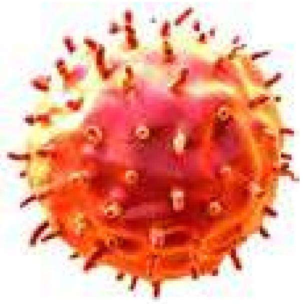
Cambridge Assessment
International Education

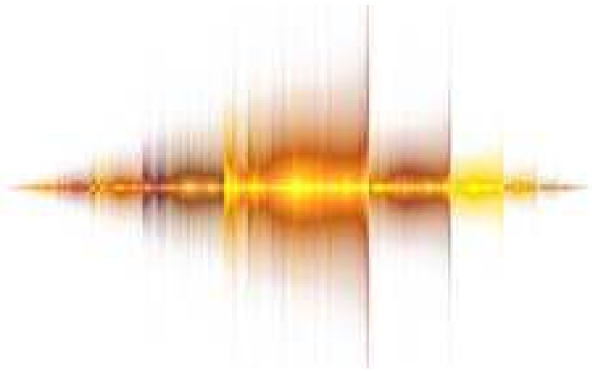
Example Candidate Responses
Paper 6

Cambridge IGCSE™
Combined Science 0653

Cambridge O Level
Combined Science 5129

For examination from 2019





Version 1

Cambridge Pathway

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Contents

Introduction

The main aim of this booklet is to exemplify standards for those teaching Cambridge IGCSE Combined Science 0653 and Cambridge O Level Combined Science 5129, and to show how different levels of candidates' performance (high, middle and low) relate to the subject's curriculum and assessment objectives.

In this booklet candidate responses have been chosen from June 2019 scripts to exemplify a range of answers.

For each question, the response is annotated with a clear explanation of where and why marks were awarded or omitted. This is followed by examiner comments on how the answer could have been improved. In this way, it is possible for you to understand what candidates have done to gain their marks and what they could do to improve their answers. There is also a list of common mistakes candidates made in their answers for each question.

This document provides illustrative examples of candidate work with examiner commentary. These help teachers to assess the standard required to achieve marks beyond the guidance of the mark scheme. Therefore, in some circumstances, such as where exact answers are required, there will not be much comment.

The questions and mark schemes and pre-release material used here are available to download from the School Support Hub. These files are:

June 2019 Question Paper 61

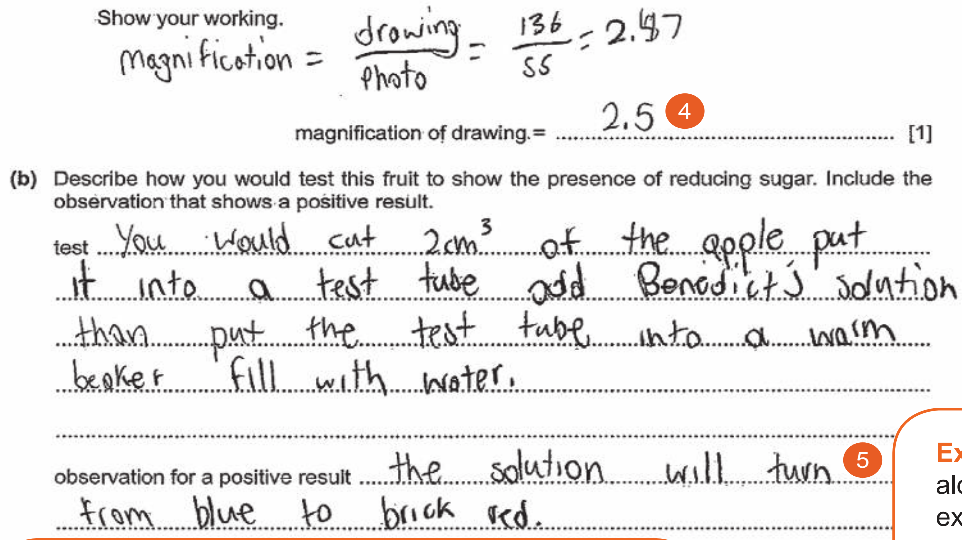
June 2019 Paper 61 Mark Scheme

Past exam resources and other teacher support materials are available on the School Support Hub:

www.cambridgeinternational.org/support

How to use this booklet

This booklet goes through the paper one question at a time, showing you the high-, middle- and low-level response for each question. The candidate answers are set in a table. In the left-hand column are the candidate answers, and in the right-hand column are the examiner comments.

Example Candidate Response – Question 1, high	Examiner comments
 Show your working. magnification = $\frac{\text{drawing}}{\text{photo}} = \frac{136}{55} = 2.47$ magnification of drawing = 2.5 ④ [1] **(b)** Describe how you would test this fruit to show the presence of reducing sugar. Include the observation that shows a positive result. test You would cut 2cm^3 of the apple put it into a test tube add Benedict's solution than put the test tube into a warm beaker fill with water. observation for a positive result the solution will turn ⑤ from blue to brick red.	④ The answer is correct to 2 significant figures, based on the candidate's measurements. Mark for (a)(iii) = 1 out of 1 ⑤ All three relevant marking points were given. Notice that the additional, irrelevant tests may be ignored because the candidate clearly stated that iodine tests for starch and biuret tests for protein, so these do not contradict the

Examiner comments are alongside the answers. These explain where and why marks were awarded. This helps you to interpret the standard of Cambridge exams so you can help your learners to refine their exam technique.

Answers are by real candidates in exam conditions. These show you the types of answers for each level. Discuss and analyse the answers with your learners in the classroom to improve their skills.

How the candidate could have improved their answer

- The drawing in **(a)(ii)** needed to show the detail of the cut surface. This meant showing some structure of the core of the apple. This detail was omitted. The candidate should also have taken care in the joining of the outline of the diagram to ensure that a smooth, continuous line (without a cross) was shown.

This section explains how the candidate could have improved each answer. This helps you to interpret the standard of Cambridge exams and helps your learners to refine their exam technique.

Common mistakes candidates made in this question

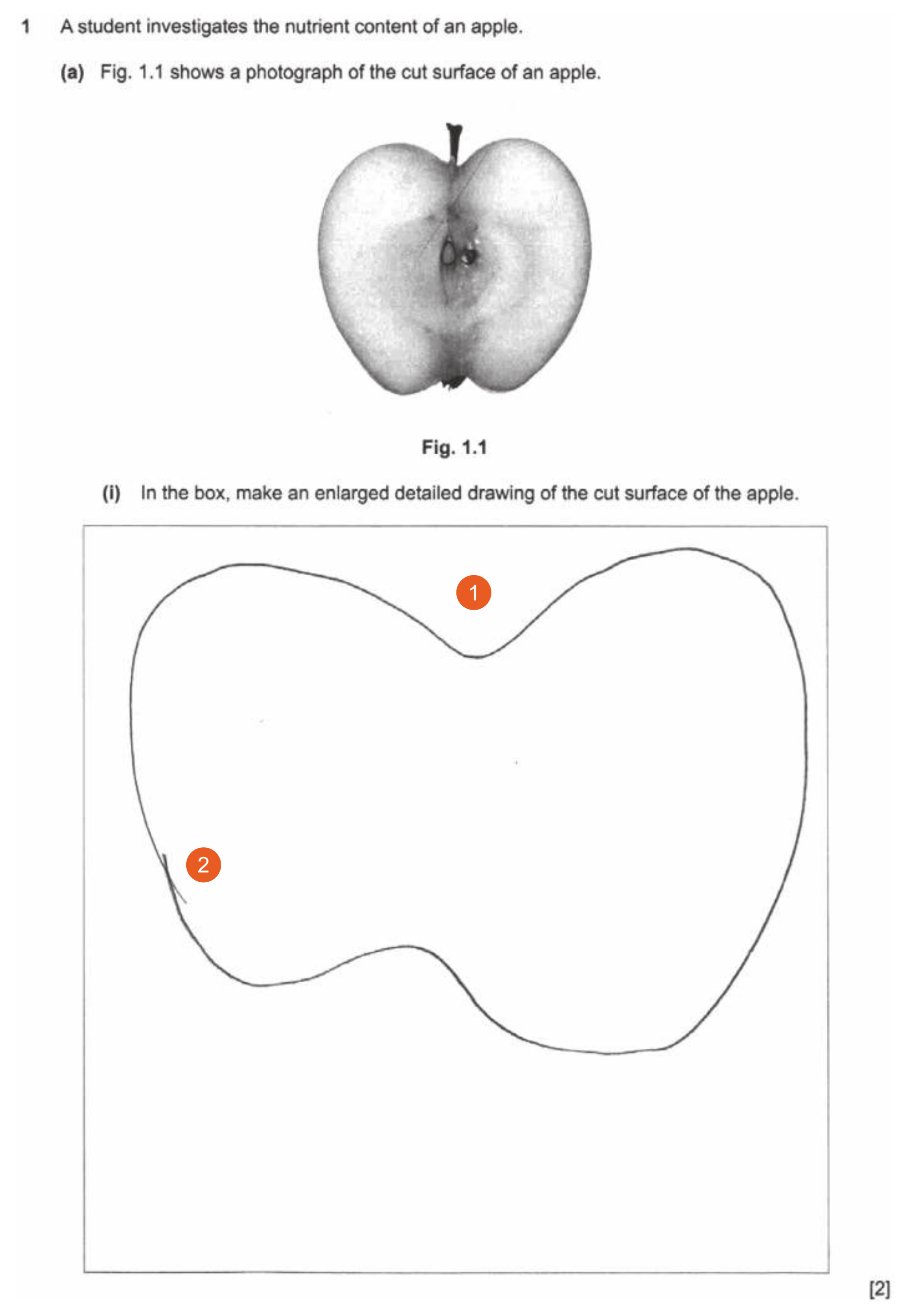
- **(a)(i)** It was common for candidates to have drawn feathered lines and/or to have omitted details of the core. Another common error was to include unnecessary and confusing shading.

Often candidates were not awarded marks because they misread or misinterpreted the questions.

Lists the common mistakes candidates made in answering each question. This will help your learners to avoid these mistakes and give them the best chance of achieving the available marks.

Question 1

Example Candidate Response – high



1 A student investigates the nutrient content of an apple.

(a) Fig. 1.1 shows a photograph of the cut surface of an apple.

Fig. 1.1

(i) In the box, make an enlarged detailed drawing of the cut surface of the apple.

[2]

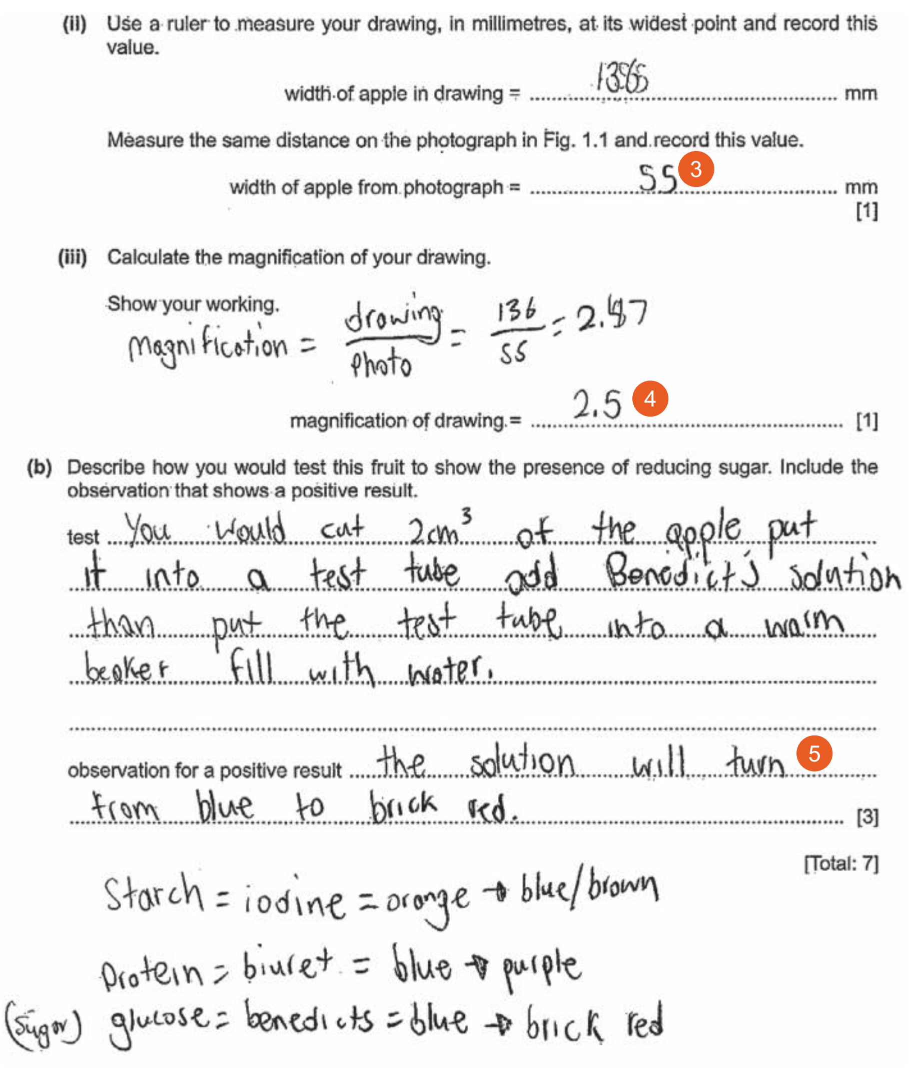
Examiner Comments

① The candidate's drawing is clearly enlarged compared to the original photograph.

② The second mark requires the main features of the cut surface to be shown. This drawing showed no details of the core. In addition, the continuous, smooth line was compromised by a 'cross' at the join.

Mark for (a)(i) = 1 out of 2

Example Candidate Response – high, continued



(ii) Use a ruler to measure your drawing, in millimetres, at its widest point and record this value.

width of apple in drawing = 136 mm

Measure the same distance on the photograph in Fig. 1.1 and record this value.

width of apple from photograph = 55 ③ mm [1]

(iii) Calculate the magnification of your drawing.

Show your working.

magnification = $\frac{\text{drawing}}{\text{photo}} = \frac{136}{55} = 2.47$

magnification of drawing = 2.5 ④ [1]

(b) Describe how you would test this fruit to show the presence of reducing sugar. Include the observation that shows a positive result.

test You would cut 2cm³ of the apple put it into a test tube add Benedict's solution than put the test tube into a warm beaker fill with water.

observation for a positive result the solution will turn ⑤ from blue to brick red. [3]

[Total: 7]

Starch = iodine = orange → blue/brown

Protein = biuret = blue → purple

(Sugar) glucose = benedicts = blue → brick red

Examiner Comments

③ The answer gives a correct measurement, in millimetres.

Mark for (a)(ii) = 1 out of 1

④ The answer is correct to 2 significant figures, based on the candidate's measurements.

Mark for (a)(iii) = 1 out of 1

⑤ All three relevant marking points were given. Notice that the additional, irrelevant tests may be ignored because the candidate clearly stated that iodine tests for starch and biuret tests for protein, so these do not contradict the main answer.

