3.12 Mains Electricity, Power and Energy: Test Pack

AQA 8464 · Calculator allowed · about 30 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Electricity supplies can be either direct current (dc) or alternating current (ac).

(a) Define what is meant by direct current (dc). **(1)**

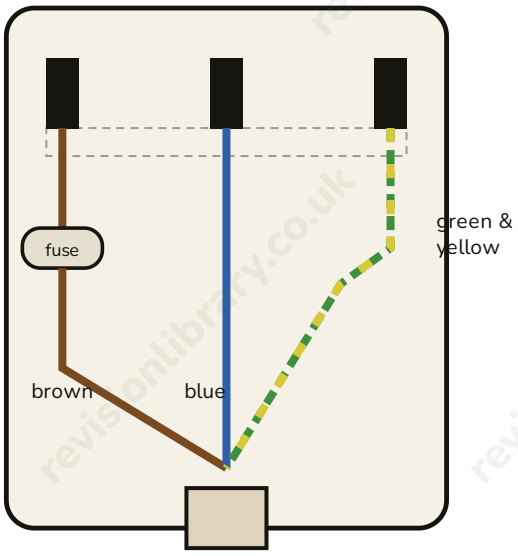
(b) Define what is meant by alternating current (ac). **(1)**

(c) State one reason why alternating current, rather than direct current, is used for the UK mains supply and for transmission through the National Grid. **(1)**

(Total for Question 1 is 3 marks)

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2 The diagram shows a UK three-pin plug with its cover removed. Three wires are connected to the pins: one with brown insulation, one with blue insulation and one with green-and-yellow insulation.



(a) Name the wire with brown insulation and state its function. **(2)**

(b) Name the wire with blue insulation and state its function. **(2)**

(c) Name the wire with green-and-yellow insulation and state its function. **(2)**

(Total for Question 2 is 6 marks)

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3 Both fuses and circuit breakers are used to protect circuits from excessively large currents, but they work in different ways.

(a) State one similarity between how a fuse and a circuit breaker protect a circuit. **(1)**

(b) State one difference between how a fuse and a circuit breaker work. **(1)**

(c) State one advantage a circuit breaker has over a fuse. **(1)**

(Total for Question 3 is 3 marks)

4 A student says: 'As long as an appliance has a fuse fitted, it is completely safe, so an earth wire is not really necessary.' Evaluate this statement.

(Total for Question 4 is 2 marks)

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5 A toaster has a metal outer casing. A hairdryer has a plastic outer casing, no earth pin, and is described as 'double insulated'.

(a) Explain why the toaster needs an earth wire connected to its metal casing. **(2)**

(b) Explain why the hairdryer does not need an earth wire, even though a fault could still occur inside it. **(2)**

(Total for Question 5 is 4 marks)

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6 A 2 kW electric heater is used for 3 hours. Electricity costs 28p per kWh.

(a) Calculate the energy transferred by the heater, in kilowatt-hours (kWh). Use E = P t. **(2)**

(b) Calculate the cost of using the heater for this time. **(2)**

(Total for Question 6 is 4 marks)

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Mark scheme · 3.12 Mains Electricity, Power and Energy: Test Pack

Question 1

(a) current that flows in one direction only, oe **B1**

(a) Answer: Current that flows in one direction only.

(b) current that repeatedly reverses direction (changes direction periodically), oe **B1**

(b) Answer: Current that repeatedly reverses direction.

(c) ac can easily be stepped up or stepped down in potential difference using transformers, and transformers only work with a changing (alternating) current, oe **B1**

(c) Answer: Transformers (used to step the potential difference up or down for efficient transmission) only work with alternating current.

Question 2

(a) live wire **B1**

(a) carries the alternating current (potential difference) from the supply into the appliance; normally at about 230 V relative to earth, oe **B1**

(a) Answer: Live wire; it carries the current (at about 230 V) from the supply into the appliance.

(b) neutral wire **B1**

(b) completes the circuit, carrying current back to the supply; normally at, or very close to, 0 V (earth potential), oe **B1**

(b) Answer: Neutral wire; it completes the circuit and is normally at about 0 V.

(c) earth wire **B1**

(c) a safety wire that connects the metal casing of an appliance to earth, providing a low-resistance path for current if a fault occurs, so a large current flows and blows the fuse (or trips the circuit breaker), disconnecting the appliance before the casing can become dangerous, oe **B1**

(c) Answer: Earth wire; a safety wire connecting the metal casing to earth so a fault current blows the fuse (or trips the breaker) and disconnects the appliance.

Question 3

(a) both automatically break (disconnect) the circuit if the current becomes too large, protecting the wiring/appliance/user, oe **B1**

(a) Answer: Both automatically disconnect (break) the circuit if the current becomes too large.

(b) a fuse contains a thin wire that heats up and melts (due to the heating effect of the current) when the current exceeds its rating, breaking the circuit; a circuit breaker is an electromagnetic switch that trips (opens) when the current exceeds its rating, oe; accept the converse **B1**

(b) Answer: A fuse contains a wire that melts (due to heating) when the current is too large; a circuit breaker uses an electromagnetic switch that trips instead.

(c) a circuit breaker can be reset and reused, whereas a blown fuse must be replaced, oe; accept: a circuit breaker typically trips (acts) faster **B1**

(c) Answer: A circuit breaker can simply be reset and reused, whereas a fuse must be replaced once it has blown.

Question 4

the statement is an oversimplification: a fuse alone only protects the wiring/circuit from a large current after a fault has occurred; without an earth wire, a fault could make the metal casing live without necessarily drawing enough current to blow the fuse, leaving the casing dangerous to touch, oe **B1**

the earth wire works together with the fuse: it provides a low-resistance path that ensures a large enough fault current flows to blow the fuse quickly, and keeps the casing at (or very near) 0 V in the meantime, so the earth wire is still needed for full protection, oe **B1**

Answer: Not fully correct: a fuse alone cannot guarantee a fault current is big enough to blow it, or that the casing stays safe in the meantime. The earth wire works together with the fuse, giving a low-resistance path so a fault current blows the fuse quickly and keeps the casing near 0 V, so it is still needed.

Question 5

(a) if a fault occurs (e.g. a live wire works loose and touches the casing), the metal casing could become live/reach a dangerous potential difference, oe **B1**

(a) the earth wire provides a low-resistance path to earth, so a large fault current flows, blowing the fuse (or tripping the breaker) and disconnecting the appliance, keeping the casing safe to touch, oe **B1**

(a) Answer: The metal casing could become live if a fault occurs; the earth wire gives a low-resistance path to earth so a large fault current blows the fuse (or trips the breaker), disconnecting the appliance before the casing can shock someone.

(b) the outer casing is plastic, which is an electrical insulator, so it cannot become live/cannot conduct a fault current to anyone touching it, oe **B1**

(b) 'double insulated' means the appliance has (at least) two independent layers of insulation between the user and any live parts, so an earth connection is not required for it to be safe, oe **B1**

(b) Answer: The plastic casing is an insulator, so it cannot become live even if a live wire touches it inside; double insulation means there are two independent layers of insulation protecting the user, so no earth wire is needed.

Question 6

(a) substitutes: E = 2 x 3 **M1**

(a) E = 6 kWh (cao) **A1**

(a) Answer: 6 kWh

(b) substitutes: cost = 6 x 28 (ft from (a)) **M1**

(b) 168p = £1.68 (cao, ft; accept either unit) **A1**

(b) Answer: 168p (£1.68)

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