K12E Electricity and Magnetism: Depth and Practice

AQA AQA KS3 Science · Calculator allowed · about 75 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Name the part of an electric circuit that gives energy to the charges so they can flow.

(1)

---

2 An electrician measures current using an ammeter. State the unit of electric current and the symbol used for it.

(2)

---

3 A simple circuit has one 9 V battery and a lamp. The current measured through the lamp is 0.3 A. State whether the current is the same at all points in this circuit and explain your answer in one sentence.

(2)

---

4 Complete the sentence. In a series circuit the total potential difference of the battery is _____ across the components, while in a parallel circuit each branch has _____ potential difference as the battery.

(3)

5 A pupil builds two circuits. Circuit A has two identical bulbs in series with one 3 V cell. Circuit B has the same two bulbs in parallel with the same 3 V cell. Which circuit will have brighter bulbs and why? Give two short points: one observation and one reason.

(3)

---

6 State the name of the device that protects a domestic electrical circuit by breaking the circuit if too much current flows. Give one reason why it is important.

(2)

---

7 A 12 V battery is connected to a resistor and the current measured is 0.6 A. Calculate the resistance of the resistor. Show your working and give the unit.

(3)

---

8 A pupil measures potential difference across a lamp and the current through it. The readings are: p.d. = 6.0 V, current = 0.50 A. Calculate the power used by the lamp. Show working and unit.

(4)

---

9 Explain why heating a wire usually increases its resistance.

(2)

10 A pupil builds an experiment to investigate how the number of coils on a wire wrapped around an iron nail changes the strength of an electromagnet. Suggest the independent variable, two control variables, and the dependent variable the pupil should use.

(4)

---

11 A student uses a stand and clamp to hang a small iron bolt from a nail electromagnet. The student measures how many paperclips the electromagnet picks up as the number of coils is changed. Give two improvements to make the experiment fair and more reliable.

(4)

---

12 State whether the following materials are magnetic or non-magnetic: a) iron b) copper.

(1)

---

13 A bar magnet is placed under a sheet of paper. Iron filings are sprinkled on top and create a pattern. Describe what the pattern of the magnetic field lines will show near the ends of the magnet and in the middle between the poles.

(3)

14 Explain why switching to a thicker wire in a circuit usually reduces the wire's resistance.

(2)

---

15 A component labelled 240 ohm is connected across a 12 V supply. Calculate the current through the component and the power it uses. Show your working and give units.

(4)

---

16 Extended response: A class is designing an experiment to compare the strength of three electromagnets made by wrapping different numbers of turns of wire around identical iron bolts. They will use the same battery for each test. Describe a fair method they could use to compare the electromagnets, including how to make it fair, how to collect and present data, how to handle anomalies, and what conclusion could be drawn. You will be assessed on the quality of your scientific communication and reasoning.

(6)

---

17 A pupil connects two identical 1.5 V cells in series to make a 3.0 V supply and attaches it to a series circuit containing three identical resistors. The total current measured is 0.10 A. Calculate the resistance of one resistor. Show working.

(4)

18 Stretch question: A wire of resistance 5.0 ohm is placed in a circuit with a 9.0 V supply. The wire warms up and its resistance increases to 6.0 ohm. Calculate the current before and after heating and state the percentage decrease in current. Show working and give answers to two significant figures where appropriate.

(4)

Mark scheme · K12E Electricity and Magnetism: Depth and Practice

Question 1

- **B1** cell or battery
- Answer: **Battery (or cell)**

Question 2

- **B1** ampere or amp
- **B1** A
- Answer: **Ampere (amp); symbol A**

Question 3

- **M1** state that current is the same at all points in a series circuit
- **A1** because charges flow in one loop so the same amount passes each point (oe)
- Answer: **Yes; the current is the same at all points because the circuit is a single loop so the same charge passes each point per second.**

Question 4

- **B1** shared or split
- **B1** the same or equal to the battery
- **B1** both blanks completed to show series splits and parallel equal pd
- Answer: **shared (split) across components; the same as the battery**

Question 5

- **M1** observation that bulbs in parallel are brighter than in series
- **A1** reason that in parallel each bulb gets the full pd of 3 V so more current flows through each bulb
- **B1** may mention in series pd is shared so each bulb gets less voltage
- Answer: **Bulbs in circuit B (parallel) are brighter; each bulb in parallel receives the full 3 V so more current flows through each, whereas in series the 3 V is shared so each bulb is dimmer.**

Question 6

- **B1** circuit breaker or fuse
- **B1** protects against fire or prevents damage to appliances or prevents electric shock (any one)
- Answer: **Fuse (or circuit breaker); it stops excessive current to prevent fires or damage to appliances.**

Question 7

- **M1** use of R = V / I with substitution R = 12 / 0.6
- **A1** 20 ohm cao
- **B1** unit ω or ohm stated
- Answer: **20 ohm**

