3.2 Electricity: 1-hour Pack

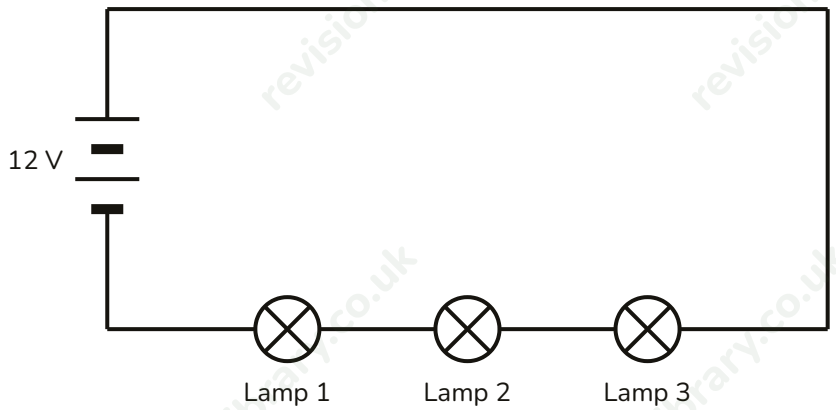
Calculator allowed · about 60 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Figure 2 shows three identical lamps connected in series with a 12 V battery.



(a) The current through lamp 1 is 0.50 A. State the current through lamp 2. **(1)**

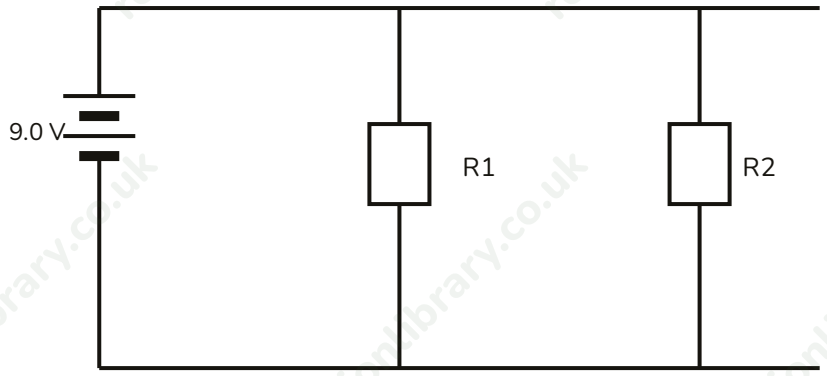
(b) The total resistance of the circuit is 24 ohm. Use the equation V = I x R to calculate the current supplied by the battery. **(3)**

.....

(Total for Question 1 is 4 marks)

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2 Figure 3 shows two resistors connected in parallel across a 9.0 V battery. The current in the first branch is 1.5 A and the current in the second branch is 0.75 A.



(a) State the potential difference across the second resistor. **(1)**

(b) Calculate the total current supplied by the battery. **(2)**

.....

(Total for Question 2 is 3 marks)

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3 Two resistors, 4.0 ohm and 6.0 ohm, are connected in series across a 10 V supply. Calculate the total resistance and the current through the series circuit.

(a) Calculate the total resistance in the series circuit. **(1)**

.....

(b) Calculate the current through the series circuit. Use I = V / R. **(2)**

.....

(Total for Question 3 is 3 marks)

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4 A classroom power supply is set to 12 V. A small heater connected to it draws a current of 0.50 A. Use V = I x R to find the resistance of the heater.

(a) Substitute the values into R = V / I. **(1)**

.....

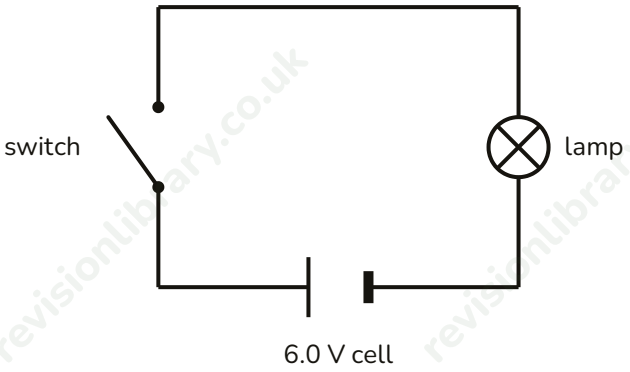
(b) Compute R and give the unit. **(2)**

.....

(Total for Question 4 is 3 marks)

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5 A student sets up a simple series circuit containing a 6.0 V cell, a switch and a lamp. When the switch is closed, a current of 0.40 A flows through the lamp for 3.0 minutes.



