

GCSE (9-1)

Examiners' report

**GATEWAY SCIENCE
COMBINED
SCIENCE A**

J250

For first teaching in 2016

J250/05 Summer 2022 series

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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 are 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.

Advance Information for Summer 2022 assessments

To support student revision, advance information was published about the focus of exams for Summer 2022 assessments. Advance information was available for most GCSE, AS and A Level subjects, Core Maths, FSMQ, and Cambridge Nationals Information Technologies. You can find more information on our [website](#).

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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 be 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.

Many candidates completed all questions in the exam within the allotted time.

Candidates who did well on this paper generally did the following:	Candidates who did less well on this paper generally did the following:
<ul style="list-style-type: none"> • Identified and applied or manipulated equations. • Demonstrated knowledge of scientific procedures (e.g. finding density, stretching springs). • Interpreted circuit diagrams to carry out calculations. • Analysed and interpreted graphs to draw conclusions and identify circuit components. 	<ul style="list-style-type: none"> • Found it difficult to identify and apply or manipulate equations. • Struggled to interpret distance-time and current-potential difference graphs. • Lacked the necessary knowledge to respond in depth to the Level of Response question about density.

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.

Most successful questions	Least successful questions
<ul style="list-style-type: none"> Calculating power Question 1 Magnetic fields Question 2 Calculating energy transferred Question 5 Identifying a contact force Question 6 	<ul style="list-style-type: none"> Identifying the circuit component Question 4 Newton's third law Question 8 Resultant force and motion Question 9 Charged objects Question 10

Assessment for learning



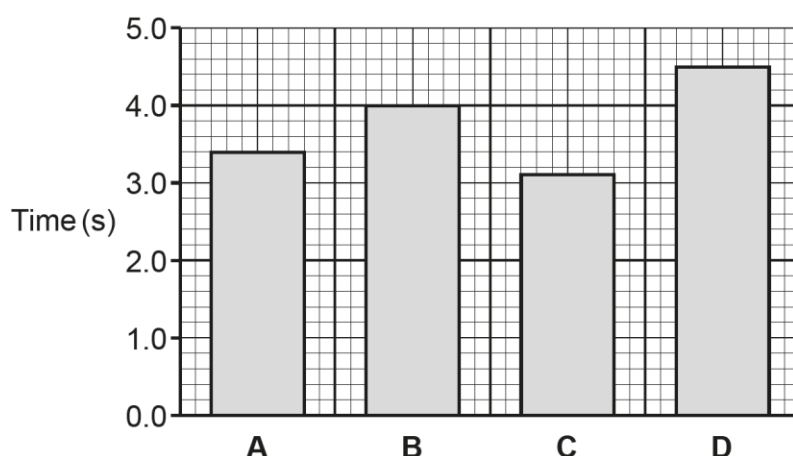
Candidates who did well on this section generally did the following.

- 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 Four weightlifters **A**, **B**, **C** and **D**, each do 2000 J of work lifting a weight.

The time taken for each of them to do their lift is shown in the graph.



Which weightlifter has the **highest** power?

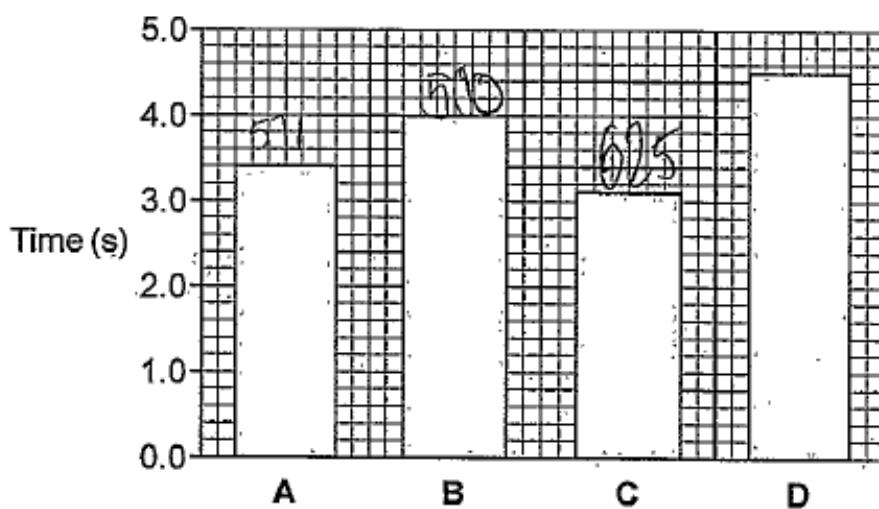
Use the Data Sheet.

Your answer

[1]

Most candidates were able to interpret the bar chart and link the highest power to the weightlifter who took the least amount of time. Many successful candidates wrote down their workings and/or an equation to calculate the power of each weightlifter.

Exemplar 1



Which weightlifter has the **highest** power?
Use the Data Sheet.

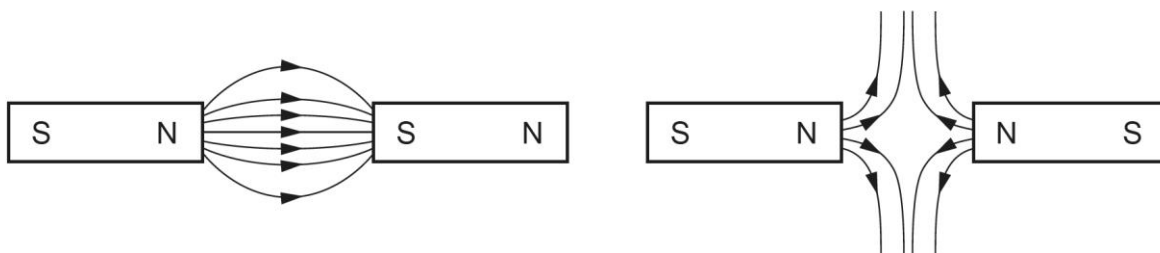
Your answer

C

Exemplar 1 shows how the candidate used the equation triangle to calculate the power of each weightlifter.

Question 2

2 The diagrams show the magnetic field lines around the bar magnets.



Which answer is **correct**?

- A N poles repel S poles.
- B The direction of the magnetic field lines is N to S.
- C The magnetic field is stronger further from the bar magnet.
- D The poles are at the centre of the bar magnet.

Your answer

[1]

The majority of candidates successfully applied their knowledge of magnetic fields to identify that only option B was the only correct statement.

Question 3

3 A student records the time it takes to run three distances. The table shows their results.

Distance (m)	25.2	25.0	25.1
Time taken (s)	40.0	41.6	42.4

How many significant figures is the student using?

- A 1
- B 2
- C 3
- D 4

Your answer

[1]

This question assessed candidates' knowledge of significant figures. Nearly one half of candidates did not know that three significant figures were being used and the most common incorrect answer was option A.

