Cambridge Assessment International Education

Example Candidate Responses – Paper 6

Cambridge IGCSE™ / IGCSE (9-1)
Chemistry 0620 / 0971

For examination from 2021

Cambridge Pathway

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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 62

0620 June 2021 Mark Scheme 62

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
4 The mineral epsomite contains hydrated magnesium sulfate. When epsomite is heated strongly, it loses water and eventually becomes anhydrous magnesium sulfate. Plan an investigation to find the percentage by mass of water in a sample of epsomite. Your plan should include how you would calculate the percentage by mass of water in epsomite. You have access to com (1) laboratory apparatus. Measure the volume ~~of~~ and mass of epsomite and add it to a (3) (2) boiling tube. Heat strongly (under a Bunsen burner) till it loses water and becomes anhydrous magnesium sulfate. Measure volume of ~~the~~ anhydrous magnesium sulfate. Compare both volumes (~~subst~~ (subtract final and initial volumes) Find the relative molecular mass (RMM) of water and use the following equation to find percentage by mass of water in epsomite: RMM of water x 100	(1) MP1 is awarded for finding the initial mass of the epsomite. (2) The sample is being held in tongs. This will lead to the loss of small pieces of the mineral during heating and so is not suitable. A suitable container, such as a crucible, is required. Hence MP2 is not awarded. (3) Holding the sample 'near a hot flame' is not sufficient. If the sample is held a few centimetres to the side of the flame, it will not

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

- The candidate made some progress with the plan but there were slips and omissions which meant many of the available marks have not been awarded. Marks have been awarded for:
  - finding the mass of the epsomite (line 1). The candidate also found the volume of the epsomite, but this measurement was irrelevant and was ignored.
  - Heating the epsomite strongly (line 2). The candida ... r'. Heating under a Bunsen rather than over a Bunse

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

- Not planning out the approach/method before starting to write the answer.
- Heating in a boiling tube or test-tube rather than a crucible.
- No ... r had be
- M ... percen

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.

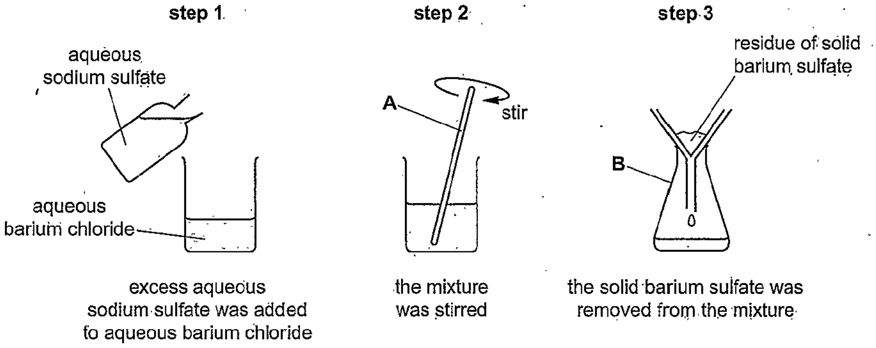
Question 1

Example Candidate Response – high

1 Barium sulfate is an insoluble salt. Barium sulfate can be made by reacting excess aqueous sodium sulfate with aqueous barium chloride.

sodium sulfate + barium chloride → sodium chloride + barium sulfate

A student made a sample of barium sulfate using the following steps.



(a) Name the items of apparatus labelled **A** and **B**.

A glass rod

B cornical flask ①

[2]

(b) Name the process shown in **step 3**.

filtration ②

[1]

(c) The general name for the solid in **step 3** is residue.

State the general name for the solution obtained from the process in **step 3**.

~~Solvent~~ ~~solute~~ solvent ③

[1]

(d) Two more steps, **step 4** and **step 5**, are needed to obtain a pure sample of barium sulfate. In each of these steps something is removed from the residue.

