Qualification Accredited

Oxford Cambridge and RSA

GCSE (9-1)

Examiners' report

GATEWAY SCIENCE COMBINED SCIENCE A

J250

For first teaching in 2016

J250/11 Summer 2023 series

Version 1

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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 11 series overview

J250/11 is one of six Higher tier papers for the GCSE (9-1) Gateway Science Combined Science A qualification. It is the first of the two physics papers covering Topics P1 Matter, P2 Forces, P3 Electricity and magnetism and CS7 Practical skills.

This is the fourth full June examination series for J250, there being very limited entries for the 2020 and 2021 November examination series.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• read the questions carefully, considered the command words, diagrams, graphs, circuit diagrams and units given, e.g. the position of letters on a circuit diagram and the units for a gradient of a graph • considered the number of marks available for the question and provided a suitably detailed response • worked through calculations in a methodical manner, showing clear steps in their calculations • gave a well-developed line of reasoning which was clear, logically structured and relevant for the level of response question, Question 15.	• did not try to answer multiple choice questions or made their response impossible to read by overwriting the letter, rather than crossing out the original letter and rewriting the new letter clearly • provided a very brief and simple explanation for questions that were worth more than 1 mark • gave just the final numerical answer for calculations, without showing the steps and working out • gave muddled responses, especially for the level of response question, Question 15.

Section A overview

This section consists of 10 multiple choice questions testing AO1 and AO2.

Question 1

1 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 gave the correct response A, electrons are in stable shells. The most common incorrect response was response B, electrons orbit a nucleus.

Question 2

2 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**.

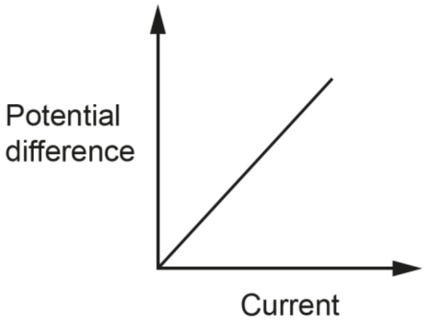
D The particles are not moving in either room.

Your answer ☐ **[1]**

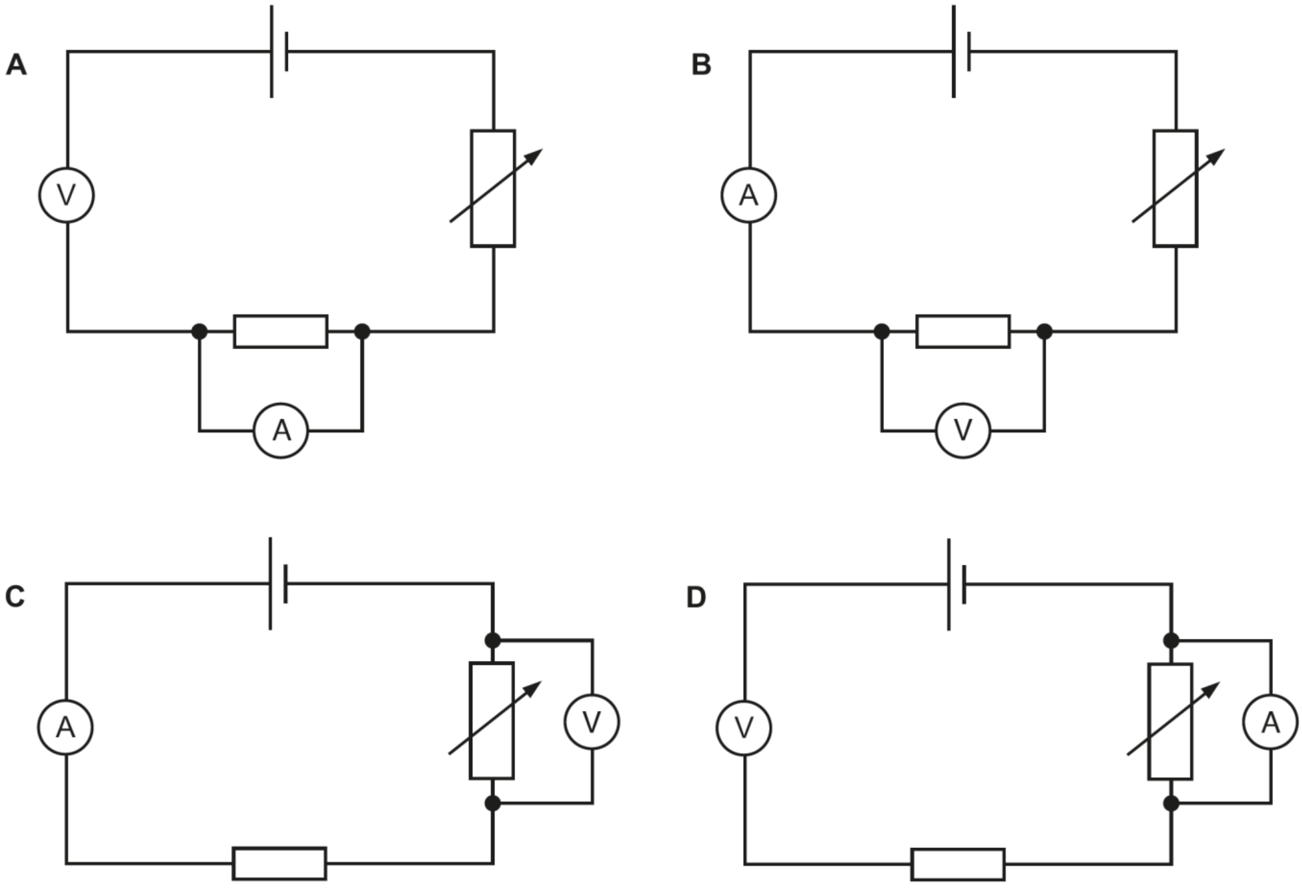
This question was well answered with the majority of candidates recognising that B, the particles are moving faster in room H, was the correct response. The most common incorrect response was A, the particles are moving at the same speed in both rooms.