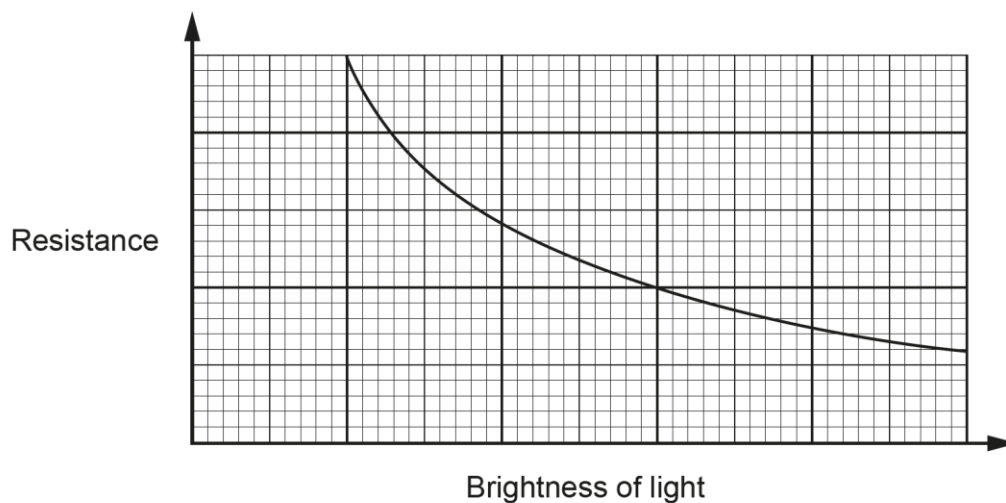
Assessment for learning



Candidates could benefit from short starter or plenary activities where they practise identifying the number of significant figures in a number or write numbers to a given number of significant figures.

Question 4

4 The graph shows how the resistance of a circuit component changes with the brightness of light.



What is the name of the circuit component?

- A Diode
- B Filament lamp
- C LDR
- D Thermistor

Your answer

[1]

Some candidates were unable to correctly identify that the graph was for an LDR. (P3.2h)

Assessment for learning



Candidates could benefit from a short activity such as a card sort where they match components with their I-V characteristic graphs.

Question 5

5 A cell transfers energy.

- The potential difference is 6 V.
- The charge flowing is 40 C.

What is the amount of energy transferred by the cell?

Use the equation: energy transferred = charge \times potential difference

- A 0.15 J
- B 0.9 J
- C 6.7 J
- D 240 J

Your answer

[1]

Almost all candidates were able to substitute the values into the equation provided to work out that the energy transferred was 240 J.

Question 6

6 Which force is a **contact** force?

- A Electrostatic
- B Friction
- C Gravity
- D Magnetic

Your answer

[1]

Most candidates were able to identify that friction is a contact force.

Question 7

7 A child is riding a bicycle. They accelerate from 0 m/s to 4 m/s in 20 seconds.

Calculate the acceleration of the child.

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

- A 0.2 m/s²
- B 4 m/s²
- C 5 m/s²
- D 8 m/s²

Your answer

[1]

This question required candidates to work out the change in the velocity of the bicycle and then substitute that number and the time given into the equation provided to calculate the acceleration. Most candidates were able to do this correctly, but the most common error observed involved using the equation upside down and dividing the time by the change in velocity.

Question 8

8 Which pair of forces are a Newton's third law pair?

- A Weight of magnet and magnetic force
- B Weight of person and friction on person
- C Weight of person and pull of person on the Earth
- D Weight of skydiver and air resistance on skydiver

Your answer

[1]

The question required candidates to apply their knowledge of Newton's third law to identify the correct pair of forces as option C. Just over half of candidates were able to identify the correct pair but the most common error observed involved candidates confusing forces acting in interaction pairs with forces on a free-body diagram and therefore choosing option D.

Misconception



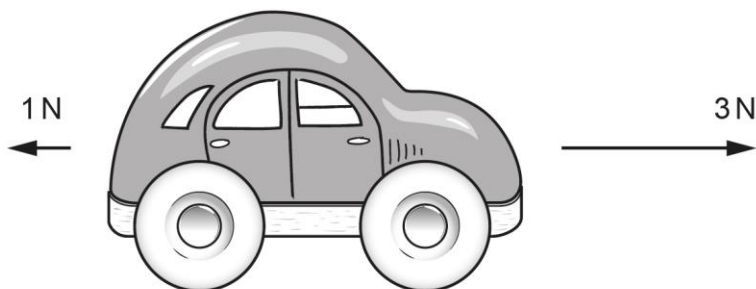
Candidates are confusing Newton's third law forces with free-body diagram forces.

Newton's third law involves pairs of forces interacting and each force acts on a different object.

Free-body diagrams involve forces acting on a single object.

Question 9

9 The diagram shows some forces acting on a toy car.



Which row in the table describes the motion of the toy car?

	Resultant force	Motion
A	2 N forwards	acceleration
B	2 N forwards	constant velocity
C	3 N forwards	acceleration
D	3 N forwards	constant velocity

Your answer

[1]

Around two thirds of candidates were unable to correctly identify the resultant force and motion for the toy car. Many candidates recognised that the car was accelerating but thought that the resultant force was 3 N and therefore chose option C.

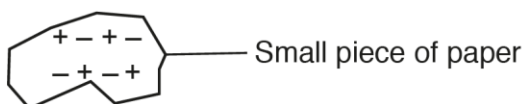
Assessment for learning



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

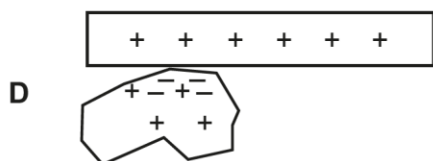
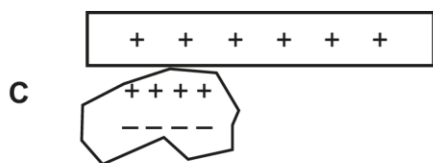
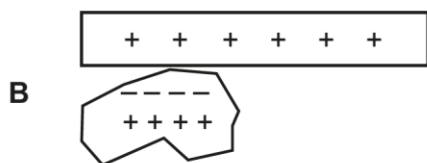
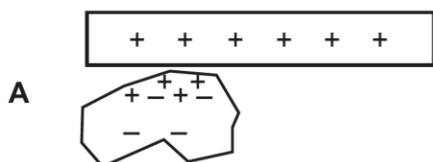
Question 10

10 The diagram shows a positively charged rod near a small piece of paper.



The paper is attracted to the rod.

Which diagram shows the **correct** distribution of positive and negative charges in the piece of paper as the rod is brought closer?



Your answer

[1]

The majority of candidates found this question challenging and did not gain credit. The most common incorrect answer was option B as candidates thought that there would be no positive charges remaining at the top of the paper.

Misconception



The most common misconception was that positive charges in the piece of paper which are repelled by the rod must therefore move further away from the rod.

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.