State what is done in each of **step 4** and **step 5** and identify the substance removed from the barium sulfate.

step 4 wash the residue

substance removed impurities ④

step 5 dry the solid barium sulfate to obtain pure sample

substance removed water ⑤

[4]

[Total: 8]

Examiner comments

① Although the spelling of 'conical' is incorrect, this is acceptable. It would be better to spell the names of apparatus correctly. Both marks are awarded.
Mark for (a) = 2 out of 2

② This a fully correct answer and one mark is awarded.
Mark for (b) = 1 out of 1

③ While the solution obtained from filtration does contain the solvent, this is not the correct term for it. The expected answer is 'filtrate'. No mark is awarded for the answer given.
Mark for (c) = 0 out of 1

④ One mark is awarded for the idea of washing the residue. However, 'impurities' is too vague as the question asks for the identity of the substance removed. Hence, a chemical name or formula is required.

⑤ Step 5 is fully correct and so both marks are awarded.
Mark for (d) = 3 out of 4

Total mark awarded = 6 out of 8

How the candidate could have improved their answer

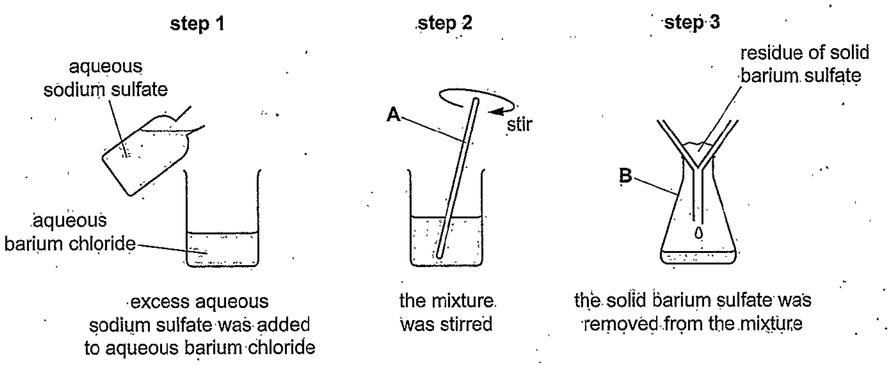
- **(a)** The candidate correctly identified both items of apparatus. The spelling 'cornical' is incorrect, but it is not ambiguous as to the type of flask and so is accepted. Both marks have been awarded.
- **(b)** The process has been correctly identified as filtration and the mark has been awarded.
- **(c)** While the solution collected by filtration does contain the solvent, the correct general term is 'filtrate' and so a mark has not been awarded.
- **(d)** The process of washing has been correctly identified in step 4, although it would have been better if the candidate had identified the substance with which the residue is washed (water). However, the substance removed has not been identified. The term 'impurities' was not awarded a mark as the question asks for the identity of the substance. Step 4 has been awarded one mark. Step 5 is fully correct and both marks have been awarded.

Example Candidate Response – middle

1 Barium sulfate is an insoluble salt. Barium sulfate can be made by reacting excess aqueous sodium sulfate with aqueous barium chloride.

sodium sulfate + barium chloride → sodium chloride + barium sulfate

A student made a sample of barium sulfate using the following steps.



(a) Name the items of apparatus labelled **A** and **B**.

A Stirring rod

B Funnel 1

[2]

(b) Name the process shown in **step 3**.

Filtration 2 [1]

(c) The general name for the solid in **step 3** is residue.

State the general name for the solution obtained from the process in **step 3**.

Precipitate 3 [1]

(d) Two more steps, **step 4** and **step 5**, are needed to obtain a pure sample of barium sulfate. In each of these steps something is removed from the residue.