Question 8

- **M1** use of P = V x I with substitution P = 6.0 x 0.50
- **A1** 3.0 W cao
- **B1** unit W shown
- **B1** answer given to 2 significant figures or exact 3.0 W
- Answer: **3.0 W**

Question 9

- **M1** statement that heating makes atoms vibrate more
- **A1** more vibrations cause more collisions with electrons so current is reduced and resistance increases (oe)
- Answer: **Heating makes the metal atoms vibrate more, causing more collisions with moving electrons, reducing current and so increasing resistance.**

Question 10

- **M1** independent variable: number of coils
- **B1** control variable 1: current through the wire or battery voltage
- **B1** control variable 2: same nail or length of wire or same wire thickness (any one reasonable)
- **A1** dependent variable: strength of electromagnet measured by number of paperclips picked up or force or mass held
- Answer: **Independent: number of coils. Controls: current or battery voltage; same nail (or same wire length/thickness). Dependent: strength measured by number of paperclips picked up.**

Question 11

- **M1** repeat each measurement and take an average
- **B1** use the same battery or regulator to keep current constant
- **B1** ensure same distance from nail to paperclips or same placement/reset protocol
- **A1** use a consistent way to count paperclips or use a scale to measure mass lifted
- Answer: **Repeat each coil number and average results; use the same battery or a power supply to keep current constant; keep placement and distance of paperclips the same; use a consistent counting method or measure mass lifted.**

Question 12

- **B1** iron magnetic; copper non-magnetic
- Answer: **a) Iron: magnetic; b) Copper: non-magnetic**

Question 13

- **M1** field lines are dense near the poles/ends
- **B1** field lines curve from north to south and are more spread out in the middle
- **A1** mention that around the middle lines are fewer or weaker indicating weaker field there
- Answer: **Iron filings show dense curved lines emerging from one end (north) and entering the other end (south); lines are closest near the poles and are more spread out and fewer in the middle, showing a weaker field there.**

Question 14

- **M1** thicker wire has a larger cross-sectional area
- **A1** more area allows more paths for electrons so fewer collisions and lower resistance
- Answer: **A thicker wire has a larger cross-sectional area, giving more pathways for electrons so fewer collisions occur and resistance is lower.**

Question 15

- **M1** use $I = V / R$ with substitution $I = 12 / 240$
- **A1** 0.05 A cao
- **M1** use $P = V \times I$ or $P = I^2 \times R$ with substitution $P = 12 \times 0.05$
- **A1** 0.6 W cao
- Answer: **Current = 0.05 A; Power = 0.6 W**

Question 16

- **Level 3** (5-6): Detailed method and justification. Method includes changing number of turns as independent variable, keeping current constant, using identical bolts and wire, repeating and averaging, clear data table and simple graph, handling anomalies and a correct scientific conclusion linking more turns to stronger electromagnet with reasoning about magnetic field and current.
- **Level 2** (3-4): Method given with some controls and repeats. Data collection described and a basic conclusion that more turns gives stronger magnet with limited explanation.
- **Level 1** (1-2): Simple statement of a test, limited control of variables and a vague or unsupported conclusion.
- **Indicative content:**
  - Independent variable: number of turns of wire on the bolt (e.g. 50, 100, 150 turns).
  - Control variables: same battery or power supply so current is constant, same wire thickness, same iron bolt, same temperature, start each trial with same bolt position.
  - Method: set up circuit with ammeter to check current is same for each test; wrap each bolt with the set number of turns; connect battery for fixed time; test strength by seeing how many identical paperclips it picks up or measure mass lifted; repeat each count three times and record all results.
  - Presentation: record results in a table and plot a graph of number of turns against average paperclips picked up or mass lifted; include error bars or range where appropriate.
  - Anomalies: repeat any outlying result and if it cannot be explained discard with reason; report all raw data and state how anomalies were treated.
  - Conclusion: expect more turns to give a stronger electromagnet because more coils increase the magnetic field for the same current; give a statement supported by the plotted data and averages.

Question 17

- **M1** find total resistance using R_total = V / I = 3.0 / 0.10
- **A1** 30 ohm cao for total R
- **M1** divide by 3 for identical resistors so R_{one} = 30 / 3
- **A1** 10 ohm cao
- Answer: **10 ohm**

Question 18

- **M1** calculate initial current I1 = 9.0 / 5.0 = 1.8 A
- **M1** calculate final current I2 = 9.0 / 6.0 = 1.5 A
- **M1** calculate decrease = 1.8 - 1.5 = 0.3 A and percentage decrease = (0.3 / 1.8) x 100
- **A1** percentage decrease = 16.7% or 16.7% to 3 s.f. (accept 17% to 2 s.f.)
- Answer: **Initial current = 1.8 A; Final current = 1.5 A; Percentage decrease = 16.7%**