Cambridge Assessment International Education

# Example Candidate Responses – Paper 5

## Cambridge IGCSE™ / IGCSE (9-1)

## Chemistry 0620 / 0971

For examination from 2021

Cambridge Pathway

# Contents

# Introduction

The main aim of this booklet is to exemplify standards for those teaching Cambridge IGCSE™ / IGCSE (9-1) Chemistry 0620 / 0971, 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 the June 2021 series 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 used here are available to download from the School Support Hub. These files are:

**0620 June 2021 Question Paper 53**

**0620 June 2021 Mark Scheme 53**

Past exam resources and other teaching and learning resources 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 – high | Examiner comments |
|---|---|

(a) Complete the table.

| experiment | volume of dilute sulfuric acid / cm³ | volume of distilled water / cm³ | volume of gas collected in 30 seconds / cm³ |
|---|---|---|---|
| 1 | 25 | 30 | 20 |
| 2 | 25 | 20 | 36 |
| 3 | 25 | 10 | 46 |
| 4 | 25 | 5 | 54 |
| 5 | 25 | 0 1 | 60 2 3 |

[4]

(b) Write a suitable scale on the *y*-axis and plot your results from Experiments 1 to 5 on the grid.

1 All of the volumes of dilute sulfuric acid and distilled water are correct and all volumes in all three columns are given to the same precision. Hence, M1 and M2 are awarded.

2 The volumes of gas collected increase as the volume of water decreases, so M3 is awarded.

3 The value is 60 is within 5 cm3 of the volume shown in the supervisor's results. So, M4 has been awarded.

**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.

**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.

## How the candidate could have improved their answer

- **(a)** The candidate correctly recorded the volumes of sulfuric acid and water and recorded all volumes to the same precision, so marks M1 and M2 were awarded. The volume of gas increased while descending the table, so M3 was awarded. The result for experiment 5 was compared to the supervisor's result and, as the value of 60 cm3 was within 5 cm3 of the result given by the supervisor, mark M4 was awarded. The fact the candidate has changed the result for experiment 5 is acceptable; the experiment may have been repeated or the candidate may have made an error when they first recorded it.
- **(b)** The candidate chose the perfect scale for the y-axis [illegible] drawn, however, is not acceptable. The gradient of the l[illegible] is not a smooth curve showing a regular trend. It is possib[illegible]ht line (a straight line would have been acceptable for the [illegible] very close to a straight line), however, straight lines on [illegible]

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

- **(b)** Candidates often drew curves that went from point to point rather than a best-fit line.
- **(c)** The extrapolation was often not a smooth continuation of the line drawn for the results of the investigation and so M1 could not be awarded although M2 could still be given if the reading was correct for the extrapolation the [illegible]
- [illegible] missing

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

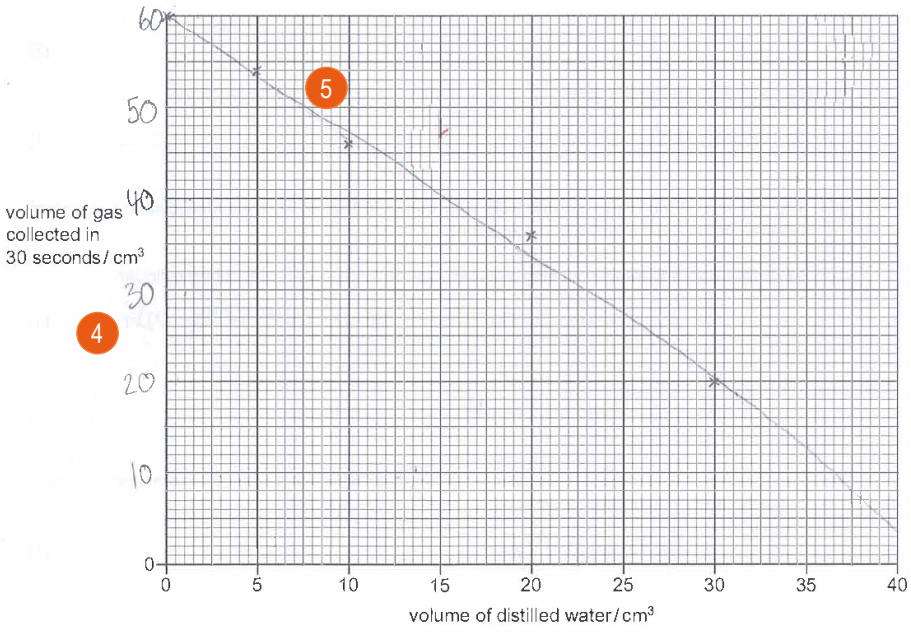
(a) Complete the table.

| experiment | volume of dilute sulfuric acid / cm³ | volume of distilled water / cm³ | volume of gas collected in 30 seconds / cm³ |
|---|---|---|---|
| 1 | 25 | 30 | 20 |
| 2 | 25 | 20 | 36 |
| 3 | 25 | 10 | 46 |
| 4 | 25 | 5 | 54 |
| 5 | 25 | 0 | 60 |

1 2 3

[4]

(b) Write a suitable scale on the *y*-axis and plot your results from Experiments 1 to 5 on the grid. Draw a smooth curve of best fit.




[4]

## Examiner comments

1 All of the volumes of dilute sulfuric acid and distilled water are correct and all volumes in all three columns are given to the same precision. Hence, M1 and M2 are awarded.

2 The volumes of gas collected increase as the volume of water decreases, so M3 is awarded.

3 The value is 60 is within 5 cm3 of the volume shown in the supervisor's results. So, M4 has been awarded.
Mark for (a) = 4 out of 4

4 The y-axis scale of each major grid square being 10 cm3 is a good choice and all of the data points are plotted correctly. Hence M1, M2 and M3 are awarded.

5 This line, although almost acceptable, is not awarded M4. The line is not sufficiently smooth. Over each successive 5 cm3 of water, the gas volume decreases by 6.5, 6.0, 7.0, 7.0, 6.0 and 7.0 and so is showing a gradient with both decreases and increases. A straight line, draw with a ruler, would have been acceptable for these points; the line drawn may be a free-hand attempt at a straight line, but free-hand straight lines are not acceptable.
Mark for (b) = 3 out of 4

## Example Candidate Response – high, continued

(c) Extrapolate (extend) the line on your graph and deduce the volume of gas that would be collected in 30 seconds if 35 $cm^3$ of distilled water was added to the dilute sulfuric acid

6 13 $cm^3$ [2]

(d) The rate of reaction can be calculated using the equation shown.

$$\text{rate of reaction} = \frac{\text{volume of gas collected}}{\text{time taken to collect the gas}}$$

(i) Use this equation to calculate the rate of reaction in Experiment 3. Give the units for the rate you have calculated.

$= \frac{46}{30}$ 7

rate = 1.53

units = $cm^3/s$ [2]

(ii) State which Experiment, 1, 2, 3, 4 or 5, had the highest rate of reaction.

Experiment 5 8 [1]

(e) The volume of the dilute sulfuric acid was measured using a measuring cylinder. A 25 $cm^3$ pipette can be used instead of a measuring cylinder.

