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Examiners' report

GCSE

COMBINED SCIENCE B (TWENTY FIRST CENTURY SCIENCE)

OCR Level 1/Level 2 GCSE (9-1) in Combined Science B (Twenty First Century Science)

J260

For first teaching in 2016

J260/03 Summer 2025 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 responses 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 Teach Cambridge.

Paper 3 series overview

Paper 3 was accessible, with most candidates attempting all questions. Where candidates omitted questions is given in the detailed report. Candidates often gave vague responses without using appropriate scientific vocabulary. This was particularly apparent in Question 7 (d), the extended prose question. There is some improvement in candidates showing their working in calculations. This is important as candidates can score marks for correct methods even on simple calculations. In general, the calculations were dealt with well. Candidates should be familiar with apparatus and techniques, not necessarily all activities but for these, they would have been required to access individual experience, not demonstrations. When using extra paper, candidates did not always clearly label which question they were continuing.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• could read and describe graphs • used scientific terms and understood there meaning • showed the working used in calculations • understood the steps used in experiments and how these could be improved.	• confused linear and non-linear graphs • did not show the equations used in calculations • were unable to explain the differences between basic scientific terms • lacked a detailed understanding of experimental procedures.

Question 1 (a) and (b)

1 Alex uses scalar and vector quantities to describe a journey through their school.

(a) Which statement describes a vector quantity?

Tick (✓) **one** box.

It has both magnitude and direction ☐

It has direction only ☐

It has magnitude only ☐

[1]

(b) Complete the table to show which quantities are scalar and which are vector.

Tick (✓) **one** box in each row.

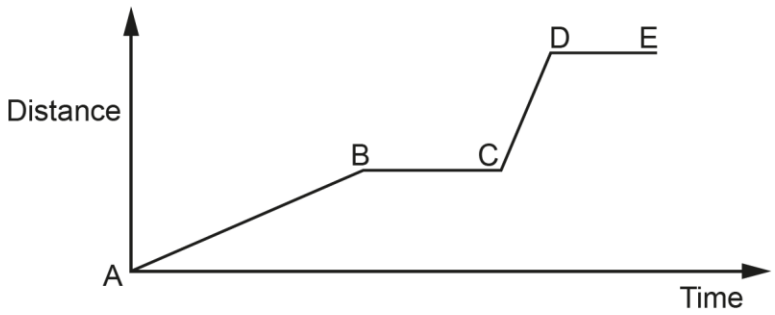
Quantity	Scalar	Vector
Distance		
Speed		
Velocity		

[2]

This was generally well answered. The most common mistake was mislabelling speed as a vector. This indicates a weakness in understanding of the directional component that differentiates vectors from scalars.

Question 1 (c) (i) and (ii)

(c) A distance–time graph of Alex's journey is shown.



Between points A and B Alex is walking at constant speed.

(i) Describe Alex's motion between points B and C.

.....

..... **[1]**

(ii) Describe how Alex's motion between points C and D is different to their motion between points A and B.

.....

..... **[1]**

Most candidates correctly described the motion as stopped in Question 1 (c) (i). However, a common mistake was to confuse the distance-time graph with a velocity-time graph and describe the motion of C-D as an acceleration.

Question 2 (a), (b) (i) and (ii)

2 A student is researching the structure of different atoms.

(a) Complete the sentences to describe the parts of an atom.

Put a (ring) around each correct option.

The nucleus of the atom has a **negative / neutral / positive** charge.

The nucleus is surrounded by negatively charged particles called **electrons / neutrons / protons**.

The diameter of the nucleus is about a **hundredth / hundred-thousandth / millionth** of the diameter of the atom.

[3]

(b) The table shows information about four different nuclei.

Nucleus	Number of protons	Number of neutrons
P	3	3
Q	2	2
R	3	4
S	4	3

A proton has a charge of +1.
A neutron has a charge of 0.

(i) Which nucleus has the largest charge?

..... **[1]**

(ii) Which **two** nuclei are isotopes of the same element?