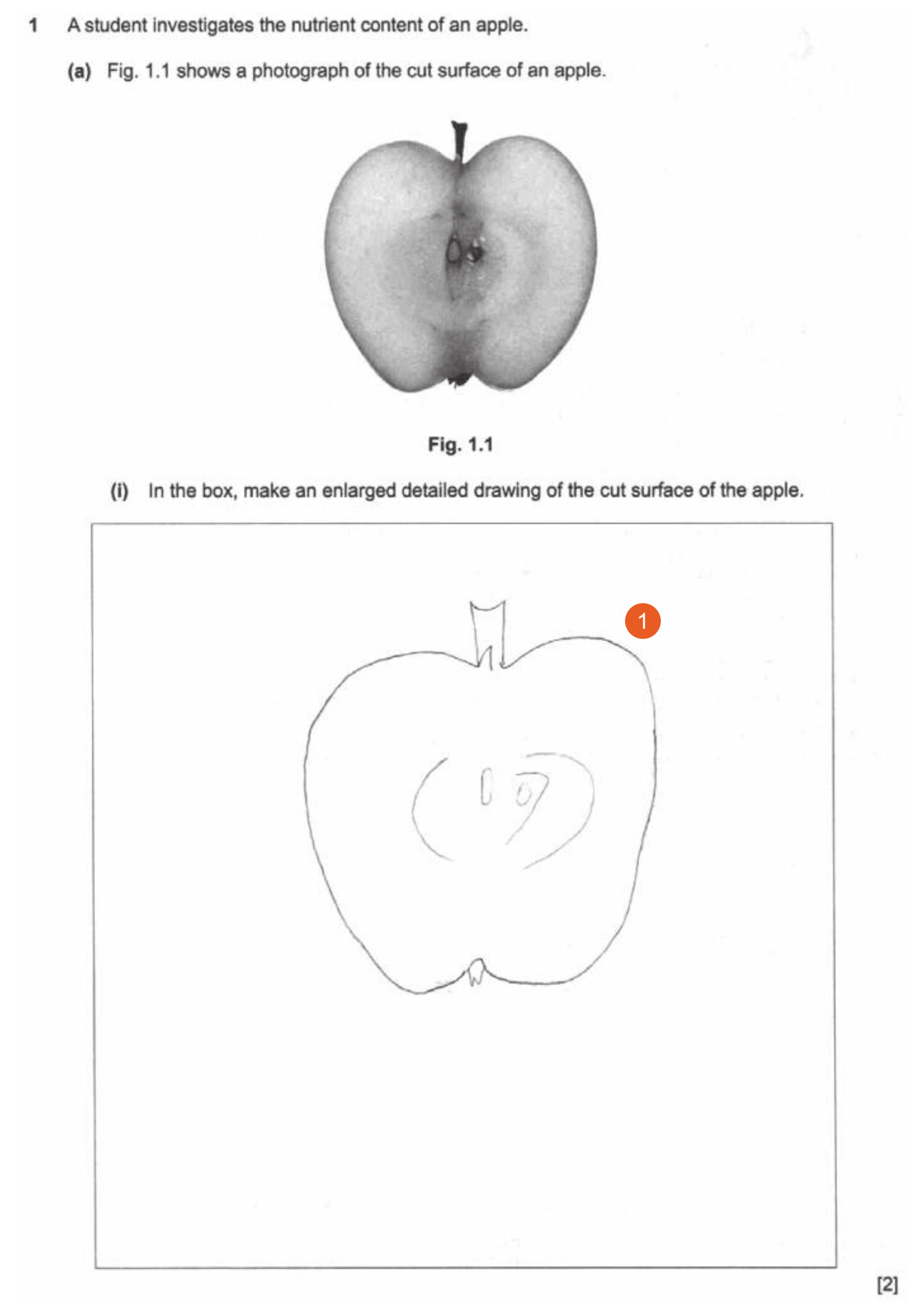
Mark for (b) = 3 out of 3

Total mark awarded = 6 out of 7

How the candidate could have improved their answer

- The drawing in **(a)(ii)** needed to show the detail of the cut surface. This meant showing some structure of the core of the apple. This detail was omitted. The candidate should also have taken care in the joining of the outline of the diagram to ensure that a smooth, continuous line (without a cross) was shown.
- **(b)** The candidate should have taken care to cross out irrelevant working or notes to make sure that the main answer was not contradicted.

Example Candidate Response – middle



1 A student investigates the nutrient content of an apple.

(a) Fig. 1.1 shows a photograph of the cut surface of an apple.

Fig. 1.1

(i) In the box, make an enlarged detailed drawing of the cut surface of the apple.

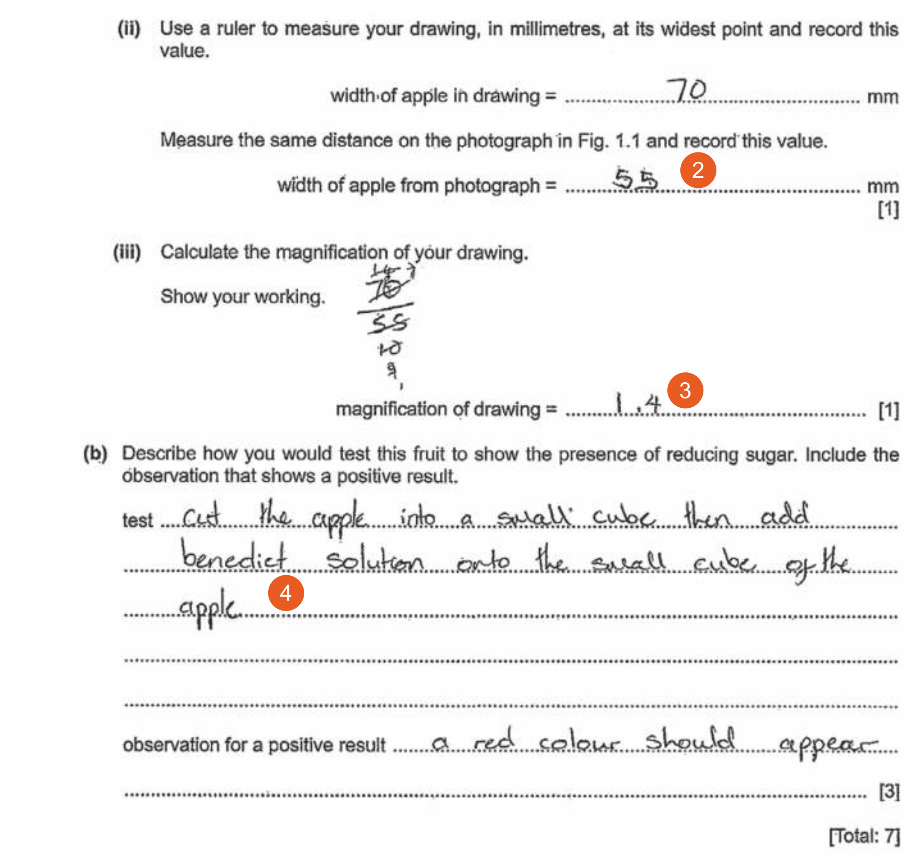
① [2]

Examiner Comments

① This drawing is enlarged compared to the original. The outline is smooth and continuous with pips shown in the core.

Mark for (a)(i) = 2 out of 2

Example Candidate Response – middle, continued



(ii) Use a ruler to measure your drawing, in millimetres, at its widest point and record this value.

width of apple in drawing = ...70........ mm

Measure the same distance on the photograph in Fig. 1.1 and record this value.

width of apple from photograph = ...55........ mm ②

[1]

(iii) Calculate the magnification of your drawing.

Show your working.

$$\frac{70}{55}$$

10
9,

magnification of drawing = ...1.4........ ③ [1]

(b) Describe how you would test this fruit to show the presence of reducing sugar. Include the observation that shows a positive result.

test ....cut the apple into a small cube then add benedict solution onto the small cube of the apple.... ④

observation for a positive result ....a red colour should appear....

[3]

[Total: 7]

Examiner Comments

② This is a correct measurement, in millimetres.

Mark for (a)(ii) = 1 out of 1

③ Although the working shown is correct, this answer is incorrect based on the candidate's measurements. It should be 1.3. As the candidate appears to have tried to work this out on paper, it suggests that a calculator was not used.

Mark for (a)(iii) = 0 out of 1

④ The answer does not mention warming the mixture.

Mark for (b) = 2 out of 3

Total mark awarded = 5 out of 7

How the candidate could have improved their answer

- It appeared that a calculator was not used in **(a)(iii)**. The candidate needed to use a calculator for calculations.
- **(b)** Where 3 marks were available, care needed to be taken to give three points about the test. In this case 'warm' was omitted.

Example Candidate Response – low

1 A student investigates the nutrient content of an apple.

(a) Fig. 1.1 shows a photograph of the cut surface of an apple.

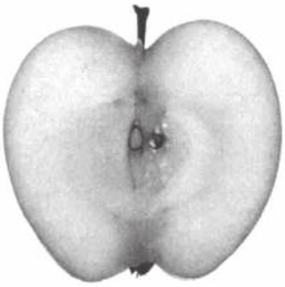
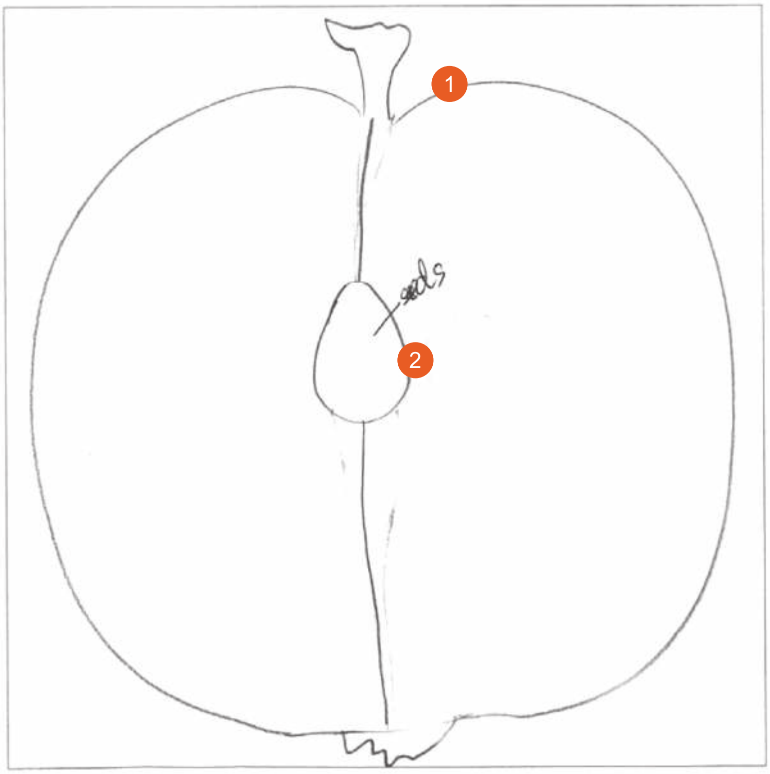


Fig. 1.1

(i) In the box, make an enlarged detailed drawing of the cut surface of the apple.



[2]

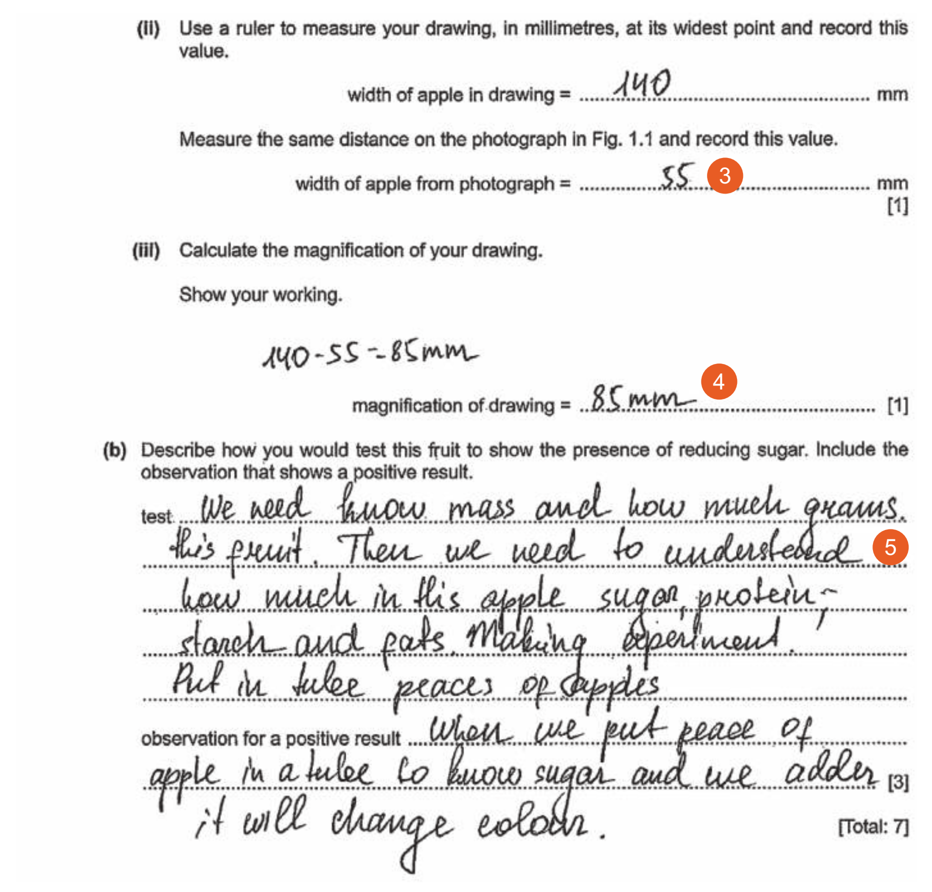
Examiner Comments

① The diagram is enlarged.

② The detail of the cut surface is not shown. There are no 'pips' in the core. The outline is not entirely 'smooth and continuous' with some feathering, particularly at the bottom. It may be noted that a 'benefit of the doubt' would probably have been awarded for the line if the pips had been shown in the centre as there was a clear attempt at a smooth and continuous outline.

Mark for (a)(i) = 1 out of 2

Example Candidate Response – low, continued



(ii) Use a ruler to measure your drawing, in millimetres, at its widest point and record this value.

width of apple in drawing = 140 mm

Measure the same distance on the photograph in Fig. 1.1 and record this value.

width of apple from photograph = 55 ③ mm [1]

(iii) Calculate the magnification of your drawing.

Show your working.

140-55 -85mm

magnification of drawing = 85mm ④ [1]

(b) Describe how you would test this fruit to show the presence of reducing sugar. Include the observation that shows a positive result.

test We need know mass and how much grams. this fruit. Then we need to understand ⑤ how much in this apple sugar, protein, starch and fats. Making experiment. Put in tubee peaces of apples

observation for a positive result When we put peace of apple in a tubee to know sugar and we adder it will change colour. [3]

[Total: 7]

Examiner Comments

③ Correct measurements, in millimetres, are given.