(i) State **one** advantage of using a 25 $cm^3$ pipette instead of a measuring cylinder.

it is more accurate than a measuring cylinder 9 [1]

(ii) State **one** disadvantage of using a 25 $cm^3$ pipette instead of a measuring cylinder.

it is harder to use. 10 [1]

(f) Name another item of apparatus, which can be used instead of an inverted measuring cylinder, to collect and measure the volume of gas made in the reaction.

gas syringe 11 [1]

## Examiner comments

6 The extrapolation of the graph line for 30 cm3 to 35 cm3 is good since it follows on acceptably from the line preceding it. The reading of 13 cm3 is correct for the extrapolation shown. Hence, both marks are awarded.
Mark for (c) = 2 out of 2

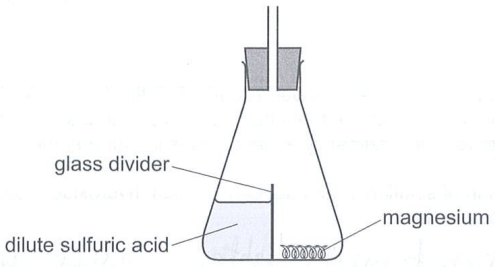
7 The calculation of 46/30 is correct as are the units. Hence, M1 and M2 are awarded.
Mark for (d)(i) = 1 out of 2

8 The identification of experiment 5 having the highest rate is correct.
Mark for (d)(ii) = 1 out of 1

9 The pipette being more accurate than a measuring cylinder is correct.
Mark for (e)(i) = 1 out of 1

10 While some candidates may find a pipette more difficult to use than a measuring cylinder, this is not an acceptable disadvantage. Stating that a pipette takes more time to use is acceptable and this answer can be improved by adding 'and so takes more time to use' at the end.
Mark for (e)(ii) = 0 out of 1

11 A gas syringe is an appropriate item of apparatus and so the mark is awarded.
Mark for (f) = 1 out of 1

| Example Candidate Response – high, continued | Examiner comments |
|---|---|
| **(g)** The diagram shows a modified conical flask that can be used in this investigation.<br>  <br><br>Explain the advantage of using this type of conical flask instead of the type you used in the investigation.<br>The stide prevents any human error or time loss, you dont have to remove the bung, making it more accurate. [2]<br>12<br>[Total: 18] | 12 This answer goes part way. The statement that the bung does not have to be removed is correct and is awarded a mark. However, while the accuracy of the results will be improved, this needs to be explained (the command word of the question asks for an explanation), and so a statement about no gas escaping/being lost is required.<br>Mark for (g) = 1 out of 2<br><br>**Total mark awarded = 14 out of 18** |

## How the candidate could have improved their answer

- **(a)** The candidate correctly recorded the volumes of sulfuric acid and water and recorded all volumes to the same precision, so marks M1 and M2 were awarded. The volume of gas increased while descending the table, so M3 was awarded. The result for experiment 5 was compared to the supervisor's result and, as the value of 60 cm3 was within 5 cm3 of the result given by the supervisor, mark M4 was awarded. The fact the candidate has changed the result for experiment 5 is acceptable; the experiment may have been repeated or the candidate may have made an error when they first recorded it.
- **(b)** The candidate chose the perfect scale for the y-axis and plotted all of their points correctly. The line they have drawn, however, is not acceptable. The gradient of the line both increases and decreases from left to right and so is not a smooth curve showing a regular trend. It is possible that the candidate attempted to draw a free-hand straight line (a straight line would have been acceptable for the results the student obtained in the experiment as they fall very close to a straight line), however, straight lines on graphs MUST be drawn with the aid of a ruler.
- The candidate drew an acceptable extrapolation in (c) as it followed on appropriately from the line they drew for the results, and the reading from the extrapolation was correct.
- **(d)** The calculation has been completed correctly and the correct units given; the experiment with the highest rate has been correctly identified.
- **(e)** While the advantage of a pipette over a measuring cylinder is correct, the disadvantage of being harder to use was not accepted. If the candidate had gone on to say that being harder to use means it would have taken more time, then the mark would have been awarded.
- **(f)** The candidate has correctly identified a gas syringe as being an alternative item of apparatus in which the gas could be collected, and its volume measured.
- **(g)** Asked for an explanation. The answer the candidate gave is only a partial explanation and so only 1 mark has been awarded. The candidate correctly stated that the bung does not need to be removed but, has not then explained why this is an advantage. While it is true that the results would be more accurate, the candidate needed to explain why they would be more accurate by stating that not removing the bung would mean that no gas would have been lost.

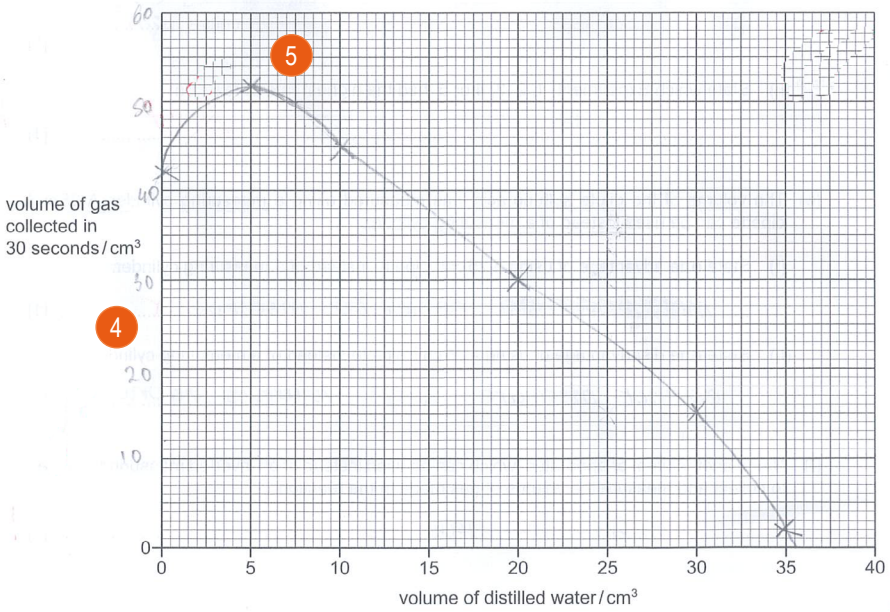
## Example Candidate Response – middle

**(a)** Complete the table.

| experiment | volume of dilute sulfuric acid / $cm^3$ | volume of distilled water / $cm^3$ | volume of gas collected in 30 seconds / $cm^3$ |
|---|---|---|---|
| 1 | 25 | 30 | 15 |
| 2 | 25 | 20 | 30 |
| 3 | 25 | 10 | 45 |
| 4 | 25 | 5 | 52 |
| 5 | 25 | 0 | 42 |

[4]

**(b)** Write a suitable scale on the *y*-axis and plot your results from Experiments 1 to 5 on the grid. Draw a smooth curve of best fit.




[4]

## Examiner comments

1 All of the volumes of dilute sulfuric acid and distilled water are correct and all volumes in all three columns are given to the same precision. Hence M1 and M2 are awarded.

2 The volumes of gas collected should increase from experiments 1 to 5. Here, they do not as the volume in experiment 5 is smaller than that in experiment 4. Hence M3 is not awarded.

3 The value of 42 is not within 5 cm3 of the volume shown in the supervisor's results. So, M4 has not been awarded.
Mark for (a) = 2 out of 4

4 The y-axis scale of each major grid square being 10 cm3 is a good choice and all of the datum points are plotted correctly. Hence M1, M2 and M3 are awarded.

5 The graph line is not a suitable best-fit line, the volume of gas increasing and then decreasing as the volume of water increases is not reasonable and the line at between 6 cm3 and 7.5 cm3 of water is a double line, which is not acceptable. So M4 is not awarded.
Mark for (b) = 3 out of 4

## Example Candidate Response – middle, continued

(c) Extrapolate (extend) the line on your graph and deduce the volume of gas that would be collected in 30 seconds if 35 cm³ of distilled water was added to the dilute sulfuric acid

2 6 ... cm³ [2]

(d) The rate of reaction can be calculated using the equation shown.

$$\text{rate of reaction} = \frac{\text{volume of gas collected}}{\text{time taken to collect the gas}}$$

(i) Use this equation to calculate the rate of reaction in Experiment 3. Give the units for the rate you have calculated.

rate of reaction = $\frac{45}{10}$ 7

rate = 4.5

units = $cm^3$ 8 [2]

(ii) State which Experiment, 1, 2, 3, 4 or 5, had the highest rate of reaction.

4 9 [1]

(e) The volumé of the dilute sulfuric acid was measured using a measuring cylinder. A 25 cm³ pipette can be used instead of a measuring cylinder.

(i) State **one** advantage of using a 25 cm³ pipette instead of a measuring cylinder.

more accurate easier to measure 10 [1]

(ii) State **one** disadvantage of using a 25 cm³ pipette instead of a measuring cylinder.

cannot measure large volumes at once 11 [1]

## Examiner comments

6 The extrapolation of the graph line for 30 cm3 to 35 cm3 is good since it follows on smoothly from the line preceding it and the reading of 2 cm3 is correct for the extrapolation shown. Hence, both marks are awarded.
Mark for (c) = 2 out of 2

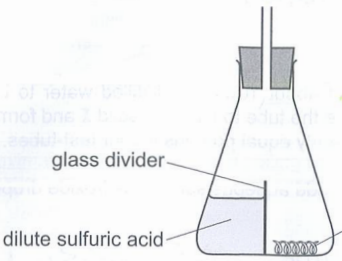
7 The volume of gas collected in experiment 3 has been divided by the volume of water rather than by the time taken to collect that volume of gas (which is 30 seconds). So M1 is not awarded.