State what is done in each of **step 4** and **step 5** and identify the substance removed from the barium sulfate.

step 4 ~~Wash~~ Rinse the barium sulfate while it is in the filter paper

substance removed ~~Sulfate~~ Sodium 4

step 5 Heat the barium sulfate

substance removed Chlorine 5

[4]

[Total: 8]

Examiner comments

1 While the diagram for step 3 does contain a funnel, the label line is not pointing to the funnel. The candidate needs to look carefully at the diagram to see what apparatus is labelled as B. One mark is awarded for A.
Mark for (a) = 1 out of 2

2 This is a fully correct answer, and a mark is awarded.
Mark for (b) = 1 out of 1

3 A precipitate can be collected by filtration, but when it is, it will be the residue and not the liquid which passes through the filter paper.
Mark for (c) = 0 out of 1

4 'Rinse' is an acceptable alternative to 'wash' although, in both cases, it is better to say that water is used (so 'rinse with water' or 'wash with water'). However, the substance removed is either sodium chloride or sodium sulfate; sodium alone is insufficient. Hence, one mark is awarded.

5 'Heat' is an acceptable method of drying, and so one mark is awarded. However, it should be water that is removed.
Mark for (d) = 2 out of 4

Total mark awarded = 4 out of 8

How the candidate could have improved their answer

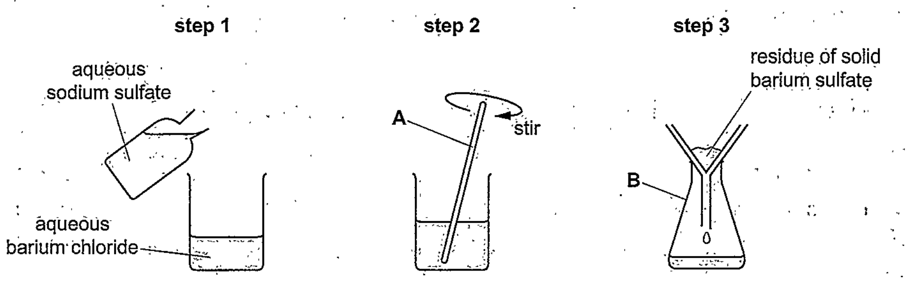
- **(a)** The candidate correctly identified the stirring rod. However, the label line from **B** is not pointing to the funnel; it stops at the conical flask and so the answer given for **B** was incorrect and only one mark has been awarded.
- **(b)** The process has been correctly identified as filtration and the mark has been awarded.
- **(c)** The candidate gave a type of product that can be collected as the residue rather than the general name for the solution obtained and so a mark was not awarded.
- **(d)** One mark has been awarded for each of step 4 and step 5. In step 4, the idea of rinsing the barium sulfate is correct (although it would have been better to say with what the barium sulfate should be rinsed, i.e. water) but the idea that sodium is removed (rather than sodium chloride) is incorrect. In step 5, heating is an acceptable method of drying the residue and so was awarded a mark, but the candidate has not identified water as the substance removed.

Example Candidate Response – low

1 Barium sulfate is an insoluble salt. Barium sulfate can be made by reacting excess aqueous sodium sulfate with aqueous barium chloride.

sodium sulfate + barium chloride → sodium chloride + barium sulfate

A student made a sample of barium sulfate using the following steps.



excess aqueous sodium sulfate was added to aqueous barium chloride | the mixture was stirred | the solid barium sulfate was removed from the mixture

(a) Name the items of apparatus labelled **A** and **B**.

A stirring stick

B ~~glass~~ beaker (1) beaker [2]

(b) Name the process shown in **step 3**.

filteration (2) [1]

(c) The general name for the solid in **step 3** is residue.

State the general name for the solid obtained from the process in **step 3**.

Sodium chloride (3) [1]

(d) Two more steps, **step 4** and **step 5**, are needed to obtain a pure sample of barium sulfate. In each of these steps something is removed from the residue.

