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GCSE (9-1)

Examiners' report

GATEWAY SCIENCE COMBINED SCIENCE A

J250

For first teaching in 2016

J250/05 Summer 2023 series

Version 1

ocr.org.uk/science

Contents

Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates.

The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. A selection of candidate answers is also provided. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report.

A full copy of the question paper and the mark scheme can be downloaded from OCR.

Paper 5 series overview

J250/05 is one of the two Foundation Physics papers for the GCSE (9–1) Gateway Science Combined Science A. It covers the topics:

- P1 Matter
- P2 Forces
- P3 Electricity and matter
- CS7 Practical skills

To do well on this paper, candidates needed to able to use the Data Sheet to identify the correct equations and manipulate them and be comfortable applying their knowledge and understanding to both familiar and unfamiliar contexts and practical science activities.

The vast majority of candidates completed all questions in the examination within the allotted time.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• identified and applied or manipulated equations • demonstrated knowledge of scientific procedures (e.g., finding power rating) • interpreted series and parallel circuit diagrams • analysed and interpreted distance-time graphs to draw conclusions and carry out calculations.	• found it difficult to identify and apply or manipulate equations • did not identify circuit symbols • seemed to lack the necessary knowledge to respond in depth to the Level of Response question about electromagnets.

Section A overview

Section A consists of 10 Multiple Choice Questions, concentrating on Assessment Objectives 1 and 2 (AO1 and AO2).

All candidates attempted all of the questions.

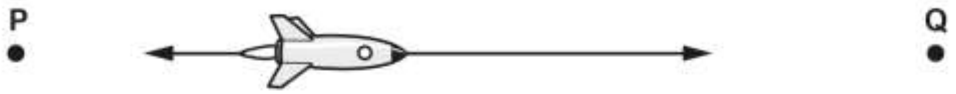
Assessment for learning

Candidates who did well on this section generally did the following:

- underlined keywords
- wrote equations and/or calculations next to the relevant questions
- worked through the distractors methodically, e.g., by crossing out obviously incorrect answers.

Question 1

1 A spaceship travels from planet **P** to planet **Q**.
The diagram shows the size of the forces acting on the spaceship.



Which sentence describes the motion of the spaceship?

A It is accelerating.

B It is decelerating.

C It is staying at a constant speed.

D Its speed is decreasing then increasing.

Your answer **[1]**

The majority of candidates were able to identify the correct motion of the spaceship, with most incorrect responses choosing option C.

Assessment for learning

Candidates could benefit from practising describing the motion of objects with different balanced or unbalanced forces acting on them.

Question 2

2 Velocity is a vector.

Which row is correct for velocity?

	Has size?	Has direction?
A	no	no
B	no	yes
C	yes	no
D	yes	yes

Your answer ☐ **[1]**

The majority of candidates found this question challenging and were not given the mark.

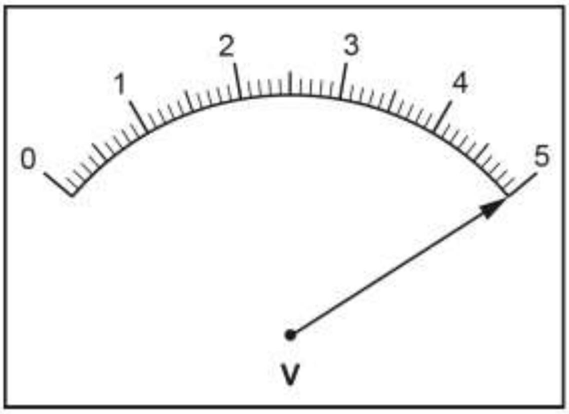
Misconception

? The most common misconception in responses to this question was that vectors have direction but not size.