8 The units shown are incorrect, as the calculation is volume divided by time; the units should be cm3 / s
Mark for (d)(i) = 0 out of 2

9 This answer is correct using the idea of 'error carried forward'. It is expected that experiment 5 would have the fastest rate of reaction but as the results table shows that the greatest volume of gas is collected in experiment 4, then experiment 4 has the greatest rate based on the recorded data. So the mark is awarded.
Mark for (d)(ii) = 1 out of 1

10 An item of apparatus being 'easier' or 'more difficult' to use is not acceptable as an advantage or a disadvantage. The advantage of using a volumetric pipette in place of a measuring cylinder is the greater accuracy of the volumetric pipette.
Mark for (e)(i) = 0 out of 1

11 It is true that a 25 cm3 pipette cannot measure larger volumes, however, as the volume of dilute sulfuric acid in every experiment is 25 cm3, that is not a problem in this investigation. The expected answer is that a pipette takes more time to use.
Mark for (e)(ii) = 0 out of 1

| Example Candidate Response – middle, continued | Examiner comments |
|---|---|
| (f) Name another item of apparatus, which can be used instead of an inverted measuring cylinder, to collect and measure the volume of gas made in the reaction.<br>gas syringe 12 [1]<br>(g) The diagram shows a modified conical flask that can be used in this investigation.<br>  <br><br>Explain the advantage of using this type of conical flask instead of the type you used in the investigation.<br>to do carry out this reaction, you would need to shake the conical flask in order to mix the 13 [2]<br>magnesium and dilute sulfuric acid, in order to carry out the ~~exp~~ expirament. In the investigation, the reaction started straight away. [Total: 18] | 12 The suggestion of using a gas syringe is a correct answer.<br>Mark for (f) = 1 out of 1<br><br>13 This answer is partially correct. The idea that you can start the reaction by shaking the flask is awarded a mark, but the candidate has not gone on to say why this is an advantage. They should go on to say that this means that the bung does not have to be removed and so there is no loss of gas.<br>Mark for (g) = 1 out of 2<br><br>**Total mark awarded = 10 out of 18** |

## How the candidate could have improved their answer

- **(a)** The candidate correctly recorded the volumes of sulfuric acid and water and recorded all volumes to the same precision, so marks M1 and M2 were awarded. The volume of gas collected in experiment 5 was lower than the volume in experiment 4, it should have been more, so M3 was not awarded. As this result does not follow the pattern shown by the other results, the candidate should, if they had time, have repeated experiment 5. The result for experiment 5 was compared to the supervisor's result and, as the value of 42 cm3 was more than 5 cm3 away from the result given by the supervisor mark, M4 was not awarded.
- **(b)** The candidate chose the perfect scale for the y-axis and plotted all of their points correctly. The line they have drawn is not a best-fit line, as the point at 0 cm3 of water does not fit the pattern shown by the other results. This point should have been treated as anomalous and ignored when drawing the curve. Also, the candidate had gone over their line between 6 cm3 and 7.5 cm3 of water; double or multiple lines are not acceptable. The candidate should have rubbed out the additional line so that it was not visible.
- The candidate drew a good extrapolation in **(c)** as it followed on smoothly from the line for the results and the reading from the extrapolation was correct.
- **(d)(i)** The candidate did not use the time taken (30 seconds) but instead used the volume of water, checking the equation given as well as the information in the instructions may have helped avoid this error. The units given should have been cm3 / s . In **(d)(ii)**, the candidate did not obtain results which showed the expected pattern. Experiment 4 was the experiment that made the greatest volume of gas and so, in this case, was the experiment that had the fastest rate.
- **(e)** It was expected that candidates would note the greater accuracy of a pipette as compared to a measuring cylinder, but that use of a pipette took longer. Answers based on 'ease of use' were not accepted and very few chemists would agree that a volumetric pipette is easier to use than a measuring cylinder. The statement that a pipette cannot measure large volumes is not relevant in this investigation as the volume of dilute sulfuric acid was 25 cm3 in every experiment.
- **(f)** The candidate correctly stated that a gas syringe could be used to measure the volume of gas produced.
- **(g)** The candidate gave part of the answer by stating that the candidate could shake the flask mix the reactants. However, what they should then have done was go on to say that this would mean the bung does not have to be removed and so gas would not be lost.

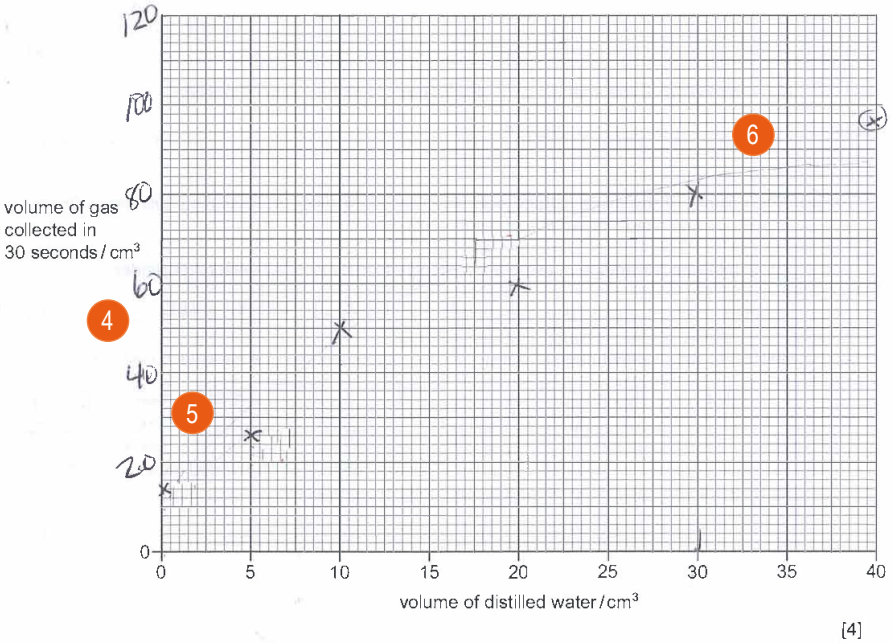
## Example Candidate Response – low

**(a)** Complete the table.

| experiment | volume of dilute sulfuric acid / cm³ | volume of distilled water / cm³ | volume of gas collected in 30 seconds / cm³ |
|---|---|---|---|
| 1 | 25 | 30 | 80 |
| 2 | 20 | 20 | 60 |
| 3 | 10 | 10 | 50 |
| 4 | 5 | 5 | 28 |
| 5 | 05 | 0 | 12 |

[4]

**(b)** Write a suitable scale on the *y*-axis and plot your results from Experiments 1 to 5 on the grid. Draw a smooth curve of best fit.




[4]

## Examiner comments

1 All volumes of sulfuric acid are incorrect bar the volume for experiment 1. However, all the volumes of water are correct, and all values are given to the same precision. So, M1 is not awarded but M2 is awarded.

2 The volume of gas should increase from experiment 1 to experiment 5, these figures decrease and so M3 is not awarded. There is a high probability the candidate has not followed the instructions and as shown in their figures, uses a decreasing rather than constant volume of sulfuric acid.

3 The volume of gas in experiment 5 is not within cm3 of the supervisor's result. So M4 is not awarded.
Mark for (a) = 1 out of 4

4 The scale is appropriate as the data takes up over half of the available space on the y-axis and the use of 20 cm3 per large grid square is an easy-to-read scale. So M1 is awarded.

5 The point for (0,12) is plotted at (0, 14) and the point for (5, 28) is plotted at (5, 26). As two points are incorrect, neither M2 nor M3 are awarded. The candidate should check their plotting. One way of doing this is, once all points have been plotted, is to read off from the graph the co-ordinates of each point and compare them to the table.

6 The graph line is very faint in places and invisible in others. While graph lines should be drawn with a sharp pencil, they do need to be easily seen. The line passes (almost) through two of the points but is above the other three points, so this line is too high to be a best-fit line for the points plotted. So, M4 is not awarded.
Mark for (b) = 1 out of 4

## Example Candidate Response – low, continued

(c) Extrapolate (extend) the line on your graph and deduce the volume of gas that would be collected in 30 seconds if 35 $cm^3$ of distilled water was added to the dilute sulfuric acid

7 96 ..... $cm^3$ [2]

(d) The rate of reaction can be calculated using the equation shown.

$$\text{rate of reaction} = \frac{\text{volume of gas collected}}{\text{time taken to collect the gas}}$$

(i) Use this equation to calculate the rate of reaction in Experiment 3. Give the units for the rate you have calculated.