State what is done in each of **step 4** and **step 5** and identify the substance removed from the barium sulfate.

step 4 The left liqued sodium chloride is left out and dryed. (4)

substance removed Sodium chloride ~~is~~

step 5 acidify with distilled acid add aqueous silver nitrate

substance removed

[4]

[Total: 8]

Examiner comments

(1) This answer scores no marks. The identification of A as a 'stirring stick' is not acceptable. In the question, candidates are told that it is used to stir the mixture and so 'stirrer' is insufficient. Candidates should be familiar with the names of common laboratory apparatus. B is not a beaker, steps 1 and 2 use a beaker but step 3 uses a conical flask.
Mark for (a) = 0 out of 2

(2) This is a fully correct answer, and a mark is awarded.
Mark for (b) = 1 out of 1

(3) The solution obtained is sodium chloride solution. However, the question asks for the general name (filtrate). It is important to read the questions carefully.
Mark for (c) = 0 out of 1

(4) If no answer is given for step 5, then the idea of drying in the last step (which would be step 4) would score a mark. However, no mark is awarded here because, in step 5, water is added again in the form of an aqueous solution and so the drying has served no purpose.
Mark for (d) = 0 out of 4

Total mark awarded = 1 out of 8

How the candidate could have improved their answer

- **(a)** Neither of the answers given is sufficient to score a mark. Candidates should know the correct names of common items of apparatus. The term ‘stick’ was not considered to be an acceptable alternative and the term ‘stirring’ was ignored as they are told in the diagrams that **A** was used to stir the mixture. The term ‘beaker’ is not an acceptable substitute for ‘conical flask’.
- **(b)** The process has been correctly identified as filtration and the mark has been awarded.
- **(c)** The candidate gave the specific name of the solution removed by filtration rather than the general name and so the mark was not awarded.
- **(d)** No marks were awarded as neither step is correct. However, if the candidate had not written an answer in step 5, then the idea of drying as the final step (which would be step 4 in this case) would have been awarded a mark. That mark could not be awarded here as, after drying, an aqueous solution (which contains water) has been added which means the drying was pointless. In step 5, the candidate had given a test for chloride ions rather than a final step in the purification process.

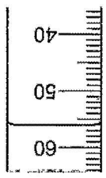
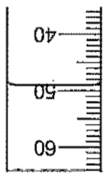
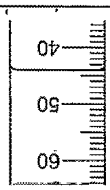
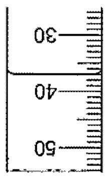
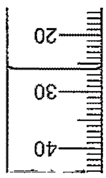
Common mistakes candidates made in this question

- **(a)** Candidates did not always look carefully at the diagram in step 3 and identified the funnel rather than the conical flask.
- **(c)** Candidates often gave a specific name (sodium chloride or sodium sulfate) rather than the general name.
- **(d)** A common error was for candidates to assume they were dealing with a solution rather than a solid residue and so they described the process of crystallisation. A careful inspection of the diagram for step 3 would have told candidates that barium sulfate was the solid residue.

Question 2

Example Candidate Response – high

(a) Use the information in the description of the experiments and the inverted measuring cylinder diagrams to complete the table.

experiment	volume of dilute hydrochloric acid/cm^3	inverted measuring cylinder diagram	volume of gas collected/cm^3
1	16		56
2	14		49
3	12		44
4	10		37
5	6		26

1

[3]