(a) An ammeter is used to measure the current in the circuit. Which statement about an ideal ammeter is correct? **(1)**

- ☐ A) It has zero resistance and is connected in series
- ☐ B) It has infinite resistance and is connected in series
- ☐ C) It has zero resistance and is connected in parallel
- ☐ D) It has infinite resistance and is connected in parallel

(b) Use the equation: charge = current x time (Q = I x t). Calculate the charge that flows through the lamp in 3.0 minutes. **(3)**

.....

(Total for Question 5 is 4 marks)

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6 A washing machine is rated at 230 V, 2.8 kW and is connected to the mains supply using a three-core cable.

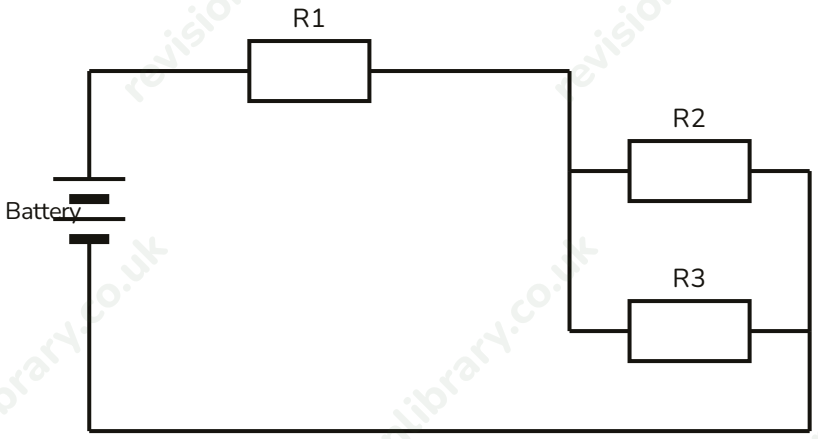
(a) State the function of the earth wire and the function of the live wire in a three-core cable. **(2)**

(b) Use the equation P = V x I to calculate the normal operating current of the washing machine, and hence select the most appropriate fuse rating from 3 A, 5 A and 13 A. **(3)**

(Total for Question 6 is 5 marks)

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7 Figure 4 shows a circuit with a battery connected to a 4.0 ohm resistor (R1) in series with a section containing two resistors, R2 and R3, connected in parallel with each other.



(a) The current from the battery is 1.5 A. Use V = I x R to calculate the potential difference across R1. **(3)**

.....

(b) The battery's potential difference is 12 V. Calculate the potential difference across the parallel section of the circuit. **(3)**

.....

(c) The current through R2 is 0.90 A. Calculate the resistance of R2, then calculate the current through R3. **(3)**

.....

(Total for Question 7 is 9 marks)

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8 A polythene rod is rubbed with a dry cloth. The rod becomes negatively charged.

(a) Explain, in terms of electrons, why the rod becomes negatively charged. **(2)**

(b) The charged rod is brought close to a thin stream of water and the stream bends towards the rod. Suggest why this happens. **(2)**

(Total for Question 8 is 4 marks)

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9 A thermistor is connected into a control circuit used to switch on a greenhouse heater automatically.

(a) State how the resistance of a thermistor changes as its temperature increases. **(1)**

(b) Explain how the thermistor's changing resistance can be used to switch on the heater automatically when the greenhouse temperature falls. **(3)**

(Total for Question 9 is 4 marks)

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10 Explain how changing the resistance in a step-up transformer primary winding circuit (while the primary is connected to an AC supply of fixed frequency and amplitude) would affect the current in the primary, the magnetic flux in the core and the voltage induced in the secondary. In your answer discuss the chain of cause and effect and state any assumptions you make about the transformer being ideal. You are assessing the relationship between supply, impedance and induced emf.

(Total for Question 10 is 6 marks)

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Mark scheme · 3.2 Electricity: 1-hour Pack

Question 1

(a) 0.50 A (current is the same at all points in a series circuit) **B1**

(a) Answer: 0.50 A

(b) rearranges to I = V / R **M1**

(b) substitutes: I = 12 / 24 **M1**

(b) I = 0.50 A cao **A1**

(b) Answer: 0.50 A

Question 2

(a) 9.0 V (p.d. is the same across parallel branches, equal to the battery p.d.) **B1**