Mark for (a)(ii) = 1 out of 1

④ This answer shows how much wider the second diagram is. This is not a magnification calculation.

Mark for (a)(iii) = 0 out of 1

⑤ The use of Benedict's solution to test for sugar has not been given in this answer.

Mark for (b) = 0 out of 3

Total mark awarded = 2 out of 7

How the candidate could have improved their answer

- **(a)(i)** The candidate needed to take care to use smooth, continuous lines in their drawing and to have shown all the necessary detail (in this case the pips). In **(a)(iii)**, magnification calculations involved dividing the measured width of the drawing by the measured width of the original. Candidates needed to have learned the reagents, conditions and tests for the food types mentioned in this syllabus. In this case, the candidate did not know the test for reducing sugars in **(b)**.

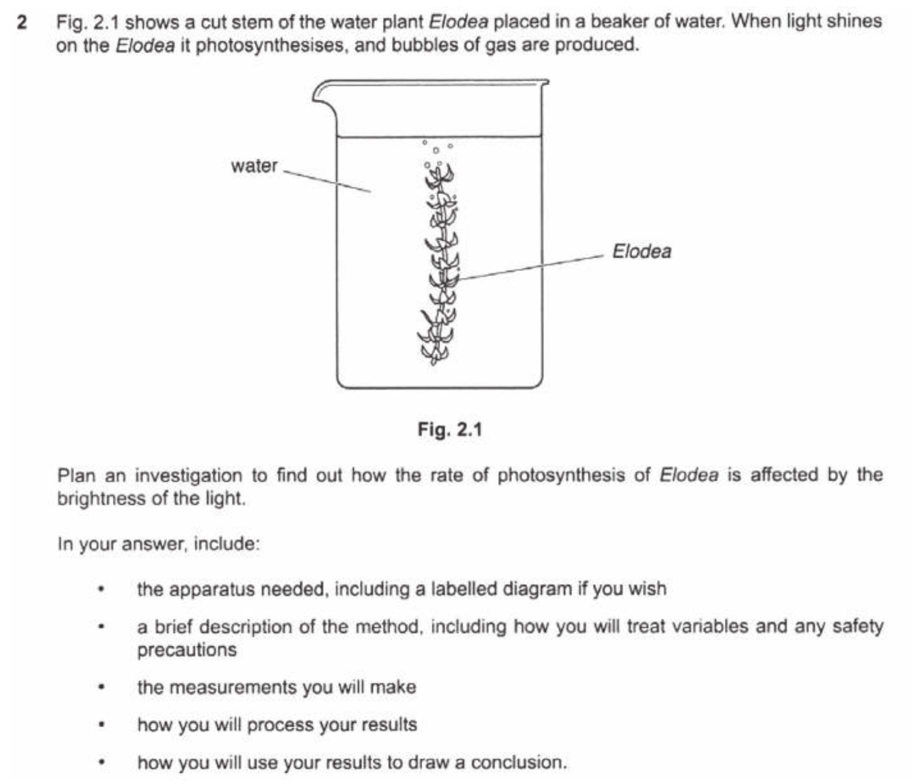
Common mistakes candidates made in this question

- **(a)(i)** It was common for candidates to have drawn feathered lines and/or to have omitted details of the core. Another common error was to include unnecessary and confusing shading.
- A common error in **(a)(ii)** was to answer in cm rather than mm.
- **(b)** Candidates who knew that Benedict's solution was used to test a reducing sugar often omitted the instruction to warm the mixture. Some gave incorrect colour changes, including giving blue as the positive result.

Question 2

Example Candidate Response – high

Examiner Comments



2 Fig. 2.1 shows a cut stem of the water plant *Elodea* placed in a beaker of water. When light shines on the *Elodea* it photosynthesises, and bubbles of gas are produced.

Fig. 2.1

Plan an investigation to find out how the rate of photosynthesis of *Elodea* is affected by the brightness of the light.

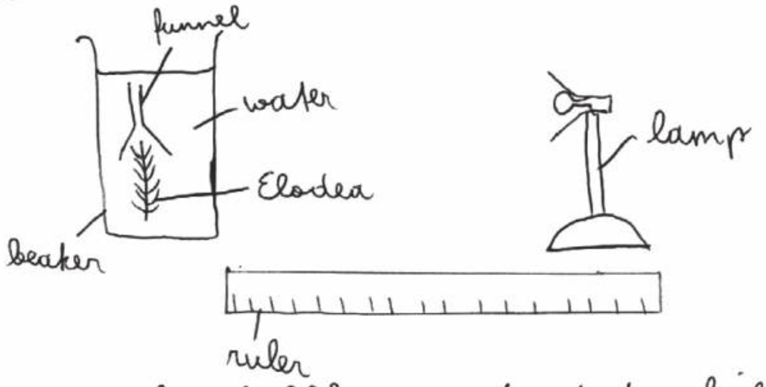
In your answer, include:

- the apparatus needed, including a labelled diagram if you wish
- a brief description of the method, including how you will treat variables and any safety precautions
- the measurements you will make
- how you will process your results
- how you will use your results to draw a conclusion.

Example Candidate Response – high, continued

Apparatus needed: Beaker, water, Elodea, a lamp, ① a funnel, a long ruler

Method: The Elodea is put into a beaker filled with water. A ruler is put onto the table to measure the distance ② between beaker and lamp. A lamp is put on the table and turned on at different distances ③ from the beaker. A funnel is put over the Elodea so that bubbles can be counted ④ better. At every distance of the lamp, the bubbles produced by the plant are counted for one minute ⑤, then again for a second minute. Then the lamp is moved. ~~The~~ It has to be taken care that the same plant is used in every reading and that the water has the same temperature. ⑥ A second beaker filled with water could be put between [7] lamp and beaker with plant. The room should also be dark. The results should be organised in ~~at~~ a table. The a graph with ~~bubble~~ 'bubbles produced' against 'distance from plant' should be drawn.



~~The~~ If less bubbles are produced at a higher distance, the conclusion is that the lower the light intensity is, the lower is the rate of photosynthesis. ⑦

Examiner Comments

① Apparatus mark: a lamp.

② Measurement mark: distance between the lamp and the beaker.

③ Method mark: vary the distance between the lamp and the beaker.

④ Measurement mark: count the bubbles.

⑤ Method mark: (counting bubbles) for a specified, fixed amount of time.

⑥ Variables mark: control the temperature.

⑦ Processing results: less bubbles at a higher distance means a lower rate of photosynthesis.

Total mark awarded = 7 out of 7

How the candidate could have improved their answer

This answer gave a detailed response, which provided a match in all four areas of the mark scheme. Notice that for all seven marks, the candidate needed to make points about all four areas of the method (apparatus; method and variables; measurements and processing results and making conclusions). The weakest area of this answer was the processing results. Better answers discussed drawing graphs of number of bubbles per unit time against distance between the lamp and the beaker, with the expectation that the graph would show an inversely proportional relationship.

Example Candidate Response – middle

2 Fig. 2.1 shows a cut stem of the water plant *Elodea* placed in a beaker of water. When light shines on the *Elodea* it photosynthesises, and bubbles of gas are produced.

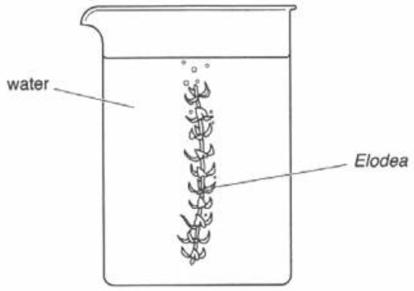
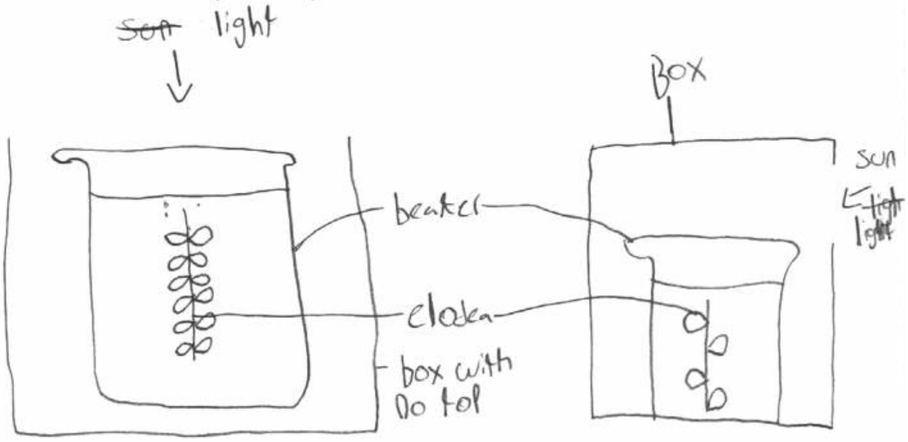


Fig. 2.1

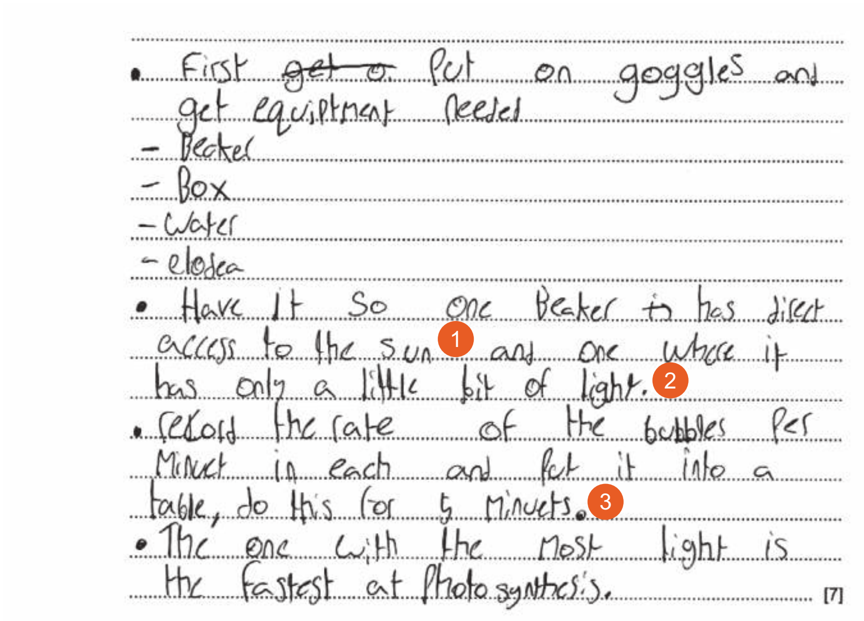
Plan an investigation to find out how the rate of photosynthesis of *Elodea* is affected by the brightness of the light.

In your answer, include:

- the apparatus needed, including a labelled diagram if you wish
- a brief description of the method, including how you will treat variables and any safety precautions
- the measurements you will make
- how you will process your results
- how you will use your results to draw a conclusion.



Examiner Comments

Example Candidate Response – middle, continued	Examiner Comments
 • First ~~get o~~ Put on goggles and get equiptment needed - Beaker - Box - Water - elodea • Have it so one Beaker ~~to~~ has direct access to the sun ① and one where it has only a little bit of light. ② • record the rate of the bubbles Per Minuet in each and Put it into a table, do this for 5 Minuets. ③ • The one with the most light is the fastest at Photosynthesis. [7]	① Apparatus mark: 'The Sun' was accepted as a light source. ② Method and variables mark: this is a very basic approach to varying the light. The idea of a light and a darker place was accepted as this is enough to show a difference in rate of photosynthesis. ③ Method and variables mark: Although the candidate does not make it clear that bubbles should be counted (so that no 'measurement' mark is available), it is clear that the time over which measurements will be taken will be controlled (5 minutes). **Total mark awarded =** **4 out of 7**

How the candidate could have improved their answer

Although this answer was given 4 marks, each point had been made at its most basic level. It was difficult to control the light from 'the Sun' so the candidate should have chosen an artificial light source. The candidate did not say how they would measure the 'rate of bubbles'. A clearer approach would have stated that bubbles would be counted. The candidate did, however, specify that this measurement would take place over a fixed time of five minutes. The answer did not mention any controls (such as temperature or length of Elodea). The processing had been discussed only at a basic level. Better answers discussed comparing number of bubbles with intensity of light or distance from a light source.

Example Candidate Response – low

2 Fig. 2.1 shows a cut stem of the water plant *Elodea* placed in a beaker of water. When light shines on the *Elodea* it photosynthesises, and bubbles of gas are produced.

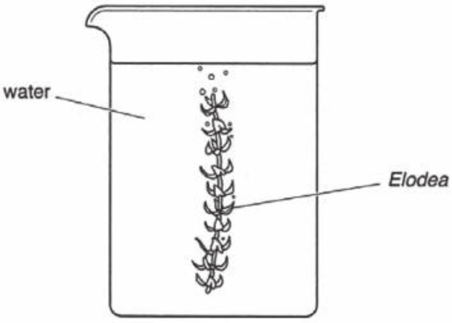


Fig. 2.1

Plan an investigation to find out how the rate of photosynthesis of *Elodea* is affected by the brightness of the light.

In your answer, include:

- the apparatus needed, including a labelled diagram if you wish
- a brief description of the method, including how you will treat variables and any safety precautions
- the measurements you will make
- how you will process your results
- how you will use your results to draw a conclusion.

Elodea is affected by the brightness of the light, because gives energy to ~~[illegible]~~ make photosynthesis.

To make this happen, you need a beaker full of ~~a~~ water (more than half) and the Elodea.

Also you should wear gloves, specially when you are going to put the plant in the water.

Each time the plant gets light I will recorded with a stopwatch ① and calculate how much time the Elodea make bubbles.

For the conclusion I will draw a ~~ge~~ table with all my records and finally draw a graph like that I can see at what [7] time do the plant ~~p~~ has more energy to make photosynthesis.

Examiner Comments

① Apparatus mark: This answer identifies that a stopwatch will be needed.