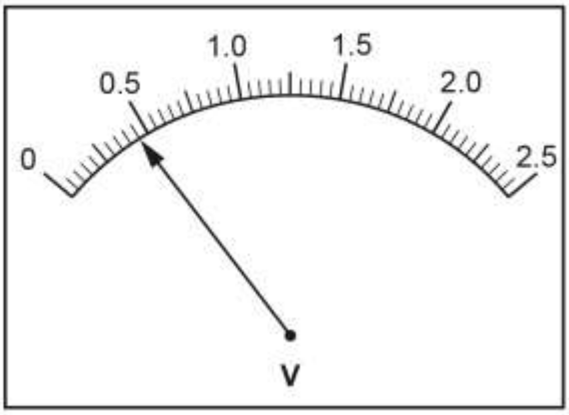
Question 3

3 Which voltmeter shows a reading of 0.5 V?

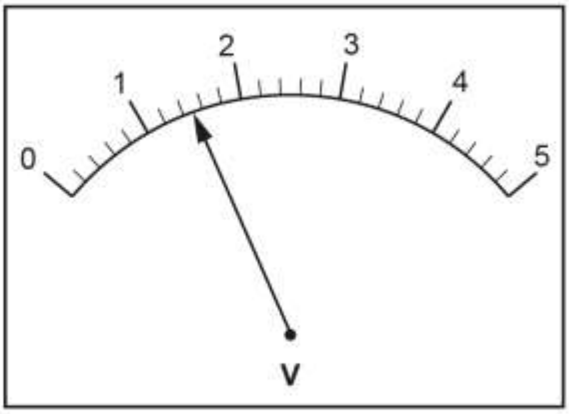
A



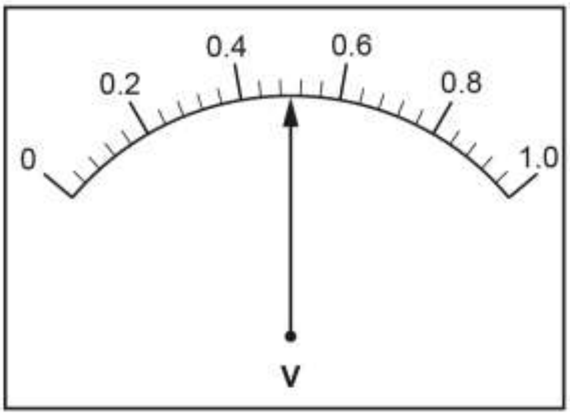
B



C



D



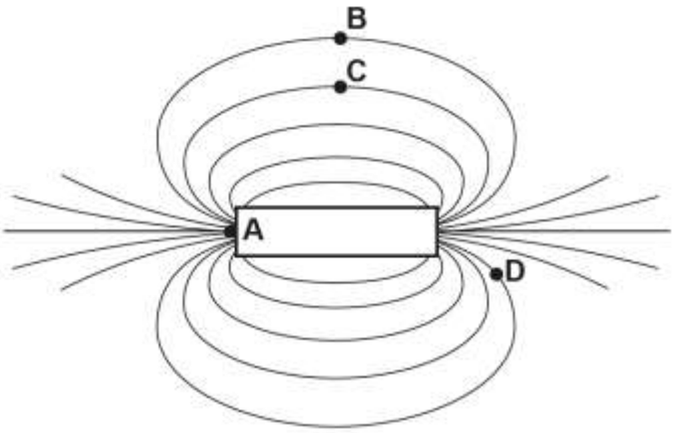
Your answer **[1]**

Almost all candidates identified that the voltmeter in option D shows a reading of 0.5V.

Question 4

4 The diagram shows the magnetic field around a bar magnet.

At which point is the magnetic field the **weakest**?



Your answer ☐ **[1]**

The majority of candidates successfully applied their knowledge of magnetic fields to identify that the field is weakest at point B.

Question 5

5 Which substance listed in the table has the highest **density**?

Substance	Mass (kg)	Volume (cm^3)
A	1.0	1.5
B	1.0	3.0
C	1.0	4.5
D	1.0	6.0

Your answer ☐ **[1]**

This question required candidates to either use an equation from the Equation Sheet to calculate the density of each substance, or to recognise that the substance with the smallest volume will have the highest density, as the mass of each substance is the same.

Almost half of the candidates answered this correctly, usually by calculating and comparing the density of each substance.

A common error was to choose option D, as some candidates thought that 0.16 is greater than 0.6.

Exemplar 1

Substance	Mass (kg)	Volume (cm^3)	Density
A	1.0	1.5	= 0.6
B	1.0	3.0	= 0.3
C	1.0	4.5	= 0.2
D	1.0	6.0	= 0.16

density = mass / volum

Your answer A **[1]**

The candidate in Exemplar 1 has used the equation to calculate and write down the density of each substance in order to determine which substance has the highest density.

Question 6

6 How much of the total mass of a hydrogen atom is made up by the nucleus?

A None of the mass

B Half of the mass

C Almost all of the mass

D All of the mass

Your answer **[1]**

The majority of candidates were unable to identify that almost all of the mass of an atom is made up by the nucleus.

Question 7

7 The mass of an astronaut is 80 kg.

Calculate the weight of the astronaut on the Moon.

Use the equation: gravitational force = mass × gravitational field strength

The gravitational field strength on the Moon is 1.6 N/kg.

A 50 N

B 128 N

C 800 N

D 1280 N

Your answer ☐ **[1]**

Almost all candidates were able to substitute the values into the equation provided to work out that the weight of the astronaut is 128N.

Question 8

8 The table shows the results from measuring the extension of a spring for different forces.

Force (N)	Extension of a spring (m)
0.0	0.00
0.9	0.05
1.8	0.10
2.7	0.15
3.6	0.20

Calculate the spring constant of the spring.

Use the equation: force exerted by a spring = extension × spring constant

A 0.045 N/m

B 0.060 N/m

C 0.72 N/m

D 18 N/m

Your answer **[1]**

This question required candidates to rearrange the equation provided to calculate the spring constant. Approximately half of candidates were able to do this correctly, with the majority of candidates who used the 'equation triangle' to rearrange the equation correctly gaining the mark.

Assessment for learning

Candidates could benefit from a short starter or plenary activity where they have to change the subject of both familiar and unfamiliar equations.

Question 9

9 Which new feature of the atomic model did Niels Bohr suggest?

A Electrons are in stable shells.

B Electrons orbit a nucleus.

C The atom has a nucleus.

D The nucleus is positive.

Your answer [ ] **[1]**

The majority of candidates found this question challenging and were not given the mark. The most common error in the responses to this question was that Niels Bohr was the scientist who suggested that electrons orbit a nucleus (option B).

Question 10

10 Two rooms have the same fixed volume. They contain identical gases at the same pressure.

Room **H** is at a higher temperature than room **L**.

Which statement is correct?

A The particles are moving at the same speed in both rooms.

B The particles are moving faster in room **H**.

C The particles are moving faster in room **L**.

D The particles are not moving in either room.

Your answer [ ] **[1]**

The majority of responses correctly identified that particles are moving faster in room H.