50 / 30

8 rate = 1.666...

units = $cm^3$ [2]

(ii) State which Experiment, 1, 2, 3, 4 or 5, had the highest rate of reaction.

Experiment 1 [1]

9

## Examiner comments

7 The very faint extrapolation is an acceptable continuation of what can be seen of the graph line, so M1 is awarded. However, the candidate reads from the graph at 40 cm3 rather than 35 cm3 and so M2 is not awarded.
Mark for (c) = 1 out of 2

8 The calculation is correct. While the answer has not been rounded, it shows the recurring nature of the decimal in an acceptable way. M1 is awarded. However, M2 is not awarded as the units are incorrect.
Mark for (d)(i) = 1 out of 2

9 The results table shows that experiment 1 produces the largest volume of gas and so, in the candidate's investigation, experiment 1 has the fastest rate. The mark is awarded by 'error carried forward'.
Mark for (d)(ii) = 1 out of 1

## Example Candidate Response – low, continued

(e) The volume of the dilute sulfuric acid was measured using a measuring cylinder. A 25 $cm^3$ pipette can be used instead of a measuring cylinder.

(i) State **one** advantage of using a 25 $cm^3$ pipette instead of a measuring cylinder.

Better because you get to have a better more accurate measurement. 10 [1]

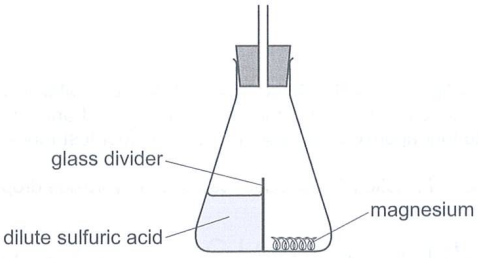
(ii) State **one** disadvantage of using a 25 $cm^3$ pipette instead of a measuring cylinder.

11 One disadvantage could be that ~~there will only~~ the amount of dilute sulfuric acid will ~~decrease~~ increase [1]

(f) Name another item of apparatus, which can be used instead of an inverted measuring cylinder, to collect and measure the volume of gas made in the reaction.

a rubber delivery tube. 12 [1]

(g) The diagram shows a modified conical flask that can be used in this investigation.




Explain the advantage of using this type of conical flask instead of the type you used in the investigation.

it is best because it gives you a more accurate number 13 [2]

[Total: 18]

## Examiner comments

10 The pipette having a better accuracy than the measuring cylinder is correct and is awarded the mark.
Mark for (e)(i) = 1 out of 1

11 The candidate uses the same volume of sulfuric acid in every experiment, and so the statement that the 'amount (which should be called "volume") of sulfuric acid will increase' is incorrect. If the volume of sulfuric acid did change from experiment to experiment, then this would be part way towards a correct answer. In parts (a) and (e) there is a strong suggestion that the candidate has not followed the instructions provided, all practical instructions should be read carefully.
Mark for (e)(ii) = 0 out of 1

12 The candidate uses a rubber delivery tube in the experiments to carry the gas from the conical flask to the inverted measuring cylinder. The rubber delivery tube is not a suitable alternative to an inverted measuring cylinder to collect the gas.
Mark for (f) = 0 out of 1

13 The command word in the question is 'explain'. As the candidate's answer does not offer any explanation as to why it is more accurate, no marks are awarded. It is important to look at the command words in questions as these give an indication of what is required.
Mark for (g) = 0 out of 2

**Total mark awarded =**
**6 out of 18**

## How the candidate could have improved their answer

- **(a)** The candidate was awarded only M2, for all volumes of water being correct and all volumes being recorded to the same precision. M1 could not be awarded as the volumes of sulfuric acid have decreased from experiment 1 to experiment 5, rather than remained constant. M3 and M4 have not been awarded because the gas volumes decrease rather than increase from experiment 1 to experiment 5 and the result in experiment 5 is not within 5 cm3 of the result reported by the supervisor. This may be because the candidate did actually use the incorrect volumes of sulfuric acid they have recorded in the table. It is important that candidates read the instructions carefully and follow them.
- **(b)** The only mark that has been awarded is for the y-axis scale. The left-hand two points have been plotted incorrectly. The candidate should have checked their plotting. One way of doing this is, once the candidate has plotted all of the points, they could then have read off from the graph the co-ordinates of each point and compared them to the table. The candidate drew a very faint graph line which passes above three of the plotted points and almost through the other two. The line was drawn too high and is not a line of best fit.
- **(c)** The extrapolation was drawn acceptably as a continuation of what can be seen of the graph line, but the reading has been taken at 40 cm3 rather than 35 cm3, so M1 was awarded but M2 was not.
- **(d)(i)** The calculation was completed correctly and, although the answer was not rounded, the recurring nature of the answer was shown in an acceptable way, so M1 was awarded. The units were not determined correctly as the '/s' has been missed out, so M2 was not awarded.
- **(d)(ii)** Although 'experiment 1' is not the expected answer, it is the correct answer based on the results obtained by the candidate, so the mark has been awarded as an 'error carried forward'.
- **(e)** While the advantage of a pipette over a measuring cylinder is correct, the disadvantage did not score a mark; as the volume of acid used is a constant in all five experiments, the statement that 'amount (which should be called "volume") of sulfuric acid will increase' is incorrect.
- The candidate has suggested the use of a rubber delivery tube as an alternative way of collecting and measuring the volume of the gas in **(f)**, this is clearly not correct.
- **(g)** It was expected that the candidate would give an explanation. Here, the candidate made a simple statement, which, while not incorrect, is not an explanation. The candidate should have read the question more carefully, if they had gone on to explain why you get a more accurate number then both marks could have been awarded.

## Common mistakes candidates made in this question

- **(b)** Candidates often drew curves that went from point to point rather than a best-fit line.
- **(c)** The extrapolation was often not a smooth continuation of the line drawn for the results of the investigation and so M1 could not be awarded although M2 could still be given if the reading was correct for the extrapolation the candidate had drawn.
- **(d)(i)** The units were often incorrect, commonly missing out the 's' or inverting them to 's/cm3'.
- **(e)** Many answers suggested that candidates were confusing a 25 cm3 pipette (a volumetric pipette) with a dropping or Pasteur pipette.
- **(g)** Many candidates did not realise that the apparatus shown would mean the bung did not need to be removed and so no gas would be lost. A common answer was for candidates to say they could see when the reaction started, which, while true, is not an improvement as they could see when the reaction started in the apparatus they had used.

# Question 2

## Example Candidate Response – high

2 You are provided with two solids, solid **I** and solid J.
Do the following tests on the substances, recording all of your observations at each stage.

**tests on solid I**

Place solid **I** in a boiling tube. Add about 10 $cm^3$ of distilled water to the boiling tube. Place a stopper in the boiling tube and shake the tube to dissolve solid **I** and form solution **I**.
Divide solution **I** into four approximately equal portions in four test-tubes.

**(a)** To the first portion of solution **I**, add aqueous sodium hydroxide dropwise and then in excess.
Record your observations.

A ~~white~~ grey-green precipitate formed. 1
It dissolved in excess, forming a dark green solution.

[2]

**(b)** To the second portion of solution **I**, add aqueous ammonia gradually until there is no further change.
Record your observations.

2
A ~~white~~ grey-green precipitate formed.

[2]

**(c)** To the third portion of solution **I**, add about 1 cm depth of dilute nitric acid followed by a few drops of aqueous silver nitrate. Leave the mixture to stand for about 5 minutes.
Record your observations.

3
A white precipitate formed, ~~then settled~~

[1]

**(d)** To the fourth portion of solution **I**, add about 2 cm depth of aqueous sodium carbonate.
Record your observations.