(a) Answer: 9.0 V

(b) adds branch currents: 1.5 + 0.75 **M1**

(b) 2.25 A cao **A1**

(b) Answer: 2.25 A

Question 3

(a) Rtot = 4.0 + 6.0 = 10 ohm cao **B1**

(a) Answer: 10 ohm

(b) substitutes: I = 10 / 10 **M1**

(b) 1.0 A cao **A1**

(b) Answer: 1.0 A

Question 4

(a) substitutes: R = 12 / 0.50 **M1**

(a) Answer: R = 12 / 0.50

(b) performs division: 12 / 0.50 **M1**

(b) 24 ohm cao **A1**

(b) Answer: 24 ohm

Question 5

(a) A - zero resistance, connected in series **B1**

(a) Answer: A

(b) converts time to seconds: t = 3.0 x 60 = 180 s **M1**

(b) substitutes correctly: Q = 0.40 x 180 **M1**

(b) Q = 72 C cao **A1**

(b) Answer: 72 C

Question 6

(a) earth wire: a safety wire that connects the metal casing to earth, carrying fault current safely away and preventing electric shock oe **B1**

(a) live wire: carries the alternating potential difference (at about 230 V) from the supply oe **B1**

(a) Answer: Earth wire: safety wire preventing shock by carrying fault current to earth. Live wire: carries the alternating p.d. from the supply.

(b) rearranges and substitutes: I = 2800 / 230 **M1**

(b) I = 12.2 A (awrt) **A1**

(b) ft selects the 13 A fuse, because the fuse rating must exceed the operating current (5 A would blow immediately) **B1**

(b) Answer: 12.2 A; a 13 A fuse should be used

Question 7

(a) identifies that the current through R1 equals the total battery current (series section) **M1**

(a) substitutes: V = 1.5 x 4.0 **M1**

(a) V = 6.0 V cao **A1**

(a) Answer: 6.0 V

(b) uses ft p.d. across R1: p.d.s in a series loop add up to the supply p.d. **M1**

(b) 12 - 6.0 **M1**

(b) 6.0 V ft **A1**

(b) Answer: 6.0 V

(c) ft uses V (parallel) / I: R2 = 6.0 / 0.90 **M1**

(c) R2 = 6.7 ohm (2 s.f.) awrt **A1**

(c) ft current through R3 = total current - current through R2 = 1.5 - 0.90 = 0.60 A **B1**

(c) Answer: R2 = 6.7 ohm; current through R3 = 0.60 A

Question 8

(a) friction between rod and cloth transfers electrons from the cloth to the rod **B1**

(a) rod gains an excess of electrons, giving it an overall negative charge oe **B1**

(a) Answer: Electrons are transferred from the cloth to the rod by friction, giving the rod an excess of electrons (negative charge).

(b) the charged rod induces an opposite charge on the near side of the water oe **B1**

(b) unlike charges attract, so the water is pulled towards the rod **B1**

(b) Answer: The rod's electric field induces an opposite charge in the water, and since unlike charges attract, the stream bends towards the rod.

Question 9

(a) resistance decreases as temperature increases **B1**

(a) Answer: Resistance decreases.

(b) as temperature falls, the thermistor's resistance increases **B1**

(b) this increases the potential difference across the thermistor in the control circuit oe **B1**

(b) the change in p.d./current is used to trigger the switching circuit, turning the heater on **B1**

(b) Answer: Falling temperature increases thermistor resistance, changing the p.d./current in the circuit enough to trigger the switch and turn on the heater.

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Question 10

Level 3 Detailed explanation linking resistance change to primary current, primary magnetising flux and then to secondary induced voltage; states ideal transformer assumption; uses correct terms such as impedance, magnetising current, flux, and Faraday's law; gives a clear causal chain and conclusion.	**5-6**
Level 2 Partial explanation that links a change in resistance to a change in current and mentions an effect on flux or induced voltage, but with limited causal detail or missing the ideal transformer assumption.	**3-4**
Level 1 Simple statements such as 'higher resistance gives lower current' without linking to flux or induced voltage, or statements that are irrelevant or incorrect.	**0-2**

Indicative content:

- Assume ideal transformer means negligible losses and primary current produces flux in core.
- Increasing primary circuit resistance reduces the primary current (I = V / Z), so magnetising current falls.
- Reduced magnetising current produces reduced magnetic flux in the core (flux is proportional to magnetising current).
- Faraday's law: induced emf in secondary is proportional to rate of change of flux; lower flux gives lower induced emf and therefore lower secondary voltage amplitude.
- If resistance increases greatly the primary current becomes small and secondary voltage falls significantly; lowering resistance increases primary current, increasing flux and secondary induced voltage, until core saturation or non-ideal effects occur.
- State any assumptions: frequency constant, supply amplitude constant, negligible winding resistance and leakage flux for ideal behaviour.

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