..... **and** ..... **[1]**

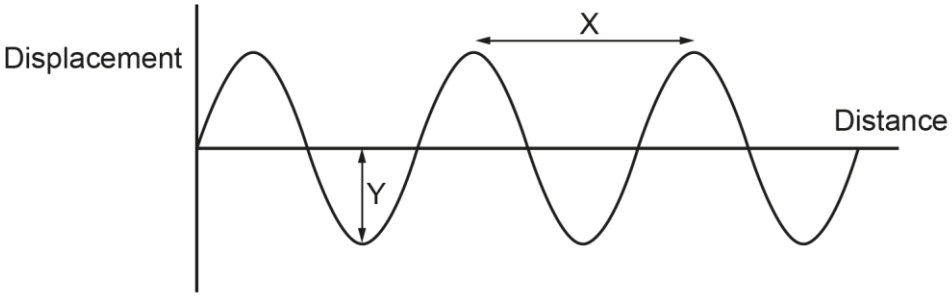
This question was challenging for many candidates. Often the diameter of the nucleus was not answered and few candidates understood the idea of isotopes.

Question 3 (a)

3 Riley and Sam are investigating the speeds of water waves and sound waves.

(a) **Fig. 3.1** represents a water wave.

Fig. 3.1



Draw lines to connect each **description** of the water wave with its correct **feature**.

Description	Feature
Arrow X on **Fig. 3.1**	Amplitude
Arrow Y on **Fig 3.1**	Frequency
The number of waves passing a point each second	Period
	Wavelength

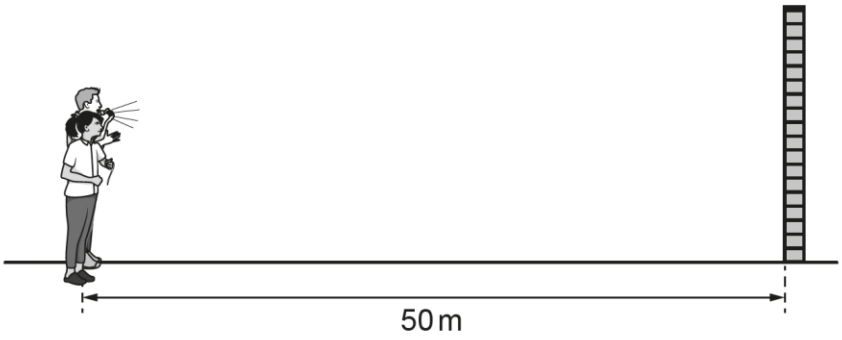
[3]

This was generally well answered. Candidates were better at identifying frequency when making other mistakes.

Question 3 (b) (i) and (ii)

(b) **Fig. 3.2** shows Riley and Sam standing 50 m from a tall, flat wall.
They are doing an experiment to measure the speed of sound in air.

Fig. 3.2



Sam blows a whistle and Riley starts a timer at the same time.
Riley stops the timer when she hears the echo from the wall.

(i) When Riley stops the timer, it shows a time of 0.40 seconds.

Calculate the speed of sound in air using this result.

Use the equation: speed = $\frac{(2 \times \text{distance to wall})}{\text{time}}$

Speed = ... m/s **[2]**

(ii) This calculated speed is **not** accurate.

The sound produced by the whistle has a frequency of 600 Hz and a wavelength of 0.55 m in air.

Calculate an accurate value of the speed of sound in air using this information.

Use the equation: wave speed = frequency × wavelength

Speed = ... m/s **[2]**

The calculations were generally performed well in this question.

Question 3 (b) (iii)

(iii) What step should Riley and Sam take to improve the accuracy of their value for the speed of sound in air?

Tick (✓) **one** box.

- Increase the time between starting and stopping the timer by standing further away from the wall. ☐
- Reduce the amplitude of the sound wave by using a quieter whistle. ☐
- Use a timer that measures to the nearest 0.001 s. ☐

[1]

A common error was to use a timer to 0.001 s. This suggests a gap in understanding of the relationship between measurement resolution and experimental design.

Question 3 (c)

(c) The water waves are transverse waves and the sound waves are longitudinal waves.

Describe the difference between transverse waves and longitudinal waves.

.....

.....

.....

..... **[2]**

Very few candidates could accurately describe the difference between longitudinal and transverse waves, even if they remembered to use the words 'parallel' and 'perpendicular'. They didn't relate this to the direction of the wave.

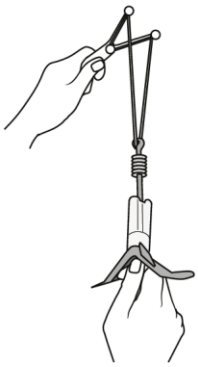
Exemplar 1

Transverse waves travel through water and longitudinal waves travel through sound.

This was a common error, relating the type of wave to its physical model.