Total mark awarded = 1 out of 7

How the candidate could have improved their answer

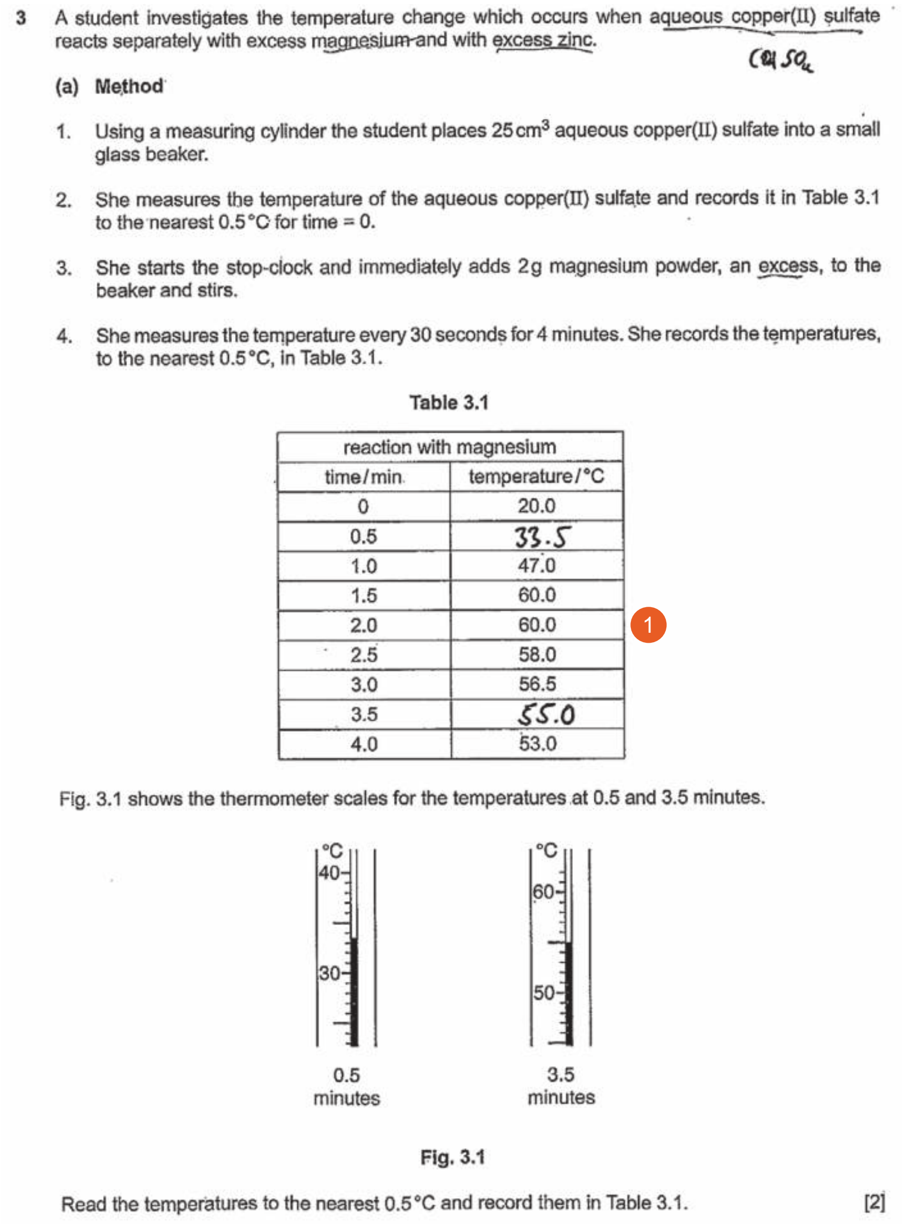
The bullet points in the question were designed to support candidates to make an answer which addressed all of the marking points. In this case, the candidate had only made one clear point (identifying a piece of apparatus: a stopwatch). The other bullets had not been addressed. The candidate did attempt a safety precaution but this was too generalised. Wearing goggles or gloves was a general safety precaution. In the plan, the safety precautions needed to be specific to the procedure, for example, keeping water away from the electric lamp or avoiding looking directly into a bright light source.

Common mistakes candidates made in this question

The most common error was that candidates did not use the bullet points to structure their answers and so missed out whole sections of their plan. The bullet points at the start of the question are designed to support candidates and they should plan their answer to address every area.

Question 3

Example Candidate Response – high



3 A student investigates the temperature change which occurs when aqueous copper(II) sulfate reacts separately with excess magnesium and with excess zinc.

$CuSO_4$

(a) **Method**

1. Using a measuring cylinder the student places 25 cm^3 aqueous copper(II) sulfate into a small glass beaker.
2. She measures the temperature of the aqueous copper(II) sulfate and records it in Table 3.1 to the nearest 0.5 °C for time = 0.
3. She starts the stop-clock and immediately adds 2 g magnesium powder, an excess, to the beaker and stirs.
4. She measures the temperature every 30 seconds for 4 minutes. She records the temperatures, to the nearest 0.5 °C, in Table 3.1.

Table 3.1

reaction with magnesium	
time / min	temperature / °C
0	20.0
0.5	33.5
1.0	47.0
1.5	60.0
2.0	60.0
2.5	58.0
3.0	56.5
3.5	55.0
4.0	53.0

1

Fig. 3.1 shows the thermometer scales for the temperatures at 0.5 and 3.5 minutes.

Fig. 3.1

Read the temperatures to the nearest 0.5 °C and record them in Table 3.1. [2]

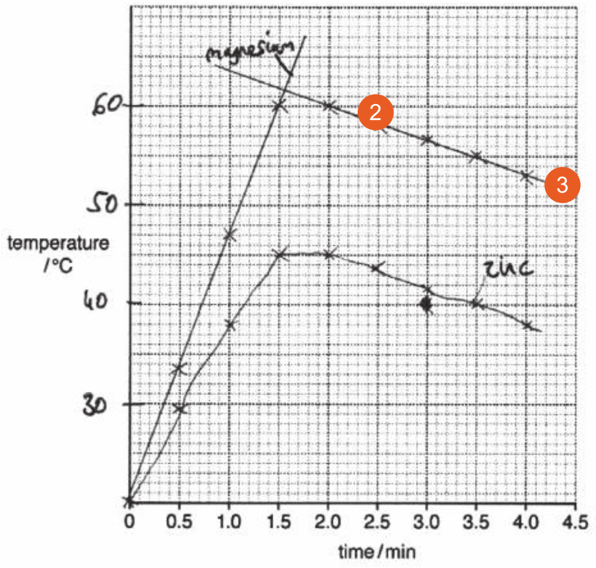
Examiner Comments

① Both readings are correctly given to the same number of decimal places as the other readings in the table.

Mark for (a) = 2 out of 2

Example Candidate Response – high, continued

(b) (i) On the grid provided plot a graph of temperature (vertical axis) against time.



[2]

(ii) Draw a best-fit straight line for the **increasing** temperatures. Extend the line further than the highest point. Label the line magnesium.

Draw a best-fit line through the **decreasing** temperatures. Extend the line back past the highest point. [1]

(iii) The maximum temperature reached by the reaction is where the two lines cross.

State the maximum temperature reached by the reaction.

maximum temperature = 61.5 ④ °C [1]

(c) Suggest a value for the maximum temperature reached if 5 g magnesium powder is reacted with 25 cm^3 of the same copper(II) sulfate solution.

maximum temperature = 50 ~~80 90 70~~ ⑤ °C [1]

Examiner Comments

② All results for magnesium are correctly plotted.

③ The lines of best fit are correctly drawn, according to the instructions given.

Mark for (b)(i) = 2 out of 2

Mark for (b)(ii) = 1 out of 1

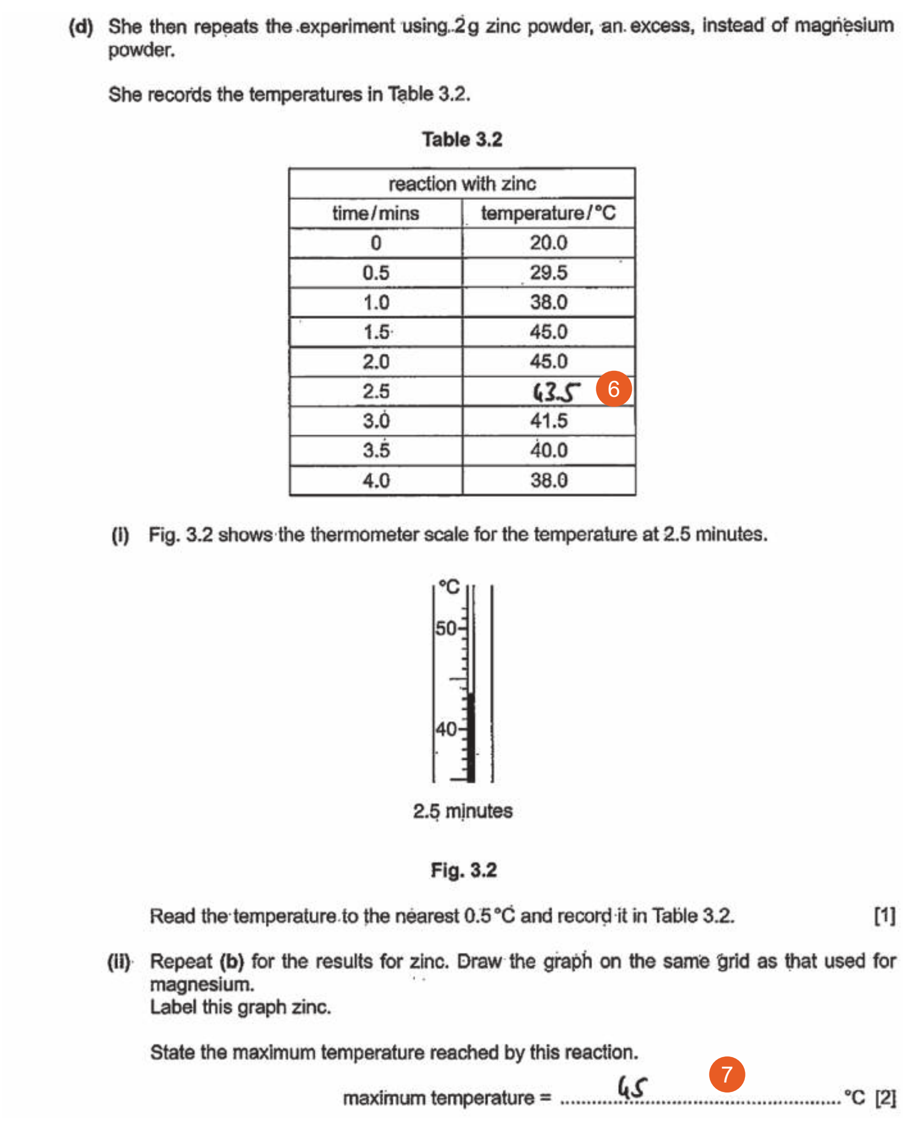
④ The correct value of temperature is given from the graph.

Mark for (b)(iii) = 1 out of 1

⑤ This answer is incorrect. The candidate did not realise that the magnesium was already in excess so that adding more makes no difference to the temperature change.

Mark for (c) = 0 out of 1

Example Candidate Response – high, continued



(d) She then repeats the experiment using 2 g zinc powder, an excess, instead of magnesium powder.

She records the temperatures in Table 3.2.

Table 3.2

reaction with zinc	
time / mins	temperature / °C
0	20.0
0.5	29.5
1.0	38.0
1.5	45.0
2.0	45.0
2.5	43.5 ⑥
3.0	41.5
3.5	40.0
4.0	38.0

(i) Fig. 3.2 shows the thermometer scale for the temperature at 2.5 minutes.

2.5 minutes

Fig. 3.2

Read the temperature to the nearest 0.5 °C and record it in Table 3.2. [1]

(ii) Repeat **(b)** for the results for zinc. Draw the graph on the same grid as that used for magnesium.
Label this graph zinc.

State the maximum temperature reached by this reaction.

maximum temperature = 45 ⑦ °C [2]

Examiner Comments

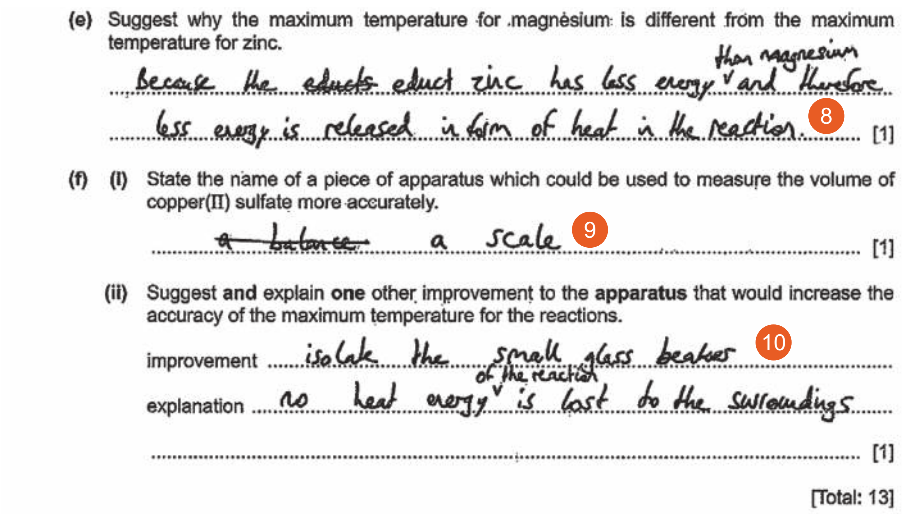
⑥ The temperature is correctly recorded to the same number of decimal places as the other readings in the table.

Mark for (d)(i) = 1 out of 1

⑦ The lines for magnesium and zinc were labelled, as asked for in the question. However, the lines for zinc were not drawn with a ruler, so the lines for zinc are incorrect and the temperature reading cannot be read with appropriate precision.

Mark for (d)(ii) = 1 out of 2

Example Candidate Response – high, continued



(e) Suggest why the maximum temperature for magnesium is different from the maximum temperature for zinc.

Because the ~~educts~~ educt zinc has less energy than magnesium and therefore less energy is released in form of heat in the reaction. ⑧ [1]

(f) **(i)** State the name of a piece of apparatus which could be used to measure the volume of copper(II) sulfate more accurately.

~~a balance~~ a scale ⑨ [1]

(ii) Suggest **and** explain **one** other improvement to the **apparatus** that would increase the accuracy of the maximum temperature for the reactions.

improvement isolate the small glass beakers ⑩

explanation no heat energy of the reaction is lost to the surroundings

[1]

[Total: 13]

Examiner Comments

⑧ The answer does not identify the difference in reactivity of the two metals as being significant.

Mark for (e) = 0 out of 1

⑨ ‘A scale’ (presumably the candidate means a balance) does not directly measure volume.

Mark for (f)(i) = 0 out of 1

⑩ A ‘benefit of the doubt’ mark is awarded here. The candidate gives the word ‘isolate’ but from the rest of the response, it is clear that the answer refers to ‘insulate’ so 1 mark is awarded.