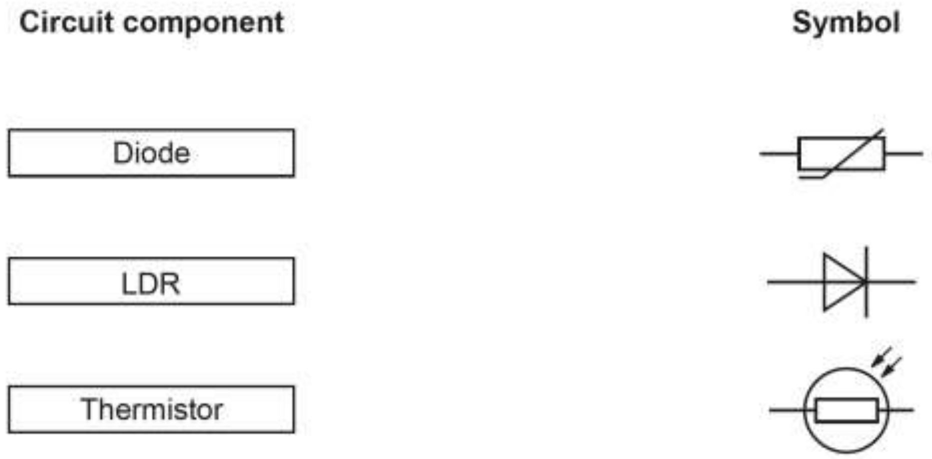
Section B overview

Section B consisted of short, 1 mark, questions as well as questions requiring longer answers and a Level of Response question. It covered all of the assessment objectives and many questions needed candidates to use mathematical skills.

Candidates who did well on this section generally:	Candidates who did less well on this section generally:
• underlined key words • substituted the correct values into equations provided on the question paper • identified equations from the Data Sheet and wrote down all of their calculations • worked methodically in order to describe how a student carried out an experiment to investigate the strength of an electromagnet in the Level of Response question • accurately read values from a graph and used these values in calculations.	• were challenged by the mathematical skills required • could not interpret series and parallel circuit diagrams • only wrote the answers to questions involving equations, no calculations were shown • gave responses that lacked depth and showed poor quality of communication •

Question 11 (a)

11 (a) Draw lines to connect each **circuit component** with its correct **symbol**.



[2]

The majority of responses were given either 1 mark, for identifying one or two of the components correctly, or 2 marks for identifying all three components correctly. The most common error was to mix up the symbols for a thermistor and an LDR.

Assessment for learning

Candidates could benefit from a short activity such as a card sort where they match components with their symbols.

Question 11 (b)

(b) Complete the sentences to describe electrical circuits.

Use words from the list.

increases	**decreases**	**stays the same**

A circuit contains one resistor. An identical resistor is added **in series** with the first. The resistance of the circuit ....

A circuit contains one resistor. An identical resistor is added **in parallel** with the first. The resistance of the circuit ....

If the temperature of a thermistor increases, its resistance ....

[2]

Candidates struggled with this low demand question assessing AO1 and only a very small number of the more successful responses were given both marks.

Misconception

The most common misconception in responses to this question was that the resistance of the circuit stays the same when another resistor is added in series.

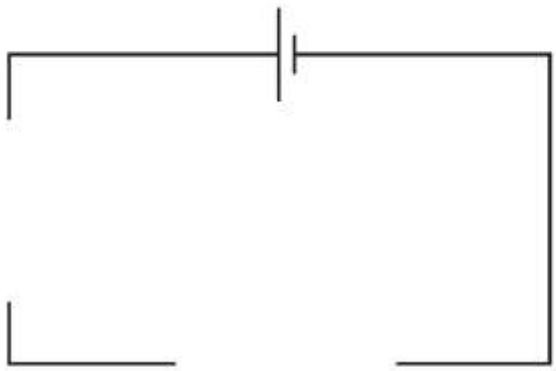
Question 11 (c)

(c) **Fig. 11.1** shows circuit symbols for an ammeter, voltmeter and resistor.

Fig. 11.1

A student measures the current in a resistor and the potential difference across the resistor.

Use the symbols in **Fig. 11.1** to complete a circuit diagram for the experiment.



[2]

Approximately two thirds of responses knew that the ammeter is placed in series with the resistor, but only the most successful responses also drew the voltmeter in the correct position. Many responses left the voltmeter out of the circuit completely or connected it in series with the ammeter.

Question 11 (d)

(d) The potential difference across a 3 Ω resistor is 4.5 V.

Calculate the current in the resistor.

Use the Equation Sheet.

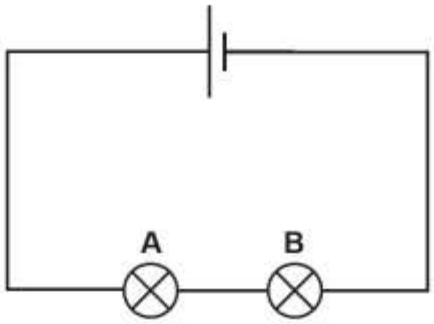
Current = ... A **[3]**

This question required candidates to identify the correct equation from the Equation Sheet and to rearrange it. Although most candidates selected the correct equation, they did not always rearrange it correctly. Many multiplied p.d. by resistance or divided resistance by p.d. Very few responses were given all 3 marks.

Question 11 (e) (i) and (ii)

(e) **(i)** A teacher connects the circuit in **Fig. 11.2**.

Fig. 11.2



Both lamps are lit. The teacher then removes lamp **A** from its holder but leaves the rest of the circuit unchanged.

Describe what happens. Give a reason for your answer.

What happens ....

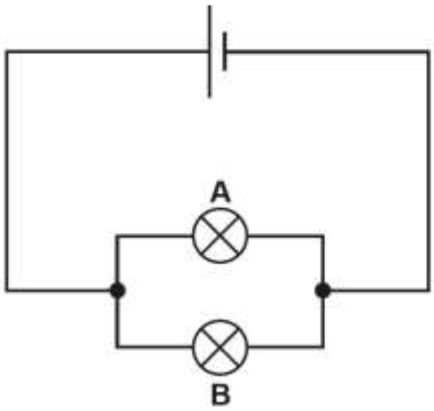
....

Reason ....

.... **[2]**

(ii) The teacher connects the circuit in **Fig. 11.3**.

Fig. 11.3



Both lamps are lit. The teacher then removes lamp **A**.

Describe what happens. Give a reason for your answer.

What happens ....

....

Reason ....

