

4.7

Magnetism and electromagnetism

Exam-style questions

100 questions • 234 marks

Written in the style of AQA papers, including the required practicals, maths and working scientifically.

How to use this booklet

Answer on paper or in an exercise book — there is no writing space here, so the

booklet can be reused and photocopied cheaply.

Marks are shown in square brackets. Use them to judge how much to write.

Where a graph is to be plotted, a grid is provided.

Use a calculator, a ruler and a pencil for drawing.

Mark your work from the separate answer booklet.

Command words used

State, Give, Name, Write down — a short factual answer, no explanation needed

Describe — say what happens, in order, without needing a reason

Explain — give a reason; 'because', 'so' or 'therefore' should appear

Calculate — show your working and give a unit

Determine — use data given, often from a graph or table

Estimate — an approximate value from reasonable assumptions

Suggest — apply what you know to an unfamiliar situation

Compare — say how things are similar and different, in the same sentence

Evaluate — give both sides, then a conclusion

Design, Plan — set out a method others could follow

Questions are labelled beside the marks where they are Higher Tier only, Separate Physics only, or Working scientifically — the apparatus, variables, accuracy, evaluation and maths skills that carry around a third of the marks in every AQA paper.

Written in the style of AQA examinations. Not past paper questions, and not published by or affiliated with AQA.

4.7.1 Permanent and induced magnetism

- 1** Two bar magnets are placed near each other on a bench.
- State what happens when two north poles are brought together. [1]
 - State the rule for the forces between magnetic poles. [1]
 - Explain why the force between two magnets is described as a non-contact force. [1]
 - Name four magnetic materials. [2]
 - Explain the difference between a permanent magnet and an induced magnet. [3]
 - Explain why a steel paperclip is attracted to either pole of a magnet. [2]
- 2** A student uses a plotting compass to investigate the magnetic field around a bar magnet.
- Describe how the student should plot a field line. Working scientifically [3]
 - State the direction in which field lines are drawn. [1]
 - State where the field is strongest, and how this is shown on a diagram. [2]
 - Explain why field lines never cross. [1]
 - Explain why a plotting compass points north when no magnet is nearby. [2]
 - Describe the field between the north pole of one magnet and the south pole of another placed close together. [2]

4.7.2 The motor effect

- 3** A current flows through a long straight wire.
- Describe the shape of the magnetic field around the wire. [2]
 - State what happens to the field strength as the distance from the wire increases. [1]
 - State two ways of increasing the strength of the field around the wire. [2]
 - Describe the field produced by a solenoid. [3]
 - Give three ways of increasing the strength of an electromagnet. [3]
 - Explain why an iron core is used rather than a copper one. [2]
 - Give one advantage of an electromagnet over a permanent magnet. [1]
- 4** A wire of length 0.060 m carries a current of 3.5 A at right angles to a magnetic field of flux density 0.25 T.
- Calculate the force on the wire. Higher Tier only [3]
 - State the unit of magnetic flux density. Higher Tier only [1]
 - State what happens to the force if the wire is turned so that it lies along the field. Higher Tier only [1]
 - A force of 0.84 N acts on a wire of length 0.40 m carrying 6.0 A. Calculate the magnetic flux density. Higher Tier only [3]
 - State the left-hand rule, naming what each finger represents. [3]
 - Explain why a current-carrying wire in a magnetic field experiences a force. Higher Tier only [3]

- 5** A simple direct current electric motor consists of a coil of wire between the poles of a magnet.
- Explain why the coil turns when a current flows. [3]
 - Explain the purpose of the split-ring commutator. [3]
 - Give three ways of making the motor turn faster. [3]
 - State two ways of reversing the direction of rotation. [2]
 - Explain why reversing both the current and the field leaves the direction of rotation unchanged. [2]
- 6** A moving-coil loudspeaker contains a coil attached to a paper cone, placed in the field of a permanent magnet.
- Explain how the loudspeaker produces sound. Separate Physics only [4]
 - Explain how the loudness and the pitch of the sound can be changed. Separate Physics only [2]
 - Explain how a moving-coil microphone is the reverse of a loudspeaker. Separate Physics only [3]