Question 4 (a)

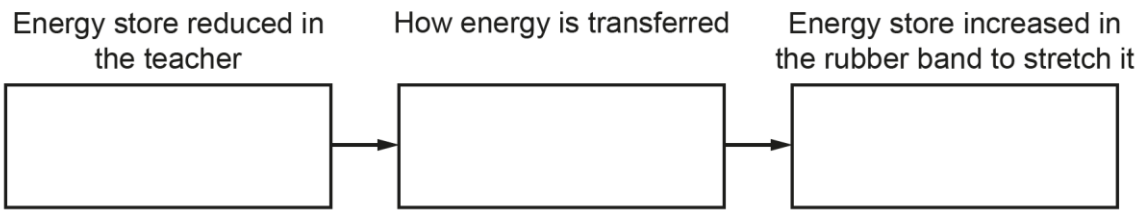
4 A teacher uses a rubber band to fire a toy rocket vertically upwards.



(a) The teacher pulls back the rocket and transfers energy to the rubber band to stretch it.

Complete **Fig. 4.1** to show the energy transfer from the teacher to the rubber band.

Fig. 4.1



[3]

This was commonly misunderstood with candidates often confusing the energy transformation between the elastic band and the rocket.

Question 4 (b) (i)

(b) The rocket is released and it leaves the rubber band at a speed of 12.0 m/s.
The mass of the rocket is 0.125 kg.

(i) Calculate the kinetic energy of the rocket as it leaves the rubber band.

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

Kinetic energy = ... J **[2]**

This was generally well answered. The most common error was to forget to square the speed.

Question 4 (b) (ii)

(ii) Calculate the maximum height reached by the rocket after it leaves the rubber band.

Use the equation: maximum height = $\frac{\text{kinetic energy}}{\text{mass} \times \text{gravitational field strength}}$

Gravitational field strength = 10 N/kg.

Use your answer to **(b)(i)**.

Maximum height = ... m **[2]**

Candidates sometimes got confused with the order of operations but generally answered well.

Question 4 (b) (iii)

(iii) Suggest **one** reason why the measured maximum height of the rocket is less than your answer calculated in **(b)(ii)**.

.....

..... **[1]**

Very few candidates mentioned air resistance as a factor in causing energy loss. This suggests a limited understanding of real-world energy dissipation.

Question 4 (c) (i) and (ii)

(c) When the rocket falls back to the ground it travels at constant speed for most of the journey.

(i) State the value of the resultant force when the rocket is travelling at a constant speed.

Resultant force = ... N **[1]**

(ii) Explain your answer.

.....

.....

.....

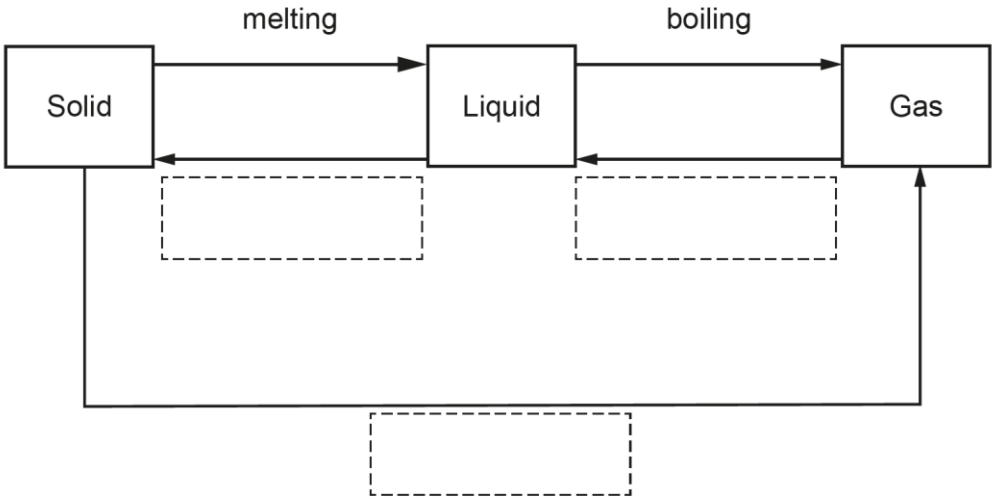
..... **[2]**

Few candidates understood the resultant force must be zero when the speed is constant and got part c (i) wrong. Those who got this correct often could not explain that balanced forces meant zero resultant force and hence acceleration was zero.