.... **[2]**

Responses showed limited understanding of series and parallel circuits, especially in Question 11(e) (i) and the majority were not given any marks.

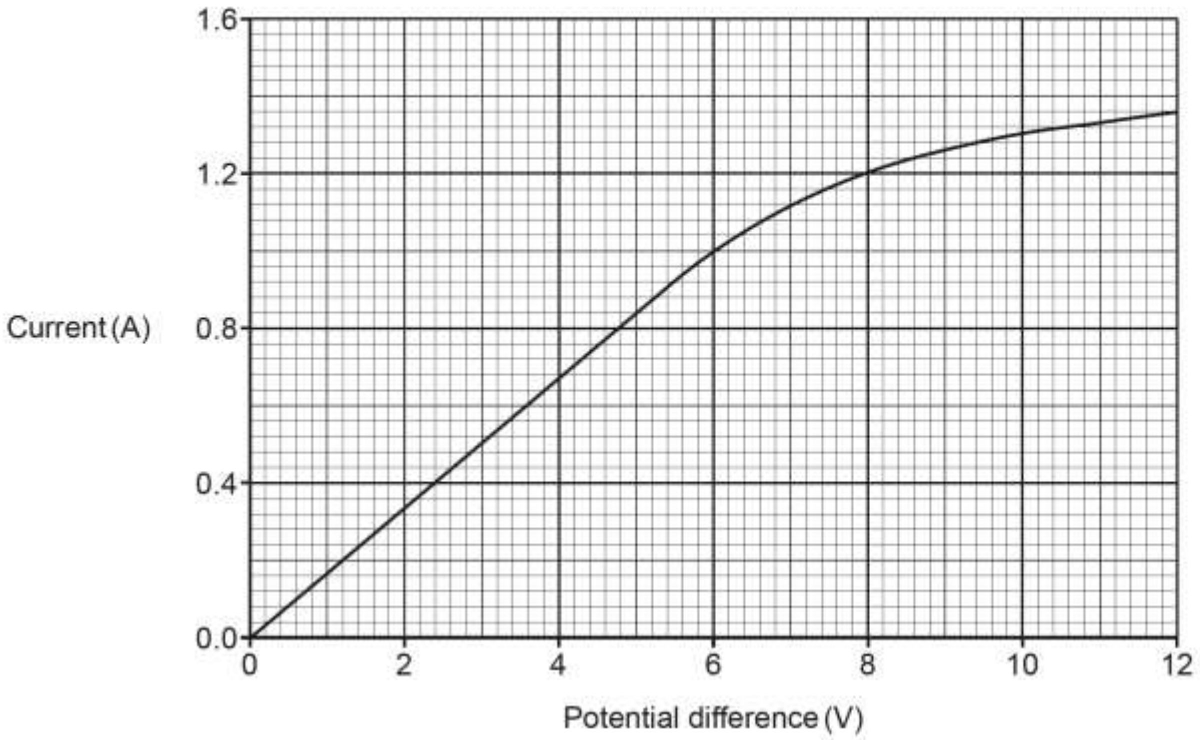
Misconception

In answering Question 11(e) (i), most candidates thought that lamp B becomes brighter as all of the current would now pass through it.

In part (ii), more than half of the candidates thought that lamp B goes off as the circuit is incomplete when lamp A is removed.

Question 11 (f)

(f) The graph shows how the current in a resistor changes when the potential difference across the resistor changes.



Which **two** statements about the graph are correct?

Tick (✓) **two** boxes.

The graph is linear when the current is more than 1.0 A. ☐

The graph is linear when the potential difference is less than 4 V. ☐

The graph is non-linear for all values of current. ☐

The ratio of potential difference : current is unchanged from 0 V to 5 V. ☐

When potential difference increases, resistance decreases. ☐

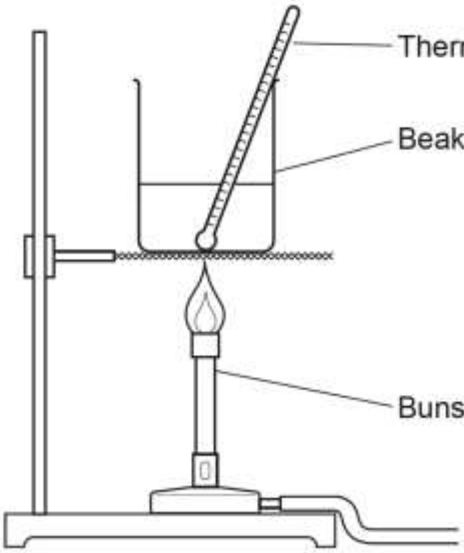
[2]

Most candidates recognised that the graph is linear when the potential difference is less than 4V, but few candidates were given both marks. There were no clear common distractors.

Question 12 (a)

12 A student does an experiment to measure the power rating of a Bunsen burner.

The diagram shows their experiment.



This is the method they follow:

- Pour 0.2 kg of water into a beaker.
- Increase the temperature of the water using the Bunsen burner.
- Measure the time taken for the temperature of the water to increase by 50 °C.

(a) Suggest a way to measure the time taken.

.... **[1]**

The majority of responses to this question were correct. Some responses were not specific enough to be given the mark, for example, clock or watch.

Question 12 (b) and (c)

(b) The mass of the water is 0.2 kg. The temperature change is 50 °C.

The specific heat capacity of water is 4200 J / kg °C.

Calculate the thermal energy transferred to the water.

Use the Equation Sheet.

Thermal energy transferred = ... J **[2]**

(c) The student repeats the experiment.
They say that the energy transferred by the Bunsen burner is 40 000 J after 200 s.

Calculate the power of the Bunsen burner.