4
Grey-green precipitate formed

[1]

**(e)** Use your observations from **(a)**, **(b)** and **(c)** to identify solid **I**.

Chromium chloride 5

[2]

## Examiner comments

1 Both marks are awarded. This answer clearly shows the two stages to the test, with the formation of a suitable coloured precipitate and a second statement giving the observation for addition in excess.
Mark for (a) = 2 out of 2

2 Only the first mark is awarded here, the initial observation is correct, but to gain M2 there must be a clear statement about what happens when excess aqueous ammonia is added.
Mark for (b) = 1 out of 2

3 The mark is awarded here. The candidate has crossed out a statement saying the precipitate settles out; there is no problem leaving this statement in as it does not detract from or contradict the statement that a white precipitate is formed.
Mark for (c) = 1 out of 1

4 This answer scores the mark for the formation of a suitably coloured precipitate. An additional observation could be made because fizzing should also have been seen, however, as only one mark is available only one of the two observations is required.
Mark for (d) = 1 out of 1

5 This answer scores both available marks, however, it would have been better to include the oxidation state of the chromium as that is given in the notes for use in qualitative analysis.
Mark for (e) = 2 out of 2

## Example Candidate Response – high, continued

**tests on solid J**

**(f)** Carry out a flame test on solid **J**.
Record your observations.

lilac flame 6 ..... [1]

**(g) (i)** Place approximately half of solid **J** in a boiling tube. Add about 10 $cm^3$ of dilute sulfuric acid to solid **J** in the boiling tube. Test any gas produced.
Record your observations.

Turned limewater cloudy 7 .....

..... [2]

**(ii)** Identify the gas produced in **(g)(i)**.

Carbon dioxide 8 ..... [1]

**(h)** Place the remaining solid **J** in a boiling tube. Add about 10 $cm^3$ of distilled water to the boiling tube. Place a stopper in the boiling tube and shake the tube to dissolve solid **J** and form solution **J**.

Divide solution **J** into two approximately equal portions in two test-tubes.

**(i)** To the first portion of solution **J**, add about 1 cm depth of aqueous sodium hydroxide.
Record your observations.

Nothing happened. 9 .....

..... [1]

**(ii)** To the second portion of solution **J**, add about 2 cm depth of aqueous copper(II) sulfate.
Record your observations.

A light blue precipitate formed. 10 .....

..... [1]

**(i)** Use your observations from **(f)** and **(g)** to identify solid **J**.

Potassium carbonate 11 .....

..... [2]

[Total: 16]

## Examiner comments

6 The flame test colour is correct.
Mark for (f) = 1 out of 1

7 Two marks are available for this question, and so the candidate should be aware that two observations will be required. The gas test and result stated is correct and so M2 is awarded, however, the candidate has not noted the formation of bubbles during the reaction, the same observation was missing in (d).
Mark for (g)(i) = 1 out of 2

8 The identity of the gas is correct.
Mark for (g)(ii) = 1 out of 1

9 The observation that nothing happened is correct. A negative test result can be helpful in identifying a compound as it tells us what ion a compound does not contain.
Mark for (h)(i) = 1 out of 1

10 This is a fully correct observation.
Mark for (h)(ii) = 1 out of 1

11 The candidate correctly uses the observations made in (f) and (g) to determine the identity of solid J. In both (e) and (f), the candidate gives a name rather than a formula; this is good practice as if a formula is given then it must be fully correct to gain the marks available.
Mark for (i) = 2 out of 2

**Total mark awarded =**
**14 out of 16**

## How the candidate could have improved their answer

- **(a)** The candidate has clearly stated the observations for the two parts to this first test (dropwise addition and then addition in excess). Both observations were correct and so both available marks were awarded.
- **(b)** While the candidate has given a correct observation for the initial adding of aqueous ammonia, and so M1 was awarded, there is no statement made as to what happens in excess, the addition of the words 'which remains in excess' would have resulted in the second mark also being awarded.
- The observation made by the candidate in **(c)** was fully correct.
- **(d)** Although the mark was awarded, there was a more difficult observation that the candidate could have made, slight effervescence should have been seen if the candidate looked carefully. As that observation is difficult to make it was not necessary in order for the mark to be awarded.
- **(e)** The identity of I is correct and both marks have been awarded, although it would have been better to give the oxidation state of the chromium ion as it is used in the notes for use in qualitative analysis.
- **(f)** The flame test colour has been recorded correctly. If yellow had been noted as an additional colour (due to sodium ions) then that would have been ignored as some sodium ions are often present but any other colours, such as red, would have resulted in this mark not being awarded.
- **(g)(i)** Only one of the two marks has been awarded, the test and result are correct, but the candidate has missed the observation that the reaction mixture effervesces. With two marks available, the candidate should have realised that two observations were required to gain all of the marks.
- The gas identity is correct in **(g)(ii)**.
- **(h)(i)** The fact that there was no visible change has been correctly reported, negative test results are useful in qualitative analysis as they tell us an ion not contained in a compound.
- **(h)(ii)** The candidate has given a perfect observation as they have also noted the shade of blue, although that was not required.
- **(i)** The identity of solid J was given correctly. It is worth noting that in both **(e)** and **(i)**, the candidate gave names rather than formula to identify the solids, this is good practice as, if a formula is given, then it must be fully correct to be awarded full marks.

## Example Candidate Response – middle

2 You are provided with two solids, solid **I** and solid **J**.
Do the following tests on the substances, recording all of your observations at each stage.

**tests on solid I**

Place solid **I** in a boiling tube. Add about 10 $cm^3$ of distilled water to the boiling tube. Place a stopper in the boiling tube and shake the tube to dissolve solid **I** and form solution **I**.
Divide solution **I** into four approximately equal portions in four test-tubes.

**(a)** To the first portion of solution **I**, add aqueous sodium hydroxide dropwise and then in excess.
Record your observations.

dark green ppt and small white ppt in excess, soluble in excess

[2]

**(b)** To the second portion of solution **I**, add aqueous ammonia gradually until there is no further change.
Record your observations.

grey-green ppt formed mostly on surface. insoluble in excess, dark green at bottom [2]

**(c)** To the third portion of solution **I**, add about 1 cm depth of dilute nitric acid followed by a few drops of aqueous silver nitrate. Leave the mixture to stand for about 5 minutes.
Record your observations.

slightly lighter green, small white ppt on surface [1]

**(d)** To the fourth portion of solution **I**, add about 2 cm depth of aqueous sodium carbonate.
Record your observations.

grey/dark blue colour, bubbled slightly [1]

**(e)** Use your observations from **(a)**, **(b)** and **(c)** to identify solid **I**.

chromium (III) chloride

[2]

## Examiner comments

1 While the formation of a green precipitate is the observation required for M1, the mark is not awarded here, as the statement that a white precipitate is formed is a contradiction as the colour is incorrect. So M1 is not awarded. However, the statement that the precipitate is soluble gains M2.
Mark for (a) = 1 out of 2

2 There are clearly two parts to this answer; there is an initial observation and then an observation in excess, both are correct and so M1 and M2 are awarded. The final statement that the contents of the tube are dark green at the bottom does not contradict the earlier observations and so it is ignored. However, if the colour is not uniform throughout the tube, it is possible that the candidate has not mixed the reactants thoroughly.
Mark for (b) = 2 out of 2

3 The observation of a white precipitate gains the mark available. The fact the solution becomes a lighter green is ignored; it will become lighter as the volume is increased by adding the dilute nitric acid which dilutes solution I.
Mark for (c) = 1 out of 1

4 The mark has been awarded for the formation of bubbles. The initial observation did not gain the available mark as there is no statement that a precipitate forms and the colour 'dark blue' is not acceptable.
Mark for (d) = 1 out of 1

5 The identity of solid I is fully correct and so both marks are awarded.
Mark for (e) = 2 out of 2

## Example Candidate Response – middle, continued

**tests on solid J**

**(f)** Carry out a flame test on solid **J**.
Record your observations.

lilac 6

~~orange~~ ~~slightly~~ pink flame ..... [1]

**(g) (i)** Place approximately half of solid **J** in a boiling tube. Add about 10 $cm^3$ of dilute sulfuric acid to solid **J** in the boiling tube. Test any gas produced.
Record your observations.

