12\ \text{V}$ supply of negligible internal resistance. Find the current drawn from the supply. [3 marks]

ANSWER KEY

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Section A

A1: $4R_p$ — For two equal resistors R : parallel gives $R/2$, series gives $2R$. The ratio series/parallel is $2R \div R/2 = 4$.

A2: 10 V — The internal resistance drops $Ir = 4.0 \times 0.50 = 2.0$ V inside the battery, leaving $V = \varepsilon - Ir = 10$ V across the terminals. Terminal voltage always sags under load.

A3: Non-ohmic, because resistance has increased with temperature — Ohmic behaviour means $I \propto V$. Here tripling V only doubles I , so $R = V/I$ has grown — the filament heats up and its lattice ions vibrate more, scattering electrons more effectively.

Section B

B1: $R = \rho L/A = (1.7 \times 10^{-8})(2.0)/(1.0 \times 10^{-6}) = 0.034 \Omega$. Stretching to $2L$ at constant volume halves A , so $R' = \rho(2L)/(A/2) = 4R = 0.136 \Omega$. Resistance scales with the square of the stretch factor.

B2: The emf is the total energy per unit charge supplied by the cell; some of it is dissipated crossing the cell's own internal resistance (Ir), so the terminals only receive $V = \varepsilon - Ir$. They are equal when no current flows (open circuit) or for an ideal cell with $r = 0$.

B3: Parallel pair: $(1/6 + 1/3)^{-1} = 2.0 \Omega$. Total: $2.0 + 4.0 = 6.0 \Omega$. Current: $I = 12/6.0 = 2.0$ A.