Question 5 (a)

5 This question is about the three states of matter.

(a) Complete the diagram by writing in the names of the changes of state.



[3]

The majority of candidates scored marks for freezing and condensing, but very few remembered sublimation for the third mark.

Question 5 (b)

(b) Describe the differences in the arrangement and behaviour of the particles in a liquid and a gas.

You can include a diagram to support your answer.

.....

.....

.....

.....

..... **[4]**

Most candidates were able to answer this, although the expression was often poor. The behaviour of gases was particularly vague.

Question 5 (c) (i)

(c) Sasha does an experiment to find the specific latent heat of vaporisation of water.

This is Sasha's method:

- Put an electric heater inside a container.
- Put some water with a mass of 1.00 kg in the container.
- Switch on the electric heater.
- Start a timer when the water starts boiling.
- Stop the timer after 300 seconds.
- Measure the new mass of the water.

This is Sasha's results table:

Starting mass of water (kg)	1.00
New mass of water (kg)	0.80
Energy transferred by the heater (J)	540 000
Time (s)	300

(i) Calculate the power of the electric heater.

Use the equation: energy transferred = power × time

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

The majority of candidates carried out this calculation correctly.

Question 5 (c) (ii)

(ii) Calculate the specific latent heat of vaporisation of water.

Use the equation: specific latent heat of vaporisation = $\frac{\text{energy transferred to water}}{\text{mass of water that changed state}}$

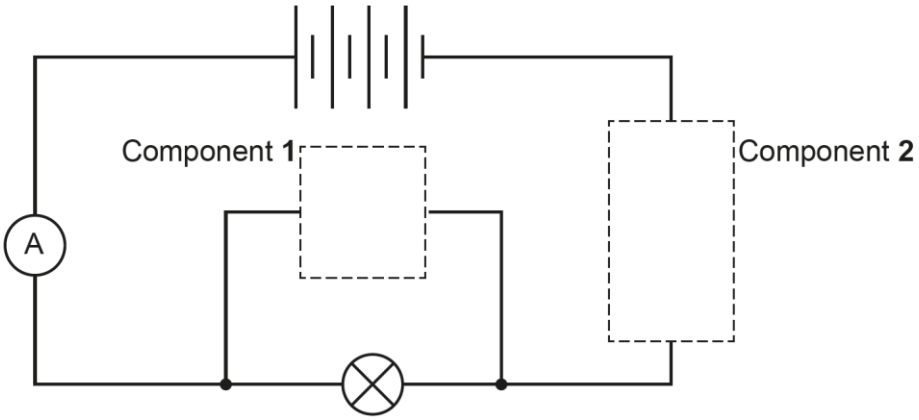
Specific latent heat of vaporisation = ... J/kg **[3]**

This calculation was performed less well. Many candidates did not realise they needed to calculate the mass change first.

Question 6 (a), (b) (i) and (ii)

6 Hiro is investigating how the current through a filament lamp varies with the potential difference across it.

The diagram shows the circuit used by Hiro.
The diagram is **not** complete.

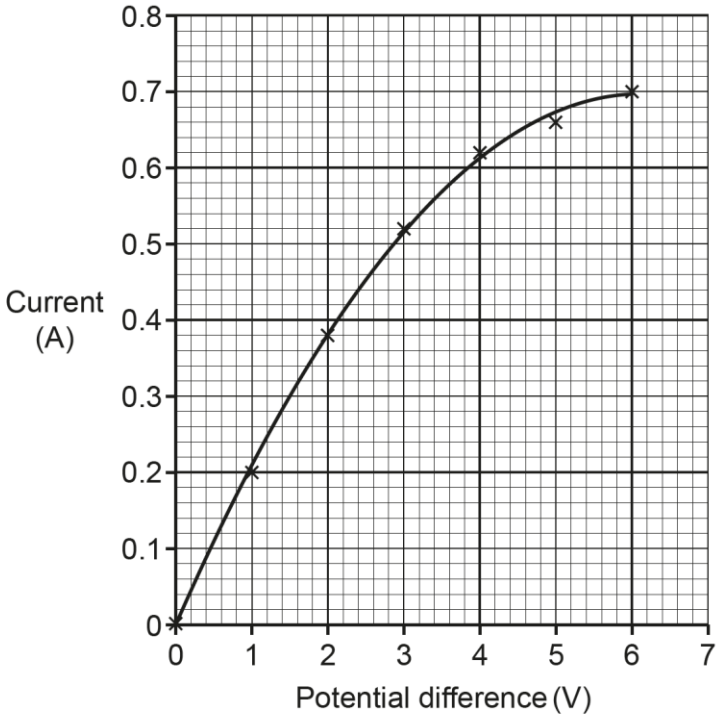


(a) Component **1** is used to measure the potential difference across the filament lamp.