7

~~blue~~ bubbling releasing gas turned damp litmus paper bleached ..... [2]

**(ii)** Identify the gas produced in **(g)(i)**.

chlorine 8 ..... [1]

## Examiner comments

6 The flame test colour is correct and so the mark is awarded. The colour 'orange' has been crossed out. Had it not been crossed out it would have been ignored, as the orange or yellow colour caused by sodium contamination is often seen in compounds of Group I elements.
Mark for (f) = 1 out of 1

7 M1 is awarded for the observation of bubbling. The statement that litmus paper is bleached is an impossible observation and could not have been seen, as there is an incorrect positive gas test. Even if the candidate goes on to give the correct positive gas test, M2 would not be awarded.
Mark for (g)(i)= 1 out of 2

8 While the identity of the gas matches the gas test result in (g)(i), no mark is awarded as the gas test result is an impossible observation and chlorine cannot be made. No error carried forward is applied when a candidate reports impossible observations.
Mark for (g)(ii) = 0 out of 1

## Example Candidate Response – middle, continued

**(h)** Place the remaining solid **J** in a boiling tube. Add about 10 $cm^3$ of distilled water to the boiling tube. Place a stopper in the boiling tube and shake the tube to dissolve solid **J** and form solution **J**.

Divide solution **J** into two approximately equal portions in two test-tubes.

**(i)** To the first portion of solution **J**, add about 1 cm depth of aqueous sodium hydroxide. Record your observations.

transparent , colourless solution.
ammonia gas produced 9 [1]

**(ii)** To the second portion of solution **J**, add about 2 cm depth of aqueous copper(II) sulfate. Record your observations.

light blue ppt , insoluble in excess. 10 [1]

**(i)** Use your observations from **(f)** and **(g)** to identify solid **J**.

potassium nitrate.
11 [2]

[Total: 16]

## Examiner comments

9 The first part of the answer is correct and if all that was written was 'transparent, colourless solution' then the mark would have been awarded. However, the statement that ammonia is produced is incorrect, and so the mark is not awarded.
Mark for (h)(i) = 0 out of 1

10 This is a fully correct answer, and the mark is awarded. Had the candidate said that the precipitate was soluble in excess the mark would not be awarded as that would be incorrect.
Mark for (h)(ii) = 1 out of 1

11 The answer given is partly correct; one mark is awarded for the identification of J as a potassium compound. It is possible that the conclusion that solid J is a nitrate comes from the incorrect observation in (h)(i), although as no aluminium foil was added, this is not the test for nitrate ions. At this point, the candidate should go back through their observations and check that they work for the identity of solid J that they have given. By doing this, the candidate may be able to avoid the incorrect positive test for chlorine given in (g) as it is clear that neither reagent used in (g) contained any chlorine.
Mark for (i) = 1 out of 2

**Total mark awarded =**
**11 out of 16**

## How the candidate could have improved their answer

- **(a)** The candidate was awarded only M2 for the statement that the precipitate formed was soluble. In excess, M1 was not awarded as the initially correct colour of the precipitate has been contradicted by the statement that there is a white precipitate.
- **(b)** Both marks have been awarded. The answer clearly shows the observations for each of the two stages of the test. The last part stating the colour is dark green at the bottom is not incorrect but suggests that the candidate did not mix the contents of the tube; in qualitative analysis tests, the reactants should be mixed by gently shaking the tube from side to side.
- **(c)** The mark has been awarded for the observation that there is a white precipitate, the statement that the solution becomes a lighter green is ignored as dilution of solution I by the dilute nitric acid would make it a lighter green.
- **(d)** The mark has been awarded for the more difficult observation of bubbles, the initial statement regarding the colour was not awarded the mark as there was no indication that a precipitate formed, and the colour is incorrect.
- **(e)** The identity of solid I was fully correct and both marks were awarded.
- **(f)** The flame test colour was correct and so the mark was awarded. The colour 'orange' had been crossed out. Had it not been crossed out it would have been ignored as the orange or yellow colour caused by sodium contamination is often seen in compounds of Group I elements.
- **(g)(i)** M1 has been awarded for the observation of bubbling. However, the statement that litmus paper was bleached was an impossible observation and could not have been seen, as there was an incorrect positive gas test even if the candidate had gone on to give the correct positive gas test, M2 would not have been awarded.
- **(g)(ii)** While the identity of the gas matched the gas test in **(g)(i)**, no mark was awarded as the gas test result was an impossible observation and chlorine could not have been made. No error carried forward was applied as the candidate reported an impossible observation.
- **(h)(i)** If the candidate had stopped writing after the first line, then the mark would have been awarded. However, they continued and stated that ammonia was produced; this is incorrect and implies a reaction took place.
- **(h)(ii)** The observation was fully correct. There was no need to comment on what happened in excess as the copper(II) sulfate was added all at once, but as the observation was not incorrect it was ignored.
- **(i)** When identifying solid J, the candidate should have looked back at their observations and checked that the final identity matched their observations, the candidate could then have repeated any tests that had observations recorded that did not fit with the identity. If the candidate had done that, then they may have corrected the error in **(g)** which had the positive test for chlorine gas, which could not have been made as neither reagent contained chlorine.

## Example Candidate Response – low

2 You are provided with two solids, solid **I** and solid **J**.
Do the following tests on the substances, recording all of your observations at each stage.

**tests on solid I**

Place solid **I** in a boiling tube. Add about 10 $cm^3$ of distilled water to the boiling tube. Place a stopper in the boiling tube and shake the tube to dissolve solid **I** and form solution **I**.
Divide solution **I** into four approximately equal portions in four test-tubes.

**(a)** To the first portion of solution **I**, add aqueous sodium hydroxide dropwise and then in excess.
Record your observations.

Solution turned lighter cloudier green colour with a green-grey precipitate that was insoluble in excess 1 [2]

**(b)** To the second portion of solution **I**, add aqueous ammonia gradually until there is no further change.
Record your observations.

Solution turned into a cloudy light green colour 2 [2]

**(c)** To the third portion of solution **I**, add about 1 cm depth of dilute nitric acid followed by a few drops of aqueous silver nitrate. Leave the mixture to stand for about 5 minutes.
Record your observations.

White precipitate formed 3 [1]

**(d)** To the fourth portion of solution **I**, add about 2 cm depth of aqueous sodium carbonate.
Record your observations.

cloudy lighter green solution 4 [1]

**(e)** Use your observations from **(a)**, **(b)** and **(c)** to identify solid **I**.

Chromium Chloride 5 [2]

## Examiner comments

1 M1 is awarded for the correct statement that a suitably coloured precipitate is formed. However, M2 is not awarded as the precipitate is said to be insoluble in excess and it should dissolve in excess.
Mark for (a) = 1 out of 2

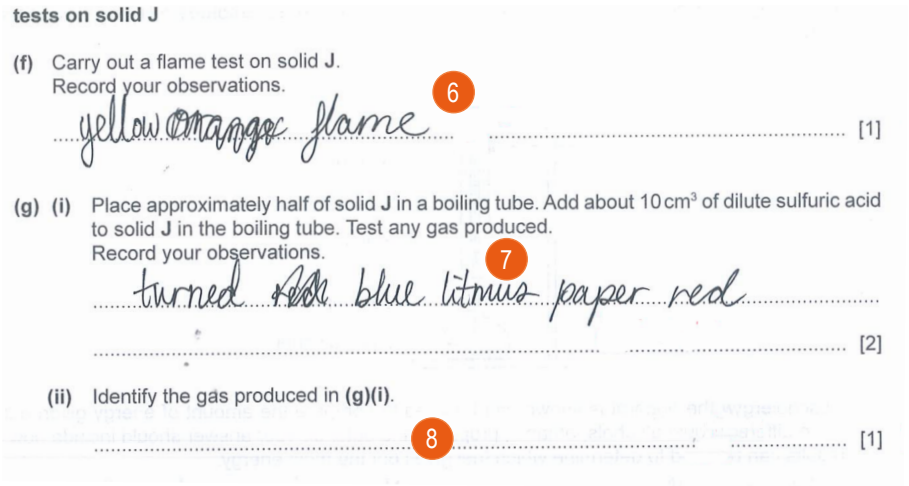
2 There should be observations for the gradual addition and for the final appearance. As the candidate gives only one observation, and it is not clear if this was during the gradual addition or at the end, it is assumed that it is made during the gradual addition and so M2 cannot be awarded. Also, M1 is not awarded as there is no indication that a precipitate is formed. The statement that it is cloudy is not sufficient. Candidates should know that when two solutions are mixed to give a cloudy product that means a precipitate is formed.
Mark for (b) = 0 out of 2

3 This answer gains the mark available.
Mark for (c) = 1 out of 1

4 There is no indication that a precipitate is formed or that there is fizzing, so the mark is not awarded.
Mark for (d) = 0 out of 1

5 This answer scores both available marks. However, it would have been better to include the oxidation state of the chromium as that is given in the notes for use in qualitative analysis.
Mark for (e) = 2 out of 2

## Example Candidate Response – low, continued



tests on solid J

(f) Carry out a flame test on solid J.
Record your observations.

yellow orange flame 6 [1]

(g) (i) Place approximately half of solid J in a boiling tube. Add about 10 $cm^3$ of dilute sulfuric acid to solid J in the boiling tube. Test any gas produced.
Record your observations.

turned blue litmus paper red 7 [2]

(ii) Identify the gas produced in (g)(i).