4.7.3 Induced potential, generators and transformers

- 7** A magnet is pushed into a coil of wire connected to a sensitive voltmeter.
- State what happens to the voltmeter reading as the magnet is pushed in. Separate Physics only [1]
 - State what happens when the magnet is held still inside the coil, and explain why. Separate Physics only [2]
 - State three ways of increasing the size of the induced potential difference. Separate Physics only [3]
 - Explain why the induced current always opposes the change that produced it. Separate Physics only [3]
 - State what happens if the magnet is pulled out instead of pushed in. Separate Physics only [1]
- 8** An alternator and a dynamo are both generators, but they produce different outputs.
- Describe how a generator produces a potential difference. Separate Physics only [3]
 - Explain the difference between the output of an alternator and that of a dynamo. Separate Physics only [3]
 - State what happens to the output if the coil is rotated faster. Separate Physics only [2]
 - Explain why the output is zero twice during each rotation of the coil. Separate Physics only [2]
- 9** A transformer has 1200 turns on its primary coil and 80 turns on its secondary coil. The input potential difference is 230 V.
- State whether this is a step-up or a step-down transformer, and explain how you can tell. Separate Physics only [2]
 - Calculate the output potential difference. Separate Physics only [3]
 - The transformer is 100% efficient and the output current is 3.0 A. Calculate the input current. Separate Physics only [3]
 - Explain why a transformer does not work with direct current. Separate Physics only [3]
 - Explain the role of the iron core. Separate Physics only [2]

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A power station generates 400 MW of power. It is transmitted along cables of total resistance $4.0\ \Omega$.

- a Calculate the current in the cables if the transmission voltage is 25 kV. Separate Physics · HT only [3]
- b Calculate the power wasted in the cables at this voltage. Separate Physics · HT only [3]
- c Explain what your answer shows about transmitting at 25 kV. Separate Physics · HT only [2]
- d Calculate the current and the power wasted if the voltage is raised to 400 kV. Separate Physics · HT only [3]
- e Explain why the National Grid uses step-up and step-down transformers. Separate Physics only [3]

Working scientifically

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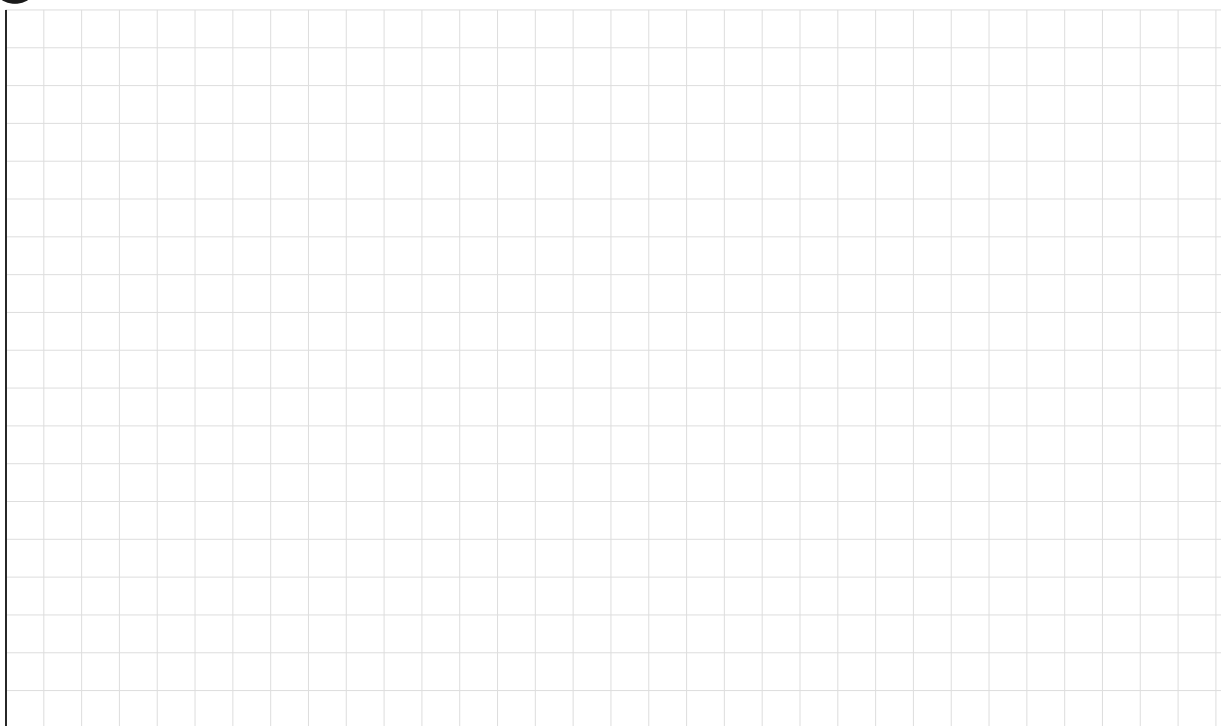
A student investigates how the number of turns on an electromagnet affects the number of paperclips it can pick up.

Number of turns	20	40	60	80	100
Paperclips picked up	3	7	10	13	17

- a Name the independent and dependent variables. Working scientifically [2]
- b State two variables that must be controlled. Working scientifically [2]
- c Plot a graph of paperclips against number of turns on the grid provided. Working scientifically [4]
- d Describe the relationship shown by the graph. Working scientifically [2]
- e Explain why the number of paperclips is a rather crude measure of magnetic strength. Working scientifically [3]
- f Explain why the current must be kept constant, and suggest how. Working scientifically [2]

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Use the grid to plot the electromagnet data from the previous question.



