K12D Electricity and Magnetism: Exam Drill

AQA AQA KS3 Physics - Electricity and Magnetism · Calculator allowed · about 75 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Name the tiny negatively charged particles that flow in a metal wire to make an electric current.

(1)

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2 A simple circuit uses a 9 V battery, a switch and a lamp. The lamp is dim when connected. Suggest two changes to make the lamp brighter and explain briefly why each change would make it brighter.

(3)

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3 Complete the sentence: The unit of electrical potential difference (voltage) is the volt, symbol V. If an appliance uses 20 J of energy for every coulomb of charge that passes through it, its potential difference is __ V.

(2)

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4 A pupil measures current and potential difference for a simple resistor. Their readings are: 0.2 A at 1.5 V, 0.4 A at 3.0 V, 0.6 A at 4.5 V. State whether these results show the resistor obeys Ohm's law and briefly explain your answer.

(3)

5 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)**

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

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6 An experiment measures how the length of a wire affects its resistance. The pupil keeps the wire thickness and material the same and only changes length. Predict how resistance changes with length and explain why, using the particle model of conduction.

(4)

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7 Give the direction of the magnetic field around a straight current-carrying wire using the right-hand rule. If the current flows up the page, which way do the field lines circle the wire when viewed from above: clockwise or anticlockwise?

(2)

8 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. State which circuit gives a larger total current and why.

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

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(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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9 A pupil investigates how the current through a filament lamp changes with potential difference. The table of average results is: V (V): 0.5, 1.0, 1.5, 2.0. I (A): 0.10, 0.18, 0.24, 0.28. (a) Plot these results on graph paper (not provided) and draw a smooth curve. (b) Use the data to explain whether the filament lamp behaves like an ohmic resistor over this range.

(a) Plot and draw a smooth curve (student work expected on separate paper). **(1)**

(b) Use the data to explain whether the filament lamp behaves like an ohmic resistor over this range. **(3)**

10 A 24 V supply powers a heater rated at 48 W. Calculate the current drawn by the heater and the resistance of the heater element.

(a) Calculate the current drawn by the heater. **(2)**

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(b) Calculate the resistance of the heater element. **(1)**

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11 A pupil tests whether adding more cells affects the brightness of a bulb. They connect 1, 2 and then 3 identical 1.5 V cells in series to the same bulb and measure the current each time. Their results are: with 1 cell: 0.08 A; with 2 cells: 0.16 A; with 3 cells: 0.24 A. (a) State the pattern shown by the results. (b) Give one variable the pupil should keep the same to make the test fair and explain why.

(a) State the pattern shown by the results. **(2)**

(b) Give one variable the pupil should keep the same to make the test fair and explain why. **(2)**

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12 An electromagnet is made by wrapping 200 turns of insulated wire around an iron nail and connecting it to a 6 V supply. The pupil then increases the number of turns to 400 while keeping the same current and supply. Explain how increasing the number of turns affects the magnetic field strength and why. Identify one practical safety consideration when using the electromagnet.

(4)

13 A circuit has a 9 V battery and two resistors, R1 and R2. R1 = 3.0 ohm is in series with a parallel pair of R2 and a 6.0 ohm resistor. R2 is unknown. The total current measured from the battery is 2.0 A. Calculate the resistance R2.

(3)

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14 A coil of wire lies near a bar magnet. The pupil moves the north pole of the magnet quickly toward the coil, and observes a brief deflection on a connected meter. (a) State what causes the deflection. (b) Explain what would happen to the meter deflection if the pupil moved the magnet away quickly instead.

(a) State what causes the deflection. **(2)**

(b) Explain what would happen to the meter deflection if the pupil moved the magnet away quickly instead. **(2)**

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15 Extended response (6 marks). Design a fair experiment to investigate how the number of coils on an electromagnet affects the mass it can lift. You should describe: the independent, dependent and control variables; the apparatus you would use; the method in clear steps; how you would make the test fair; and how you would record and use the data to reach a conclusion. Make sure your answer is suitable for Years 7 to 9.

(6)

16 A pupil tests a series circuit and finds a small change in the measured current when an extra identical resistor is added in series. Explain one possible experimental error or limitation that could cause the change in current to be larger or smaller than expected, and give one way to reduce this error.

(2)

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

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

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

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18 A small magnetic compass is placed near a current-carrying wire. The compass needle is observed to turn. (a) State what this shows about the wire. (b) Describe one safety measure when demonstrating electricity and magnetism with pupils.