Most successful questions	Least successful questions
<ul style="list-style-type: none"> • Describing elastic and plastic materials Question 11 (b) • Converting grams to kilograms and calculating weight Question 11 (d) • Calculating charge flow Question 13 (b) • Determining distance travelled on distance-time graph Question Q14 (a) (i) 	<ul style="list-style-type: none"> • Explaining a prediction Question 11 (a) (i) • Identifying constant speed on a distance-time graph Question 14 (a) (iii) • Explaining the use of a variable resistor Question 15 (a) (i) • Describing the difference between specific heat capacity and specific latent heat Question 16 (a) • Calculating current and potential difference in a series circuit. Questions 17 (b) and 17 (c)

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

- Underlined key words
- Identified equations from the Data Sheet and wrote down all of their calculations
- Identified independent, dependent and control variables
- Worked methodically in order to describe how a student carried out an experiment to calculate density and how to improve their method, in the Level of Response question
- Applied their knowledge to interpret and identify relationships from graphs.

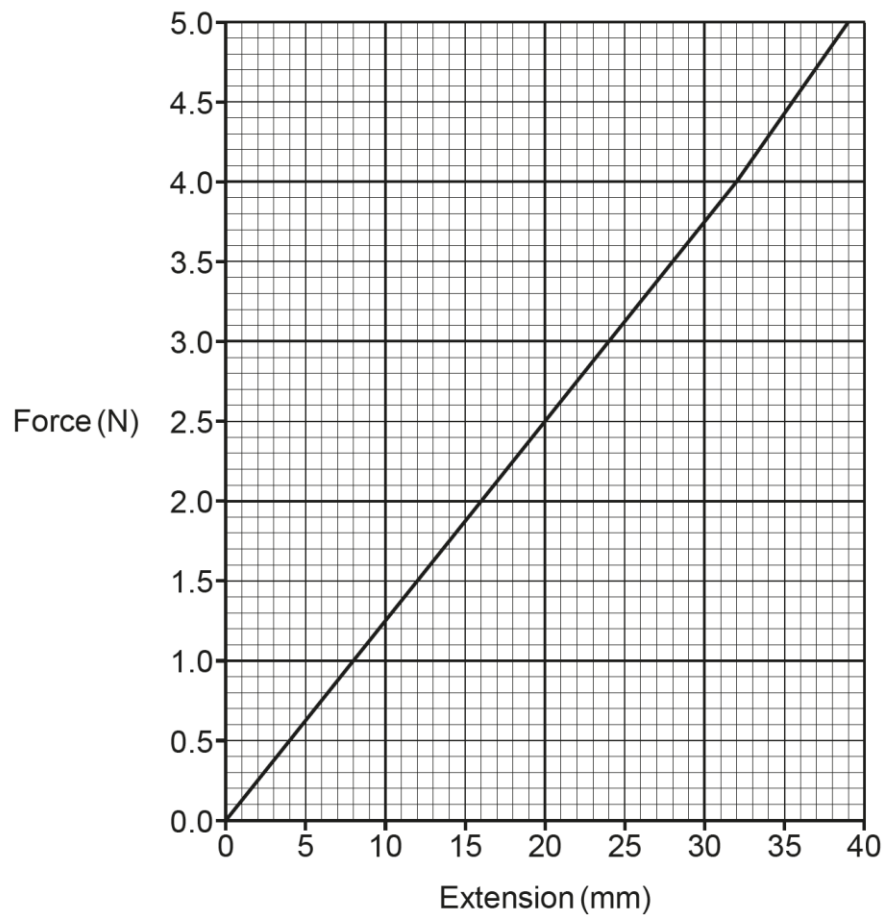
Candidates who did less well on this section generally did the following:

- Struggled with the mathematical skills required
- Only wrote the answers to questions involving equations, no calculations were shown
- Gave answers that lacked depth and showed poor quality of communication
- Struggled to interpret graphs and the relationships shown.

Question 11 (a) (i)

11 (a) A student stretches **one** spring by applying a force to it. **Fig. 11.1** shows the results.

Fig. 11.1

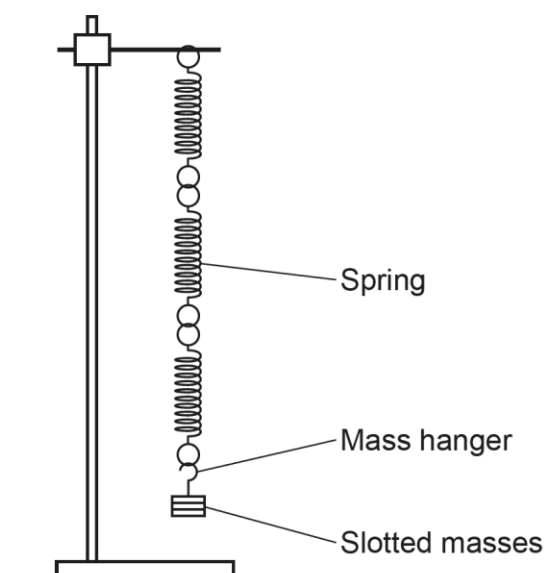


The student makes a prediction:

'The more springs I join together, the greater the total extension when the same force is applied.'

Fig. 11.2 shows a diagram of the springs.

Fig. 11.2



(i) Explain why the student makes this prediction.

.....

.....

..... [2]

Candidates struggled with this low demand question and only the more successful responses could give a reason about why the prediction had been made. Most candidates just repeated the question stem in their answer (the more springs, the greater the extension), and gave no further detail. Candidates need to be careful to answer the question asked (explain the prediction) not to just repeat the question in their answer.

Question 11 (a) (ii)

(ii) The student has the equipment shown in **Fig. 11.2**.

What **other** piece of equipment do they need to test this prediction?

..... [1]

Question 11 (a) (iii)

(iii) What do they change to test the prediction?

..... [1]

Question 11 (a) (iv)

(iv) What do they measure to test the prediction?

..... [1]

Question 11 (a) (v)

(v) What do they keep the same to test the prediction?

..... [1]

Questions 11 (a) (ii) to 11 (a) (v) assessed AO3 and required candidates to identify equipment and the different variables in the experiment. About half of candidates were able to do this successfully but many struggled to identify the independent, dependent and control variables correctly.

Assessment for learning



Candidates could benefit from short activities, e.g. where they have to identify the different types of variables in both familiar and unfamiliar experiments.

Question 11 (b)

(b) Children often make models with clay. Clay and rubber bands behave differently.

Draw lines to connect each **property** to its correct **description**, and each **description** to the correct **example**.

Property	Description	Example
Elastic	Keeps its new shape when force removed	Rubber band
Plastic	Regains original shape when force removed	Clay

[2]

Most candidates were given both marks.

Question 11 (c)

(c) Some children are talking about squashing a lump of clay on a desk.

- Child **A** says, 'Forces are not required to squash the clay.'
- Child **B** says, 'There is only one force acting on the clay when I squash the clay.'
- Child **C** says, 'There are three forces acting on the clay when I squash the clay.'

Who is correct?
Tick (✓) **one** box.

- Child **A**
- Child **B**
- Child **C**

[1]

Most candidates answered this incorrectly and thought that Child B was correct.

Question 11 (d) (i)

(d) The mass of a lump of clay is 150 grams. 1 gram = 0.001 kg.

(i) What is the mass of the lump of clay in kg?

Mass = kg [1]

Question 11 (d) (ii)

(ii) The mass of another lump of clay is 0.35 kg.

Calculate the weight of this lump of clay.

