2.1 Mains electricity

Name: _____ Class: _____ Date: _____ **Total: 21 marks**

Objective

Build the skills to answer exam questions on **mains electricity** : insulation, earthing and fuses, the heating effect of a current, $P = IV$, $E = IVt$, and alternating and direct current.

You must be able to:

- explain how fuses, earthing and double insulation protect people
- calculate power, current and energy with $P = IV$ and $E = IVt$
- choose the right fuse for an appliance
- calculate the cost of using an appliance

1 Key knowledge and worked examples

Power and energy

idea	equation or rule
power	$P = I \times V$ (unit W)
energy transferred	$E = I \times V \times t$ (unit J, with t in seconds)
fuse	choose the rating just above the normal current (fuses are often 3 A, 5 A, 13 A)
kilowatt-hour	1 kWh is the energy of 1 kW for 1 hour = 3 600 000 J
mains in the UK	about 230 V a.c.

Worked example 1: current. A 2300 W kettle runs on 230 V. Find the current.

1. Known: $P = 2300$ W; $V = 230$ V.
2. Rule: $I = P \div V$.
3. Numbers: $2300 \div 230$.
4. Result: 10 **A** (so a 13 A fuse).

Worked example 2: energy. A 2000 W heater runs for 5 minutes. Find the energy transferred.

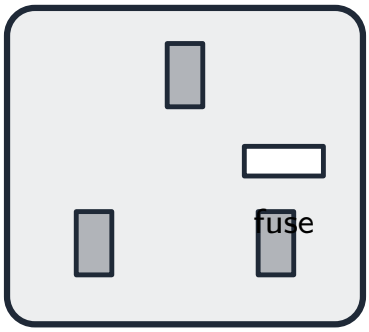
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1. Known: $P = 2000$ W; $t = 300$ s.
2. Rule: $E = Pt$ (same as IVt).
3. Numbers: 2000×300.
4. Result: $600\,000$ **J**.

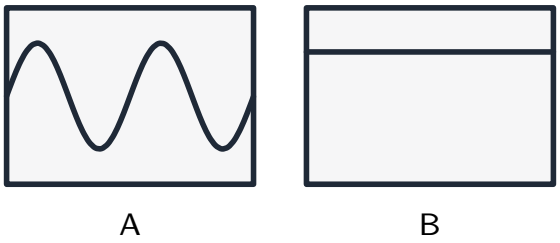
Answer shapes: for safety devices, say what fault happens, what current flows, and what the device does.

2 Practice

2.1 A 1000 W heater runs on 230 V. Calculate the current, and choose a 3 A, 5 A or 13 A fuse. [2]



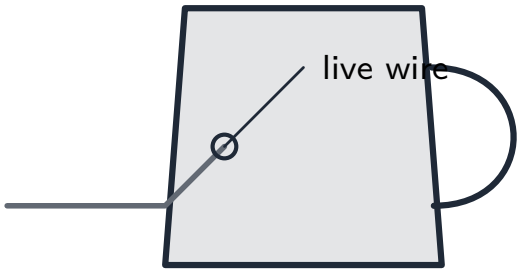
2.2 Explain the difference between alternating current (a.c.) and direct current (d.c.). [2]



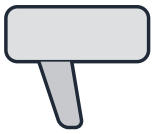
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3 Exam-style questions

3.1 The live wire inside a metal kettle comes loose and touches the metal case. Explain how the earth wire and the fuse protect the user. [3]



3.2 A hair dryer is used for 15 minutes every day. Information about it is shown. Electricity costs 30p per kWh.



voltage	230 V
power	1840 W

(a) Calculate the current in the hair dryer. [2]

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(b) Calculate the energy it transfers each day, in joules and in kWh. [3]

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(c) Calculate the cost of using the hair dryer for 30 days. [3]

(d) The hair dryer has a plastic case and only two wires. Explain how it is designed to be safe, and why the heating element gets hot. [6]

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Solutions

Marking: **M1** a correct method, **A1** the correct answer, **B1** an independent mark.

Each answer shows the steps, then the **result**.

2.1

- $1000 \div 230 = 4.3$ A
- 5 A fuse

2.2

- a.c. keeps changing direction
- d.c. flows in one direction only, e.g. from a cell

3.1

- the earth wire connects the case to earth, giving a low-resistance path
- a large current flows from live to earth
- the fuse melts and cuts off the supply, so the case is not live

3.2

(a) $1840 \div 230 = \mathbf{8.0}$ A

(b) $1840 \times 900 = \mathbf{1\,656\,000}$ J; $1.84 \times 0.25 = \mathbf{0.46}$ kWh

(c) $0.46 \times 30 = 13.8$ kWh; 13.8×30p $= 414$p $= \$\mathbf{4.14}$

(d) points to include:

- double insulation: the plastic case does not conduct, so it cannot become live; no earth wire is needed (K)
- a fuse in the plug (e.g. 13 A, above 8.0 A) melts if the current is too large (K)
- the cable has insulated wires and is thick enough for the current, so it does not overheat (App)
- the heating element is a resistor; electrons collide with the ions as they flow (K)
- this transfers energy to the thermal store of the element, so it gets hot (An)
- the fan blows air over the element, transferring the energy to the air (An)

Levels: **5–6** a full, logical answer with correct physics and correct terms; **3–4** several correct points, partly linked; **1–2** one or two relevant points.

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