Question 3

3 The graph shows how potential difference varies with current for a fixed resistor.



Which circuit could be used to produce the graph?



Your answer [1]

The majority of candidates gave the correct response B, the circuit with an ammeter in series and a voltmeter connected across the fixed resistor. The most common incorrect response was response C, the circuit with an ammeter correctly in series but with the voltmeter connected across the **variable** resistor.

Question 4

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

Substance	Mass (kg)	Volume (cm^3)
A	0.5	1.5
B	0.5	3.0
C	1.0	1.5
D	1.0	3.0

Your answer **[1]**

The majority of candidates correctly selected option C, mass of 1.0 kg and volume of 1.5 cm^3. Candidates often calculated each density to determine the substance with the highest density.

Exemplar 1

Substance	Mass (kg)	Volume (cm^3)	
A	0.5	1.5	0·3
B	0.5	3.0	0·167
C	1.0	1.5	0·67
D	1.0	3.0	0·3

Your answer C

This response shows a candidate who has calculated the density for each of the substances, A, B, C and D. The candidate has written the answers at the end of each row so that it is easy to determine the substance with the highest density. Other candidates calculated each value in the space next to the question but because they did not then label each calculation carefully, they sometimes chose the incorrect substance.

Question 5

5 Two magnets, **X** and **Y**, are placed next to each other.

Magnet **X** Magnet **Y**

Which row is correct?

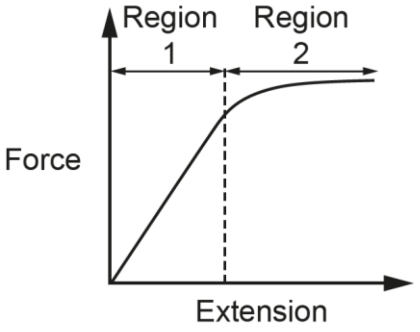
	Magnet **X** produces a force on Magnet **Y**	Magnet **Y** produces a force on Magnet **X**
A	no	no
B	yes	no
C	no	yes
D	yes	yes

Your answer ☐ **[1]**

This question was well answered with the majority of candidates recognising that D, both magnets produce a force on the other magnet, was the correct response. The most common incorrect response was A, the magnets did not produce a forces on each other.

Question 6

6 The force–extension graph is shown for a copper wire.



Which row describes the behaviour of copper in region 1 and region 2?

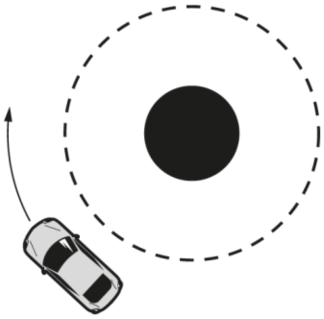
	Region 1	**Region 2**
A	elastic	elastic
B	elastic	plastic
C	plastic	elastic
D	plastic	plastic

Your answer ☐ **[1]**

The majority of candidates selected option B. Region 1 is linear extension and elastic deformation below the limit of proportionality. Region 2 shows significant extension beyond the limit of proportionality, associated with plastic deformation..

Question 7

7 A car travels around a roundabout at 20 mph.



Why is the car accelerating?

A The direction of the car is changing.

B The forces on the car are balanced.

C The mass of the car is decreasing.

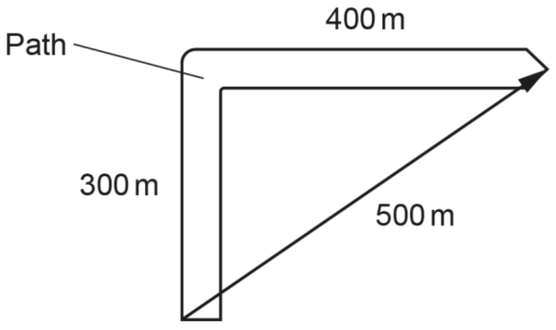
D The speed of the car is changing.

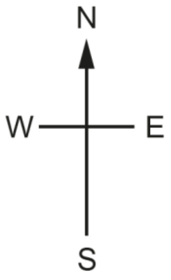
Your answer [ ] **[1]**

A large majority of candidates selected option A, the direction of the car is changing, as the reason why the car is accelerating. The most common incorrect response was B, the forces on the car are balanced.