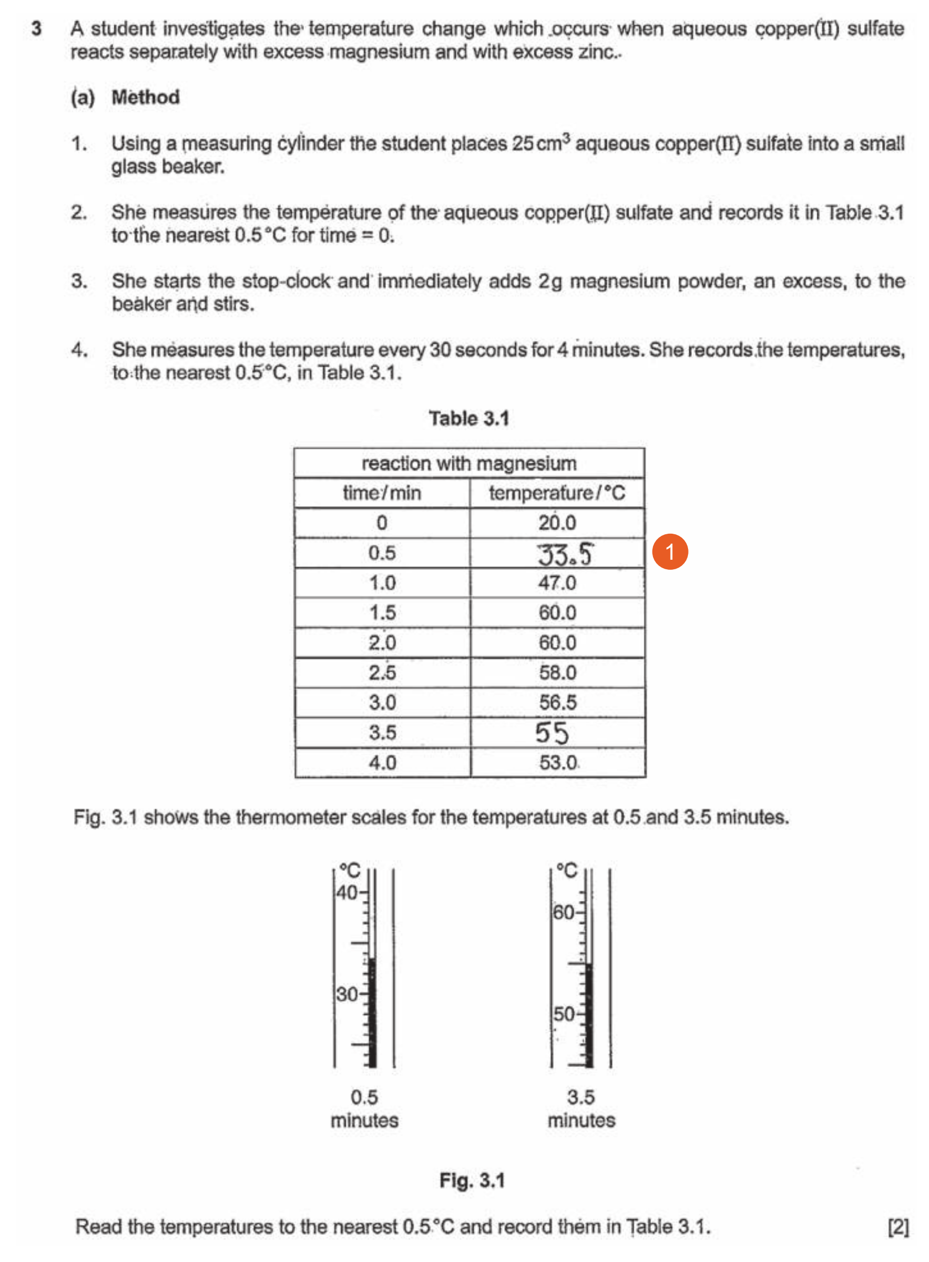
Mark for (f)(ii) = 1 out of 1

Total mark awarded = 9 out of 13

How the candidate could have improved their answer

- Candidates found aspects of this question very challenging. The original information contained a large amount of important points. The idea that the zinc was initially in excess is needed to answer **(c)**.
- The candidate missed this information. When drawing graphs, candidates should have drawn lines with a ruler where appropriate (curves, where appropriate, need to be smooth). When a piece of apparatus was asked for, candidates should have given the name specifically.
- **(f)(i)** To have measured volume, a better answer would have been a pipette or a syringe (a measuring cylinder was used in the question).

Example Candidate Response – middle



3 A student investigates the temperature change which occurs when aqueous copper(II) sulfate reacts separately with excess magnesium and with excess zinc.

(a) Method

1. Using a measuring cylinder the student places 25 cm^3 aqueous copper(II) sulfate into a small glass beaker.
2. She measures the temperature of the aqueous copper(II) sulfate and records it in Table 3.1 to the nearest 0.5 °C for time = 0.
3. She starts the stop-clock and immediately adds 2 g magnesium powder, an excess, to the beaker and stirs.
4. She measures the temperature every 30 seconds for 4 minutes. She records the temperatures, to the nearest 0.5 °C, in Table 3.1.

Table 3.1

reaction with magnesium	
time / min	temperature / °C
0	20.0
0.5	33.5 ①
1.0	47.0
1.5	60.0
2.0	60.0
2.5	58.0
3.0	56.5
3.5	55
4.0	53.0

Fig. 3.1 shows the thermometer scales for the temperatures at 0.5 and 3.5 minutes.

Fig. 3.1

Read the temperatures to the nearest 0.5 °C and record them in Table 3.1. [2]

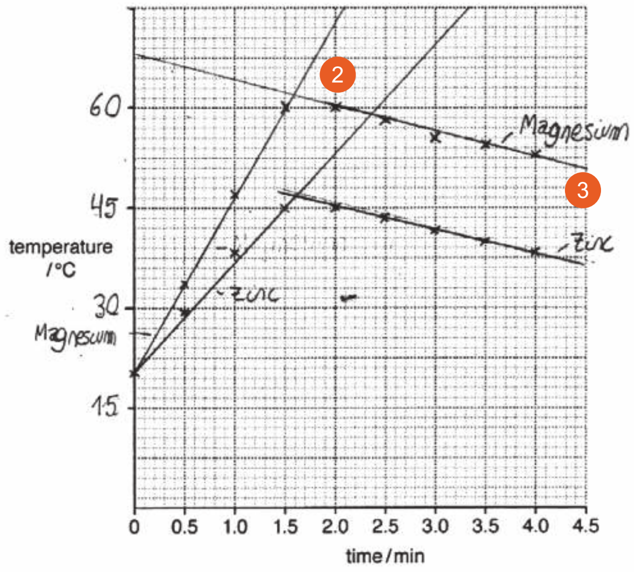
Examiner Comments

① Only one of the answers (33.5) is given to the same number of decimal places as the other values in the table.

Mark for (a) = 1 out of 2

Example Candidate Response – middle, continued

(b) **(i)** On the grid provided plot a graph of temperature (vertical axis) against time.



[2]

(ii) Draw a best-fit straight line for the **increasing** temperatures. Extend the line further than the highest point. Label the line magnesium.

Draw a best-fit line through the **decreasing** temperatures. Extend the line back past the highest point. [1]

(iii) The maximum temperature reached by the reaction is where the two lines cross.

State the maximum temperature reached by the reaction.

maximum temperature = ...62 ④.......... °C [1]

(c) Suggest a value for the maximum temperature reached if 5 g magnesium powder is reacted with 25 cm^3 of the same copper(II) sulfate solution.

maximum temperature = ...50 ⑤.......... °C [1]

Examiner Comments

② The choice of scale is (just) appropriate and points were correctly plotted. It is advisable to choose simple scales such as 2, 5 or 10. This one has values of 15 for each large square on the vertical axis. A ‘benefit of the doubt’ was applied to allow a match to the first marking point.

③ Lines of best fit are correctly drawn according to the instructions.

Mark for (b)(i) = 2 out of 2

Mark for (b)(ii) = 1 out of 1

④ The temperature is correct, from the lines on the graph.

Mark for (b)(iii) = 1 out of 1

⑤ This answer is incorrect. The candidate had not realised that the magnesium was already in excess so that adding more makes no difference to the temperature change.

Mark for (c) = 0 out of 1

Example Candidate Response – middle, continued

(d) She then repeats the experiment using 2 g zinc powder, an excess, instead of magnesium powder.

She records the temperatures in Table 3.2.

Table 3.2

reaction with zinc	
time / mins	temperature / °C
0	20.0
0.5	29.5
1.0	38.0
1.5	45.0
2.0	45.0
2.5	43.5 ⑥
3.0	41.5
3.5	40.0
4.0	38.0

(i) Fig. 3.2 shows the thermometer scale for the temperature at 2.5 minutes.

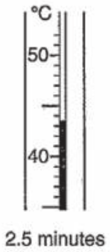


Fig. 3.2

Read the temperature to the nearest 0.5 °C and record it in Table 3.2. [1]

(ii) Repeat **(b)** for the results for zinc. Draw the graph on the same grid as that used for magnesium.
Label this graph zinc. ⑦

State the maximum temperature reached by this reaction.

maximum temperature = ...46.5.......................... °C [2]

Examiner Comments

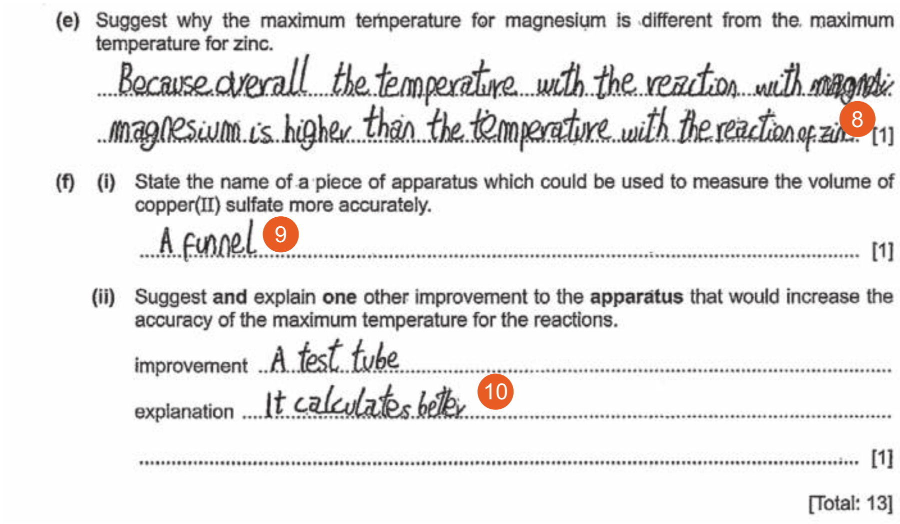
⑥ The temperature is correctly recorded to the same number of decimal places as the other readings in the table.

Mark for (d)(i) = 1 out of 1

⑦ All instructions are followed. The lines were labelled and the lines for zinc have been drawn with a ruler and the maximum temperature correctly read.

Mark for (d)(ii) = 2 out of 2

Example Candidate Response – middle, continued



(e) Suggest why the maximum temperature for magnesium is different from the maximum temperature for zinc.

Because overall the temperature with the reaction with magnesi magnesium is higher than the temperature with the reaction of zin ⑧ [1]

(f) **(i)** State the name of a piece of apparatus which could be used to measure the volume of copper(II) sulfate more accurately.

A funnel ⑨ [1]

(ii) Suggest **and** explain **one** other improvement to the **apparatus** that would increase the accuracy of the maximum temperature for the reactions.

improvement A test tube

explanation It calculates better ⑩

[1]

[Total: 13]

Examiner Comments

⑧ This answer states the temperature change but did not explain why the temperature change is different.

Mark for (e) = 0 out of 1

⑨ A funnel does not measure volume.

Mark for (f)(i) = 0 out of 1

⑩ This answer is incorrect; the use of a test tube would not improve the accuracy.

Mark for (f)(ii) = 0 out of 1

Total mark awarded = 8 out of 13

How the candidate could have improved their answer

- It was important to take care, when recording readings in a table, to have recorded readings to the same number of decimal places as the others in the table.
- **(a)** A reading of ‘55’ was incorrect. The final decimal place needed to be given: ‘55.0’ was the correct answer.
- In naming apparatus in **(e)** the candidate should have considered that the question asked about measuring volume and so the answer needed to be a piece of apparatus that could have been used to measure volume. A funnel does not measure volume.

Example Candidate Response – low

3 A student investigates the temperature change which occurs when aqueous copper(II) sulfate reacts separately with excess magnesium and with excess zinc.

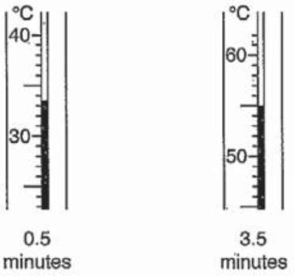
(a) Method

1. Using a measuring cylinder the student places 25 cm^3 aqueous copper(II) sulfate into a small glass beaker.
2. She measures the temperature of the aqueous copper(II) sulfate and records it in Table 3.1 to the nearest 0.5 °C for time = 0.
3. She starts the stop-clock and immediately adds 2 g magnesium powder, an excess, to the beaker and stirs.
4. She measures the temperature every 30 seconds for 4 minutes. She records the temperatures, to the nearest 0.5 °C, in Table 3.1.

Table 3.1

reaction with magnesium	
time / min	temperature / °C
0	20.0
0.5	33.5 ①
1.0	47.0
1.5	60.0
2.0	60.0
2.5	58.0
3.0	56.5
3.5	55
4.0	53.0

Fig. 3.1 shows the thermometer scales for the temperatures at 0.5 and 3.5 minutes.



0.5 minutes

3.5 minutes

Fig. 3.1

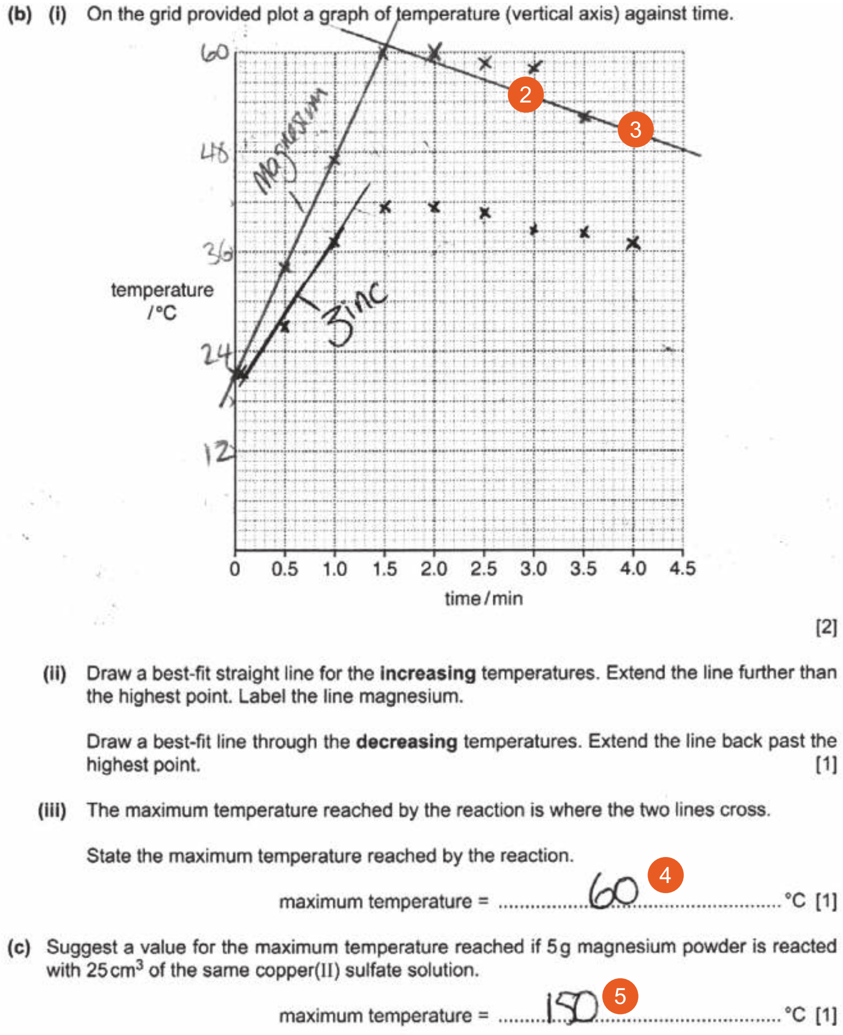
Read the temperatures to the nearest 0.5 °C and record them in Table 3.1. [2]

Examiner Comments

① Only one of the answers (33.5) is given to the same number of decimal places as the other values in the table.