Use the equation: power = $\frac{\text{energy transferred}}{\text{time}}$

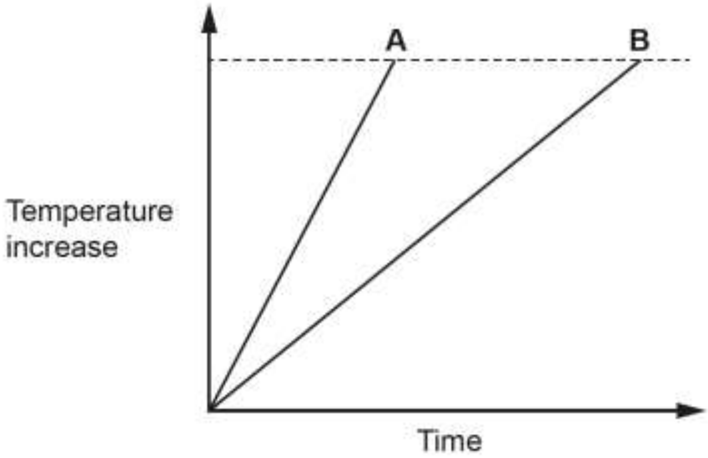
Power = ... W **[2]**

Questions 12(b) and 12(c) were answered correctly by the majority of candidates.

Question 12 (d) (i)

(d) Another student repeats the experiment for two Bunsen burners **A** and **B**.

The graph shows the time taken for the temperature of 0.2 kg of water to increase by 50 °C.



(i) The student says, 'Bunsen burner **A** has the highest power.'

Explain how the graph shows this.

....

.... **[1]**

This question assessed AO3 and the majority of responses were correct. Of the incorrect responses, most did not express their answers clearly enough, for example, 'line A increased the quickest'.

Question 12 (d) (ii)

(ii) The manufacturer says, 'The line on the graph for Bunsen burner **B** is **not** accurate. The power of the Bunsen burners should be the same.'

Both Bunsen burners are working correctly.

What did the student do wrong when testing Bunsen burner **B**?

Tick (✓) **one** box.

They used too much water. ☐

They wrapped insulation around the beaker. ☐

They placed a lid on the beaker. ☐

They started recording the time too late. ☐

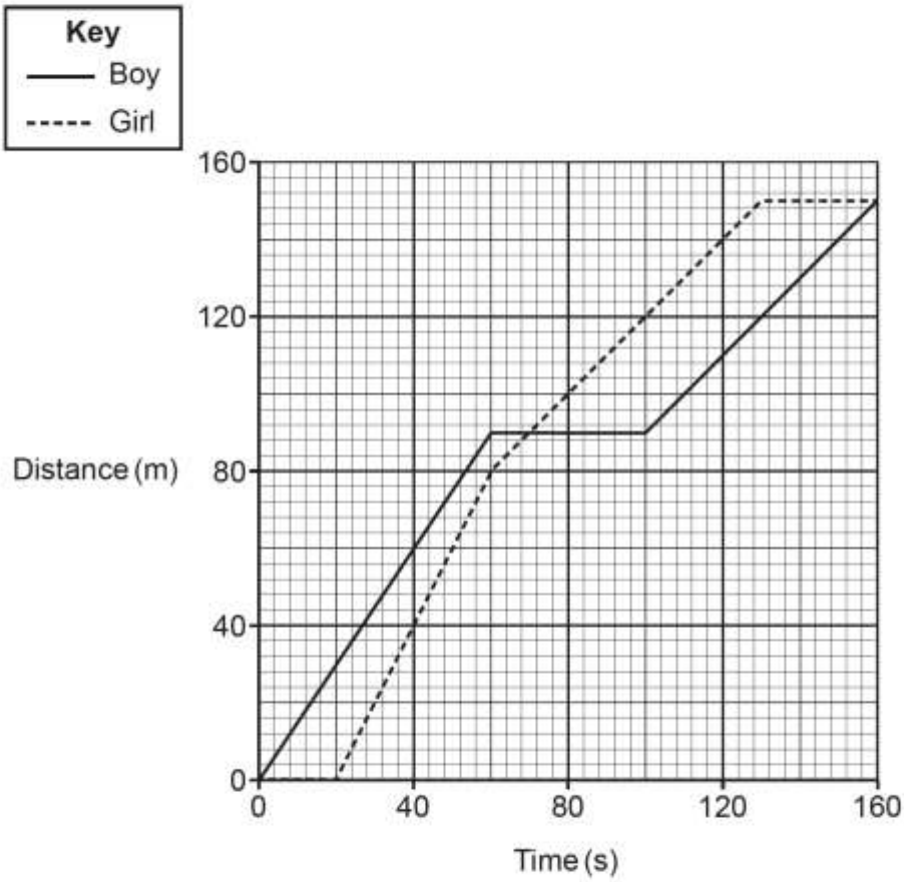
[1]

The majority of responses to this question were incorrect. Many did not appreciate that the other three options would cause the water to increase in temperature more quickly.

Question 13 (a), (b) and (c)

13 A boy and a girl walk from their house to a shop. They walk there in different ways.

The distance–time graph shows their motion.



(a) How long does the boy stop for during the walk?

Time stopped = ... s **[1]**

(b) The boy and girl are at the same distance from the house when they are at the shop.

At what **other** time are the boy and girl at the same distance from the house?

Other time = ... s **[1]**

(c) Calculate the boy's average speed for the whole journey.

Use the Equation Sheet.

Give your answer to **2** significant figures.

Average speed = ... m/s **[4]**

This question required candidates to read values off the graph, interpret sections of the graph and to identify and rearrange the equation from the Equation Sheet to calculate the speed.

Most candidates were able to determine the time in part (a) but fewer than half of the candidates could identify where the boy and the girl were the same distance from the house.