Question 8

8 A child walks 300 m north along a path. The path turns through a 90° angle.
They then walk another 400 m east.





Which statement is correct?

A The total displacement is 500 m.

B The total displacement is 700 m.

C The total distance travelled is 500 m.

D The total distance travelled is 1200 m.

Your answer ☐ **[1]**

More successful candidates were able to work out that the total displacement is 500 m, option A. These candidates tended to draw on the diagram or draw a separate diagram with a line and arrow for 300 m, a line and arrow for 400 m and then the displacement line and arrow from the start to the end of the journey. Many of these diagrams were drawn to scale as a double check. The most common incorrect response was B, the total displacement is 700 m followed by C, the total distance travelled is 500 m.

Misconception

Some candidates find it difficult to distinguish between distance travelled (a scalar quantity) and displacement (a vector quantity). In this question, the candidates are asked which statement is correct, with the statements containing two options about displacement and two options about distance. Many candidates gave the answer as the total displacement being 700 m, when this is actually the total distance travelled.

Question 9

9 The diagram shows some forces acting on an object.

What is the resultant force on the object?

A 5.4 N

B 12 N

C 13 N

D 14.9 N

Your answer ☐ **[1]**

Most candidates gave the incorrect response to this question, option B and 12 N, rather than the correct answer of option C and 13 N.

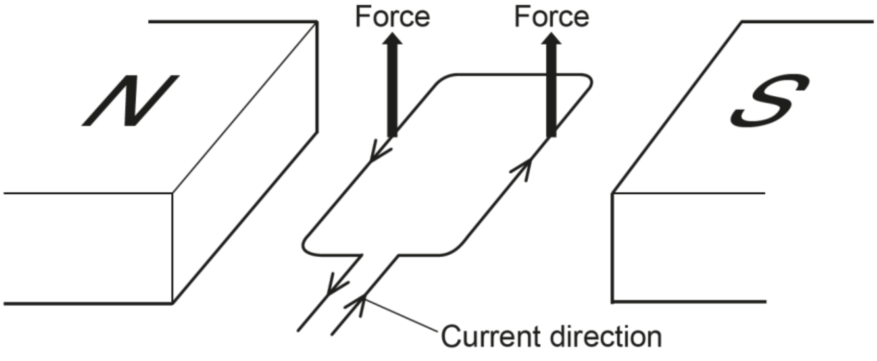
Assessment for learning

Candidates need to read the question carefully and look at all the information on the diagram. This question asks candidates to give the resultant force on the object. The majority of candidates only looked at the 2 N force to the left and the 14 N force to the right on the diagram to deduce the resultant force. These candidates did not consider the 5 N vertical force. All the forces must be considered on a force diagram.