Use the equation: gravitational force = mass \times gravitational field strength

Gravitational field strength = 10 N/kg.

Weight = N [2]

Most candidates correctly converted 150 grams into kilograms in Question 11 (d) (i) and substituted the values for mass and gravitational field strength into the equation to calculate weight in Question (d) (ii). However, some candidates struggled to use the equation, even though it was provided, and divided the quantities rather than multiply them, or they converted 0.35 kg into grams before substituting into the equation.

Assessment for learning

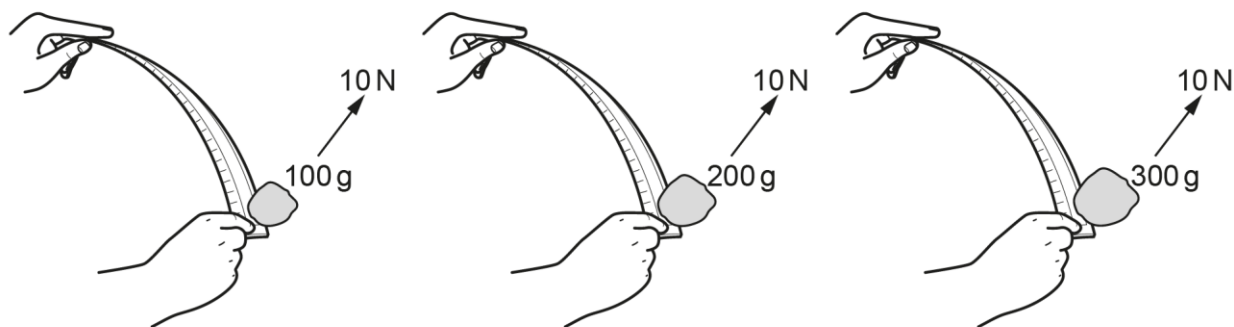
Candidates could again benefit from writing down calculations rather than only their final answer so that compensatory marks may be given.

Question 11 (e) (i)

(e) One child uses a ruler to hit lumps of clay across the desk.

Fig. 11.3 shows the child hitting three different lumps of clay.

Fig. 11.3



(i) Which lump of clay has the **greatest** acceleration?

Use the Data Sheet.

Tick (✓) **one** box.

- 100 g
- 200 g
- 300 g

[1]

Question 11 (e) (ii)

(ii) Explain the reason for your answer to (e)(i).

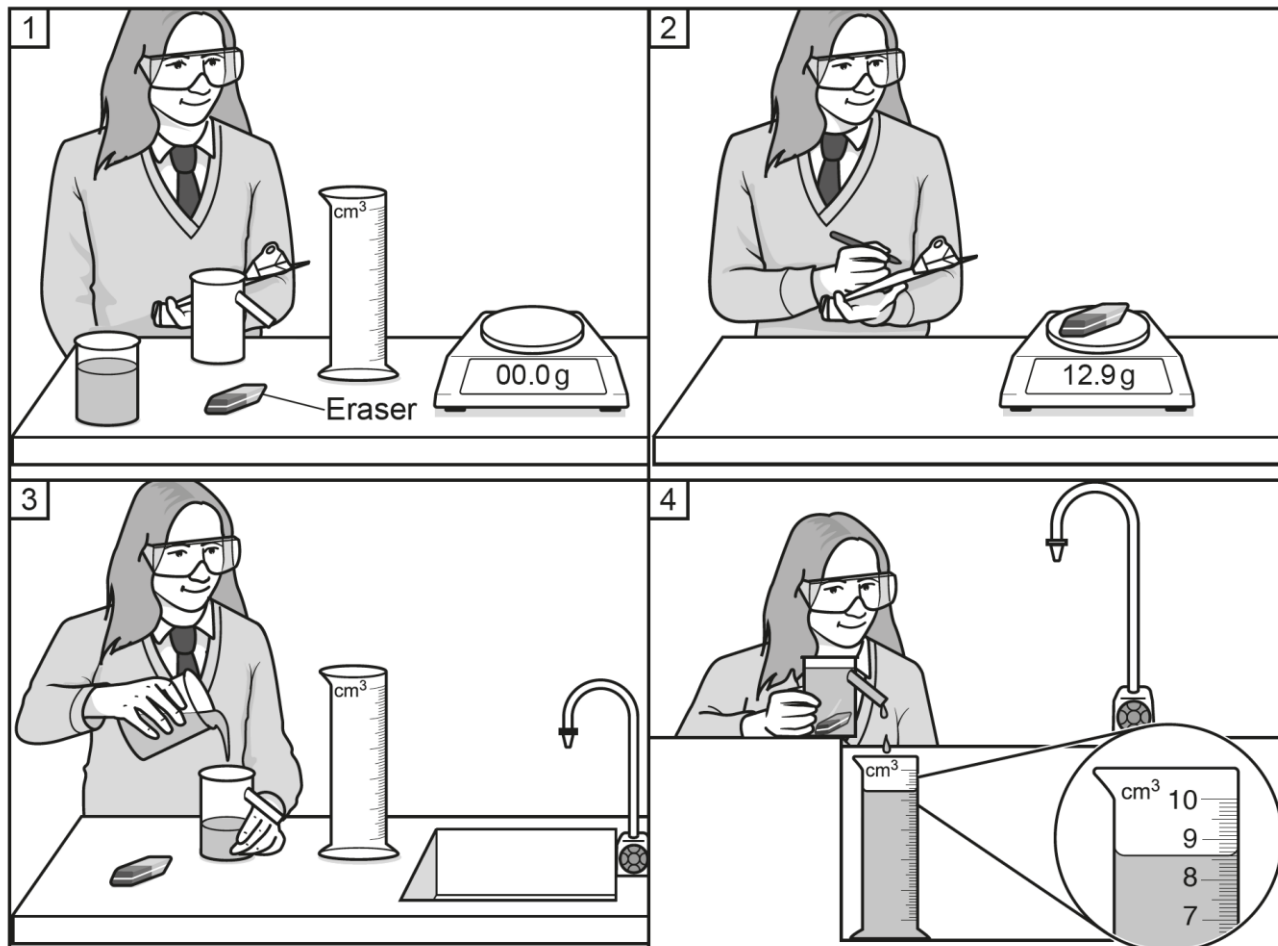
.....
 [1]

The majority of candidates correctly identified in Question 11 (e) (i) that the 100 g mass had the greatest acceleration but struggled to fully explain why they had chosen this mass in part Question 11 (e) (ii). Most answers identified that it was the smallest mass but did not state that the same force was applied to each mass. Some candidates gained this mark by calculating the acceleration for each mass.

Question 12*

12* A student does an experiment to find out the density of an eraser. The eraser has an irregular shape.

The diagrams show the student's method:



Describe how the student works out the **density** of the eraser. Use the Data Sheet and include calculations in your answer.

Describe how the student can improve their method.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

[6]

This Level of Response question was designed to give opportunities for both lower and higher ability foundation tier candidates. It assessed AO1, AO2 and AO3, and required students to use the diagrams to help describe how to work out the density of the eraser, to calculate the density and to suggest improvements.