Component **2** is used to change the potential difference across the filament lamp.

Complete the diagram by drawing in the symbols for component **1** and component **2**. **[2]**

(b) The graph shows Hiro's results.



(i) Use the graph to find the current in the filament lamp when the potential difference across it is **2.4 V**.

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

(ii) Calculate the resistance of the filament lamp when the potential difference across it is 2.4 V.

Use the equation: resistance = $\frac{\text{potential difference}}{\text{current}}$

Use your answer to **(b)(i)**.

Resistance = ... Ω **[2]**

This was well answered, except for the variable resistor in part a.

Question 6 (b) (iii)

(iii) Explain the relationship between current and potential difference shown on the graph.

.....

.....

.....

..... **[2]**

Very few candidates managed to score marks here. Many incorrectly described the graph as proportional and almost never referenced the change of resistance shown by the graph.

Question 7 (a)

7 Ling wants to find out more about the electricity supply and electricity usage in their home.

(a) Complete the sentences about the UK domestic electricity supply.

The frequency of the supply is ..... Hz

The potential difference of the supply is V

[2]

This was direct recall from the specification, although very few were able to correctly answer.

Question 7 (b)

(b) Domestic electricity supply in the UK provides alternating current.

State the difference between alternating current and direct current.

.....

..... **[1]**

This question was not answered well overall . A common misconception was that d.c. comes from one source and a.c. from many sources. Many candidates did not include direction in their answers.

Exemplar 2

direct ~~or~~ current is when it stays the same throughout but alternating current is when it changes throughout **[1]**

This response shows a candidate not including direction in the answer.

Question 7 (c)

(c) Ling wants to know how much they spend on boiling water in the kettle each week.
Ling estimates that the kettle is switched on for a total of **5** hours each week.

Calculate the cost of using the kettle each week.

Power of the kettle = 2.6 kW.
Cost of 1 kWh = 35 p.

Use the Equation Sheet.

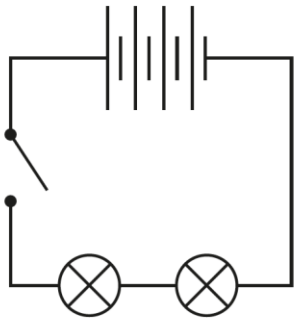
Cost = £ ..... **[4]**

Many candidates were able to correctly determine the energy used as 13 kWh but could not carry the calculation through to the final cost.

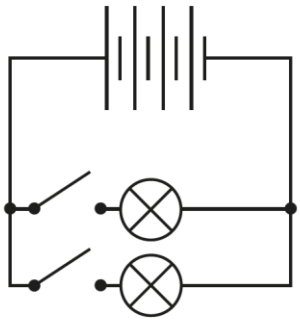
Question 7 (d)*

(d)* Ling makes Circuits **A** and **B** to work out what kind of circuit is used in the home.

Circuit A



Circuit B



Explain why Circuit **B** is used in the home rather than Circuit **A**.

Include in your answer:

- a comparison of the potential difference across the lamps in each circuit
- why the current through the battery in Circuit **B** is larger.

.....

.....

.....

.....

.....

..... **[6]**

Candidates often found this question challenging to answer. Many candidates identified the two switches, each operating a light, as a reason for selecting Circuit B to use in the home but very few could go beyond this.

Assessment for learning

Candidates are advised to use the question to structure their answers. For example, in this case they are asked to do three things:

1) explain why circuit B is used in the home

2) compare the difference in potential difference in each circuit

3) explain why the battery in Circuit B is larger.