Mark for (a) = 1 out of 2

Example Candidate Response – low, continued



(b) (i) On the grid provided plot a graph of temperature (vertical axis) against time.

[2]

(ii) Draw a best-fit straight line for the **increasing** temperatures. Extend the line further than the highest point. Label the line magnesium.

Draw a best-fit line through the **decreasing** temperatures. Extend the line back past the highest point. [1]

(iii) The maximum temperature reached by the reaction is where the two lines cross.

State the maximum temperature reached by the reaction.

maximum temperature = 60 ④ °C [1]

(c) Suggest a value for the maximum temperature reached if 5 g magnesium powder is reacted with $25\,cm^3$ of the same copper(II) sulfate solution.

maximum temperature = 150 ⑤ °C [1]

Examiner Comments

② The scale chosen is linear, however it was too large (the values should not be plotted at the upper limit of the grid) and not appropriate (it is advisable to choose simple scales such as 2, 5 or 10. This one had values of 12 for each large square on the vertical axis). This made it difficult for the candidate to correctly plot values.

Mark for (b)(i) = 1 out of 2

③ The line of best fit is drawn correctly. The line is actually lower than three of the points.

Mark for (b)(ii) = 0 out of 1

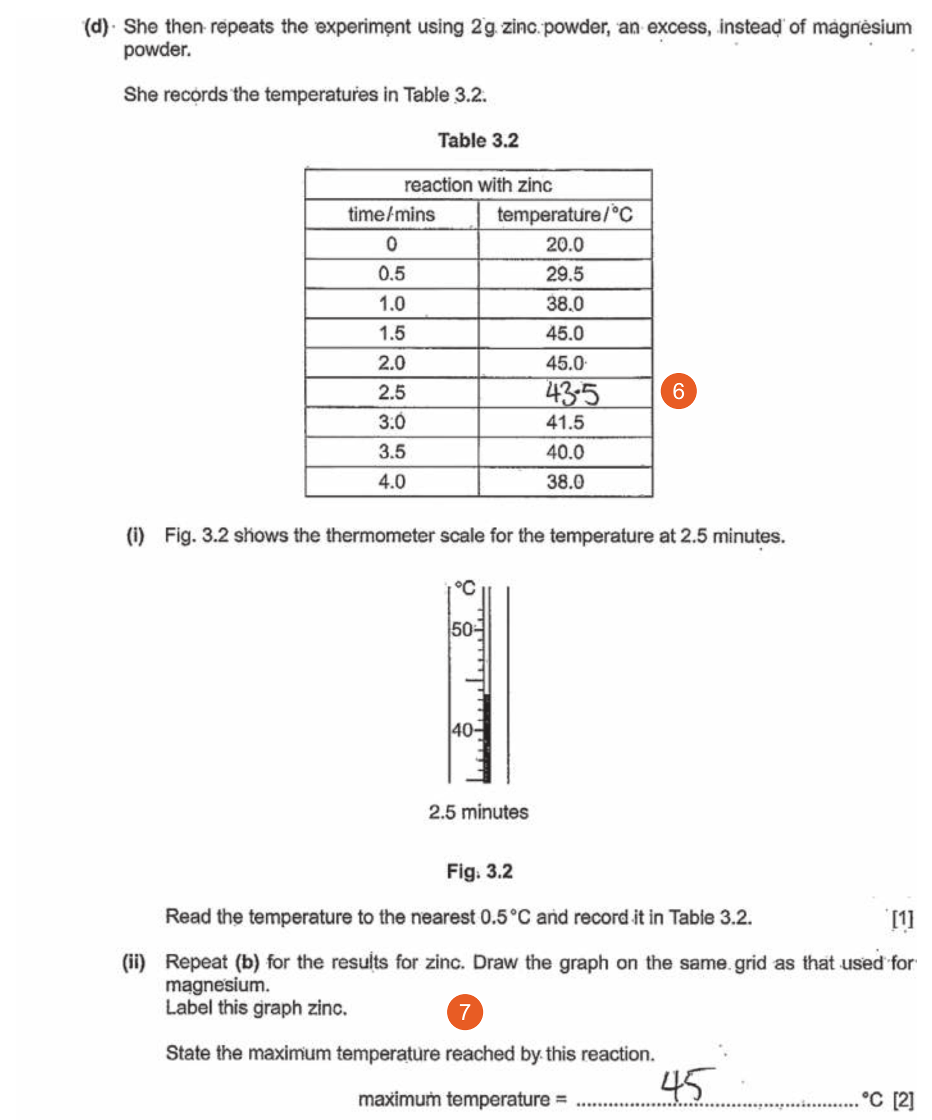
④ This answer is incorrect. The line extends beyond the grid, so that a reading of the temperature is not possible. The maximum temperature is above 60°C, which is the maximum reading which can be made on this graph.

Mark for (b)(iii) = 0 out of 1

⑤ This answer is incorrect. The candidate has not realised that the magnesium was already in excess so that adding more makes no difference to the temperature change.

Mark for (c) = 0 out of 1

Example Candidate Response – low, continued



(d) She then repeats the experiment using 2 g zinc powder, an excess, instead of magnesium powder.

She records the temperatures in Table 3.2.

Table 3.2

reaction with zinc	
time / mins	temperature / °C
0	20.0
0.5	29.5
1.0	38.0
1.5	45.0
2.0	45.0
2.5	43.5
3.0	41.5
3.5	40.0
4.0	38.0

⑥

(i) Fig. 3.2 shows the thermometer scale for the temperature at 2.5 minutes.

Fig. 3.2

Read the temperature to the nearest 0.5 °C and record it in Table 3.2. [1]

(ii) Repeat **(b)** for the results for zinc. Draw the graph on the same grid as that used for magnesium.
Label this graph zinc. ⑦

State the maximum temperature reached by this reaction.

maximum temperature = ...45........ °C [2]

Examiner Comments

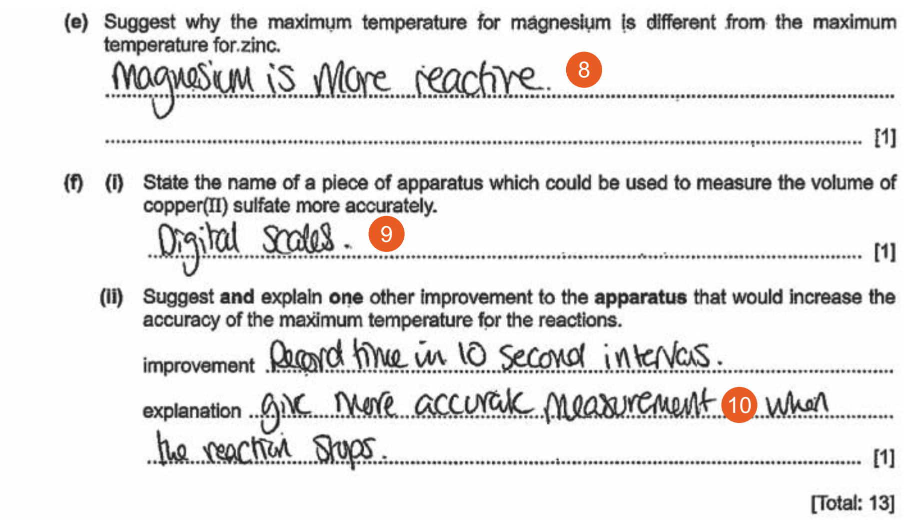
⑥ The temperature is correctly recorded to the same number of decimal places as the other readings in the table.

Mark for (d)(i) = 1 out of 1

⑦ There are labels for the magnesium and zinc lines on the graph, however, the best fit descending line for zinc was not drawn, so it is not possible to read a maximum temperature change for zinc.

Mark for (d)(ii) = 1 out of 2

Example Candidate Response – low, continued



(e) Suggest why the maximum temperature for magnesium is different from the maximum temperature for zinc.

Magnesium is More reactive. ⑧

[1]

(f) (i) State the name of a piece of apparatus which could be used to measure the volume of copper(II) sulfate more accurately.

Digital Scales. ⑨ [1]

(ii) Suggest **and** explain **one** other improvement to the **apparatus** that would increase the accuracy of the maximum temperature for the reactions.

improvement Record time in 10 second intervals.

explanation give more accurate measurement ⑩ when the reaction stops. [1]

[Total: 13]

Examiner Comments

⑧ The answer correctly states that magnesium is more reactive.

Mark for (e) = 1 out of 1

⑨ Scales do not directly measure volume.

Mark for (f)(i) = 0 out of 1

⑩ This is a reasonable suggestion for a general experimental improvement, but the main source of error in the experiment is the heat loss to the surroundings. This answer did not address the main source of error.

Mark for (f)(ii) = 0 out of 1

**Total mark awarded =
5 out of 13**

How the candidate could have improved their answer

- It was important to have taken care, when recording readings in a table, to have recorded readings to the same number of decimal places as the others in the table.
- **(a)** A reading of ‘55’ was incorrect. The final decimal place needed to be given: ‘55.0’ is the correct answer.
- When choosing scales for a graph, the candidate should have ensured that the plotted points occupied more than half the available graph area, but did not reach its limit. In this case, the plotted points were at the limit of the grid, which meant that lines of best fit could not be drawn and readings from extrapolated lines were outside the limits of the grid area.

Common mistakes candidates made in this question

- Candidates commonly did not record both values in **(a)** to one decimal place. It was common that they omitted the decimal place for any answer that ended in 0. Hence 55 was often given rather than 55.0.
- When drawing graphs, some candidates chose complex scales (such as increasing in 6 or 12). Others chose scales either too small (less than half the grid) or too large (so that some values were at the limits of the grid). Having drawn best-fit lines, some candidates did not take sufficient care that straight lines went through all points or had the same number of points either side of the line. Instructions to label the graph were often missed.

Question 4

Example Candidate Response – high

4 A student calculates the density of a liquid using two different methods.

Method 1

(a) He measures the mass m_c of an empty measuring cylinder.

m_c = 102.31 g

He adds approximately 75 cm^3 of the liquid to the measuring cylinder.

(i) Fig. 4.1 shows part of the measuring cylinder scale.

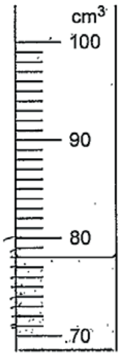


Fig. 4.1

Read and record the volume V_L of the liquid to the nearest 0.5 cm^3. ①

V_L = 78.0 cm^3 [1]

(ii) State how parallax (line of sight) errors are avoided when using a measuring cylinder.

Bring eye ~~pe~~ on same ~~hieght~~ height as liquid and ~~are~~ read in angle of 90°C ② [1]

(iii) He measures and records the total mass of the measuring cylinder and liquid.

total mass = 189.00 g

Determine the mass m_L of the liquid. Use the equation shown.

m_L = total mass − m_c

m_L = 86.69 ③ g [1]

189.00 − 102.31

Examiner Comments

① Correct answer with the correct number of decimal places. Notice that when reading a measuring cylinder, it is possible to give values to halfway between the smallest marking on the scale. In this case, the smallest markings were at 1 cm^3, so the answer should have been to one decimal place, ending in 0.5 or 0.0.

Mark for (a)(i) = 1 out of 1

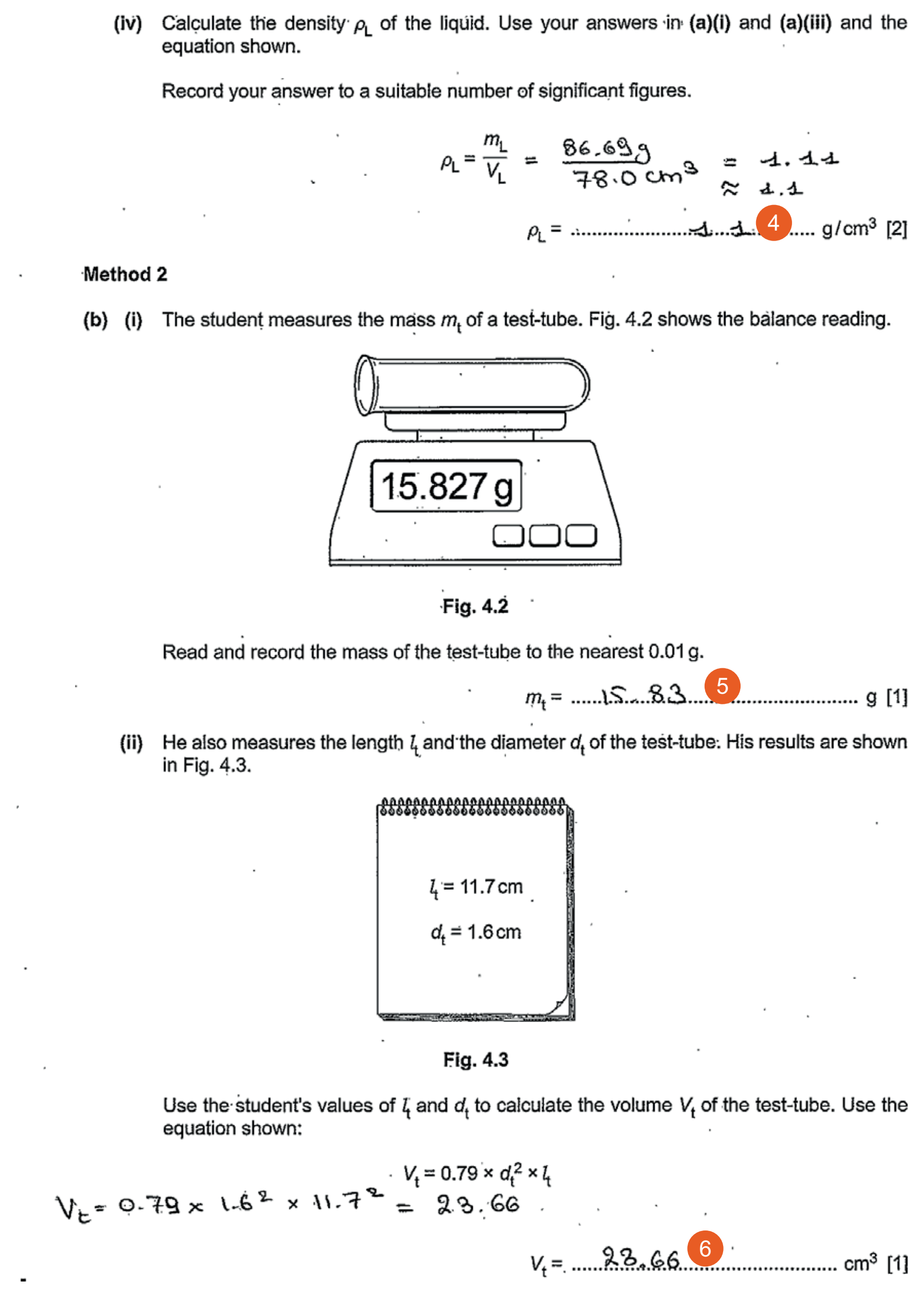
② A correct method of avoiding parallax error is to take a reading at eye level to the liquid.