The question proved challenging to most students and they did not attempt each part, with only approximately one third gaining Level 2 or above. Most candidates recognised that the mass of the rubber needed to be measured but did not mention the correct equipment. Describing how to measure the volume was often attempted but many less successful responses struggled to describe what was happening in the diagram in enough detail or poor quality of communication prevented them from gaining credit.

For Level 1, candidates usually calculated the density of the eraser using the mass and volume shown in the diagram and the equation from the Data Sheet. A more complete response for Level 2 or 3 included a clear and detailed description of how the density of the eraser was worked out and/or an improvement.

Assessment for learning



All candidates will have experienced this practical activity or similar in one of the Practical Activity Groups. Candidates could benefit from short activities, e.g. where they have to match pieces of equipment with what needs to be measured or writing short, concise methods for different experiments.

Many candidates would benefit by underlining key parts of the question to help check that they have included all parts of the question in their response.

It would also be beneficial for students to think about which improvements could be made to their method each time they carry out one an experiment.

Misconception



Some candidates thought that the water displaced by the eraser was the equal to its density.

Exemplar 2

$$D = \frac{m}{V}$$

13

weigh rubber
eureka

Describe how the student works out the **density** of the eraser.
Use the Data Sheet and include calculations in your answer.

Describe how the student can improve their method:

The student will need scales, eureka can, measuring cylinder. The student will weigh the rubber and record the weight. She then weighs pours water into the eureka can and records how much water was poured into it. The rubber gets ^{placed} into the eureka can and the water level would rise. The student water will be poured out of the funnel. ~~or~~ The amount of water loss is calculated and worked down. You can calculate the density of the eraser by doing mass divided by volume. To improve her results she must re-do the test with the same weight of rubber and same amount of liquid to test the results are valid. You can also put a cylinder in by the eureka to calculate find out how much water was lost from the rubber entering the can. [6]

Exemplar 2 shows a Level 2 response, 4 marks. The candidate has provided a good description of how to measure mass and volume, including the equipment needed, although it lacks some detail. The candidate has also suggested repeating the test as an improvement. Ideally, it would have been clear that the mass and volume measurements would have been repeated and a mean calculated for each.

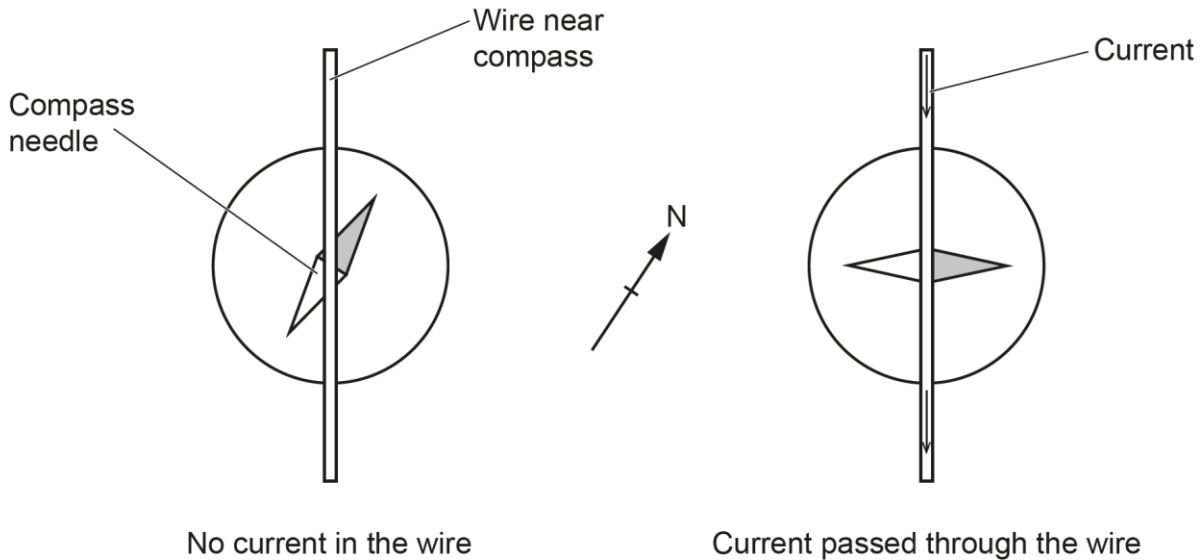
To access Level 3, the candidate needed to use the readings on the diagram for mass and volume in order to calculate the density of the eraser.

Question 13 (a)

13 In 1820, a scientist called Oersted did an experiment with a compass.

- He placed a wire near a compass.
- He passed a current through the wire.

The diagram shows his experiment. The direction of magnetic north is also shown.



(a) Magnetic fields are produced by currents in wires.

Describe how the diagram shows this.

.....

..... [1]

Question 13 (b)

(b) A teacher repeats the experiment.

- The current in the wire is 5.0A.
- The current is in the wire for 30 seconds.

Calculate the charge flowing through the wire.

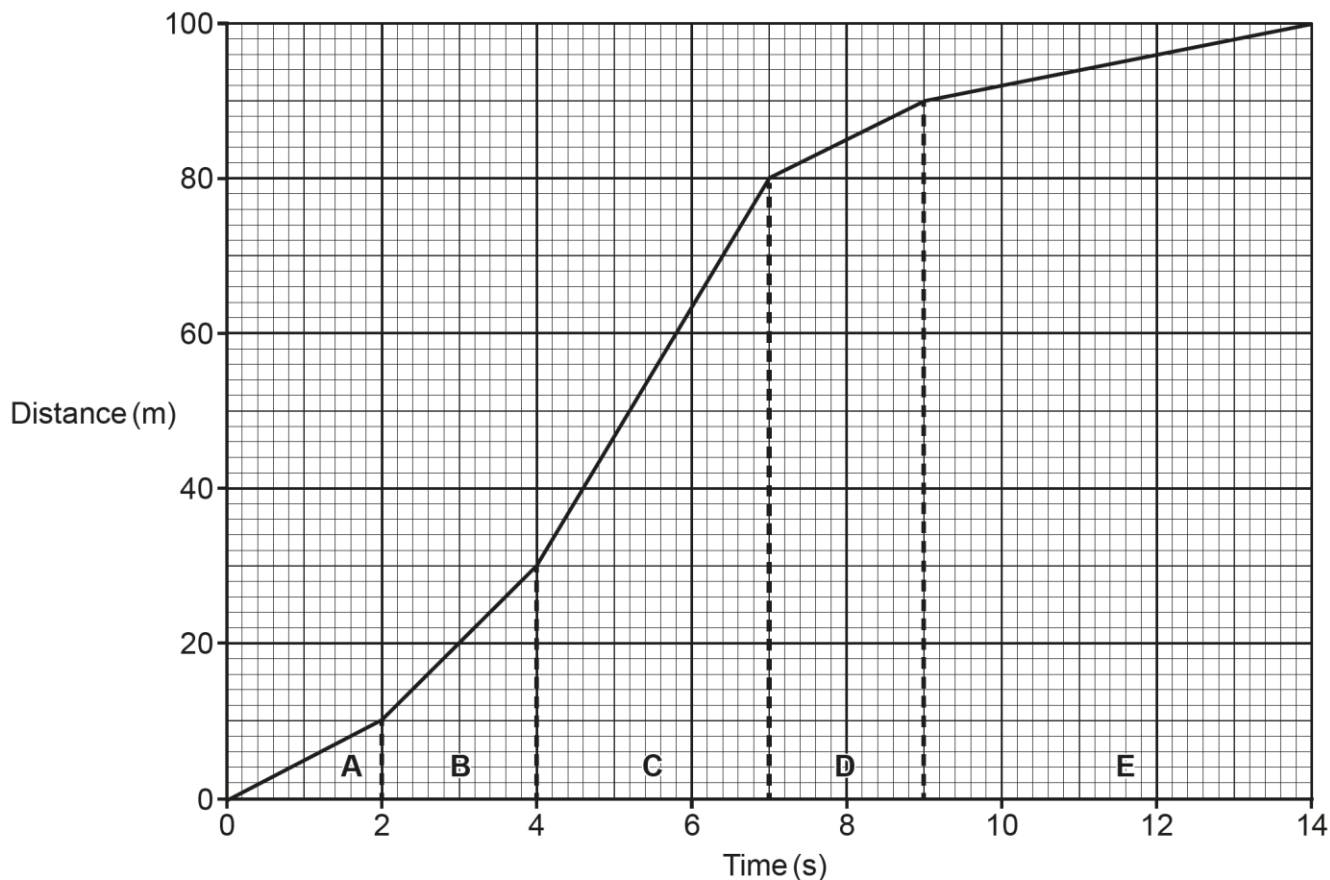
Use the equation: charge flow = current × time