8 [1]

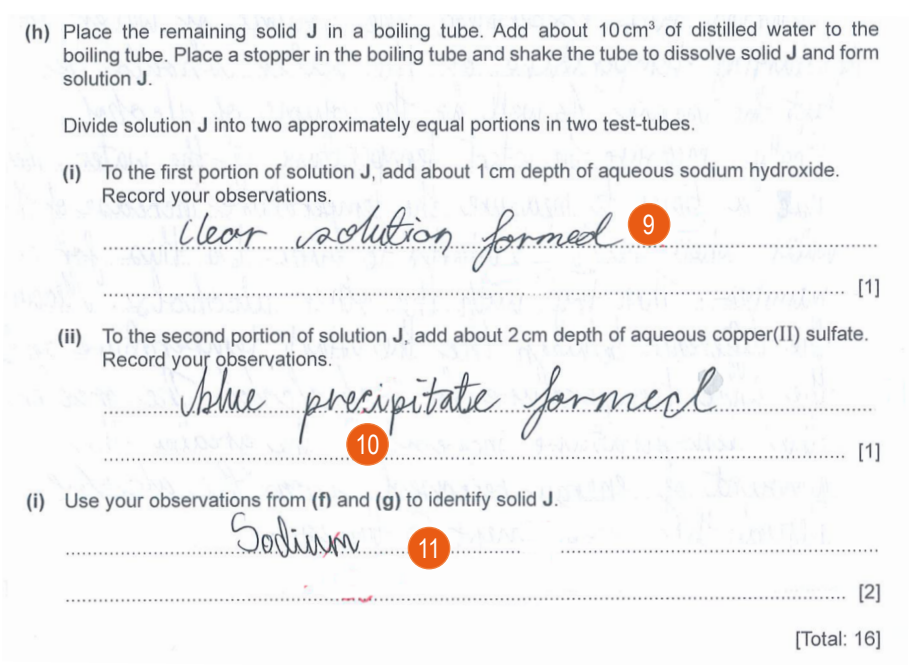
## Examiner comments

6 The statement that a yellow flame is seen is ignored as compounds of Group I elements are often contaminated with traces of sodium ions. However, the mark is not awarded as there is no mention of the lilac colour caused by potassium ions.
Mark for (f) = 0 out of 1

7 There is no gas test in the notes for qualitative analysis that has a positive result of blue litmus turning red. The candidate needs to conduct more gas tests until they get a positive result that is shown in the notes for qualitative analysis. The blue litmus turning red is probably the result of acid spray (caused by the vigorous effervescence, which the candidate has not reported). As there is neither a correct gas test and result nor a correct observation, neither M1 nor M2 are awarded.
Mark for (g)(i) = 0 out 2

8 As no positive gas test is reported in (g)(i), the candidate is not able to identify the gas. The candidate should go back and repeat the test in (g)(i).
Mark for (g)(ii) = 0 out of 1

## Example Candidate Response – low, continued



(h) Place the remaining solid **J** in a boiling tube. Add about 10 $cm^3$ of distilled water to the boiling tube. Place a stopper in the boiling tube and shake the tube to dissolve solid **J** and form solution **J**.

Divide solution **J** into two approximately equal portions in two test-tubes.

(i) To the first portion of solution **J**, add about 1 cm depth of aqueous sodium hydroxide. Record your observations.

clear solution formed 9

[1]

(ii) To the second portion of solution **J**, add about 2 cm depth of aqueous copper(II) sulfate. Record your observations.

blue precipitate formed 10

[1]

(i) Use your observations from **(f)** and **(g)** to identify solid **J**.

Sodium 11

[2]

[Total: 16]

## Examiner comments

9 The inclusion of the word 'formed' suggests that there is a change, and so the mark is not awarded. Both solutions used are clear and any suggestion of a change is incorrect.
Mark for (h)(i) = 0 out of 1

10 This is a correct observation and scores the mark.
Mark for (h)(ii) = 1 out of 1

11 A mark is awarded for 'sodium' as this is correct based on error carried forward from the flame test colour. The idea of 'error carried forward' is used when a reasonable error is made in an earlier observation, contamination by sodium ions is common and so while the flame colour in (f) does not score, this conclusion does score. If the candidates give' a totally incorrect flame colour in (f) (such as 'green') then error carried forward is not applied as that is not a reasonable error. However, no anion has been identified and so M2 is not awarded.
Mark for (i) = 1 out of 2

**Total mark awarded =**
**6 out of 16**

## How the candidate could have improved their answer

- **(a)** M1 has been awarded for the correct statement that a suitably coloured precipitate was formed. However, M2 was not awarded as the precipitate was said to be insoluble in excess and it should have dissolved in excess.
- **(b)** There should be an observation given for the gradual addition and for the final appearance. As the candidate has given only one observation, and it is not clear if this was during the gradual addition or at the end, it is assumed that it was made during the gradual addition and so M2 has not been awarded. Also, M1 was not awarded as there is no indication that a precipitate was formed. The statement that it went cloudy was not sufficient; candidates should know that when two solutions are mixed to give a cloudy product that means a precipitate was formed.
- **(c)** The observation made was fully correct.
- **(d)** There was again no indication that a precipitate was formed (as in **(b)**) and so the mark was not awarded.
- **(e)** Both marks were awarded, although it would have been better to include the oxidation state of the chromium.
- **(f)** The statement that a yellow flame was ignored (as compounds of Group I elements often contain traces of sodium ions), if the candidate had also given a correct colour for potassium, then the mark would have been awarded.
- **(g)** The candidate did not give the correct gas test and result and the candidate did not notice the fizzing which occurred, so neither mark has been awarded. As the reported observation in **(g)(i)** does not match any positive gas test in the analysis notes, the candidate was unable to identify the gas. At this point, the candidate should have repeated the test in **(g)(i)** until they obtained a positive gas test result.
- **(h)(i)** By adding 'formed', the candidate gave an answer which implied a change. As there should have been no change, the mark was not awarded. The observation in **(h)(ii)** was correct and gained the mark available.
- **(i)** The identity of solid **J** was not complete, a mark was awarded using 'error carried forward' for sodium as a yellow flame was reported in **(f)**. The idea of 'error carried forward' is used when a reasonable error has been made in an earlier observation, contamination by sodium ions is common and so while the flame colour in **(f)** did not score, this conclusion did score. If the candidate had given a totally incorrect flame colour in **(f)** (such as 'green') then error carried forward would not have been applied as that would not be a reasonable error. As no anion has been given, M2 was not awarded.

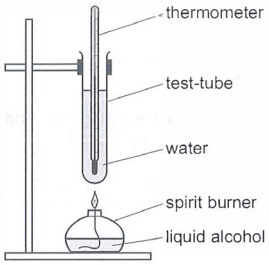
## Common mistakes candidates made in this question

- **(a), (b)** Candidates often did not make it clear if the observation was for dropwise (or gradual) addition or for when there was no further change.
- Use of the word 'cloudy' in place of 'precipitate'; if two solutions are mixed to produce a cloudy product, then candidates should state that a precipitate is formed.
- **(i)** The most common error was to state that solid **J** was a copper compound (presumably because a blue precipitate was obtained in **(h)(ii)**).

# Question 3

## Example Candidate Response – high

3 The energy given out when different liquid alcohols are burned can be compared using the apparatus shown.




Describe how the apparatus shown can be used to compare the amount of energy given out by three different liquid alcohols, ethanol, propanol and butanol. Your answer should include how the results can be used to determine which fuel gives out the most energy.

Set up equipment shown in diagram Put 10 $cm^3$ of ethanol into the spirit burner and leave it for ~~minute~~ one minute. Record the highest temperature reached in the one minute. Repeat using other alcohols: propanol and butanol with same volume and same time frame. Compare results and whatever alcohol reached the highest temperature on the thermometer gives out the most energy. Wear safety goggles as harmful chemicals are used and fire. Replicate experiment to find an average so results are more reliable and accurate.

