3.2 Electricity and Magnetism: 30-minute Pack

Calculator allowed · about 30 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 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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2 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. **(2)**

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

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3 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)

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4 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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5 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)

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

(1)

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8 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 four improvements to make the experiment fair and more reliable.

(4)

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Mark scheme · 3.2 Electricity and Magnetism: 30-minute Pack

Question 1

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	**M1**
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	**A1**

Answer: **2.0 ohm**

Question 2

(a) state that changing magnetic field induces a current in the coil (electromagnetic induction)	**M1**
(a) brief link to moving the magnet changing magnetic flux so a current appears causing the meter deflection	**A1**

(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) state that a current is induced in the opposite direction when the magnet is moved away	**M1**
(b) explain that the meter would deflect briefly in the opposite direction because the change of flux is reversed	**A1**

(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 3

Level 3 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.	**5-6**
Level 2 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.	**3-4**
Level 1 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.	**1-2**

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 4

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

Answer: **20 V**

Question 5

recognise that V/I is constant for each pair	**M1**
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)	**A1**

Answer: **Yes. V/I = 7.5 for all three readings so V is proportional to I and the resistor obeys Ohm's law.**

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Question 6

state that resistance increases as length increases	**M1**
link to more collisions or more material for electrons to pass through	**M1**
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	**A1**

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

cell or battery	**B1**

Answer: **Battery (or cell)**

Question 8

repeat each measurement and take an average	**M1**
use the same battery or regulator to keep current constant	**B1**
ensure same distance from nail to paperclips or same placement/reset protocol	**B1**
use a consistent way to count paperclips or use a scale to measure mass lifted	**A1**

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.**

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