No answer is required here — the grid is for your graph.

[0]

13 A student investigating the motor effect obtains these readings for the force on a wire at different currents.

Current in A	1.0	2.0	3.0	4.0	5.0
Force in N	0.04	0.09	0.12	0.21	0.20

- Identify the two readings that do not fit the pattern. Working scientifically [2]
- Describe the relationship suggested by the remaining readings. Working scientifically [2]
- Suggest a cause of the anomalous readings. Working scientifically [2]
- Describe how the student should proceed. Working scientifically [2]
- Explain why the current should not be left switched on between readings. Working scientifically [2]

14 A company advertises a 'magnetic bracelet' that it claims improves health by 'realigning the body's magnetic field'.

- Explain why a scientist would be sceptical of this claim. Working scientifically [3]
- Describe how a fair trial of the bracelet could be designed. Working scientifically [4]

15 A scrapyard crane uses a large electromagnet to lift cars.

- Explain why an electromagnet is used rather than a permanent magnet. [2]
- The crane lifts a car of mass 1100 kg. Calculate the minimum force the electromagnet must exert. $g = 9.8 \text{ N/kg}$ Maths skill [2]
- Suggest why the crane cannot be used to lift aluminium parts. [2]
- Explain how this property is used to separate metals at a recycling plant. [2]

16 A circuit breaker uses an electromagnet to switch off a circuit if the current becomes too large.

- Explain how the circuit breaker works. [3]
- Give two advantages of a circuit breaker over a fuse. [2]

17 A student makes an electric bell using an electromagnet, a springy metal arm and a contact screw.

- Explain why the bell rings continuously while the switch is pressed. [4]
- Explain why a soft iron core is used in the electromagnet rather than steel. [2]

18 A student investigates how the speed of a magnet moving through a coil affects the induced potential difference.

Speed in m/s	0.20	0.40	0.60	0.80	1.00
Peak potential difference in mV	12	25	36	49	61

- Describe the relationship shown by the data. Working scientifically [2]
- Explain this relationship. Separate Physics only [2]
- Predict the reading at a speed of 0.50 m/s. Maths skill [2]
- Suggest why the readings are given in millivolts rather than volts. Working scientifically [2]
- Describe one change that would increase all the readings. Separate Physics only [1]

- 19** Compare the magnetic field of a solenoid with that of a bar magnet.
- a** Give one similarity and one difference. [2]
 - b** Describe how to work out which end of a solenoid is the north pole. [2]
- 20** A technician must choose between a 12 V motor and a 230 V motor for a battery-powered model.
- a** Explain which motor is suitable and why. [2]
 - b** The 12 V motor draws 1.5 A. Calculate its power. Maths skill [2]
 - c** Calculate the energy transferred if the motor runs for 4.0 minutes. Maths skill [2]
 - d** The motor is 60% efficient. Calculate the useful energy output. Maths skill [2]
- 21** Explain why a bicycle dynamo produces a larger potential difference when the bicycle is ridden faster.
- Give your answer. Separate Physics only [3]
- 22** State three uses of electromagnets in everyday devices, and for each give the property that makes an electromagnet suitable.
- Give your answer. [6]
- 23** A relay uses a small current in one circuit to switch on a much larger current in another.
- a** Explain how a relay works. [4]
 - b** Give one safety advantage of using a relay in a car starter motor circuit. [2]
 - c** Explain why the core of the relay is made of soft iron. [2]
- 24** State what is meant by a magnetic field, and explain how field strength varies around a magnet.
- a** Define a magnetic field. [1]
 - b** Describe how the field strength varies with distance from a bar magnet. [2]
 - c** Explain how a field diagram shows where the field is strongest. [1]
- 25** A student winds 50 turns of wire around an iron nail and connects it to a 1.5 V cell. The electromagnet picks up 4 paperclips. The cell is replaced with a 4.5 V battery.
- a** Predict what happens to the number of paperclips, and explain why. [3]
 - b** Explain why the wire may become hot. [2]
 - c** Suggest a risk of leaving the electromagnet switched on for a long time. Working scientifically [2]
- 26** Describe an experiment to demonstrate the motor effect using a copper rod, two rails, a power supply and a magnet.
- a** Describe the method and the expected observation. Working scientifically [3]
 - b** State what would happen if the magnet were turned round. [1]

Extended response

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A student is given a battery, a coil of wire, an iron nail, a switch and some paperclips.

Describe how the student could build an electromagnet and investigate what affects its strength. Your answer should include the variables, the measurements and how to make the results reliable.

[6]

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Explain how a transformer works and why transformers are essential to the National Grid.

Give your answer.

[6]