



QUESTION WORKBOOK

Circuits and Kirchhoff's laws

Electricity · Year 12

AQA 3.5.1.4 · CIE 9.2.3, 10.1.1, 10.1.2, 10.2.1, 10.2.2, 10.2.3, 10.2.4, 10.2.5, 10.2.6, 10.2.7
OCR A 4.1.1(g), 4.2.1(a), 4.2.1(b), 4.2.5(a), 4.2.5(b), 4.3.1(a), 4.3.1(b), 4.3.1(c), 4.3.1(d), 4.3.1(e),
4.3.1(f)

20 questions · 60 marks

PRINT EDITION

SECTION A · Warm-up

A1 State Kirchhoff's first law and the conservation principle it expresses. [2]

A2 Two resistors of $20\ \Omega$ and $30\ \Omega$ are connected in series. Calculate the total resistance. [2]

A3 Two $20\ \Omega$ resistors are connected in parallel. Calculate the total resistance. [2]

A4 Two $1.5\ \text{V}$ cells are connected in series to form a battery. State the emf of the battery. State the emf if the two identical cells are instead connected in parallel, and give one advantage of the parallel arrangement. [2]

A5 Explain why the combined resistance of two resistors in parallel is always less than the smaller of the two resistances. [2]

- A6** State which form of the power equation is most direct for comparing the powers dissipated in two resistors in series, and give the reason. [2]

SECTION B · Standard

- B1** A $6.0\ \Omega$ resistor and a $3.0\ \Omega$ resistor are connected in parallel across a 12 V supply. Calculate (a) the total resistance and (b) the total current from the supply. [3]

- B2** A $4.0\ \Omega$ and an $8.0\ \Omega$ resistor are connected in series across a 12 V supply. Calculate (a) the current in the circuit and (b) the potential difference across each resistor. [4]

- B3** At a junction in a circuit, currents of 3.0 A and 2.0 A flow in, and a single wire carries the current out. Determine the current in the output wire, stating the law you use. [2]

- B4** A resistor of $5.0\ \Omega$ carries a current of $2.0\ \text{A}$. Calculate the power dissipated in it.

[2]

- B5** An electric shower is rated $10.5\ \text{kW}$ at $230\ \text{V}$. Calculate the current it draws and the resistance of its heating element.

[3]

- B6** A phone charger's packaging claims it delivers $38\ \text{kJ}$ of energy in a 45 minute charge. In a test it supplies a steady $2.1\ \text{A}$ at $5.0\ \text{V}$ for the full 45 minutes. Deduce whether the claim is accurate.

[3]

- B7** A battery of emf $24\ \text{V}$ drives a current round a series loop containing three components. The pds across two of them are $9.0\ \text{V}$ and $7.5\ \text{V}$. Determine the pd across the third component, stating the law you use.

[2]

- B8** A camping heater runs from a 12 V supply of negligible internal resistance and has two identical $4.6\ \Omega$ elements. Calculate the total power when the elements are connected (a) in series and (b) in parallel. [4]

SECTION C · Stretch

- C1** A $4.0\ \Omega$ resistor is connected in series with a parallel combination of a $6.0\ \Omega$ and a $3.0\ \Omega$ resistor, across a 12 V supply. Calculate (a) the total resistance, (b) the total current and (c) the current in each of the parallel resistors. [4]

- C2** A 60 W lamp is switched on for 5.0 minutes while connected to a 230 V supply. Calculate (a) the energy it transfers and (b) the charge that flows through it. [4]

C3 State Kirchhoff's second law and the conservation principle it expresses. [3]

C4 A car's two headlamps, each of resistance $6.0\ \Omega$, are connected in parallel. The pair is in series with wiring of total resistance $0.40\ \Omega$ across the car's $12\ \text{V}$ supply. The circuit is protected by a $5.0\ \text{A}$ fuse. Deduce whether the fuse melts when both headlamps are on. [4]

C5 A $3.0\ \Omega$ resistor and a $9.0\ \Omega$ resistor are connected in series across a $6.0\ \text{V}$ supply of negligible internal resistance. Calculate the power dissipated in each resistor, and state which runs hotter. [4]

- C6** Two identical filament lamps are connected to a battery of negligible internal resistance, first in series and then in parallel. Explain fully why the lamps are brighter in parallel, and why the battery discharges sooner. A student claims that each lamp in series dissipates exactly one quarter of its parallel power. Comment on that claim. [6]