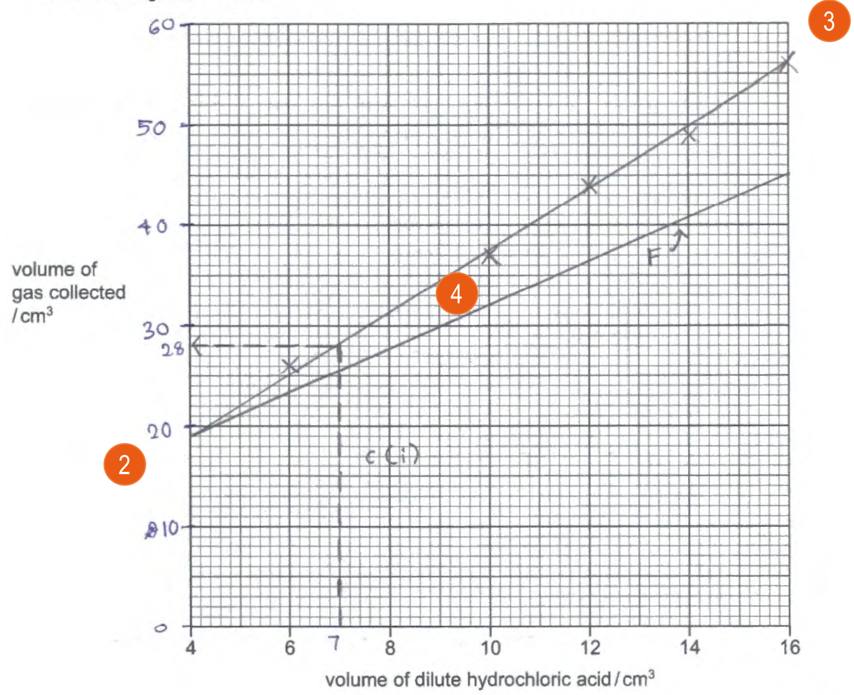
Examiner comments

1 All five volumes of dilute hydrochloric acid are correct, as are the five readings from the measuring cylinders. All three marks are awarded.

Mark for (a) = 3 out of 3

Example Candidate Response – high, continued

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



[4]

(c) (i) **From your graph**, deduce the volume of gas that would be collected if 7 cm³ of dilute hydrochloric acid was used.

Show clearly **on the grid** how you worked out your answer. 5

28 cm³
[2]

(ii) The volume of gas made per cm³ of dilute hydrochloric acid can be calculated using the equation shown.

$$\text{volume of gas per cm}^3 \text{ of acid} = \frac{\text{volume of gas collected in cm}^3}{\text{volume of acid in cm}^3}$$ 6

Use this equation and your answer to **(c)(i)** to calculate the volume of gas made per cm³ of dilute hydrochloric acid.

volume per cm³ = $\frac{28\ \text{cm}^3}{7\ \text{cm}^3}$ = 4 ~~cm³~~ cm³/cm³ ..... 4 cm³/cm³ [1]

Examiner comments

2 The graph scale is suitable, the scale has each large grid square = 10 cm³ (recommended scales are where each large grid square = 1, 2 or 5 x 10^n). Hence marking point M1 is awarded.

3 All five points have been plotted correctly. Each datum point is shown by an 'x', this is as recommended. M2 and M3 are awarded.

4 The line is a suitable best-fit straight line. The points do not lie on a perfect straight line but there approximately equal numbers of points above and below the line. M4 is awarded.
Mark for (b) = 4 out of 4

5 The working is clearly shown on the graph, the labelling of the working as being for (c)(i) is helpful. The reading obtained is correct for the line drawn. Both M1 and M2 are awarded.
Mark for (c)(i) = 2 out of 2

6 The volume of gas in (c)(i) is correctly divided by seven. It would have been better to give the answer as 4.0 as any volume of gas between 25 cm³ and 31 cm³ will give an answer of 4 when rounded to the nearest whole number. However, the answer is acceptable and so both marks are awarded.
Mark for (c)(ii) = 1 out of 1

Example Candidate Response – high, continued

(d) The bung was removed and then replaced immediately after the sodium carbonate was added to the boiling tube.

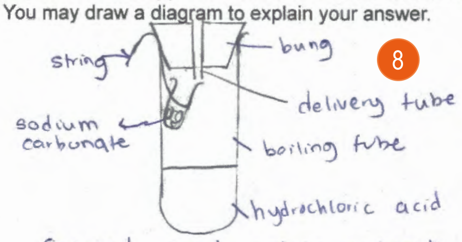
(i) Explain why the bung must be replaced immediately after the sodium carbonate is added to the boiling tube.