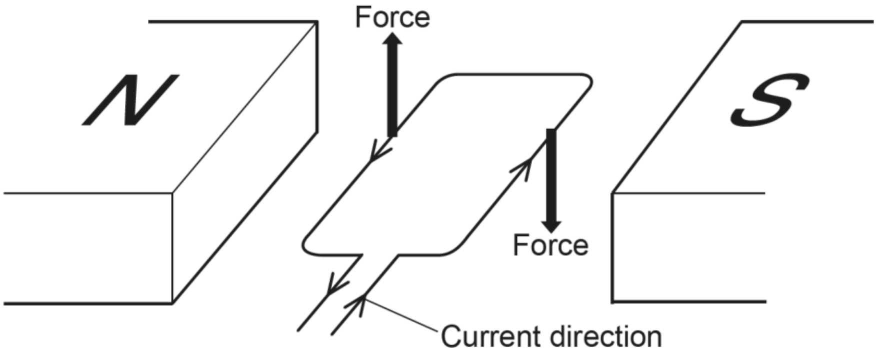
Question 10

10 Which diagram explains how a simple d.c. electric motor spins?

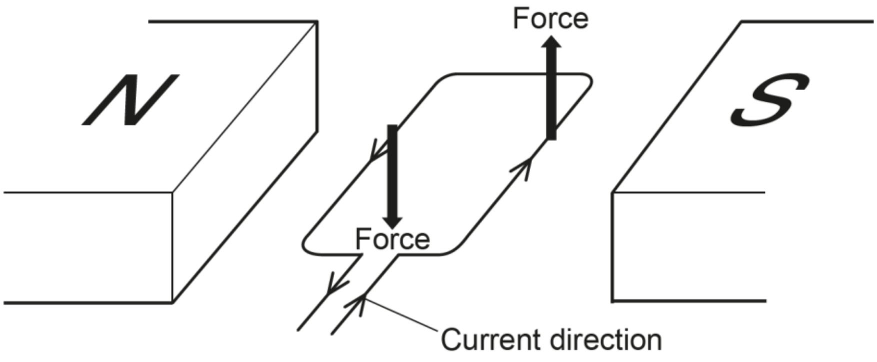
A



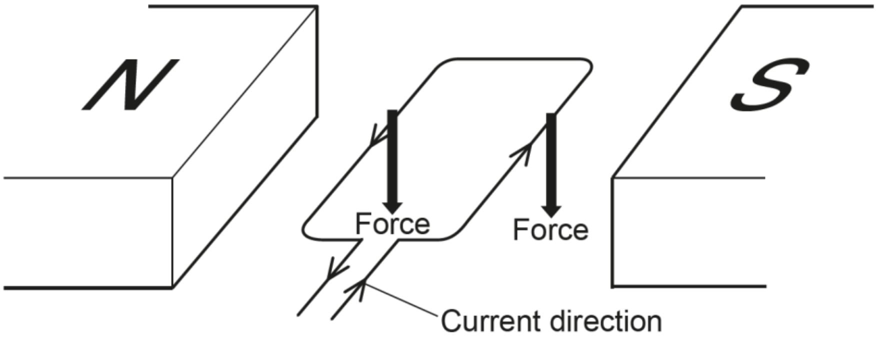
B



C



D



Your answer ☐ **[1]**

The majority of candidates gave the correct response, B, to explain how a simple d.c. motor works. The most common incorrect response was response C, where the forces were reversed.

Misconception

Many candidates found it difficult to use Fleming's left-hand rule. They appear to have either used their right hand, confused the direction of the magnetic field, or they confused the directions that the fingers and thumb represent. The forefinger is lined up with the magnetic field lines pointing from north to south, the second finger is lined up with the arrow shown from the current direction in the diagram, and the thumb then shows the direction of the motor effect force on the wire carrying the current.

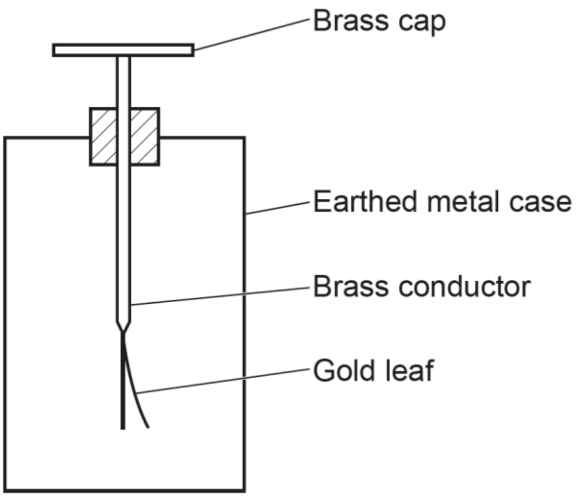
Section B overview

This section consists of five multiple part questions testing AO1, AO2 and AO3.

Question 11 (a)

11 **Fig. 11.1** shows a gold leaf electroscope that can be used to measure electric charge.

Fig. 11.1



(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]

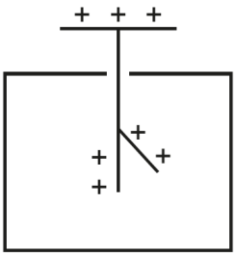
Most candidates gained 1 mark for stating that electrons move, however a significant number of candidates thought that protons were moving. A minority of candidates gave the correct direction of the electrons moving from the gold leaf electroscope to the positively charged rod.

Question 11 (b)

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

Fig. 11.2 shows the positively charged gold leaf electroscope.

Fig. 11.2



Explain why the gold leaf rises.

....

.... **[1]**

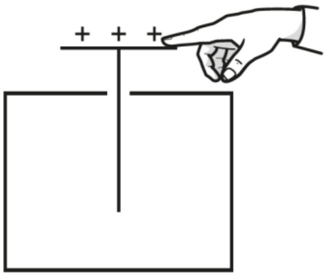
The majority of candidates gave the response of the positive charges repelling. Some candidates thought the gold leaf rises because of attractive forces between the charge on the leaf and the charge on the brass cap.

Question 11 (c)

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

Complete **Fig. 11.3** to show what happens to the gold leaf.
Explain your answer.

Fig. 11.3



Explanation ....

....

....