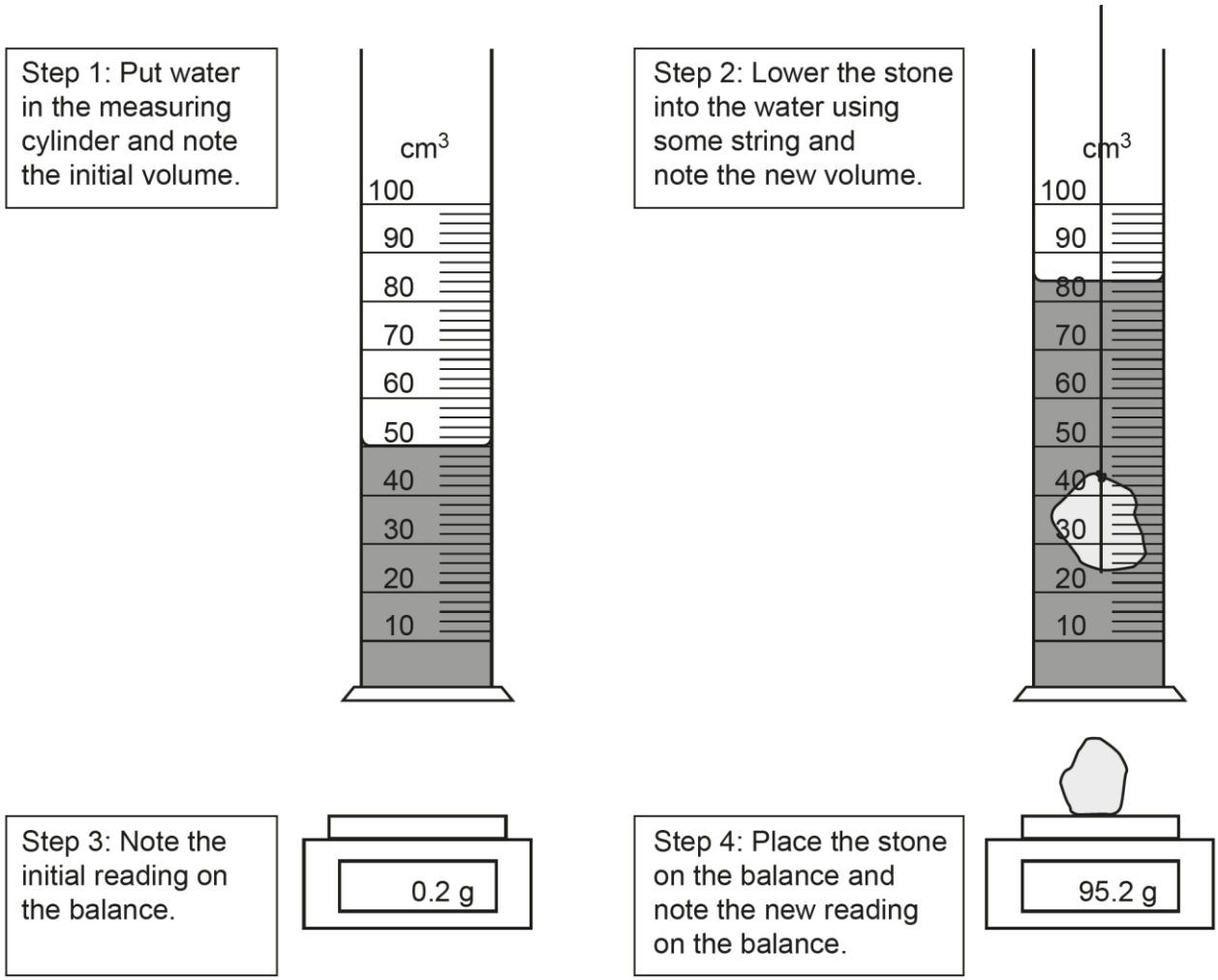
If candidates use three sections to their answer, they increase the chances of scoring well.

Question 8 (a) (i)

8 Ryan does an experiment to determine the density of a stone sample.
They use a 100 cm^3 measuring cylinder and a balance that can measure up to 100.0 g.

Fig. 8.1 shows the steps followed by Ryan.

Fig. 8.1



(a)
(i) Calculate the volume of the stone, using **Fig. 8.1**.

Volume = ... cm^3 **[2]**

There were a wide range of complicated attempts to calculate the volume of the stone. Even when the difference between the volumes was used there was often an error in reading the scale at 84 cm^3.

Question 8 (a) (ii)

(ii) What type of error does the balance show in **Fig. 8.1**?
Tick (✓) **one** box.

Random error ☐

Recording error ☐

Systematic error ☐

[1]

This was generally well answered with recording error being the most common mistake.

Question 8 (a) (iii)

(iii) Calculate the mass of the stone.

Mass = ... g **[1]**

This was generally well answered. The most common incorrect answer was 95.2g.

Question 8 (a) (iv)

(iv) Calculate the density of the stone.

