3.7 Magnetism and Electromagnetism: 1-hour Pack

AQA 8463 · Calculator allowed · about 60 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 A generator rotates a coil in a magnetic field. The teacher says that increasing the number of turns in the coil increases the output.

(a) State what effect increasing the number of turns has on the induced voltage. **(1)**

(b) Give a simple reason for this effect. **(1)**

(Total for Question 1 is 2 marks)

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2 State the magnetic material commonly used to make the core of a high-quality electromagnet that is switched on and off repeatedly.

(Total for Question 2 is 1 mark)

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3 A long, straight wire carries an electric current.

(a) State the shape of the magnetic field pattern produced around a long, straight, current-carrying wire. **(1)**

(b) State two factors that affect the strength of the magnetic field at a point near the wire. **(2)**

(c) Higher Tier only. State the rule that can be used to work out the direction of the magnetic field around a straight current-carrying wire. **(1)**

(Total for Question 3 is 4 marks)

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4 A straight wire carrying a current is placed between the poles of a strong magnet, at right angles to the magnetic field.

(a) State what happens to the current-carrying wire. **(1)**

(b) Name the rule that can be used to predict the direction of this force. **(1)**

(c) For Fleming's left-hand rule, with the thumb and first two fingers of the left hand held at right angles to each other, state what is represented by: (i) the First finger, (ii) the SeCond finger, (iii) the thuMb. **(3)**

(Total for Question 4 is 5 marks)

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5 Explain how a relay switch in a car can use a small control current to switch a much larger current to the starter motor. In your answer include how the components work together and why a relay is useful.

(Total for Question 5 is 6 marks)

6 A student investigates electromagnetic induction using a coil connected to a voltmeter and a bar magnet moved in and out of the coil. The peak voltmeter readings measured are: magnet moved quickly in gives 1.2 V, moved slowly in gives 0.4 V. The coil has 50 turns.

(a) Calculate the ratio of induced voltage for quick movement compared to slow movement. **(2)**

(b) Explain why the reading is larger when the magnet is moved quickly. Mention the coil turns in your explanation. **(4)**

(Total for Question 6 is 6 marks)

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7 A student is asked to design a safer classroom demonstration of an electromagnet picking up metal objects. The original demo used a mains supply. The student suggests using a 6.0 V battery instead.

(a) Evaluate the suggestion to use a 6.0 V battery instead of mains, giving two advantages, one potential drawback and one further relevant point. **(5)**

(Total for Question 7 is 5 marks)

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8 A straight wire of length 0.20 m carries a current of 4.0 A. The wire is placed at right angles to a uniform magnetic field of flux density 0.30 T. Use F = B I L to calculate the magnetic force on the wire.

(Total for Question 8 is 2 marks)

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9 A straight conductor carries current into the page. Sketch or describe the direction of the magnetic field lines immediately around the conductor and state the rule used to determine this direction.

(Total for Question 9 is 3 marks)

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10 A moving-coil loudspeaker converts a varying (alternating) electrical current into sound. Explain, using ideas about the motor effect, how the loudspeaker produces sound from an electrical signal.

(Total for Question 10 is 6 marks)

11 An alternating current (a.c.) generator produces a current that continuously reverses direction as its coil rotates in a magnetic field.

(a) Explain why the direction of the induced current reverses as the coil rotates. **(2)**

(Total for Question 11 is 2 marks)

12 A transformer is used to change the size of an alternating potential difference.

(a) Describe the basic structure of a transformer. **(2)**

(b) Explain why a transformer only works with alternating current (a.c.) in the primary coil, not direct current (d.c.). **(3)**

(Total for Question 12 is 5 marks)

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Mark scheme · 3.7 Magnetism and Electromagnetism: 1-hour Pack

Question 1

(a) increase in induced voltage **B1**

(a) Answer: It increases the induced voltage.

(b) more turns mean more loops cut by the changing field so more emf is induced, oe **B1**

(b) Answer: More turns mean more loops cutting the changing magnetic field so a larger emf is induced.

Question 2

soft iron cao **B1**

Answer: Soft iron

Question 3

(a) a pattern of concentric circles, centred on the wire, oe **B1**

(a) Answer: A pattern of concentric circles centred on the wire.

(b) increasing the size of the current increases the strength of the field, oe **B1**

(b) increasing the distance from the wire decreases the strength of the field, oe **B1**

(b) Answer: The size of the current (larger current, stronger field) and the distance from the wire (greater distance, weaker field).

(c) the right-hand grip rule: the thumb points in the direction of the (conventional) current and the fingers curl in the direction of the field, oe **B1**

(c) Answer: The right-hand grip rule.

Question 4

(a) it experiences a force (this is called the motor effect), oe **B1**

(a) Answer: It experiences a force (the motor effect).

(b) Fleming's left-hand rule **B1**

(b) Answer: Fleming's left-hand rule.

(c) (i) the (magnetic) Field **B1**

(c) (ii) the (conventional) Current **B1**

(c) (iii) the direction of Motion / the force (thrust) **B1**

(c) Answer: First finger = Field, seCond finger = Current, thuMb = Motion/force.