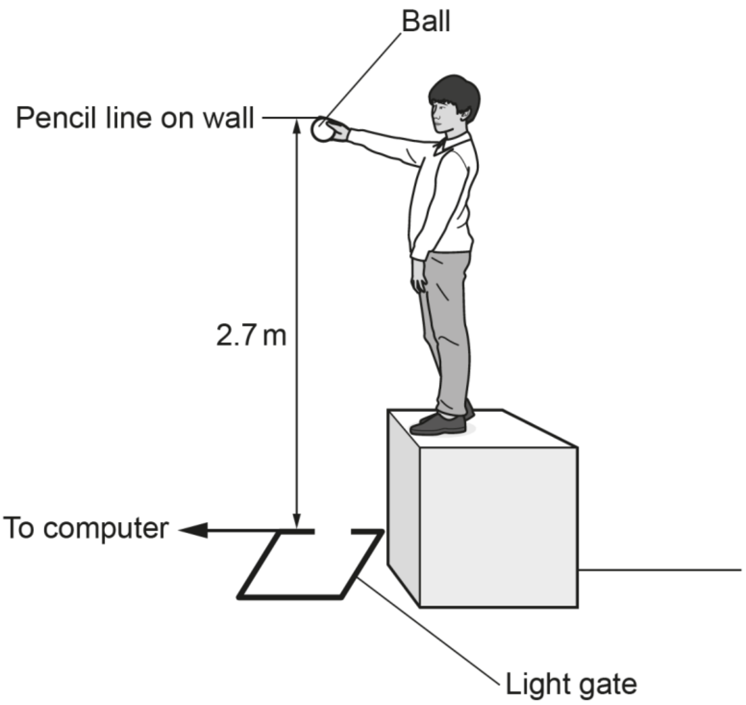
.... **[2]**

Few candidates gained marks for this question. Many candidates did not read the instruction to complete Fig. 3.3 and so did not draw on the diagram. Many candidates wrote about positive electrons or ions moving from the bass cap to the finger. Candidates who gained a mark tended to give the answer that the golf leaf went back to its original position or the gold leaf fell back down again.

Question 12 (a)

12 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 $(\text{final velocity})^2 - (\text{initial velocity})^2 = 2 \times \text{acceleration} \times \text{distance}$ to calculate the acceleration due to gravity.
	Drop the ball through the light gate.

[1]

This question was well answered by the majority of candidates. Care needs to be taken when writing numbers as some candidates wrote the number 2 in a way that looked too similar to their number 3.

Question 12 (b)

(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]

The majority of candidates gained 1 mark for drawing a line from 'The ball is thrown downwards.' to 'Hold the ball in a clamp stand and loosen the clamp to release.' Very few candidates gained the second mark as they drew a line from 'The computer calculates the wrong velocity.' to 'Repeat the same measurement 3 times.'

Question 12 (c) (i)

(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]**

Most candidates gave incorrect responses to this question such as 'the height of the ball', 'the distance the ball travelled', 'the velocity of the ball', 'the speed of the ball' or 'the time it took the ball to get to the light gate'.

Question 12 (c) (ii)

(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.

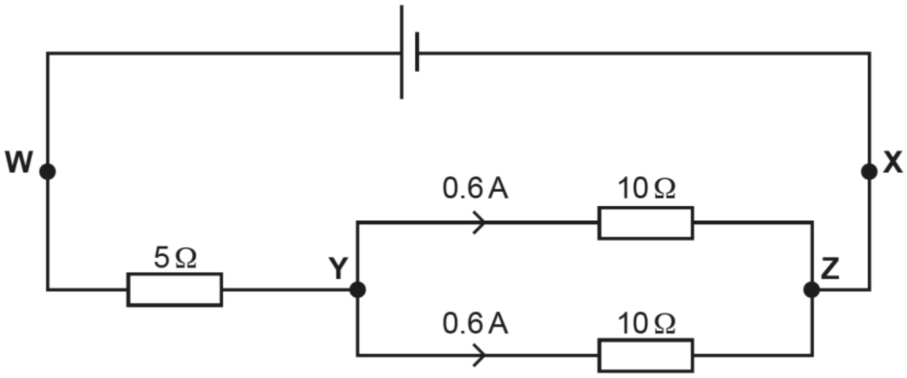
Use the equation: (final velocity)^2 – (initial velocity)^2 = 2 × acceleration × distance

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

Candidates usually either gained the full 3 marks or just 1 mark for this question. Candidates gaining just 1 mark often did not realise the initial velocity was 0 m/s or were unable to rearrange the equation correctly.

Question 13 (a)

13 A student builds the circuit shown in the diagram.
W, **X**, **Y** and **Z** are points in the circuit.



(a) Calculate the potential difference between **Y** and **Z**.

Use the Equation Sheet.

Potential difference between **Y** and **Z** = ... V **[3]**

Candidates mostly either gained the full 3 marks or just 1 mark for this question. The 1 mark was usually given for the correct equation of potential difference = current × resistance. A significant number of candidates added the values of the two 10 Ω resistors and/or the two 0.6 A currents labelled on the circuit diagram, giving a final answer of 12 V or 24 V.

Assessment for learning

Candidates need to read the question carefully and look carefully at any diagrams, especially circuit diagrams. This question asks candidates to calculate the potential difference between Y and Z, so candidates need to look at the position of the points Y and Z in the circuit diagram. Some candidates calculated the potential difference by including the 5 Ω resistor which is not found between Y and Z.

Question 13 (b)

(b) The resistance of the circuit between **Y** and **Z** must be less than 10 Ω.

Explain why.

....

....

....

.... **[2]**

This was a challenging question with very few candidates gaining 2 marks. A minority of candidates realised the circuit between Y and Z was a parallel circuit and so gained 1 mark. Candidates found it difficult to express why the resistance of the circuit between Y and Z must be less than 10 Ω with answers such as 'if the resistance is too high the current will not flow', 'the current is only 1 A' and 'resistance decreases so the current can increase'.

Question 13 (c)

(c) Calculate the current at **W**.

Current at **W** = ... A **[1]**

Many candidates gave the response of 1.2 A. As the addition was quite simple, 0.6 A + 0.6 A = 1.2 A, working out was rarely seen. 0.6 A was a common incorrect response.

Question 13 (d)

(d) Which statement describes the values of the current at **W** and **X**?

Tick (✓) **one** box.

