

GCSE Combined Science: Trilogy

Worksheet: Electromagnetism

TIME 35 min	TOTAL 32 marks	CALCULATOR Allowed	DIFFICULTY Easy, Medium
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Topics: The motor effect

NAME	CLASS	DATE
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- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Answer all questions in the spaces provided.
- In all calculations, show clearly how you work out your answer.
- The marks for questions are shown in brackets.

0 1

0 1 . 1 What shape are the magnetic field lines around a long, straight, current-carrying wire?

Tick (✓) **one** box.

Straight lines parallel to the wire

☐

Concentric circles centred on the wire

☐

Straight lines radiating outward from the wire

☐

A uniform field, like inside a solenoid

☐

[1 mark]

0 1 . 2 What is a solenoid?

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.....

[1 mark]

0 2

0 2 . 1

When there is a current in a wire, what is produced around the wire?

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[1 mark]

0 2 . 2

Give **two** factors that affect the strength of the magnetic field at a point near a straight wire.

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[2 marks]

0 2 . 3

Describe the shape of the magnetic field lines around a long, straight wire that is carrying a current.

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[1 mark]

0 2 . 4

What is an electromagnet?

Tick (✓) **one** box.

A solenoid with an iron core

☐

A solenoid with a copper core

☐

A permanent magnet made of steel

☐

A straight wire carrying a current

☐

[1 mark]

0 3

0 3 . 1

Give **one** way to reverse the polarity (which end is the north pole) of an electromagnet, without changing anything about the coil itself.

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[1 mark]

0 3 . 2

State what happens to the magnetic field of an electromagnet when the current is switched off.

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[1 mark]

0 4

A student investigates how the number of turns on an electromagnet’s coil affects its strength, by counting how many identical steel paperclips it can pick up. The current is kept constant. Table 1 shows the results.

Table 1

Number of turns	Number of paperclips picked up
10	3
20	6
30	9
40	12

0 4 . 1

Describe the relationship shown by the results.

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[2 marks]

0 4 . 2

Give **one** variable, other than the current, that the student should keep constant for this to be a fair test.

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[1 mark]

0 5

An electric bell contains an electromagnet, a springy iron armature with a hammer attached, and a contact screw. When the bell push is pressed, current flows through the electromagnet's coil and through the contact, which is initially touching the armature.

0 5 . 1

Explain how the bell produces a continuous ringing sound for as long as the bell push is held down.

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[4 marks]

0 6

A student wants to make an electromagnet from a length of insulated wire, a low-voltage power supply, a switch and an iron nail. The student will use the electromagnet to pick up small steel paper clips.

0 6 . 1

Describe how the student could make the electromagnet. Explain why the electromagnet picks up the paper clips when the current is switched on but drops them when the current is switched off, and describe how the electromagnet could be made stronger.

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[6 marks]

0 7

A long, straight wire passes vertically through a horizontal piece of card. Four small plotting compasses are placed on the card around the wire. When there is no current in the wire, all the compasses point north.

0 7 . 1

A large direct current is switched on in the wire.

Describe what happens to the compasses.

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[2 marks]

0 7 . 2

The direction of the current is reversed.

Describe what happens to the compasses.

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[1 mark]

0 7 . 3

The compasses are moved further away from the wire. The current is not changed.

Suggest what the student observes. Give a reason for your answer.

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[2 marks]

0 8

Figure 1 shows a long, straight wire, viewed end-on. The current in the wire is directed out of the page, towards you.

Figure 1



current out of the page

0 8 . 1

Draw the magnetic field pattern around the wire. Show at least three field lines, with arrows to show the correct direction.

[2 marks]

0 8 . 2

State one way of increasing the strength of the magnetic field around the wire.

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[1 mark]

0 8 . 3

The current in the wire is reversed, so that it now flows into the page. Describe how the field pattern changes.

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[2 marks]

END OF QUESTIONS

Original practice questions written to match the specification. Not produced by, affiliated with or endorsed by AQA.

Mark scheme

GCSE Combined Science: Trilogy · Worksheet: Electromagnetism · 32 marks

Question 1 (2 marks)

01.1 [1 mark]

Correct: Concentric circles centred on the wire

01.2 [1 mark]

Answer: A long coil of wire.

- a long coil of wire (that produces a magnetic field when it carries a current) (1)
-
-

Question 2 (5 marks)

02.1 [1 mark]

Answer: A magnetic field

- a magnetic field (1)
-

02.2 [2 marks]

Answer: The size of the current and the distance from the wire.

- the size of the current (in the wire) (1)
 - the distance from the wire (1)
-

02.3 [1 mark]

Answer: Concentric circles centred on the wire.

- (concentric) circles around the wire (1)
-

02.4 [1 mark]

Correct: A solenoid with an iron core

Question 3 (2 marks)

03.1 [1 mark]

Answer: Reverse the direction of the current.