(a) State what the compass needle turning shows about the wire. **(1)**

(b) Describe one safety measure when demonstrating electricity and magnetism with pupils. **(2)**

Mark scheme · K12D Electricity and Magnetism: Exam Drill

Question 1

- **B1** electrons cao
- Answer: **Electrons**

Question 2

- **M1** suggest increasing the voltage (use a higher voltage battery)
- **M1** suggest reducing total resistance (use a lamp with lower resistance, or use thicker/shorter connecting wires, or remove any other resistors from the series circuit)
- **A1** explain that higher voltage or lower resistance increases current so more power reaches the lamp
- Answer: **Any two from: use a higher voltage battery; reduce resistance in the circuit (use a lamp with lower resistance, use thicker/shorter connecting wires, or remove other resistors from the series circuit). Both increase current so the lamp receives more power and becomes brighter.**

Question 3

- **M1** use V = energy / charge with 20 / 1
- **A1** 20 V cao
- Answer: **20 V**

Question 4

- **M1** recognise that V/I is constant for each pair
- **A1** calculate V/I = 1.5/0.2 = 7.5, 3.0/0.4 = 7.5, 4.5/0.6 = 7.5
- **A1** conclude resistor obeys Ohm's law because V is proportional to I (V/I constant)
- Answer: **Yes. V/I = 7.5 for all three readings so V is proportional to I and the resistor obeys Ohm's law.**

Question 5

- (a) **M1** add resistances: 2.0 + 2.0
- (a) **A1** 4.0 ohm cao
- (a) Answer: **4.0 ohm**
- (b) **M1** use I = V / R with 12 / 4.0
- (b) **A1** 3.0 A cao
- (b) Answer: **3.0 A**

Question 6

- **M1** state that resistance increases as length increases
- **M1** link to more collisions or more material for electrons to pass through
- **A1** explain that longer wire gives more collisions so current is reduced for the same potential difference
- **A1** or state resistance is directly proportional to length, oe
- Answer: **Resistance increases as length increases, because electrons collide more often with atoms in a longer wire, reducing current for the same voltage.**

Question 7

- **B1** anticlockwise (counterclockwise) cao
- **B1** reference to right-hand rule or curling fingers of right hand
- Answer: **Anticlockwise; curling the fingers of the right hand around the wire with the thumb pointing up shows anticlockwise field lines.**

Question 8

- (a) **M1** add resistances in series: 6.0 + 6.0 = 12.0 ohm
- (a) **A1** 12.0 ohm; current = 12 / 12 = 1.0 A cao
- (a) Answer: **Total resistance 12.0 ohm; current 1.0 A**
- (b) **M1** calculate parallel: 1/R = 1/6.0 + 1/6.0 = 1/3.0 so R = 3.0 ohm
- (b) **A1** 3.0 ohm; current = 12 / 3.0 = 4.0 A cao
- (b) Answer: **Total resistance 3.0 ohm; current 4.0 A**
- (c) **B1** Circuit B (parallel) gives larger current because it has lower total resistance so more current flows from the same voltage
- (c) Answer: **Circuit B (parallel) gives a larger current because its total resistance is smaller so more current flows for the same voltage.**

Question 9

- (a) **M1** one mark for correct plotting of points or indication that points plotted suitably on V (x) and I (y) axes
- (a) Answer: **Points plotted and smooth curve drawn (on student graph).**
- (b) **M1** note that V/I is not constant as voltage increases
- (b) **M1** calculate examples: at 0.5 V, V/I = 0.5/0.10 = 5.0 ohm; at 2.0 V, V/I = 2.0/0.28 = 7.14 ohm
- (b) **A1** conclude filament is not ohmic over this range because resistance increases with voltage (curve not straight)
- (b) Answer: **No. V/I increases from about 5.0 ohm at 0.5 V to about 7.14 ohm at 2.0 V, so the resistance changes and the lamp is not ohmic over this range.**

Question 10

- (a) **M1** use P = V I and rearrange to I = P / V with 48 / 24
- (a) **A1** 2.0 A cao
- (a) Answer: **2.0 A**
- (b) **B1** use R = V / I with 24 / 2.0 = 12.0 ohm cao
- (b) Answer: **12.0 ohm**

Question 11

- (a) **M1** recognise proportional increase in current as number of cells increases
- (a) **A1** state that current increases roughly in direct proportion to the number of cells (0.08, 0.16, 0.24)
- (a) Answer: **The current increases proportionally with the number of cells: 0.08 A, 0.16 A, 0.24 A.**
- (b) **M1** name a sensible control variable, e.g. the same bulb or same resistor
- (b) **A1** explain that keeping the bulb the same keeps its resistance constant so changes in current are due to number of cells only
- (b) Answer: **Keep the same bulb (same resistor) so the resistance does not change; this ensures changes in current are caused only by the number of cells.**