Question 5

Level 3 Detailed explanation of how a relay works, linking the small control current to magnetism in the coil, movement of an armature or switch, and switching of a larger circuit; clear reason why this is useful, including safety or reduced wiring. **5-6**

Level 2 Partial explanation linking coil and magnetism to movement of contacts; mentions that a small current controls a larger one and gives one plausible reason why this is useful. **3-4**

Level 1 Simple statements: coil makes magnet when current flows; this can close a switch; limited or no explanation of why it is useful. **1-2**

Indicative content:

- A current in the control coil produces a magnetic field that magnetises the core and attracts an armature or moves a switch contact.
- Movement of the armature closes a separate set of contacts in the high-current circuit to the starter motor, allowing the larger current to flow.
- The coil circuit carries a small current and the contact circuit carries the larger starter current, so the control circuit wiring and switch do not need to be heavy duty.
- A relay protects the driver and low-current switch from high currents and allows safer and more convenient control over high-power devices.
- Mention could include reduced voltage drop, isolation between circuits, or preventing heavy current through the ignition switch.

Question 6

(a) substitutes ratio 1.2 / 0.4 **M1**

(a) 3.0 cao **A1**

(a) Answer: 3.0

(b) states that quicker movement causes a larger rate of change of magnetic field **M1**

(b) links larger rate of change to larger induced emf/voltage **M1**

(b) mentions coil turns: more turns (50) mean more emf for given change, so a larger reading results **A1**

(b) conclusion: therefore moving quickly gives a larger induced voltage, as seen 1.2 V vs 0.4 V cao **A1**

(b) Answer: Moving the magnet quickly gives a larger rate of change of magnetic field through the 50-turn coil, which induces a larger emf. More turns mean each loop contributes to the emf, so with 50 turns the quick movement gives 1.2 V while slow movement gives 0.4 V.

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Question 7

(a) advantage: battery is safer than mains (lower voltage and no dangerous AC) or reduces risk of electric shock **B1**

(a) advantage: battery is portable and easy to isolate quickly, making the demo more convenient **B1**

(a) draws a reasoned drawback: battery may provide lower current so electromagnet may be weaker **M1**

(a) explains drawback with consequence: fewer clips picked up or need many batteries / short battery life **A1**

(a) additional point such as checking battery capacity or including a resistor to limit current for safety **B1**

(a) Answer: Using a 6.0 V battery is safer (lower risk of shock) and more portable, but it may give a lower current so the electromagnet could be weaker or the battery may run flat quickly; you may need multiple batteries or a suitable resistor and to check battery capacity.

Question 8

substitutes into F = B I L: F = 0.30 x 4.0 x 0.20 **M1**

0.24 N cao **A1**

Answer: 0.24 N

Question 9

magnetic field lines are concentric circles around the wire **B1**

direction is clockwise as viewed from the observer (consistent with current into the page) or equivalent description **B1**

states use of right-hand rule (thumb in direction of current, fingers show field) or named rule **B1**

Answer: Concentric circular field lines around the wire, clockwise when viewed with current into the page; use the right-hand rule (thumb in direction of current, fingers show field).

Question 10

Level 1 Simple, isolated statement(s) are made, for example that a current or a force is involved, or that the cone vibrates. There is little or no explanation of how sound is produced, and no reference to the motor effect. **1-2**

Level 2 The coil, magnet and motor effect are described, and it is stated that the coil (and cone) move as a result of the force produced. There is some explanation of how this leads to sound, but the link between the alternating current and the vibration of the cone is incomplete. **3-4**

Level 3 A complete, logically linked explanation is given: the alternating current in the coil, in the magnetic field of the permanent magnet, produces a force (motor effect) that alternates in direction, moving the coil and attached cone in and out; this makes the cone vibrate, creating sound waves in the air; the amplitude and frequency of the current are linked to the loudness and pitch of the sound produced. **5-6**

Indicative content:

- The loudspeaker contains a coil of wire, attached to the speaker cone, placed within the magnetic field of a permanent magnet
- An alternating current from the electrical signal (e.g. from an amplifier) flows through the coil
- The current-carrying coil is in a magnetic field, so it experiences a force (the motor effect)
- As the current in the coil continuously changes direction (it is alternating), the direction of the force on the coil also continuously alternates
- This makes the coil, and the cone attached to it, move in and out repeatedly (vibrate)
- The vibrating cone makes the surrounding air particles vibrate, producing sound waves
- A larger current produces a larger force, so a bigger vibration (amplitude) and a louder sound
- A higher frequency alternating current produces faster vibrations of the cone, producing a higher-pitched sound

Question 11

(a) as the coil rotates, the direction each side of the coil moves relative to the magnetic field reverses every half turn, oe **B1**

(a) by the generator effect, reversing the direction of relative movement reverses the direction of the induced potential difference/current, oe **B1**

(a) Answer: As the coil rotates, each side moves in a reversed direction relative to the field every half turn, which by the generator effect reverses the induced current's direction.

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Question 12

(a) a transformer has a primary coil and a secondary coil of insulated wire, oe **B1**

(a) both coils are wound around a common (soft) iron core, oe **B1**

(a) Answer: A primary coil and a secondary coil of wire, both wound around a common soft iron core.

(b) an alternating current in the primary coil produces a continuously changing magnetic field in the iron core, oe **B1**

(b) this changing magnetic field induces an alternating potential difference in the secondary coil, by the generator effect, oe **B1**

(b) a direct current would produce a constant (unchanging) magnetic field, so no potential difference would be induced in the secondary coil, oe **B1**

(b) Answer: Alternating current produces a continuously changing magnetic field in the core, which induces a p.d. in the secondary coil by the generator effect; direct current gives a constant field, so no p.d. would be induced.

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