- reverse the direction of the current through the coil (1)

03.2 [1 mark]

Answer: The field disappears almost completely.

- the field disappears (almost) completely / the iron core loses (almost all of) its magnetism (1)

Question 4 (3 marks)

04.1 [2 marks]

Answer: The number of paperclips is directly proportional to the number of turns.

- the number of paperclips picked up increases as the number of turns increases (1)
- the number of paperclips is directly proportional to the number of turns (1)

04.2 [1 mark]

Answer: The type of paperclip (or the core material / coil length).

- the type/size of paperclip / the core material / the size (length) of the coil / the distance between the coil and the paperclips (1)

Question 5 (4 marks)

05.1 [4 marks]

Answer: Current magnetises the electromagnet, which attracts the armature so its hammer strikes the bell; this movement also breaks the contact, switching the electromagnet off so the spring pulls the armature back and remakes contact — repeating rapidly to ring continuously.

- current flows through the coil, magnetising the iron core (electromagnet), which attracts the iron armature (1)
 - the armature moves towards the electromagnet, and the hammer attached to it strikes the bell (1)
 - as the armature moves, it also breaks contact with the contact screw, which breaks the circuit, so the electromagnet loses its magnetism (1)
 - the springy armature then springs back, remaking contact with the screw, which completes the circuit again and repeats the whole process rapidly, striking the bell over and over (1)
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Question 6 (6 marks)

06.1 [6 marks]

Answer: Level-of-response answer: wind the insulated wire many times around the iron nail to make a coil, and connect the ends to the power supply through the switch. The current in the coil produces a magnetic field; the coil shape makes the field inside strong, and the iron nail becomes an induced magnet, making the field much stronger, so the paper clips are attracted. When the current is switched off, the coil's field disappears and the iron nail, an induced magnet, quickly loses its magnetism, so the clips fall. It can be made stronger by increasing the current or the number of turns on the coil.

Levels of response

- **Level 3 (5–6)** A detailed, coherent answer. Relevant points are accurate, linked in a logical sequence and use correct scientific terms.
- **Level 2 (3–4)** Several relevant points with some linking, but the answer has gaps, errors or lacks detail.
- **Level 1 (1–2)** Simple statements making one or two relevant points, with little or no linking.
- **No marks (0)** Nothing relevant or worthy of credit.

Indicative content

- wind the insulated wire many times around the iron nail to form a coil (solenoid)
- connect the ends of the coil to the low-voltage power supply through the switch, so that there is a current in the coil when the switch is closed
- the current in the coil produces a magnetic field; shaping the wire into a coil makes the field inside it strong (and uniform)
- the iron nail becomes an induced magnet in this field, making the field much stronger, so the (steel) paper clips are attracted to it
- when the current is switched off, the coil's magnetic field disappears and the iron nail, being an induced magnet, loses (most of) its magnetism quickly, so the paper clips fall off
- the electromagnet can be made stronger by increasing the current (e.g. a higher supply potential difference) or by increasing the number of turns on the coil

Notes: Also credit sensible safety points, e.g. use a low potential difference and switch off between uses, because the coil can become hot. Level 1 (1–2 marks): describes winding wire around the nail, or states one way of making the electromagnet stronger. Level 2 (3–4 marks): describes how to make the electromagnet and gives some explanation of why it attracts the clips or why they drop, but the explanation is incomplete. Level 3 (5–6 marks): a clear method, a correct explanation of both the attraction (field of the coil, induced magnetism of the iron) and the release (field removed, induced magnet loses its magnetism), and a correct way of making the electromagnet stronger.

Question 7 (5 marks)

07.1 [2 marks]

Answer: The needles turn so that together they form a circle around the wire.

- the compass needles turn / point in different directions (1)
- they line up to form a circle around the wire (each needle points along a circle centred on the wire) (1)

07.2 [1 mark]

Answer: Each needle turns to point the opposite way.

- each needle turns round to point in the opposite direction (1)

07.3 [2 marks]

Answer: The needles swing back towards north, because the wire's field is weaker further away.

- the needles turn back towards north / are turned less by the current (1)
- the magnetic field of the wire is weaker further from the wire, so the Earth's magnetic field has a bigger effect (1)

Question 8 (5 marks)

08.1 [2 marks]

Answer: At least three concentric circles centred on the wire, with arrows showing an anticlockwise direction.

- at least three concentric circles, centred on the wire (1)
- arrows showing an anticlockwise direction (as drawn), found using the right-hand grip rule for a current out of the page (1)

08.2 [1 mark]

Answer: Increase the current in the wire.

- increase the current (in the wire) (1)

08.3 [2 marks]

Answer: The pattern stays the same shape (concentric circles), but the direction of the field reverses, becoming clockwise as drawn.

- the field pattern is still a set of concentric circles centred on the wire (the shape is unchanged) (1)
 - the direction of the field reverses — it is now clockwise (as viewed in the diagram) instead of anticlockwise (1)
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