Mark for (a)(ii) = 1 out of 1

③ Both mass values in the question were given to 2 decimal places. The candidate correctly calculated the mass of liquid and gave the answer correctly to 2 decimal places.

Mark for (a)(iii) = 1 out of 1

Example Candidate Response – high, continued



(iv) Calculate the density ρ_L of the liquid. Use your answers in **(a)(i)** and **(a)(iii)** and the equation shown.

Record your answer to a suitable number of significant figures.

$$\rho_L = \frac{m_L}{V_L} = \frac{86.69\text{g}}{78.0\text{ cm}^3} = 1.11 \approx 1.1$$

ρ_L = ...1.1...... ④ g/cm³ [2]

Method 2

(b) **(i)** The student measures the mass m_t of a test-tube. Fig. 4.2 shows the balance reading.

15.827 g

Fig. 4.2

Read and record the mass of the test-tube to the nearest 0.01 g.

m_t = ...15.83...... ⑤ g [1]

(ii) He also measures the length l_t and the diameter d_t of the test-tube. His results are shown in Fig. 4.3.

l_t = 11.7 cm

d_t = 1.6 cm

Fig. 4.3

Use the student's values of l_t and d_t to calculate the volume V_t of the test-tube. Use the equation shown:

$$V_t = 0.79 \times d_t^2 \times l_t$$

$V_t = 0.79 \times 1.6^2 \times 11.7^2 = 23.66$

V_t = ...23.66...... ⑥ cm³ [1]

Examiner Comments

④ The candidate calculated the value correctly and gives their answer to a suitable number of significant figures. For this question, 2 or 3 significant figures was accepted.

Mark for (a)(iv) = 2 out of 2

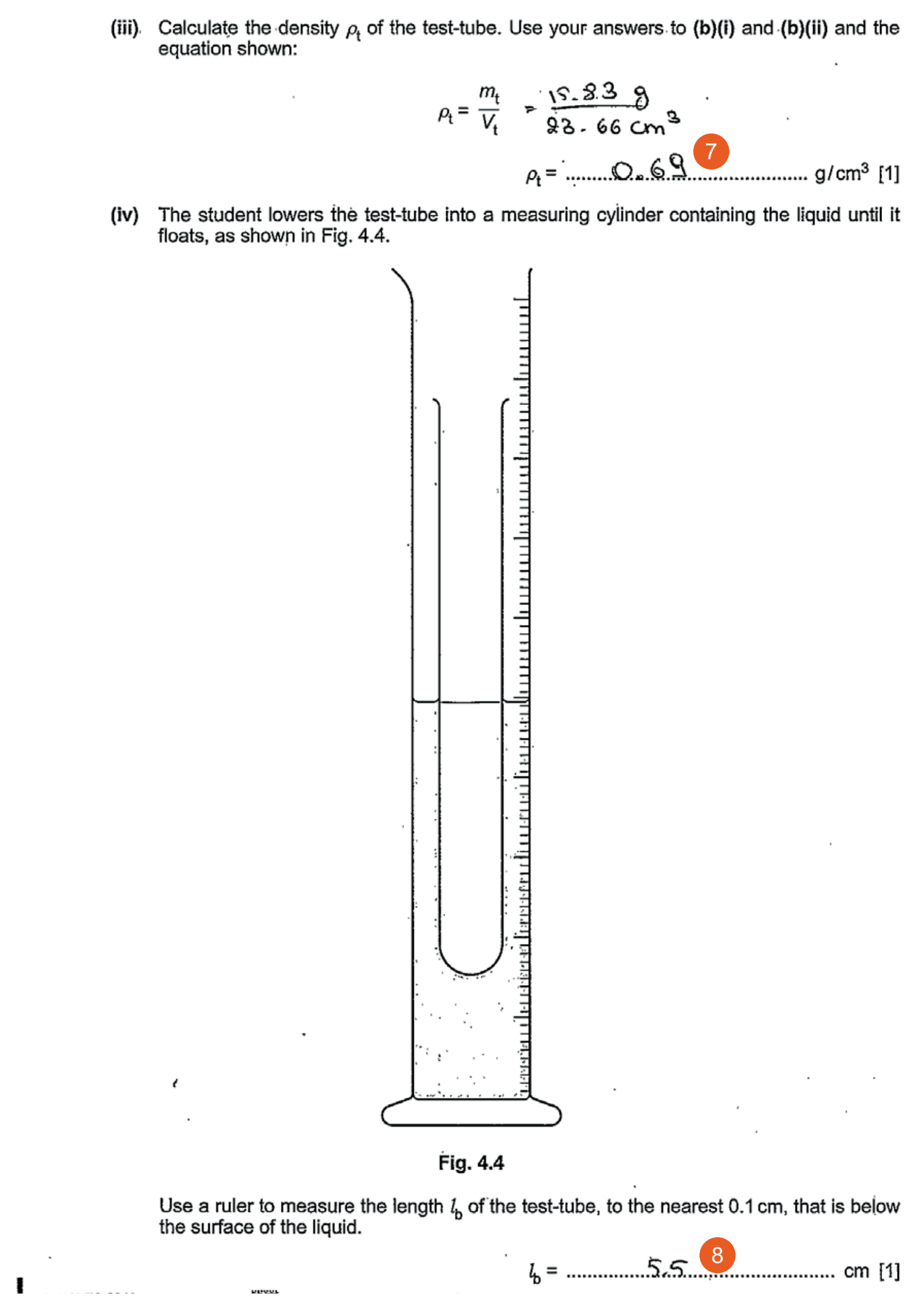
⑤ The answer correctly gives the mass to the nearest 0.1g.

Mark for (b)(i) = 1 out of 1

⑥ The candidate correctly calculates the volume of the test tube. In this case, significant figures have been assessed elsewhere in this question, so the number of significant figures is not significant here.

Mark for (b)(ii) = 1 out of 1

Example Candidate Response – high, continued



(iii) Calculate the density ρ_t of the test-tube. Use your answers to **(b)(i)** and **(b)(ii)** and the equation shown:

$$\rho_t = \frac{m_t}{V_t} = \frac{15.83\ g}{23.66\ cm^3}$$

ρ_t = ...0.69........ g/cm³ [1] ⑦

(iv) The student lowers the test-tube into a measuring cylinder containing the liquid until it floats, as shown in Fig. 4.4.

Fig. 4.4

Use a ruler to measure the length l_b of the test-tube, to the nearest 0.1 cm, that is below the surface of the liquid.

l_b = ...5.5........ cm [1] ⑧

Examiner Comments

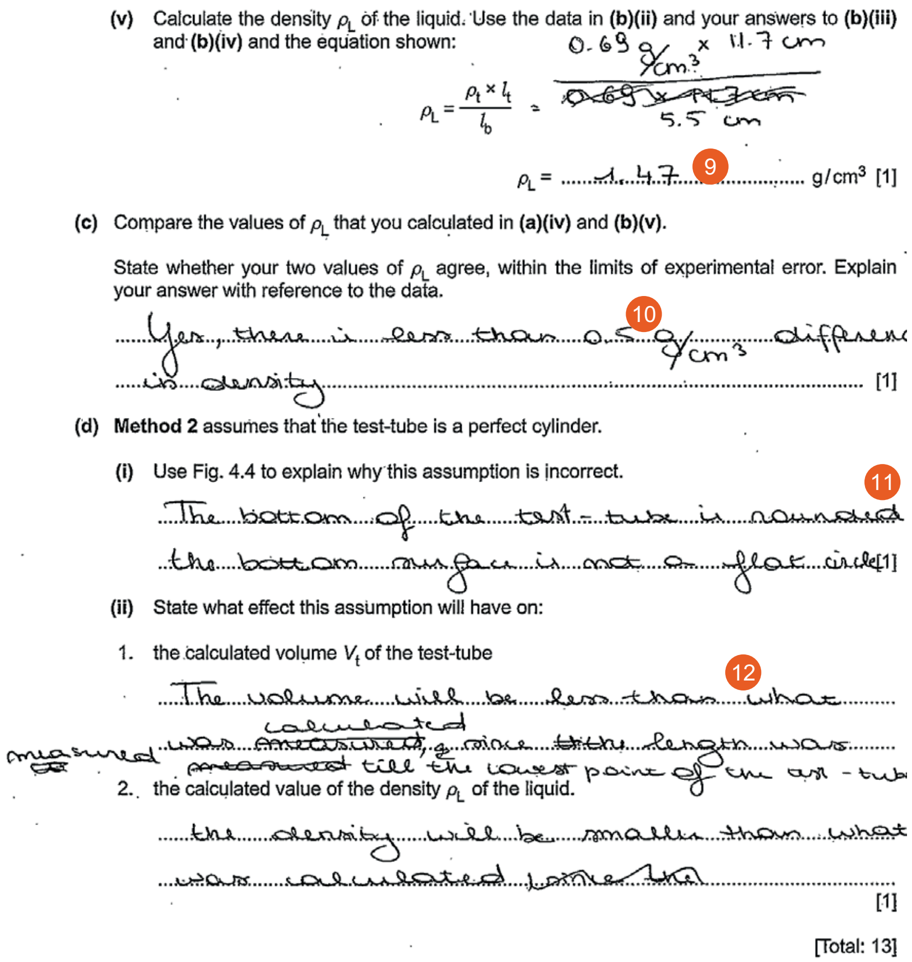
⑦ Based on candidate's values, the answer to this calculation is 0.67. The value given is, therefore, incorrect.

Marks for (b)(iii) = 0 out of 1

⑧ The answer is correct and is given in cm, as the question asks.

Mark for (b)(iv) = 1 out of 1

Example Candidate Response – high, continued



(v) Calculate the density ρ_L of the liquid. Use the data in **(b)(ii)** and your answers to **(b)(iii)** and **(b)(iv)** and the equation shown:

$$\rho_L = \frac{\rho_t \times l_t}{l_b} = \frac{0.69\ \text{g/cm}^3 \times 11.7\ \text{cm}}{\cancel{0.69 \times 11.7\ \text{cm}}\ \ 5.5\ \text{cm}}$$

ρ_L = 1.47 ⑨ g/cm^3 [1]

(c) Compare the values of ρ_L that you calculated in **(a)(iv)** and **(b)(v)**.

State whether your two values of ρ_L agree, within the limits of experimental error. Explain your answer with reference to the data.

Yes, there is less than 0.5 ⑩ g/cm^3 differenc in density [1]

(d) **Method 2** assumes that the test-tube is a perfect cylinder.

(i) Use Fig. 4.4 to explain why this assumption is incorrect. ⑪

The bottom of the test-tube is rounded the bottom surface is not a flat circle [1]

(ii) State what effect this assumption will have on:

1. the calculated volume V_t of the test-tube

The volume will be less than ⑫ what was ~~measured~~ calculated, since ~~th~~ the length was ~~measured~~ till the lowest point of the air-tube

measured

2. the calculated value of the density ρ_L of the liquid.

the density will be smaller than what was calculated ~~since the~~

[1]

[Total: 13]

Examiner Comments

⑨ This answer shows fully correct working based on the candidate's incorrect answer to (b) (iii). An ECF (error carried forward) can therefore be applied.

Mark for (b)(v) = 1 out of 1

⑩ A difference of 0.37 between the two values for density is significant and represented over a 30% error. This is too great for the values to be considered to be in agreement.

Mark for (c) = 0 out of 1

⑪ The answer explains that, as the test tube is rounded at the bottom, it is not a perfect cylinder.

Mark for (d)(i) = 1 out of 1

⑫ This answer shows that the candidate understands that the calculated volume is too high, but incorrectly stated this will cause the calculated density to be too low (rather than too high).

Mark for (d)(ii) = 0 out of 1

Total mark awarded = 10 out of 13

How the candidate could have improved their answer

- The candidate made an error in the calculation of density in **(b)(iii)**. The written working was correct, implying an error in the use of the calculator. It was wise to have double checked calculated values twice.
- **(c)** The candidate stated that values agreed within experimental error when there was a difference of over 30% between values. It would have been usual to have expected agreement within less than 10%.

Example Candidate Response – middle

4 A student calculates the density of a liquid using two different methods.

Method 1

(a) He measures the mass m_c of an empty measuring cylinder.

$$m_c = 102.31\,\text{g}$$

He adds approximately 75 cm³ of the liquid to the measuring cylinder.

(i) Fig. 4.1 shows part of the measuring cylinder scale.

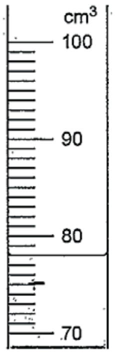


Fig. 4.1

Read and record the volume V_L of the liquid to the nearest 0.5 cm³.

V_L = ...80...... ① cm³ [1]

(ii) State how parallax (line of sight) errors are avoided when using a measuring cylinder.

Crouch down to become eyelevel with the liquid in the measuring cylinder ② [1]

(iii) He measures and records the total mass of the measuring cylinder and liquid.

total mass = 189.00 g

Determine the mass m_L of the liquid. Use the equation shown.

$$m_L = \text{total mass} - m_c$$

m_L = ...86,69...... ③ g [1]

Examiner Comments

① The answer does not consider the small-scale markings but shows a reading to the nearest major mark at 80.

Mark for (a)(i) = 0 out of 1

② A correct method of avoiding parallax error is to take a reading at eye level to the liquid.

Mark for (a)(ii) = 1 out of 1

③ Both mass values in the question are given to 2 decimal places. The candidate has correctly calculated the mass of liquid and gave the answer correctly to 2 decimal places.

Mark for (a)(iii) = 1 out of 1

Example Candidate Response – middle, continued

(iv) Calculate the density ρ_L of the liquid. Use your answers in **(a)(i)** and **(a)(iii)** and the equation shown.

Record your answer to a suitable number of significant figures.

$$\rho_L = \frac{m_L}{V_L}$$

ρ_L = 1,09 ④ g/cm^3 [2]

Method 2

(b) **(i)** The student measures the mass m_t of a test-tube. Fig. 4.2 shows the balance reading.

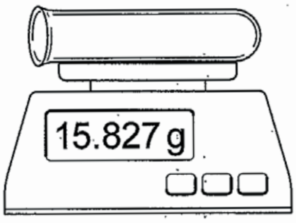
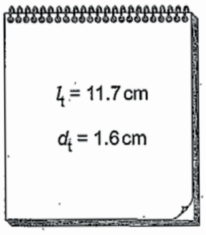


Fig. 4.2

Read and record the mass of the test-tube to the nearest 0.01 g.

m_t = 15,83 ⑤ g [1]

(ii) He also measures the length l_t and the diameter d_t of the test-tube. His results are shown in Fig. 4.3.