Use your answers from **(a)(i)** and **(a)(iii)** and the Equation Sheet.

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

Density = ... g/cm^3 **[4]**

Often the answer was given to two decimal places as opposed to two significant figures.

Question 8 (b)

(b) Explain **two** changes that Ryan can make to improve their experiment.

1 .....

.....

.....

.....

2 .....

.....

.....

.....

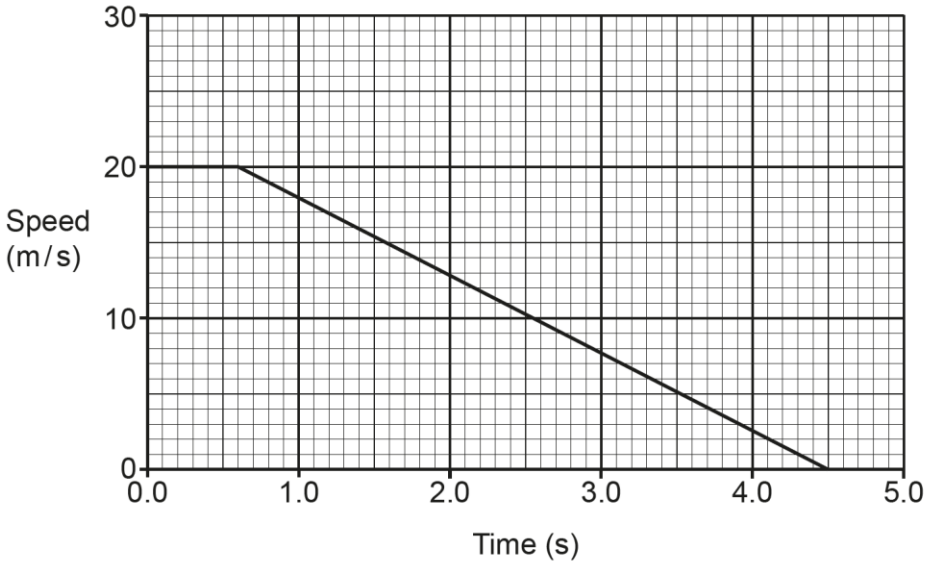
[4]

Candidates often proposed valid improvements but did not justify them scientifically. Common errors showed a lack of understanding of the experiment, for example carrying out repeats and zeroing the balance.

Question 9 (a)

9 Casey is driving a car along a straight, level road when they see a road block ahead.

The graph shows how the speed of the car changes with time immediately after Casey sees the road block.



(a) While Casey is reacting to the obstruction the car continues to travel at constant speed.

Calculate the distance travelled by the car while Casey is **reacting**.

Use the Equation Sheet.

Distance = ... m **[4]**

Most candidates correctly identified the equation but few could rearrange the equation. This was often compounded by mis-reading the graph.

Question 9 (b)

(b) The initial kinetic energy of the car is 174 kJ.

When Casey presses the brakes, the braking force acting on the car is 4350 N.

The work done by the brakes to stop the car = the kinetic energy lost by the car.

Calculate the distance travelled while the car is braking.

Use the equation: work done = force × distance

Distance = ... m **[4]**

Candidates often had difficulty rearranging the equation. They often did not convert 174 kJ to joules, resulting in a power of ten error.

Question 9 (c)

(c) In the village where Casey lives the speed limit has been reduced from 30 mph to 20 mph.

Explain how reducing the speed limit can improve road safety in the village.

.....

.....

.....

..... **[2]**

Few candidates explicitly linked the safety to reduction in kinetic energy or force. Most only gained a mark for less collisions.

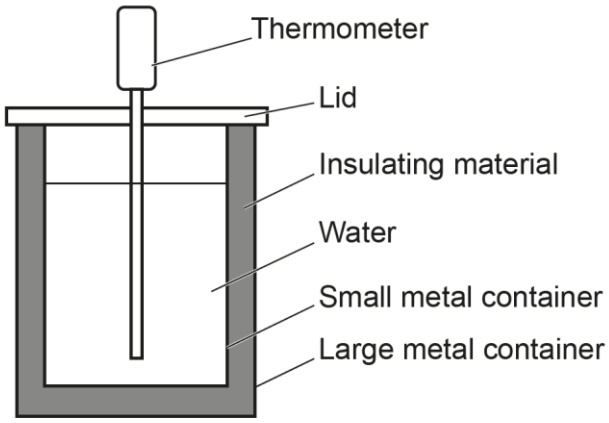
Question 10 (a) (i)

10 Amit does an experiment at room temperature to compare the thermal conductivity of different insulating materials.

(a) This is Amit's method:

- Place a small metal container inside a large metal container.
- Place some insulating material between them.
- Pour water at a temperature of 80 °C into the small container and place a lid on it.
- Measure the temperature of the water every minute for 30 minutes using a thermometer.
- Repeat the experiment using different insulating materials.

