

Exercise walk-through

2.6

Current, resistance and circuits (statements 64–73, core practical 7)

Pearson Edexcel · International A-Level · Physics

Intensity needs an area conversion

- 1 **Convert** $A = 25 \times 10^{-4} = 0.0025 \text{ m}^2$
- 2 **Incident** $P = IA = 800 \times 0.0025 = 2.0 \text{ W}$
- 3 **Useful** $P_{out} = \eta P = 0.20 \times 2.0 = 0.40 \text{ W}$

Decision

A 0.50 W device cannot run from this useful output.

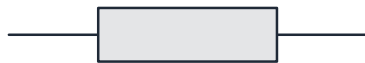
Frequency and intensity change different things

Change	Photon energy	Maximum electron energy
Intensity rises; frequency fixed	Unchanged	Unchanged
Frequency rises	Increases	Increases above threshold

Exercises 2.1·2.2

2.1 A 0.25 A current flows for 40 s through a component with p.d. 6.0 V. Calculate charge, transferred energy and power. [3]

$$I = 0.25 \text{ A}, V = 6.0 \text{ V}$$



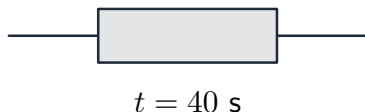
$$t = 40 \text{ s}$$

2.2 Derive the effective resistance of two parallel resistors from charge conservation. Explain why the effective resistance is smaller than either branch resistance. [4]

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2.1 $Q = It = 0.25 \times 40 = 10 \text{ C}$. $W = VQ = 6.0 \times 10 = 60 \text{ J}$. $P = VI = 6.0 \times 0.25 = 1.5 \text{ W}$.

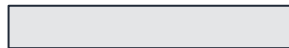
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2.2 Parallel branches share p.d. V . Charge conservation gives $I = I_1 + I_2$. Substitute $I = V/R$ to get $1/R = 1/R_1 + 1/R_2$. Added branch conductance increases total current at fixed voltage, so resistance is smaller.

Exercises 2.3·3.1

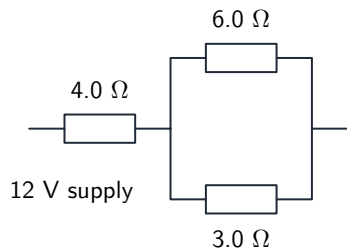
2.3 A metal wire has $n = 8.0 \times 10^{28} \text{ m}^{-3}$, area $1.0 \times 10^{-6} \text{ m}^2$ and current 1.6 A. Calculate electron drift speed. Use $e = 1.60 \times 10^{-19} \text{ C}$. [3]

$$I = 1.6 \text{ A}$$



$$A = 1.0 \times 10^{-6} \text{ m}^2$$

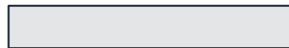
3.1 A 4.0Ω resistor is in series with a parallel combination of 6.0Ω and 3.0Ω , supplied by an ideal 12 V source. Calculate total current and power in the 3.0Ω branch. Explain why using $12^2/3.0$ for that branch is wrong. [5]



Exercises 2.3.3.1

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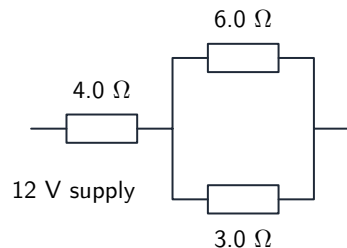
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$$A = 1.0 \times 10^{-6} \text{ m}^2$$

2.3 Use $I = nqvA$ for directed carrier flow. $v = I/(nqA)$. $v = 1.6/(8.0 \times 10^{28} \times 1.60 \times$

3.1 A 4.0Ω resistor is in series with a parallel combination of 6.0Ω and 3.0Ω , supplied by an ideal 12 V source. Calculate total current and power in the 3.0Ω branch. Explain why using $12^2/3.0$ for that branch is wrong. [5]



3.1 $R_p = (1/6 + 1/3)^{-1} = 2.0 \Omega$. $I = V/(R_p + 4) = 12/6 = 2.0 \text{ A}$. $V_p = IR_p = 4.0 \text{ V}$.

Exercise 3.2

3.2 Plan a resistivity measurement using a uniform wire. An R - l best-fit line has gradient $5.0 \, \Omega \text{ m}^{-1}$ and intercept $0.20 \, \Omega$. Diameter is 0.30 mm . Calculate resistivity and suggest the origin of the intercept. [6]

$$d = 0.30 \text{ mm}$$



R - l gradient: $5.0 \, \Omega/\text{m}$

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R – l gradient: $5.0 \, \Omega/\text{m}$

3.2 Measure V, I across several measured contact separations, then $R = V/I$. Use a small current/switch off between readings to limit heating. Measure diameter repeatedly with a zero-checked micrometer. $A = \pi d^2/4 = 7.07 \times 10^{-8} \text{ m}^2$. $\rho = A \times \text{gradient} = 3.53 \times 10^{-7} \, \Omega \text{ m}$. Fixed contact/lead resistance can cause the intercept; it should not be included in the gradient-based wire resistivity.

Exercise 3.3

3.3 On current–voltage axes, sketch an ohmic conductor, a filament lamp and a diode. State the relevant temperature condition for the ohmic graph. Explain why the tangent gradient of a curved graph does not generally give the reciprocal of V/I . [6]

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3.3 Ohmic: straight line through the origin, at constant temperature and other physical conditions. Lamp: symmetric curve flattening as voltage magnitude rises due to heating. Diode: little reverse current before breakdown and steep forward rise after its knee. V/I is the operating-point resistance using the line from the origin; a tangent describes a small change in current divided by a small change in voltage, which need not equal I/V .