The current at **W** is equal to the current at **X**. ☐

The current at **W** is more than the current at **X** as the current at **X** equals 0A. ☐

The current at **X** is more than the current at **W**. ☐

The current at **X** is more than 0A but less than the current at **W**. ☐

[1]

The majority of candidates gave the response 'The current at W is equal to the current at X.' A common incorrect response was 'The current at X is more than 0 A but less than the current at W.'

Question 13 (e)

(e) Calculate the power dissipated by one of the 10 Ω resistors.

Use the Equation Sheet.

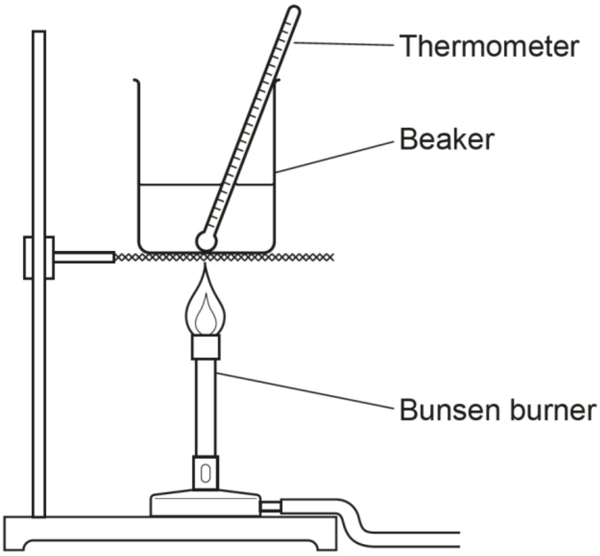
Power dissipated = ... W **[3]**

The majority of candidates were able to correctly calculate the power dissipated and so gain all 3 marks available. These candidates tended to begin by writing the equation, power = $(\text{current})^2$ × resistance, then rewriting the equation with the numbers substituted into it, and finally writing the correct calculated answer. Candidates who did not have the correct answer usually forgot to square the current and just multiplied the current and the resistance together giving an answer of 6 W.

Question 14 (a)

14 Three students **A**, **B** and **C** do an experiment to measure the power rating of a Bunsen burner.

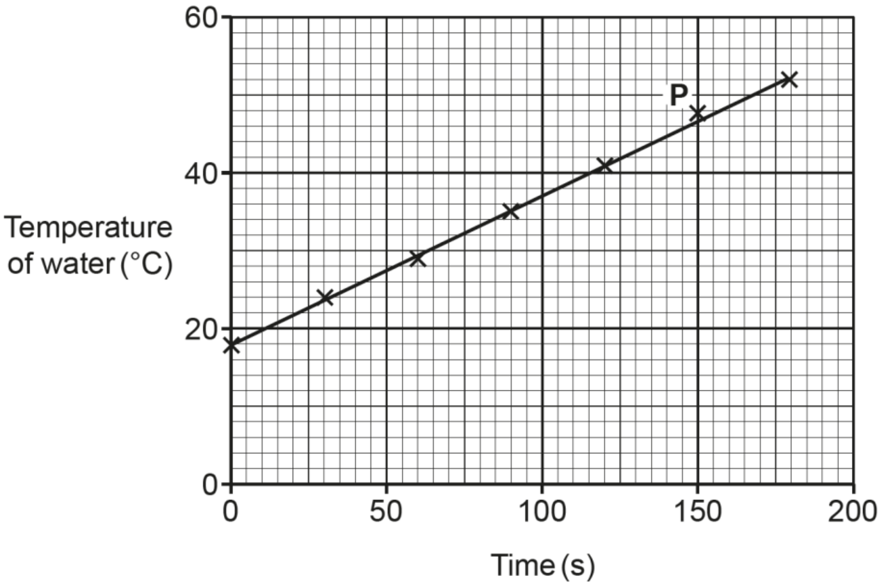
The diagram shows their apparatus.



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 temperature of the water every 30 seconds.

The graph shows student **A**'s results.



(a) Student **A** uses point **P** on the graph to calculate the gradient of the line of best fit.

Explain why student **A**'s calculation is **incorrect**.

....

.... **[1]**

The majority of responses gave a correct explanation why student A's calculation is incorrect. The usual correct responses were 'the point does not lie on the line of best fit' or 'a gradient cannot be calculated from a single point'.

Question 14 (b)

(b) Calculate the gradient of the line of best fit on the graph.
Give your answer to **2** significant figures.

Gradient = ... °C / s **[3]**

Only about a third of responses were given all 3 marks available for this question. Many candidates found it challenging to calculate the gradient: many drawing a very small triangle on the graph in an attempt to calculate the gradient; others taking correct readings from the graph to calculate the gradient, but then not knowing what to do with these readings. The conversion of the candidates' calculated answers to 2 significant figures was well done.

Question 14 (c) (i)

(c) **(i)** What is the significance of the *y* intercept of the line on the graph?

.... **[1]**

The majority of candidates gave the significance of the y intercept on the line on the graph as 'the temperature of the water before heating' or 'the initial temperature of the water'. Some candidates thought the significance of the y intercept on the line on the graph as 'the increase in temperature' or just gave the number '18' as their response.