Charge flow =C [2]

Some candidates were familiar with the concept of the magnetic effect of a current in a wire causing the compass needle to deflect in Question 13 (a) but some candidates had the misconception that the current passed through the compass needle. The majority of candidates used the equation and quantities provided to correctly calculate the charge flow through the wire in Question 13 (b).

Question 14 (a) (i)

14 This is a distance-time graph for an athlete running a race.



(a) (i) What distance does the athlete run?

Distance = m [1]

Question 14 (a) (ii)

(ii) In which **two** parts of the graph is the athlete moving at the **same** speed?

Tick (✓) **two** boxes.

A B C D E

[1]

Question 14 (a) (iii)

(iii) In each part of the graph the athlete moves at a **constant** speed.

How does the graph show this?

..... [1]

Question 14 (a) (iv)

(iv) How long does it take the athlete to run part **D**?

Answer = s [1]

Question 14 (b)

(b) Calculate the speed of the athlete in part **A**.

Use the equation: distance travelled = speed \times time

Speed = m/s [3]

This question required candidates to read values off the graph, interpret different sections of the graph and to rearrange the equation provided to calculate the speed.

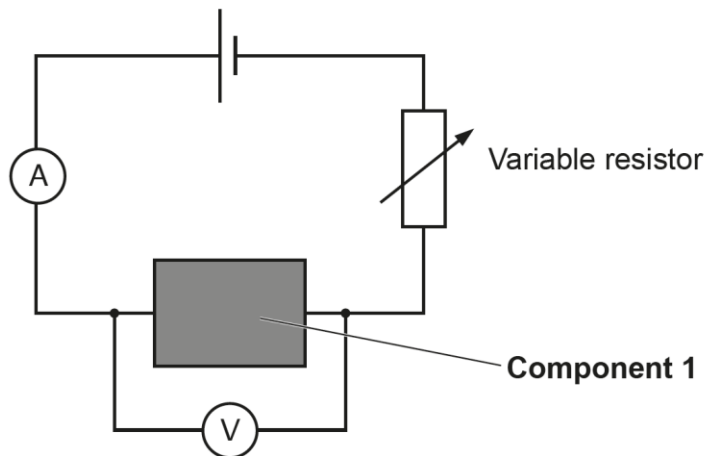
Most candidates were able to determine the distance travelled in Question 14 (a) (i) and the time taken in Question 14 (a) (iv), but in Question 14 (a) (ii), they struggled to link the sections of the graph with equal gradients to the parts of the race where the athlete was travelling at the same speed. Most candidates were also unable to explain how the graph showed that the athlete was travelling at a constant speed for each section, in part Question 14 (a) (iii).

In part (b), of those candidates who could manipulate the equation correctly, almost all gained full marks. Many candidates, however, only wrote down their final answer so could not gain compensatory marks if their answer was incorrect.

Question 15 (a) (i)

15 A student uses the circuit in **Fig. 15.1** to test two different circuit components. They measure the current and potential difference for **Component 1**.

Fig. 15.1



(a) (i) Explain why a variable resistor is used in the circuit.

.....
 [1]

Many could not explain the role of a variable resistor in a circuit, with vague responses referring to, e.g. energy, slowing the current down.

Assessment for learning



Candidates should be aware that ideas about stronger/weaker/faster/slower current or electricity will not be given marks.

Question 15 (a) (ii)

(ii) The current in **Component 1** is 0.1A.

What is the current in the variable resistor?

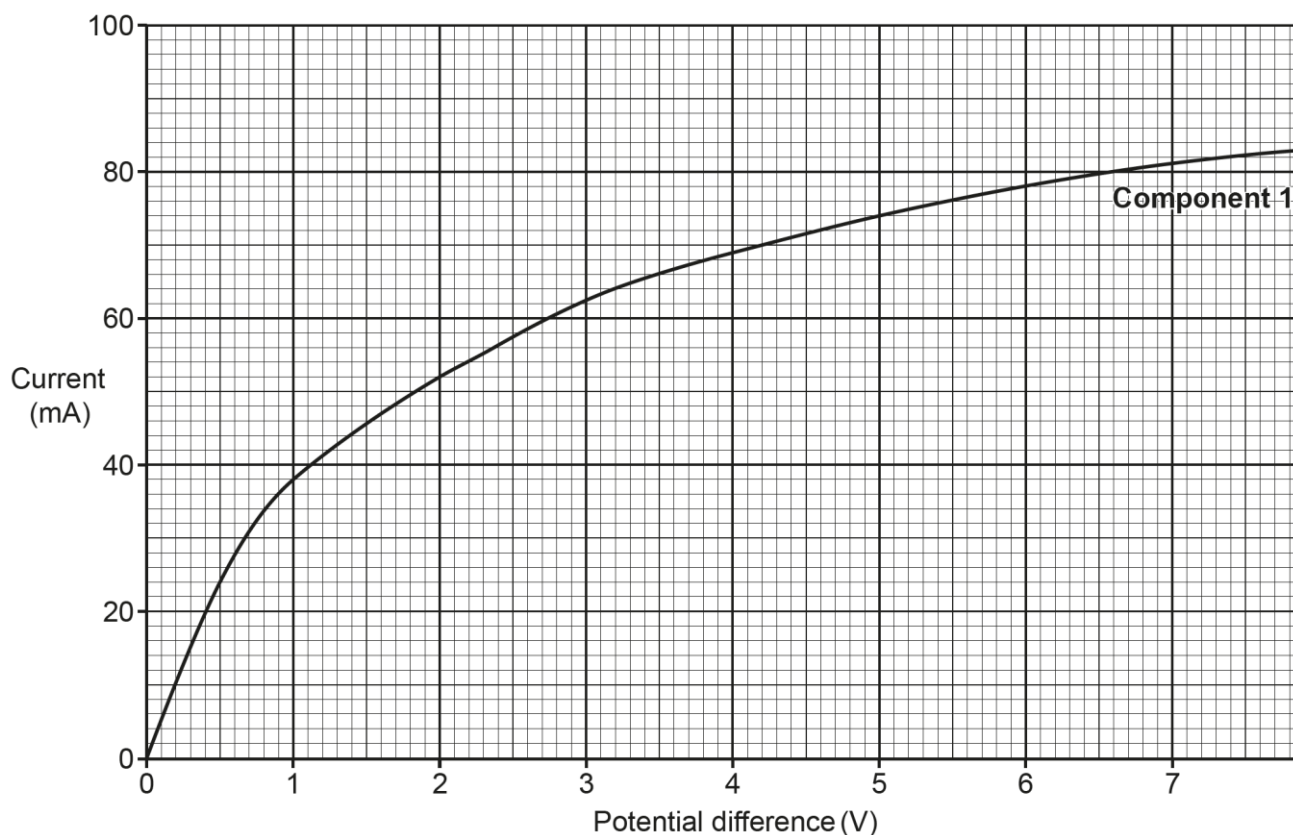
Current = A [1]