[6]

## Examiner comments

1 As the method the candidate is describing is based on the temperature reached after being heated for 1 minute, there is no mark awarded for using a set volume of ethanol as that variable does not need to be controlled using this method.

2 It is clear the water is being heated for 1 minute, so a mark is awarded at this point.

3 Recording the highest temperature reached in the 1 minute of heating is equivalent to recording the final temperature and so a mark is awarded.

4 All three alcohols are being used to heat the water, so a mark is awarded.

5 In the note to the side, it is clear that the same volume of water is being used with each alcohol, this scores a mark. However, it would be better for the candidate to plan their answer first rather than need to add additional notes to the side.

6 This statement shows how the results are used to determine which alcohol gives out the most energy and is awarded a mark.

7 At no point in the description is there an indication that the start temperature of the water is measured, or the temperature rise is calculated. The temperature rise is important as it takes more energy to heat a set volume of water from 20 oC to 30 oC than from 30 oC to 35 oC. Overall, this is a good experimental plan, but some important points are missing, and so full marks are not awarded.

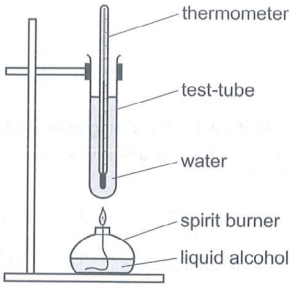
**Total mark awarded =**
**5 out of 6**

## How the candidate could have improved their answer

- The method the candidate has described is based on heating a set volume of water for a set period of time. Marks have been awarded for:
  - using the same volume of water in each experiment (halfway down on the right)
  - repeating the experiment with all three alcohols (line 5)
  - heating the water for a set time, one minute (line 3)
  - measuring the temperature reached (line 4)
  - stating that the alcohol that gives the highest temperature rise gives out the most energy (line 8).
- The fact that there are additions to the method (particularly regarding using the same volume of water) suggests that the candidate did not plan their answer before starting to write it. In their answer, the candidate has not mentioned the start temperature or the temperature rise. Both of these are important points as it is not actually the final temperature that is important but the increase in temperature.

## Example Candidate Response – middle

3 The energy given out when different liquid alcohols are burned can be compared using the apparatus shown.




Describe how the apparatus shown can be used to compare the amount of energy given out by three different liquid alcohols, ethanol, propanol and butanol. Your answer should include how the results can be used to determine which fuel gives out the most energy.

- keeps the distance of the flame ~~to~~ to the test tube equal for each experiment 1
- the water/
- for 1 minute - test which alcohol increases the temperature of the water the most in 1 minute 2
- the experiments should be repeated 3 times each 3 to ensure there are no anomolies and find an average
- the experiment which increases the water the most is the alcohol which gives out the most energy. 4 5
- The water should start at the same temperature for each experiment to make fair tests 6
- don't touch the flame or heated test tube so you don't burn yourself 7 [6]

## Examiner comments

1 This answer starts with how to make the investigation a 'fair-test'. However, at this stage, we do not know what the method is, the information on fair testing would have been better in with the description.

2 This tells us the water will be heated for 1 minute and so a mark is awarded.

3 It is not clear enough that all three fuels will be used to heat the water, so a mark is not awarded.

4 Combining this with the first statement in the paragraph is just enough to award the conclusion mark (the largest increase in temperature is the one which gives out the most energy).

5 Starting with water at the same temperature is acceptable for measuring the start temperature of the water and so a mark is awarded.

6 There is no indication that the final temperature of the water needs to be measured. If the final temperature is not measured, then the temperature increase cannot be calculated.

7 No marks are awarded for safety precautions of this type. The answer overall has the makings of a good plan but lacks important detail and so has only scored 3 marks. The candidate should plan out the answer first, which would result in a more logical sequence and probably fewer details being missed.

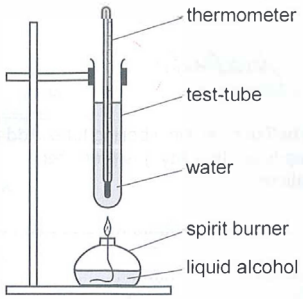
**Total mark awarded =**
**3 out of 6**

## How the candidate could have improved their answer

- The candidate has described the basis of a method which will work, but details were missed out and the sequence of the answer suggests that the answer was not planned out before being written. The candidate has started with a statement about how to make the experiment a fair test. As the method has not yet been described, this is not a good place to start.
- On line 4, the candidate has stated that the water will be heated for 1 minute, this was awarded a mark. On line 8, the candidate has stated how the results will tell us which alcohol gave out the most energy. In the last paragraph, the candidate returns to the idea of fair testing and has been awarded a mark for having the same start temperature of the water.
- Although the candidate looked at which alcohol increases the temperature of the water most, there was no instruction to measure the final temperature of the water nor to control the volume of the water. As no final temperatures have been measured, there can be no calculation of a temperature rise. There was also no clear statement that the experiment must be repeated with all three fuels.
- If the candidate had planned their answer before starting to answer the question, they would probably have made fewer omissions and so been awarded more marks.

## Example Candidate Response – low

3 The energy given out when different liquid alcohols are burned can be compared using the apparatus shown.




Describe how the apparatus shown can be used to compare the amount of energy given out by three different liquid alcohols, ethanol, propanol and butanol. Your answer should include how the results can be used to determine which fuel gives out the most energy.

by watching the reaction take place, you can use a stopwatch to time how long it takes for the spirit burner makes the water get to its boiling point. While the thermometer keeps track of how much the temperature of the water is increasing by every 30 seconds. With the thermometer and time you will be able to find the average heat / thermal energy transferred for each different liquid alcohol. Once you calculate the average energys, you can compare the results with the other tests and the highest number is the fuel that gives out the most energy [6]

1 2 3 4

## Examiner comments

1 The method is based on the time taken to heat the water to a specified temperature (the boiling point). A mark is awarded for each heating of the water to a set temperature (boiling point) and measuring the time taken to do this.

2 There is no instruction as to when to start timing and so the mark available for starting timing when heating is started is not awarded.

3 The mark for how to use the results to determine which alcohol gives out the most energy is not awarded as we do not know what the numbers we are comparing to are. As the plan is to measure the time taken to reach the boiling point, the lowest time will be the alcohol which gives out the most energy.

4 While the basic idea of the plan is clear and gains two marks (time taken to reach boiling point) there is no experimental detail. It is not possible for the plan to be followed to obtain results from which a conclusion can be drawn. For this method to work, the volume of the water and starting temperature of the water needs to be the same for all three alcohols used and the time taken from the start of heating to the water boiling needs to be compared. Many of the best answers seen for the planning question have the answer written as a list of steps in the order in which they need to be done.

**Total mark awarded =**
**2 out of 6**

## Common mistakes candidates made in this question

- The candidate has made clear the approach used – timing how long it takes to heat the water to boiling point (100 °C). Two marks were awarded for this idea. However, there are no experimental details that would allow someone to follow the plan and so no more marks could be awarded. It is essential, using this approach, that the volume of water used is the same for all three fuels and that the water starts at the same temperature each time. The conclusion of 'the highest number is the fuel that gives out most energy' has not been awarded a mark. Initially, the candidate stated that the idea is to time how long it takes for the water to reach boiling point, so it is the shortest time that is the fuel which gives out the most energy. However, the approach has changed part way through the answer, as there is an intention to calculate the thermal energy transferred. This will not work as, if the same volume of water, at the same temperature is used, and heated to boiling point then the energy transferred will always be the same.
- Some of the best and clearest answers seen for planning tasks have the plan written as a series of steps. If the candidate had done this and planned the method out before starting to write it, then there is a good chance that there would have been sufficient detail to be able to award more marks.

## Common mistakes candidates made in this question

- Not planning out the approach/method before starting to write the answer.
- Missing out important details such as what needs to be measured and when.
- Not having a clear link between the results obtained and determining which alcohol gives out the most energy.

Cambridge Assessment International Education
The Triangle Building, Shaftesbury Road, Cambridge, CB2 8EA, United Kingdom
t: +44 1223 553554
e: info@cambridgeinternational.org  www.cambridgeinternational.org