Question 14 (c) (ii)

(ii) What is the significance of the gradient of the line on the graph?

.... **[1]**

This question was not answered well with many candidates not realising the gradient of the line on the graph represented a rate of change of temperature. Many candidates just thought the gradient of the line on the graph represented 'the change in temperature' or 'the increase in temperature'. Some candidates gave general responses such as 'it is constant' or 'it is a straight line'.

Question 14 (d)

(d) Student **B** repeats the experiment. The gradient of their line of best fit is 0.25 °C / s.
The specific heat capacity of water is 4200 J / kg °C.

Use student **B**'s value to calculate the thermal energy transferred to 0.2 kg of water after 200 s.

Use the Equation Sheet.

Thermal energy transferred = ... J **[3]**

Candidates usually either gained the full 3 marks or just 1 mark for this question. Some candidates did not calculate the temperature rise as 50 °C (by using 0.25 × 200), and used 0.25 °C as the temperature change.

Assessment for learning

Candidates need to read the question carefully and look carefully at any units given for quantities. In this question, the gradient is given as 0.25 °C / s and not 0.25 °C. Many candidates assumed the 0.25 was the temperature rise (rather than the temperature rise per second) and that the question was about the temperature after 200 seconds.

Question 14 (e)

(e) Student **C** also repeats the experiment.

They say the thermal energy transferred is 32 000 J after 200 s.

Use student **C**'s value to calculate the power of the Bunsen burner.

Use the Equation Sheet.

Power = ... W **[3]**

The majority of candidates were able to correctly calculate the power, and so gained all 3 marks available. These candidates tended to begin by writing the equation, power = work done ÷ time, then rewrote the equation with the numbers substituted into it, and finally wrote the correct calculated answer.

Candidates who did not have the correct answer usually multiplied the work done and the time giving an answer of 6 400 000 W.

Question 15*

15* **Fig. 15.1** shows the distance–time graph for a skydiver after jumping out of a plane.

The graph describes the distance the skydiver falls through until the parachute opens.

Fig. 15.2 shows the free-body force diagram for the skydiver in the air.

Fig. 15.1

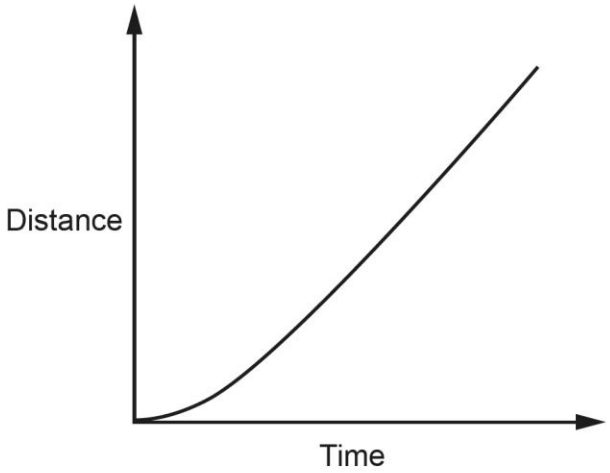
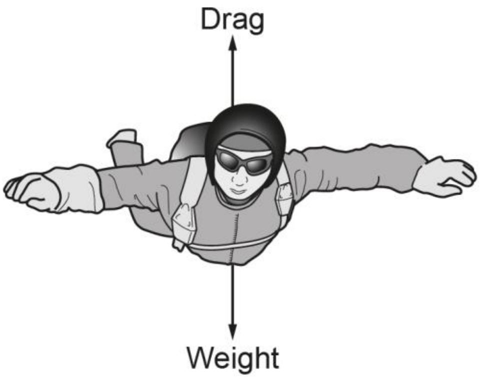


Fig. 15.2



Explain the shape of **Fig. 15.1**. Use information from **Fig. 15.2** in your answer.

....

....

....

....

....

.... **[6]**

This is the Level of Response question. This question was attempted by the majority of candidates and the full range of the marks available were given. Many candidates gained marks for AO3.1a by analysing and interpreting the distance-time graph. These responses were usually in order from the time the skydiver jumped out of the plane until the parachute opened. Good responses integrated the AO1.1 knowledge about the forces on the skydiver to the various stages of the graph. Many candidates mentioned both the weight and drag forces in their response, but some candidates did not make it clear which force was the larger at the beginning, when the skydiver first jumped out of the plane. Some candidates also thought the weight would change as the skydiver fell, and there was a lack of understanding that the drag would increase as the skydiver accelerated.