Fewer than half of candidates successfully applied the rule for the current in a series circuit.

Question 15 (b)

(b) Fig. 15.2 shows the results for **Component 1**.

Fig. 15.2



- The student replaces **Component 1** with **Component 2**.
- They repeat the experiment.

The table shows the results for **Component 2**:

Potential difference (V)	Current (mA)
0	0
1	20
2	40
3	60
4	80

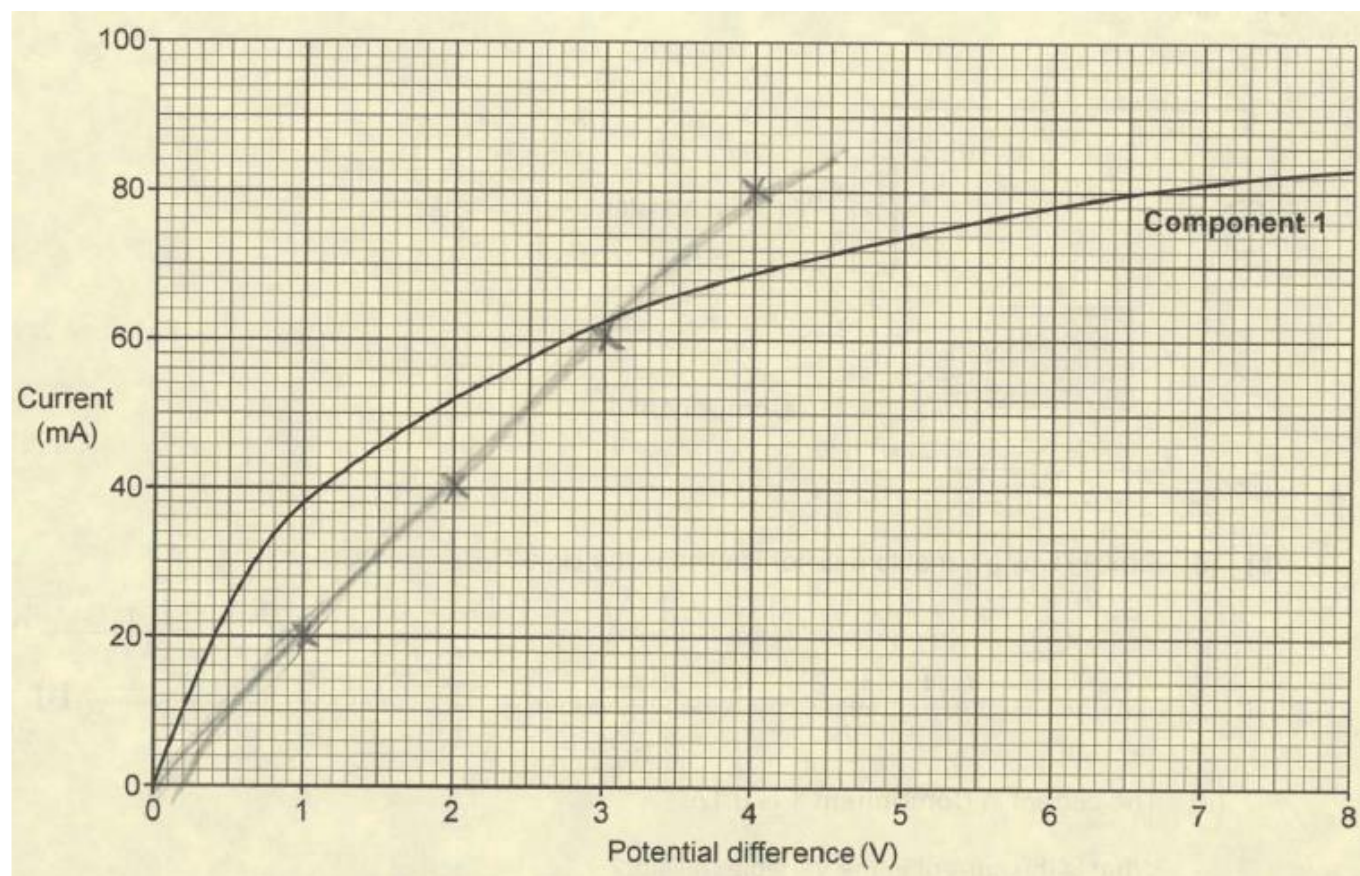
Plot the results from the table on **Fig. 15.2**.

Draw a suitable line of best fit.

[2]

There was an equal spread of marks for this question with about one third of candidates not gaining any credit. Candidates often forgot to plot the point where the potential difference and current were both zero so could not score the plotting mark. Candidates should be aware that if their plotted points are too large in radius, they will not score. The line of best fit was mostly well attempted but some were drawn freehand, rather than with a ruler, or were too 'feathery' to gain credit.

Exemplar 3



Exemplar 3 shows a response which was given 0 marks. The point at the origin was omitted and there was a poor attempt at the line of best fit.

Question 15 (c) (i)

- (c) (i) What is the potential difference when the resistance of **Component 1** and **Component 2** are the same?

Use **Fig. 15.2**.

Potential difference = V [1]

Question 15 (c) (ii)

- (ii) Explain why you chose your answer to (c)(i).

.....
 [1]

Question 15 (d)

- (d) Draw lines to connect each **component** to its correct **name**.

Component	Name
<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;">Component 1</div>	<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;">Resistor</div>
<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;">Component 2</div>	<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;">Filament lamp</div>
	<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;">Diode</div>

[2]

The majority of candidates found Question 15 (c) and (d) very challenging with only some successful responses seen. The potential differences suggested in Question 15 (c) (i) were mostly random and a large number of candidates then omitted Question 15 (c) (ii).