Question 12

- **M1** state that magnetic field strength increases when number of turns increases
- **M1** link to more turns producing a stronger combined magnetic field around the iron core
- **A1** explain that more loops increase magnetic field lines density and the iron core becomes more strongly magnetised
- **A1** give a safety consideration such as the coil heating up, so avoid long use or use insulation and do not touch hot wire
- Answer: **Increasing the number of turns strengthens the magnetic field because more loops produce a denser field of magnetic lines and the iron core becomes more strongly magnetised. Safety: the coil can heat up, so avoid prolonged use and do not touch the coil or allow bare wires to contact skin.**

Question 13

- **M1** use I_total = 2.0 A so R_total = V / I = 9 / 2 = 4.5 ohm
- **M1** write R_total = R1 + R_parallel so R_parallel = 4.5 - 3.0 = 1.5 ohm
- **A1** use 1/R_parallel = 1/R2 + 1/6.0 so 1/1.5 = 1/R2 + 1/6 => 0.6667 = 1/R2 + 0.1667 so 1/R2 = 0.5 giving R2 = 2.0 ohm cao
- Answer: **2.0 ohm**

Question 14

- (a) **M1** state that changing magnetic field induces a current in the coil (electromagnetic induction)
- (a) **A1** brief link to moving the magnet changing magnetic flux so a current appears causing the meter deflection
- (a) Answer: **Because the magnetic field through the coil changes as the magnet moves, a current is induced in the coil and the meter deflects.**
- (b) **M1** state that a current is induced in the opposite direction when the magnet is moved away
- (b) **A1** explain that the meter would deflect briefly in the opposite direction because the change of flux is reversed
- (b) Answer: **The meter would deflect briefly in the opposite direction because moving the magnet away reduces the magnetic flux through the coil and induces a current in the opposite direction.**

Question 15

- **Level 3** (5-6): Detailed plan with correct identification of variables, clear step-by-step method, appropriate apparatus and safety, a fair testing strategy and a clear approach to recording and analysing data to reach a valid conclusion.
- **Level 2** (3-4): A reasonable plan that names variables, gives a workable method and suggests ways to make the test fair, with basic ideas for recording and interpreting data.
- **Level 1** (1-2): Simple or incomplete ideas such as listing variables or apparatus but lacking a clear method or fair testing details; weak plan for recording or interpreting results.
- **Indicative content:**
  - Independent variable: number of turns on the coil.
  - Dependent variable: mass lifted by electromagnet (measured in grams).
  - Control variables: current through coil (use the same power supply and measure current), core type (same iron nail), wire thickness, temperature, and contact with mass.
  - Apparatus: power supply with fixed voltage, ammeter, iron nail, insulated copper wire, set of small masses or paper clips, scale or standard masses, switch, ruler, stopwatch, thermometer, insulating gloves.
  - Method steps: wind a chosen number of turns around the nail, connect to the power supply and measure current, bring magnet near masses and see maximum mass lifted, repeat three times for each number of turns, record averages.
  - Fair test: keep current constant by adjusting voltage or adding series resistance and measuring current; use the same core and coil position; repeat measurements and calculate mean; avoid coil heating by short testing intervals.
  - Recording and conclusion: make a table of turns, current, and mass lifted; plot mass against number of turns; expect mass to increase with turns; comment on anomalies and repeat if inconsistent.

Question 16

- **M1** identify a plausible error or limitation such as poor connections adding extra resistance, battery voltage varying due to internal resistance, or instruments not zeroed
- **A1** give a way to reduce it such as checking and tightening connections, using fresh batteries or a regulated power supply, and using better meters or repeating and averaging
- Answer: **Poor connections or internal resistance of the battery could change the current; reduce this by checking and tightening connections, use a fresh or regulated power supply, and repeat measurements to average out anomalies.**

Question 17

- (a) **M1** use R = V / I with 0.9 / 0.30
- (a) **A1** 3.0 ohm cao
- (a) Answer: **3.0 ohm**
- (b) **B1** 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
- (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 18

- (a) **B1** that a magnetic field is produced around the wire when current flows
- (a) Answer: **That a magnetic field is produced around the wire when current flows.**
- (b) **M1** state a safety measure such as using low voltages, ensuring wires are insulated and connections tight, or keeping coil cool
- (b) **A1** explain why it is needed, e.g. low voltages reduce risk of shocks and insulated wires prevent exposed conductors causing short circuits
- (b) Answer: **Use low voltages and check that wires and connections are well insulated and secure; this reduces the risk of electric shock and short circuits.**