This is the apparatus used:



(i) State **two** variables that Amit should control in this experiment.

1 .....

2 .....

[2]

Candidates tended to be too general in naming variables, e.g. 'temperature' and 'water'. More specific answers were required, for example 'initial temperature' and 'volume of water'.

Question 10 (a) (ii)

(ii) Explain why Amit uses metal containers rather than plastic containers.

.....

.....

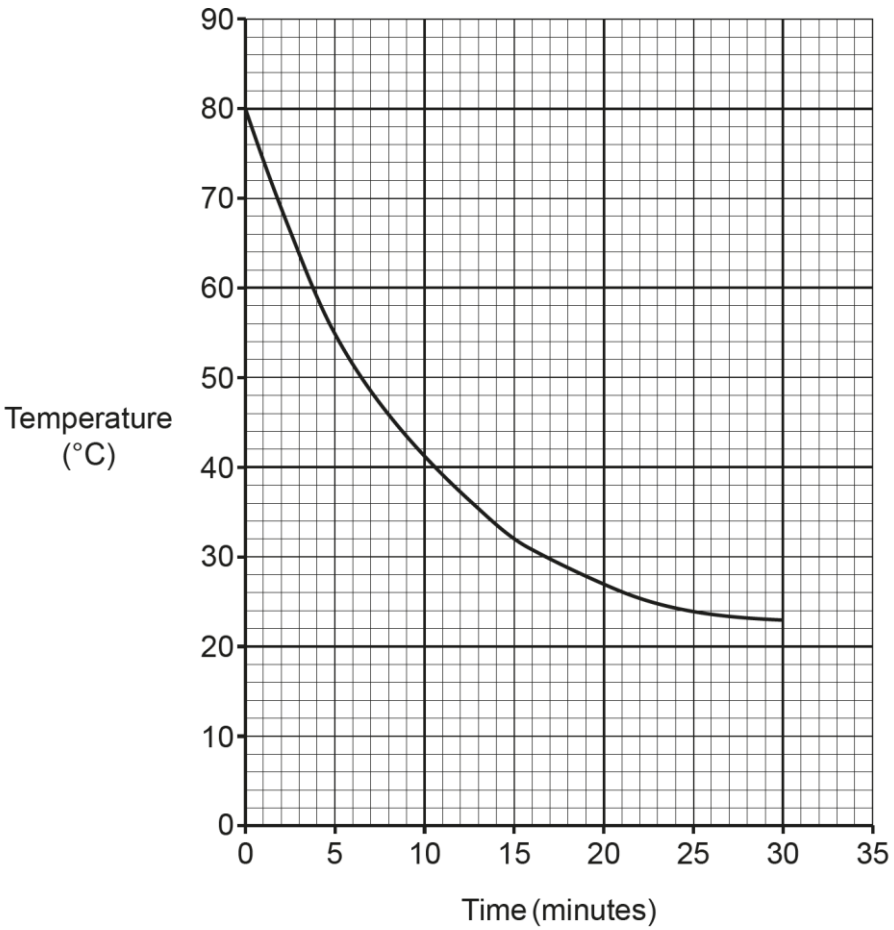
.....

..... **[2]**

Many candidates identified the metal as a good conductor of heat, but then went on to contradict themselves by suggesting it will keep the heat in. The most common error was to suggest that the plastic will melt.

Question 10 (b) (i) and (ii)

(b) The graph shows Amit's results for one insulating material.



(i) Draw a tangent to the curve at time of 15 minutes. **[1]**

(ii) Calculate the gradient of the tangent drawn in **(b)(i)**.

Gradient = ... °C / minute **[2]**

Very few candidates could correctly draw a tangent and so could not calculate the gradient. Those that correctly drew the tangent often did not identify the gradient as negative.

Question 10 (b) (iii)

(iii) Sketch a curve on **the graph** to show the results of the experiment when a material of **higher** thermal conductivity is used. **[2]**

Candidates often drew lines above the given line, incorrectly starting at 90 °C and not stopping at room temperature.

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