3.2 Electricity and Magnetism: 1-hour Pack

Calculator allowed · about 60 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 A pupil measures the resistance of a small piece of wire using a circuit with a voltmeter across the wire and an ammeter in series. Their readings are: V = 0.9 V, I = 0.30 A.

(a) Calculate the resistance of the wire using the readings given. **(2)**

.....

(b) Suggest one reason the measured resistance may be higher than the wire's true resistance and state how to improve the accuracy. **(1)**

.....

2 A circuit contains two identical 2.0 ohm resistors connected in series to a 12 V supply. Calculate the total resistance of the resistors and the current through the circuit.

(a) Calculate the total resistance of the two resistors in series. **(2)**

.....

(b) Calculate the current through the circuit from the 12 V supply. **(2)**

.....

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3 A pupil builds two circuits to compare series and parallel connections. Circuit A: two identical 6.0 ohm resistors in series connected to a 12 V battery. Circuit B: the same two resistors in parallel connected to the same 12 V battery. Calculate for each circuit (i) the total resistance and (ii) the current drawn from the battery.

(a) Circuit A: total resistance and current from the 12 V battery. **(2)**

(b) Circuit B: total resistance and current from the 12 V battery. **(2)**

(c) State which circuit gives a larger total current and why. **(1)**

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

(1)

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5 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)

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

(2)

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7 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)

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8 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)

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9 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)

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

(2)

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11 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)

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12 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)

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13 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)

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14 Explain why heating a wire usually increases its resistance.

(2)

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15 Some materials are magnetic and some are not.

(a) Which of these materials is magnetic: copper, iron, aluminium, plastic? **(1)**

- ☐ copper
- ☐ iron
- ☐ aluminium
- ☐ plastic

(b) Name two other elements (besides iron) that are magnetic. **(2)**

(c) State whether a magnet attracts or repels a piece of unmagnetised iron. **(1)**

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16 Explain how a simple electromagnet works, and describe one everyday application of an electromagnet. In your answer, evaluate why an electromagnet is more useful than a permanent magnet in that application.

(6)

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Mark scheme · 3.2 Electricity and Magnetism: 1-hour Pack

Question 1

(a) use R = V / I with 0.9 / 0.30 **M1**

(a) 3.0 ohm cao **A1**

(a) Answer: **3.0 ohm**

(b) identify cause and improvement, e.g. additional resistance from poor connections or contact resistance; improve by cleaning contacts and using crocodile clips or using a four-wire method **B1**

(b) Answer: **Poor or loose connections add extra resistance; improve accuracy by cleaning and tightening contacts, use good crocodile clips or a four-wire measurement if available.**

Question 2

(a) add resistances: 2.0 + 2.0 **M1**

(a) 4.0 ohm cao **A1**

(a) Answer: **4.0 ohm**

(b) use I = V / R with 12 / 4.0 **M1**

(b) 3.0 A cao **A1**

(b) Answer: **3.0 A**

Question 3

(a) add resistances in series: 6.0 + 6.0 = 12.0 ohm **M1**

(a) 12.0 ohm; current = 12 / 12 = 1.0 A cao **A1**

(a) Answer: **Total resistance 12.0 ohm; current 1.0 A**

(b) calculate parallel: 1/R = 1/6.0 + 1/6.0 = 1/3.0 so R = 3.0 ohm **M1**

(b) 3.0 ohm; current = 12 / 3.0 = 4.0 A cao **A1**

(b) Answer: **Total resistance 3.0 ohm; current 4.0 A**

(c) Circuit B (parallel) gives larger current because it has lower total resistance so more current flows from the same voltage **B1**

(c) Answer: **Circuit B (parallel) gives a larger current because its total resistance is smaller so more current flows for the same voltage.**

Question 4

iron magnetic; copper non-magnetic **B1**

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

Question 5

field lines are dense near the poles/ends **M1**

field lines curve from north to south and are more spread out in the middle **B1**

mention that around the middle lines are fewer or weaker indicating weaker field there **A1**

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 6

thicker wire has a larger cross-sectional area **M1**

more area allows more paths for electrons so fewer collisions and lower resistance **A1**

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

Question 7

use I = V / R with substitution I = 12 / 240 **M1**

0.05 A cao **A1**

use $P = V \times I$ or $P = I^2 \times R$ with substitution $P = 12 \times 0.05$ **M1**

0.6 W cao **A1**

Answer: **Current = 0.05 A; Power = 0.6 W**

Question 8

Level 3 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. **5-6**

Level 2 Method given with some controls and repeats. Data collection described and a basic conclusion that more turns gives stronger magnet with limited explanation. **3-4**

Level 1 Simple statement of a test, limited control of variables and a vague or unsupported conclusion. **1-2**

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.

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Question 9

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

Answer: **10 ohm**

Question 10

ampere or amp	**B1**
A	**B1**

Answer: **Ampere (amp); symbol A**

Question 11

state that current is the same at all points in a series circuit	**M1**
because charges flow in one loop so the same amount passes each point (oe)	**A1**

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 12

observation that bulbs in parallel are brighter than in series	**M1**
reason that in parallel each bulb gets the full pd of 3 V so more current flows through each bulb	**A1**
may mention in series pd is shared so each bulb gets less voltage	**B1**

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 13

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

Answer: **20 ohm**

Question 14

statement that heating makes atoms vibrate more	**M1**
more vibrations cause more collisions with electrons so current is reduced and resistance increases (oe)	**A1**

Answer: **Heating makes the metal atoms vibrate more, causing more collisions with moving electrons, reducing current and so increasing resistance.**

Question 15

(a) iron	**B1**

(a) Answer: **Iron**

(b) nickel	**B1**
(b) cobalt	**B1**

(b) Answer: **Nickel and cobalt**

(c) attracts	**B1**

(c) Answer: **Attracts**

Question 16

Level 1 Simple statements are made about electromagnets or an application, with limited scientific detail and little or no linkage between ideas.	**1-2**
Level 2 The basic operation of an electromagnet is explained with some correct detail. A relevant application is described, but the evaluation of why an electromagnet is preferable to a permanent magnet is incomplete or only partly correct.	**3-4**
Level 3 A clear and logically structured explanation of how the electromagnet works is given, a relevant application is described accurately, and a full evaluation is provided of why an electromagnet (rather than a permanent magnet) is used, with sound reasoning throughout.	**5-6**

Indicative content:

- Current flowing through a coil of insulated wire produces a magnetic field around the coil.
- Wrapping the wire in a coil (solenoid shape) makes the individual field lines from each turn add together, strengthening the overall field.
- Placing an iron core inside the coil concentrates the field further, because the iron becomes magnetised (an induced magnet) only while current flows.
- The magnetic field can be switched on and off simply by switching the current on and off.
- The strength of the field can be varied by changing the size of the current, or the number of turns on the coil.
- Reversing the direction of the current reverses the polarity of the electromagnet.
- Application example: an electromagnetic crane in a scrapyard/recycling centre lifts and sorts scrap iron and steel.
- The magnet can be switched off to release the load exactly where needed, which a permanent magnet cannot do.
- Application example: an electric bell, where an electromagnet attracts an iron striker to hit a bell, then releases it as the circuit breaks, repeating automatically.
- A permanent magnet's strength and polarity cannot be controlled or turned off, so it is unsuitable where controllable attraction/release is needed.

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