Some candidates were given marks in Question 15 (d) as they were able to correctly identify the names of components 1 and 2 from their current-potential difference graphs (P3.2).

Question 16 (a)

16 (a) Describe the difference between specific heat capacity and specific latent heat.

.....

.....

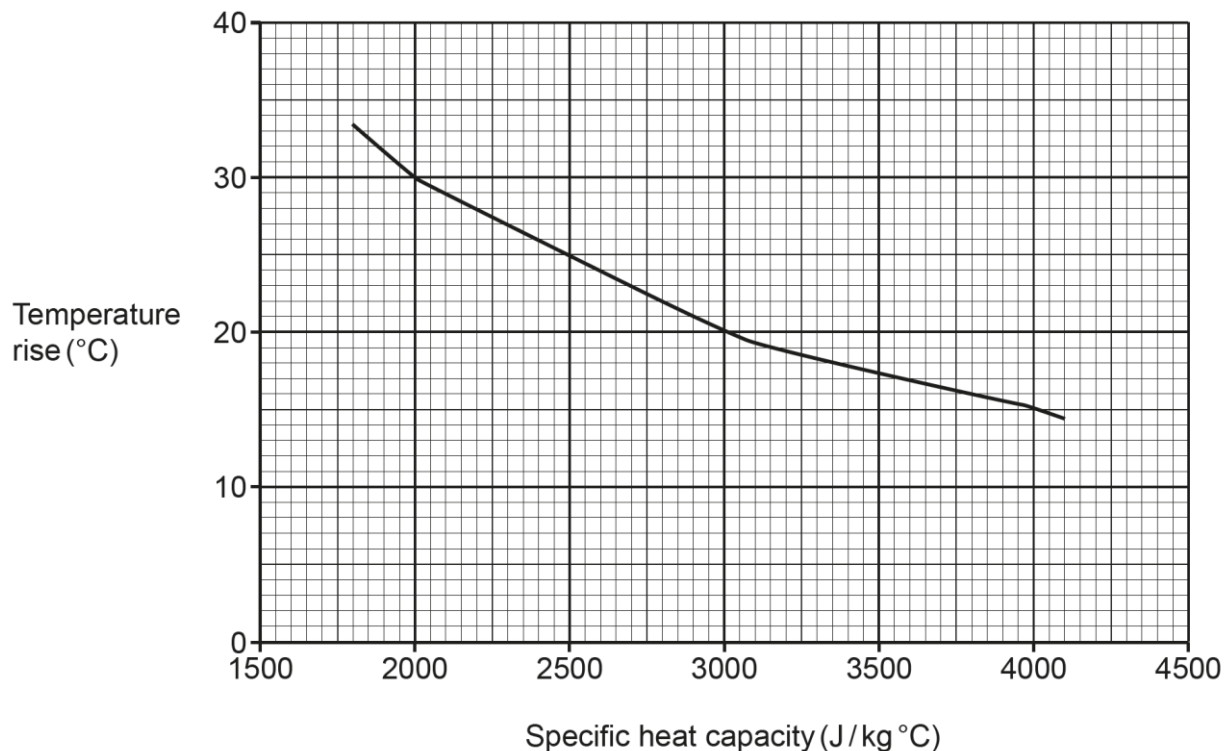
.....

..... [2]

Many candidates could not recall the basic definition of specific heat capacity or specific latent heat (P1.2). A large number of candidates did not attempt this question and, of those that did, the responses made vague references to heat, energy or temperature. A few candidates were given 1 mark for knowing that SHC is for a change of temperature and SLH is linked to a change of state.

Question 16 (b) (i)

- (b) A small heater is used to increase the temperature of different liquids. The graph shows how the temperature rise changes due to the varying specific heat capacities of these liquids.



- (i) Using the graph, describe the relationship between temperature rise and specific heat capacity.

.....
 [1]

Question 16 (b) (ii)

- (ii) A liquid has a specific heat capacity of 1600 J/kg °C.

Use the graph to estimate the temperature rise of the liquid.

Temperature rise = °C [2]

Question 16 (b) (iii)

(iii) State **one** assumption you made when answering (b)(ii).

.....
 [1]

Most candidates were able to describe the relationship shown by the graph in Question 16 (b) (i). However, there was little evidence that candidates were aware they had to extrapolate the graph to estimate the temperature rise of the liquid in Question 16 (a) (ii). Of the responses that were given marks in Question 16 (b) (ii), only a small proportion gained the assumption mark in Question 16 (b) (iii) as some responses did not explain this clearly enough.

Assessment for learning



Candidates could benefit from practising how to describe the relationships and trends shown by both familiar and unfamiliar graphs.

Question 16 (c)

(c) A student calculates the specific heat capacity of water. The student does **one** experiment and gets this result:

- Student's value = 4250 J/kg °C.
- Textbook value = 4200 J/kg °C.

Complete the sentence below.
 Use one of the words.

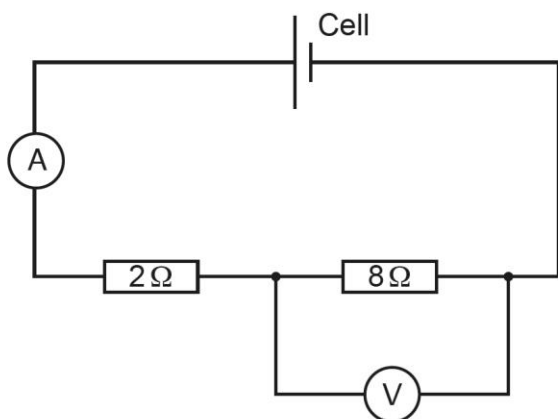
Accurate	Precise	Reliable	Repeatable	Systematic
-----------------	----------------	-----------------	-------------------	-------------------

The student's value is [1]

The meaning of these scientific terms was not well known, with fewer than one quarter of candidates using the correct term.

Question 17

17 A teacher builds the circuit shown in the diagram.



(a) Give the **total** resistance of the circuit.

Total resistance = Ω [1]

Question 17 (b)

(b) The voltmeter reads 4 V.

Calculate the ammeter reading.
Use the Data Sheet.

Ammeter reading = A [3]

Question 17 (c)

(c) Calculate the potential difference across the cell.

Potential difference = V [1]

The majority of candidates found Question 17 very challenging and did not gain any credit, especially for parts (b) and (c).

Just under half of candidates could successfully apply the rule for resistors in series to work out the total resistance of the resistors in the circuit in Question 17 (a).

Nearly all candidates struggled to recognise that the ammeter reading showed the current through the $8\ \Omega$ resistor in part (b). A few candidates gained a compensatory mark for writing down the equation relating resistance, potential difference and current but the majority of candidates did not show their workings so compensatory marks could not be given. Some candidates attempted to use the equation $P=I^2R$ or randomly multiplied or added various values from the circuit diagram.

There were various methods of arriving at the correct answer for Question 17 (c). Candidates struggled to use the idea of proportion or apply $V=IR$ so very few correct answers were seen.

Misconception



Candidates often worked out the total resistance of resistors in series by multiplying the values of each resistor together.

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