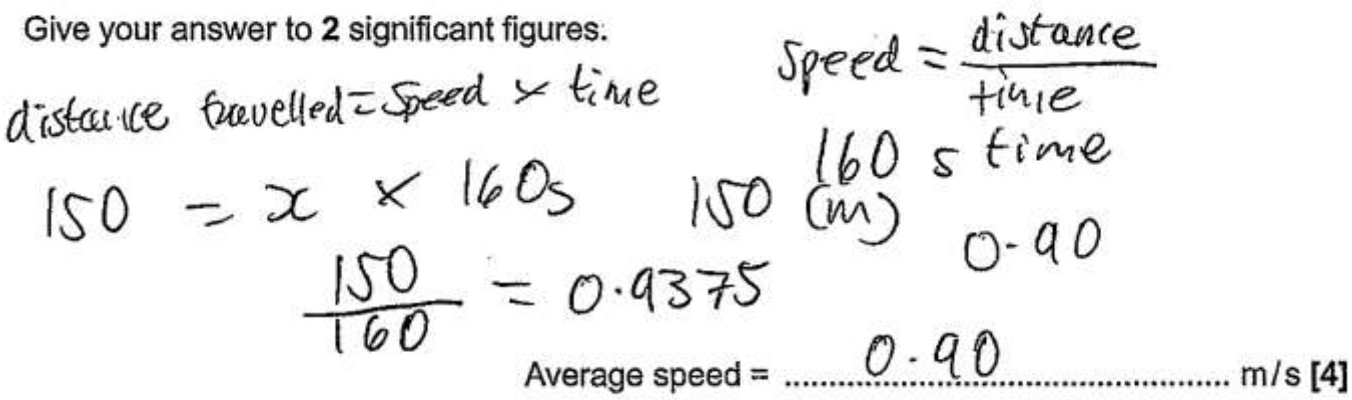
In part (c), there was a spread of marks with only the minority of candidates being given all four marks. Many candidates, however, only wrote down their final answer so could not gain method marks if their answer was incorrect.

Other common errors included misreading the values from the graph and incorrectly rearranging the equation to determine speed.

Assessment for learning

Candidates could benefit from writing down calculations rather than only their final answer, so that method marks may be given if their final value is incorrect.

Exemplar 2


Give your answer to **2** significant figures.

distance travelled = Speed × time

Speed = distance / time

150 = x × 160s

150 (m)

160 s time

150 / 160 = 0·9375

0·90

Average speed = 0·90 m/s **[4]**

Exemplar 2 shows a response where the candidate has:

- written down the correct equation from the Equation Sheet and rearranged it correctly
- substituted the correct values read from the graph
- calculated the answer correctly (to 4 significant figures)
- incorrectly rounded the final answer to 2 significant figures.

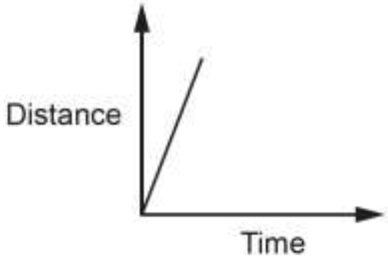
If the candidate had only written down their final answer of 0.90 (m / s) they would have scored zero.

Question 13 (d) (i)

(d) The girl walks back to the house. She accelerates for part of the journey.

(i) Which distance–time graph describes her motion for this part of her journey?

Tick (✓) **one** box.



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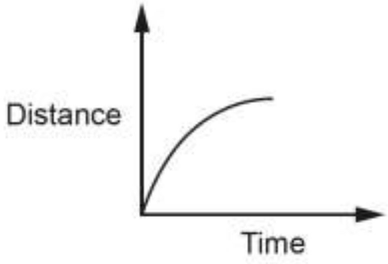

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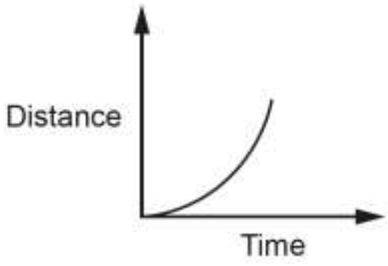

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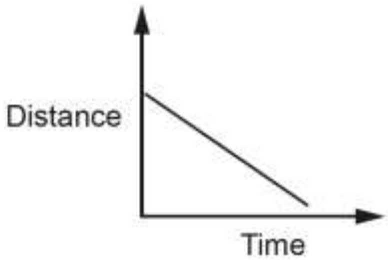


☐

[1]

Few responses identified the correct distance-time graph representing acceleration, with the first option regularly chosen instead.

Question 13 (d) (ii)

(ii) The girl's change in velocity is 1.2 m/s. The time taken is 3 seconds.

Calculate the girl's acceleration.

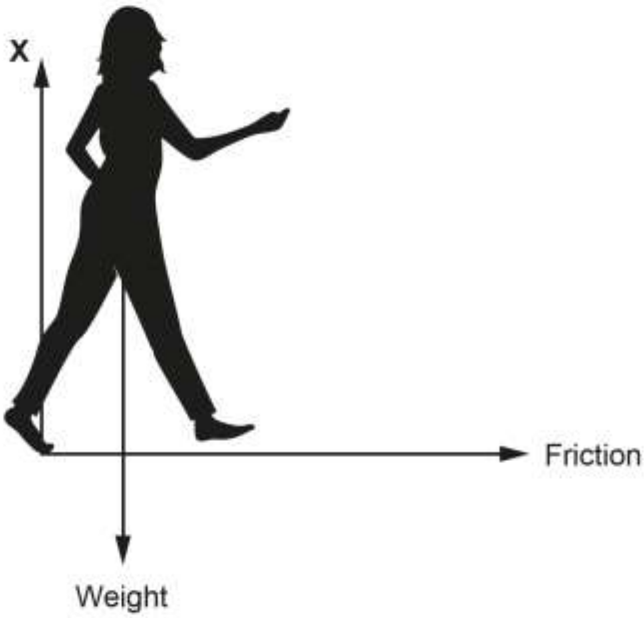
Use the equation: acceleration = $\frac{\text{change in velocity}}{\text{time}}$

Acceleration = ... m/s^2 **[2]**

The majority of responses were given both marks.