2,56

Fig. 4.3

Use the student's values of l_t and d_t to calculate the volume V_t of the test-tube. Use the equation shown:

$$V_t = 0.79 \times d_t^2 \times l_t$$

V_t = 23,7 ~~66208~~ ⑥ cm^3 [1]

Examiner Comments

④ This answer is incorrect. No working is shown so it is not possible to look for any partial credit.

Mark for (a)(iv) = 0 out of 2

⑤ The answer correctly gave the mass to the nearest 0.1g.

Mark for (b)(i) = 1 out of 1

⑥ The candidate correctly calculates the volume of the test tube. Notice that significant figures have been assessed elsewhere in this question, so this correctly rounded value is perfectly acceptable.

Mark for (b)(ii) = 1 out of 1

Example Candidate Response – middle, continued

(iii) Calculate the density ρ_t of the test-tube. Use your answers to **(b)(i)** and **(b)(ii)** and the equation shown:

$$\rho_t = \frac{m_t}{V_t}$$

0,67

ρ_t = ~~0,67356627~~ g/cm³ [1]

(iv) The student lowers the test-tube into a measuring cylinder containing the liquid until it floats, as shown in Fig. 4.4.

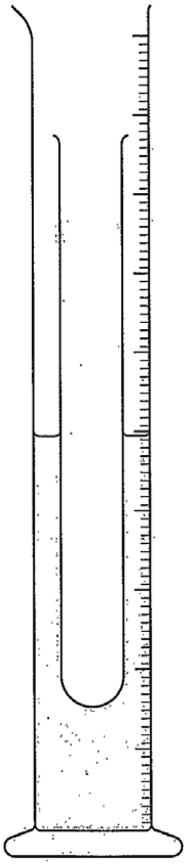


Fig. 4.4

Use a ruler to measure the length l_b of the test-tube, to the nearest 0.1 cm, that is below the surface of the liquid.

l_b = 5,5 ⑦ cm [1]

Examiner Comments

Mark for (b)(iii) is 1 out of 1

⑦ The answer is correct and is given in cm, as the question asks.

Mark for (b)(iv) = 1 out of 1

Example Candidate Response – middle, continued

(v) Calculate the density ρ_L of the liquid. Use the data in **(b)(ii)** and your answers to **(b)(iii)** and **(b)(iv)** and the equation shown:

$$\rho_L = \frac{\rho_t \times l_t}{l_b}$$

ρ_L = ~~2,68~~ 0,49 ⑧ g/cm^3 [1]

(c) Compare the values of ρ_L that you calculated in **(a)(iv)** and **(b)(v)**.

State whether your two values of ρ_L agree, within the limits of experimental error. Explain your answer with reference to the data.

~~No~~ Yes there is only a difference of 0,6 which I ⑨ beiliere is still in the statutes of experimental error [1]

(d) **Method 2** assumes that the test-tube is a perfect cylinder.

(i) Use Fig. 4.4 to explain why this assumption is incorrect.

It has a domed bottom and curves outwards at the top which of couse ~~is~~ leaves the ⑩ [1] body empty

(ii) State what effect this assumption will have on:

1. the calculated volume V_t of the test-tube

It is quit difficult to get aprecise measurement of the curved lip at the top of the cylinder

2. the calculated value of the density ρ_L of the liquid. ⑪

If the volume measurements are off the density will be off since half of the equation [1] isn't quite accurate.

[Total: 13]

Examiner Comments

⑧ This calculated value is incorrect. Notice that the candidate has not shown working. As this question is only for 1 mark, a partially correct answer would still be 0 marks. However, it is good technique to always show working.

Mark for (b)(v) = 0 out of 1

⑨ A difference of 0.6 is a very large difference when the lowest value is approximately 0.5 (this represents over 100% error). Therefore, these values are not within acceptable experimental error.

Mark for (c) = 0 out of 1

⑩ Although the comment about the domed bottom is correct, the candidate also mentions the curved top. As the volume is measured by calculating the portion of the test-tube that is submerged it is incorrect to include reference to the top so this answer is incorrect.

Mark for (d)(i) = 1 out of 1

⑪ The candidate does not clearly state whether the values would be too high or too low.

Mark for (d)(ii) = 0 out of 1

Total mark awarded = 7 out of 13

How the candidate could have improved their answer

- Two of the candidate's calculated values were incorrect. The candidate needed to show working so that, where possible, partial credit may have been awarded for an incorrect final answer with partially correct working.
- **(c)** A very large difference in values was considered by the candidate to have been within the limits of experimental error. It would have been usual to expect agreement within less than 10%.

Example Candidate Response – low

4 A student calculates the density of a liquid using two different methods.

Method 1

(a) He measures the mass m_c of an empty measuring cylinder.

$m_c = 102.31\,g$

He adds approximately 75 cm³ of the liquid to the measuring cylinder.

(i) Fig. 4.1 shows part of the measuring cylinder scale.

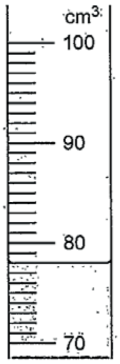


Fig. 4.1

Read and record the volume V_L of the liquid to the nearest 0.5 cm³. ①

V_L = ~~78.3~~ 78 cm³ [1]

(ii) State how parallax (line of sight) errors are avoided when using a measuring cylinder.

keep the measuring ~~ct~~ cilinder on a flat and stable table. ② [1]

(iii) He measures and records the total mass of the measuring cylinder and liquid.

total mass = 189.00 g

Determine the mass m_L of the liquid. Use the equation shown.

m_L = total mass − m_c

189.00 − ~~78.8~~78 =

m_L = ~~118.2~~ 111 ③ g [1]

Examiner Comments

① This answer should be to one decimal place (78.0). Notice that when reading a measuring cylinder, it is possible to give values to halfway between the smallest marking on the scale. In this case, the smallest markings are at 1 cm³, so the answer should have been to one decimal place, ending in 0.5 or 0.0.

Mark for (a)(i) = 0 out of 1

② This is good practice but does not explain how to avoid parallax error.

Mark for (a)(ii) = 0 out of 1

③ The candidate appears to have used the wrong values to calculate the mass lost. Both values are given in the question.

Mark for (a)(iii) = 0 out of 1

Example Candidate Response – low, continued

(iv) Calculate the density ρ_L of the liquid. Use your answers in **(a)(i)** and **(a)(iii)** and the equation shown.

Record your answer to a suitable number of significant figures.

$$\frac{189.00}{70.5}$$

$$\rho_L = \frac{m_L}{V_L}$$

ρ_L = 2④7 g/cm³ [2]

Method 2

(b) (i) The student measures the mass m_t of a test-tube. Fig. 4.2 shows the balance reading.

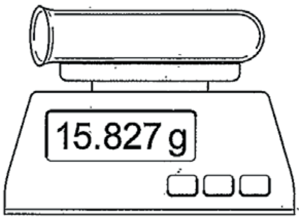


Fig. 4.2

Read and record the mass of the test-tube to the nearest 0.01 g.

m_t = 15.83 ⑤ g [1]

(ii) He also measures the length l_t and the diameter d_t of the test-tube. His results are shown in Fig. 4.3.

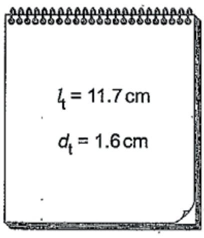


Fig. 4.3

Use the student's values of l_t and d_t to calculate the volume V_t of the test-tube. Use the equation shown:

0.79 × 1.6 × 11.7

$$V_t = 0.79 \times d_t^2 \times l_t$$

V_t = 14.8 ⑥ cm³ [1]

Examiner Comments

④ Although ECF (error carried forward) may be applied to this question, in this case, the candidate carried forward different values to those given earlier in the question. The candidate's own value for V_L is 78, not 70.5 so ECF cannot be allowed.

Mark for (a)(iv) = 0 out of 2

⑤ The answer correctly gives the mass to the nearest 0.1g.

Mark for (b)(i) = 1 out of 1

⑥ The candidate has omitted to square the value of the diameter, d_t. This leads to an incorrect final value.

Mark for (b)(ii) = 0 out of 1

Example Candidate Response – low, continued

(iii) Calculate the density ρ_t of the test-tube. Use your answers to **(b)(i)** and **(b)(ii)** and the equation shown:

$$\rho_t = \frac{m_t}{V_t} \qquad \frac{15.83}{2.7}$$

ρ_t = ...5.8........ g/cm³ [1] ⑦

(iv) The student lowers the test-tube into a measuring cylinder containing the liquid until it floats, as shown in Fig. 4.4.

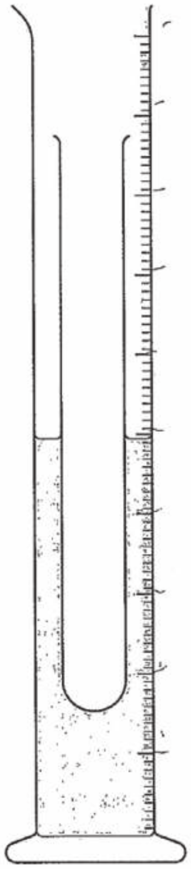


Fig. 4.4

Use a ruler to measure the length l_b of the test-tube, to the nearest 0.1 cm, that is below the surface of the liquid.

l_b = ...5.5........ cm [1] ⑧

Examiner Comments

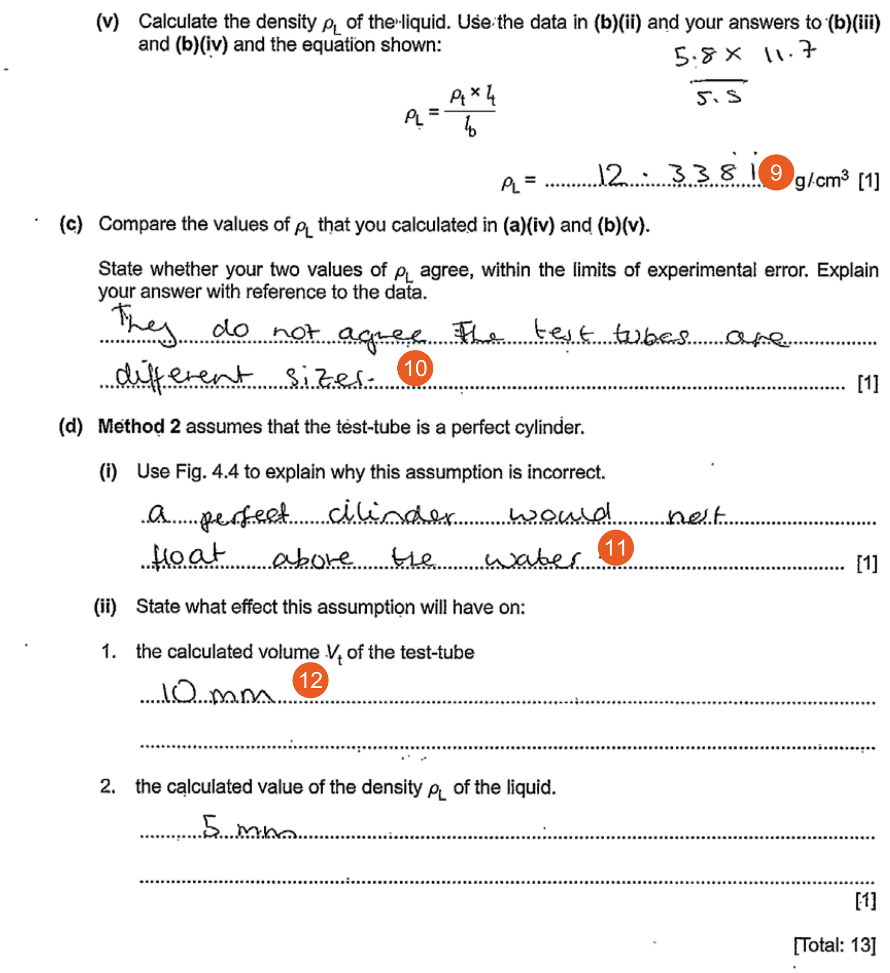
⑦ The candidate has used the wrong value for V_t. The value given in (b) (ii) is 14.8. Therefore, no error carried forward can be allowed.

Mark for (b)(iii) = 0 out of 1

⑧ The answer is correct and is given in cm, as the question asks.

Mark for (b)(iv) = 1 out of 1

Example Candidate Response – low, continued



(v) Calculate the density ρ_L of the liquid. Use the data in **(b)(ii)** and your answers to **(b)(iii)** and **(b)(iv)** and the equation shown:

$$\frac{5.8 \times 11.7}{5.5}$$

$$\rho_L = \frac{\rho_t \times l_t}{l_b}$$

ρ_L = 12.3381 ⑨ g/cm³ [1]

(c) Compare the values of ρ_L that you calculated in **(a)(iv)** and **(b)(v)**.

State whether your two values of ρ_L agree, within the limits of experimental error. Explain your answer with reference to the data.

They do not agree. The test tubes are different sizes. ⑩ [1]

(d) **Method 2** assumes that the test-tube is a perfect cylinder.

(i) Use Fig. 4.4 to explain why this assumption is incorrect.

a perfect cilinder would not float above the water ⑪ [1]

(ii) State what effect this assumption will have on:

1. the calculated volume V_t of the test-tube

10 mm ⑫

2. the calculated value of the density ρ_L of the liquid.

5 mm

[1]

[Total: 13]

Examiner Comments

⑨ In this answer, the candidate uses an incorrect value from (b)(iii) (5.8) to correctly calculate the density. Although 5.8 is an incorrect value, an error carried forward may be allowed as this follows from an earlier error.

Mark for (b)(v) = 1 out of 1

⑩ The answer does not refer to the differences between the values of the density.

Mark for (c) = 0 out of 1

⑪ This answer does not identify the difference between a test-tube and a perfect cylinder (the test-tube has a rounded bottom).

Mark for (d)(i) = 0 out of 1

⑫ This answer is unclear. Where lines are given, it is usual to expect an answer in words.

Mark for (d)(ii) = 0 out of 1

Total mark awarded =
3 out of 13

How the candidate could have improved their answer

This candidate answered several numerical questions incorrectly. When reading a scale, it was important to read to 0.5 of the smallest division, leading to an answer ending in 0.5 or 0.0. **(a)(i)** would hence have become 78.0. Where formulae were given for calculations, it was usual to find the necessary values given in the question. Care needed to be taken to make sure the correct values were selected. In later questions, answers to earlier parts were often needed in calculations. Similarly, care needed to be taken that the right values were used so that error carried forward may have been applied throughout the question.

Common mistakes candidates made in this question

- It was common for candidates to record the measuring cylinder volume without a decimal place (78 rather than 78.0). Similarly, significant figure and decimal place errors were often seen in **(a)(iv)** and **(b)(i)**.
- **(b)(iv)** Some candidates recorded either the full length of the test-tube, rather than the length below the water or recorded values in mm rather than in cm.
- **(c)** It was common to see candidate answers which said that the values agreed, even although they were a great deal more than 10% different.

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