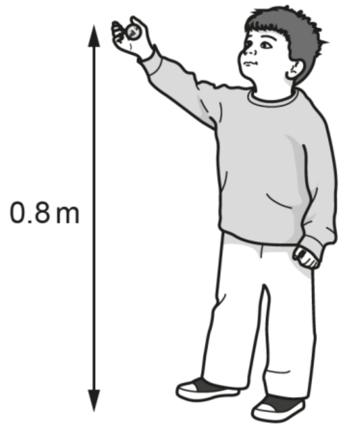
Exemplar 2

At first the speed of the skydiver is changing at an increasing rate, shown by the curved start of the graph. this is because the weight of the skydiver ~~of the drag~~ is bigger than the drag by air resistance, so the unbalanced forces cause the resultant force to be acceleration downwards due to weight. The graph starts to become linear as the skydiver approaches terminal velocity. The drag acts to oppose the weight reducing the size of the resultant force, which explains the steeper curve, until the forces are balanced and the skydiver is moving at a constant speed, as there is no resultant force acting on his body. This is shown by the linear shape of the graph. The gradient represents speed, and the distance and time are ~~equ~~ directly proportional, so the speed is constant. ~~Re~~ He has reached terminal velocity. **[6]**

The candidate in Exemplar 2 has integrated their response for AO3.1a with AO1.1 and kept their explanation in order as the skydiver jumped out of the plane until the parachute opened. This is a good example of a response that meets all the criteria for Level 3 and was given 6 marks.

Question 16 (a)

16 (a) A child is holding a marble at a height of 0.8 m.



The mass of the marble is 0.015 kg.

Calculate the gravitational potential energy of the marble.

Gravitational field strength = 10 N / kg.

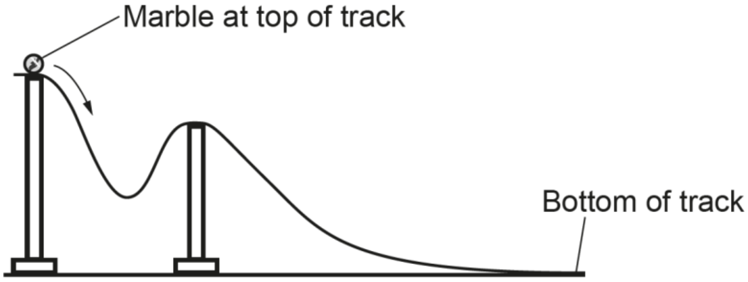
Use the equation:
gravitational potential energy = mass × gravitational field strength × height

Gravitational potential energy = ... J **[2]**

The majority of candidates were able to calculate the gravitational potential energy by using the equation given to them in the question. A few candidates forgot to include the gravitational field strength and so ended with the answer of 0.015 × 0.8 = 0.012 J.

Question 16 (b) (i)

(b) The child rolls the marble along a track. The diagram shows the marble and track.



(i) The kinetic energy of the marble at the bottom of the track is less than the potential energy of the marble calculated at the top of the track.

Suggest and explain why.

....

....

....

.... **[2]**

This was a challenging question, with very few candidates gaining any marks. Most candidates wrote about the loss in gravitational potential energy as the marble rolled down the track, and about why it would have to 'use some of the kinetic energy' to get over the bump in the track. Very few candidates explained that the discrepancy was due to the work done against friction (e.g. between the marble and the track) or the fact that some of the energy would be transferred to a thermal store.

Assessment for learning

Candidates need to read the question carefully. This question stated that the kinetic energy of the marble at the bottom of the track is less than the potential energy of the marble calculated at the top of the track. Many candidates just rewrote this in their answers and did not consider why there was a difference.

Question 16 (b) (ii)

(ii) The mass of the marble is 0.015 kg.

The kinetic energy of the marble at the bottom of the track is 0.03 J.

Calculate the speed of the marble at the bottom of the track.

Use the equation: kinetic energy = $\frac{1}{2}$ × mass × (speed)^2

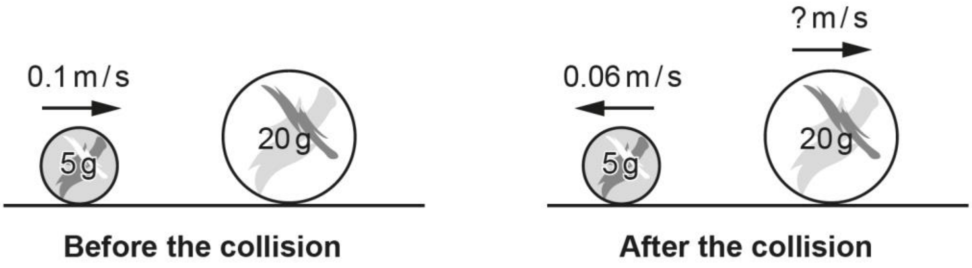
Speed of marble = ... m/s **[3]**

The majority of candidates were able to calculate the speed of the marble. These candidates were able to rearrange the given equation, however some candidates were unable to rearrange the equation and others doubled the 4 m/s rather than taking the square root.

Question 16 (c)

(c) The child now has a small marble and a large marble.
The child rolls the small marble across the floor.
The small marble collides with the stationary large marble.

The diagram shows the marbles before and after the collision.



The mass of the small marble is 5 grams. The mass of the large marble is 20 grams.

Use the information in the diagram to calculate the speed of the large marble after the collision.

Use the Equation Sheet.

Speed of large marble = ... m / s **[3]**

This was a very challenging question with very few candidates gaining any marks. A few candidates gained 1 mark for calculating a momentum, for example 5 g x 0.1 m/s for the small marble before the collision. Very few candidates applied the idea about conservation of momentum, with many candidates trying to use the equation to calculate kinetic energy instead.

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