Question 13 (d) (iii)

(iii) The free body force diagram shows how the girl accelerates as she walks along the ground.



What is the name of force **X**?

Tick (✓) **one** box.

Air resistance	☐
Gravity	☐
Normal contact force	☐
Upthrust	☐

[1]

Very few candidates correctly identified the correct name of force X.

Misconception

The most common misconception in responses to this question was that as force X is an upwards force, it must be upthrust.

Assessment for learning

Candidates would benefit from short activities where they draw or label the forces acting on different objects.

Question 14*

14* An electromagnet can be made from a coil of wire and a soft iron core.

A student investigates how the strength of an electromagnet varies with the number of turns.

Fig. 14.1 shows the electromagnet and **Fig. 14.2** shows a graph of the results.

Fig. 14.1

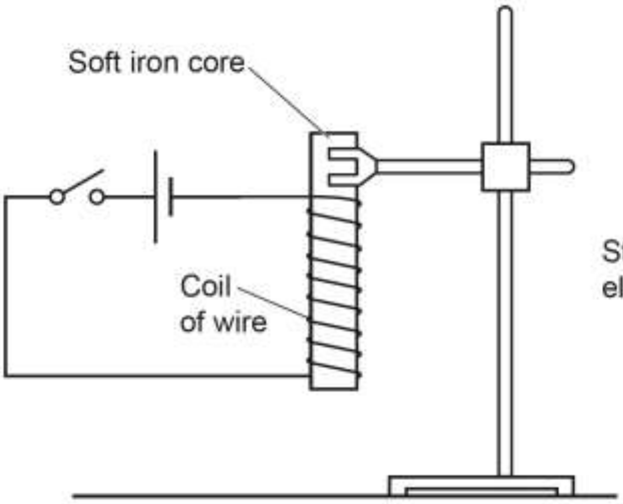
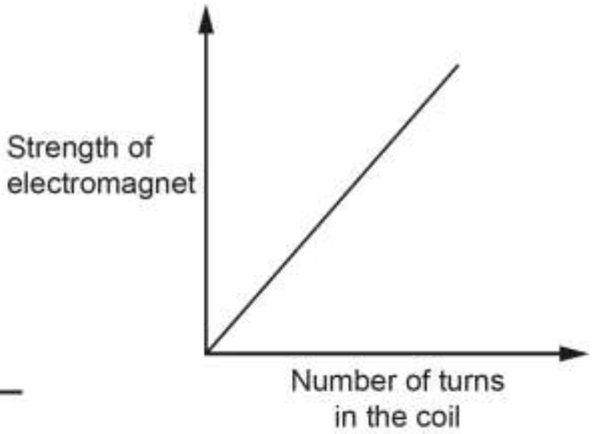


Fig. 14.2



Describe how the experiment is done using **Fig. 14.1**.

Explain what the graph in **Fig. 14.2** tells us.

....

....

....

....

....

.... **[6]**

This Level of Response question was of low demand and assessed AO1 and AO3. It required candidates to use the diagram to describe how to investigate the relationship between the number of turns on the electromagnet and its strength. Candidates were also asked to explain the relationship shown on the graph in Fig. 14.2.

The question proved challenging to most candidates with less than one third gaining Level 2 or above. Most responses contained a basic explanation of the graph but did not appear to understand what an electromagnet is. There were attempts to describe what was happening in the diagram, but the lack of detail or poor quality of communication prevented the candidates from gaining the higher levels.

For a Level 1 response, candidates usually gave a basic explanation of the graph, for example, as the number of turns increases, the strength of the electromagnet increases. A more complete response for Level 2 or 3 included a clear and detailed description of the experiment and identified a directly proportional relationship between the number of turns on the electromagnet and its strength.

Exemplar 3

The stronger the electromagnet, the more times the coil has to be turned. In 14.1 the coil is wrapped around the soft iron core, you then see how much the magnet can hold until something falls off, you then take it all off and add more coils than last time and repeat. As more coil is added, the strength of the electromagnet should be increasing.

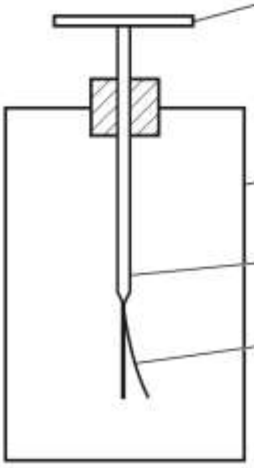
Exemplar 3 shows a Level 2 response. The candidate gives a basic description of the graph in Fig. 14.2. There is a clear description of the method of wrapping the coil around the iron core, seeing 'how much the magnet can hold until something falls off' and repeating this with a different number of coils.

To access Level 3, the candidate needs to add more detail to their method, e.g., pass a current through the coil, count the number of paperclips that the magnet can hold, and give a more detailed explanation of the graph, e.g., the strength of the electromagnet is directly proportional to number of turns on the coil.

Question 15 (a), (b) and (c)

15 **Fig. 15.1** shows a gold leaf electroscope that can be used to measure electric charge.

Fig. 15.1



(a) A positively charged rod is rubbed across the brass cap of the gold leaf electroscope.

Complete the sentence to explain how the gold leaf electroscope becomes **positively** charged.

Use words from the list.

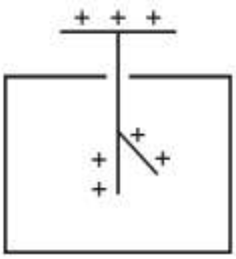
Electrons	**Gold leaf electroscope**	**Neutrons**	**Protons**
Positively charged rod			

.... move from the .... to the ....
[2]

(b) When the gold leaf electroscope is positively charged, the gold leaf rises.

Fig. 15.2 shows the positively charged gold leaf electroscope.

Fig. 15.2



Explain why the gold leaf rises.

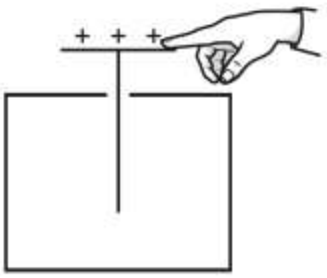
....

.... **[1]**

(c) A scientist earths the cap of the positively charged gold leaf electroscope by touching it with their finger.

Complete **Fig. 15.3** to show what happens to the gold leaf.
Explain your answer.

Fig. 15.3



Explanation ....

....

....

.... **[2]**

This question was an overlap question with the Higher tier paper and therefore of standard demand. It assessed candidates' understanding and application of static electricity and the use of a gold leaf electroscope.

Candidates were challenged by all parts of this question and less than half of candidates achieved 2 or more marks out of the 5 marks available.

Although in part (a) many candidates identified electrons correctly, they did not state the correct direction of movement.

In part (b), only some of the most successful candidates recognised that the leaf rises due to the same charges repelling each other. Very few candidates could explain part (c) correctly, instead suggesting that protons moved from the electroscope to the finger.

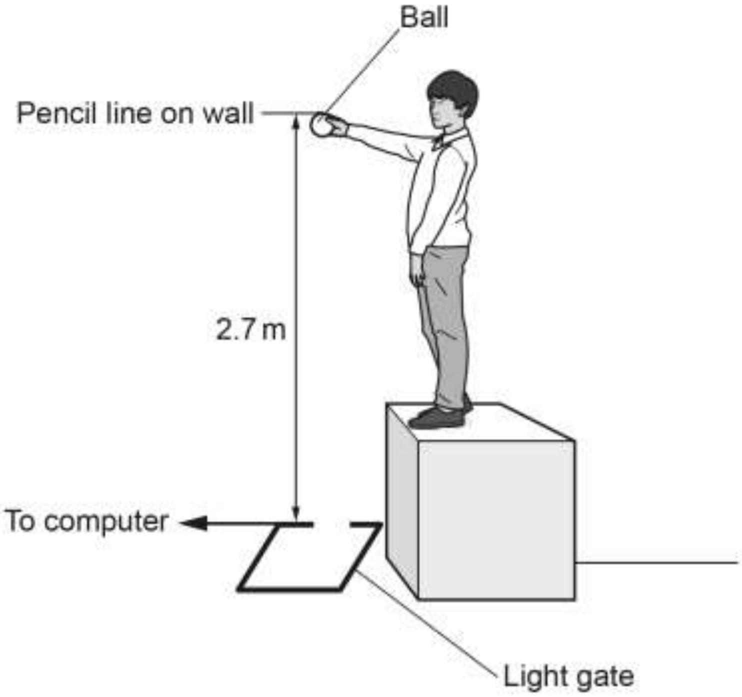
Misconception

In the responses to parts (a) and (c), approximately one third of candidates believe that protons are transferred between objects.

Question 16 (a), (b), (c) (i) and (c) (ii)

16 A student measures the acceleration due to gravity by dropping a ball through a light gate.

The diagram shows the experiment.



(a) Put the steps in the correct order to describe a method for the experiment.

Write numbers **1–4** in the boxes below. Step **5** has been filled in for you.

☐	Write down the computer's value for the final velocity.
☐	Make a pencil line on the wall.
☐	Measure a height of 2.7 m with a tape measure.
5	Use (final velocity)^2 – (initial velocity)^2 = 2 × acceleration × distance to calculate the acceleration due to gravity.
☐	Drop the ball through the light gate.

[1]

(b) Draw lines to match each **source of error** in the experiment to the correct **way to remove the error**.

Source of error	**Way to remove the error**
	Hold the ball in a clamp stand and loosen the clamp to release.
The ball is thrown downwards.	Repeat the same measurement 3 times.
The ball is dropped from the wrong height.	Make sure the ball is dropped through the centre of the light gate.
The computer calculates the wrong velocity.	Make sure the ball is at the same level as the pencil line.

[2]

(c) The light gate and computer are used to calculate the final velocity of the ball.

(i) What information does the student have to enter into the computer?

.... **[1]**

(ii) The computer displays a final velocity of 7.2 m/s when the student drops the ball from 2.7 m.

Calculate a value for the acceleration due to gravity.

Use the equation: $(\text{final velocity})^2 - (\text{initial velocity})^2 = 2 \times \text{acceleration} \times \text{distance}$

Acceleration due to gravity = ... m/s^2 **[3]**

Question 16 was also an overlap question and assessed AO1, AO2 and AO3.

The majority of candidates were able to describe the method in part (a) by listing the steps in the correct order.

Although most candidates gained 1 mark in part (b), very few candidates could identify the correct way to remove all three sources of error. The most common incorrect suggestion was that repeating the measurement three times would remove the error of the computer calculating the wrong velocity. Candidates should be aware that repeating results improves precision, but that repeat readings are not enough to improve accuracy.

In part (c) (i), candidates appeared to be unfamiliar with the use of light gates to determine the velocity of an object, with many incorrect answers referring to the height from which the ball was dropped.

A large majority of candidates were not given any marks for part (c) (ii) as they could not rearrange the equation correctly. Candidates also struggled to link the terms in the equation with the numbers in the question, with very few candidates recognising that the initial velocity of the ball was zero.

Some candidates who showed their calculations gained a method mark for 51.8 or 5.4, highlighting the importance of writing down workings and not just the final answer.

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