To make sure the ~~volume of~~ gas does not escape and make the ~~measurements~~ measurements less accurate [1]

7

(ii) Explain how the apparatus could be altered so that the bung does **not** have to be removed. You may draw a diagram to explain your answer.

8



Suspend solid sodium carbonate in a smaller ~~test~~ tube inside the boiling tube with a string [2]

(e) State **one** advantage of using a burette rather than a measuring cylinder to measure the volume of the dilute hydrochloric acid.

More accurate measurements of volume of ~~acid~~ acid [1]

9

(f) In Experiments 1 to 5, the sodium carbonate was in excess.

Sketch **on the grid** the graph you would expect if all of the experiments were repeated using dilute hydrochloric acid of half the concentration.

Label your line **F**. [2]

10

[Total: 16]

Examiner comments

7 The candidate correctly identifies that the gas made will escape. The mark is awarded.
Mark for (d)(i) = 1 out of 1

8 The suspension of the sodium carbonate in a small tube inside the reaction vessel is an excellent solution to the problem and is awarded M1. However, the question asks for an explanation and the candidate has not explained how this change to the apparatus will prevent the need to remove the bung and so the loss of gas. An additional statement that the tube can be tipped to start the reaction would gain M2. It is important that candidates consider the command word; 'explain' requires more to be said than just a description of how the apparatus is changed.
Mark for (d)(ii) = 1 out of 2

9 This is a correct answer, and the mark is awarded.
Mark for (e) = 1 out of 1

10 The line shown on the graph is not awarded any marks. If the concentration of the acid is halved, then, as the sodium carbonate is in excess, the volumes of gas produced will be half of those made in the original five experiments. One mark is available for a qualitative change (a line that shows all of the gas volumes are lower than in the original experiment) and a second mark for a quantitative change (a line that shows all of the gas volumes are half of the original experiment). In this answer, the lines touch and so, at one point, the gas volumes are the same, so no marks are awarded.
Mark for (f) = 0 out of 2

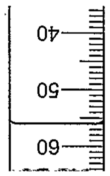
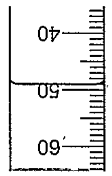
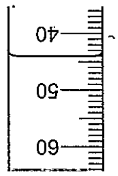
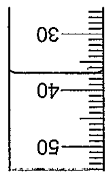
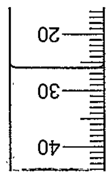
Total mark awarded = 13 out of 16

How the candidate could have improved their answer

- **(a)** All the data has been recorded correctly and so all three marks have been awarded.
- **(b)** The graph scale was suitable, each large grid square = 10 cm^3 (recommended scales are where each large grid square = 1, 2 or 5 x 10^n). Hence, M1 was awarded. All five points were plotted correctly and so M2 and M3 were awarded. The candidate used crosses (X) to represent each point; this is the recommended symbol to use. The line drawn was an acceptable best-fit line. The points are not on a perfect straight line but there were approximately equal numbers of points above and below the line, so M4 was awarded.
- **(c)(i)** There was very clear working on the graph and the value read from the graph was correct for the candidate's line, so both marks were awarded.
- **(c)(ii)** The calculation was correct, although it would have been better to give the value as 4.0, as all volumes of gas from 25 cm^3 to 31 cm^3 would have given an answer of 4 when rounded to the nearest whole number.
- **(d)(i)** The candidate has correctly stated that gas would be lost and so has been awarded the mark. However, in **(d)(ii)**, they have described a change to the apparatus rather than explained it. One mark has been awarded for the change to the apparatus. To gain the second mark, the candidate would have had to go on to say how the reaction can be started without removing the bung (such as by tipping the tube).
- **(e)** The answer was correct and a mark was awarded.
- **(f)** The sketched line should have shown that the gas volume would have been halved if the concentration of the acid was halved. The candidate has drawn the lines touching at 4 cm^3 of acid. This is incorrect, and no marks were awarded.

Example Candidate Response – middle	Examiner comments

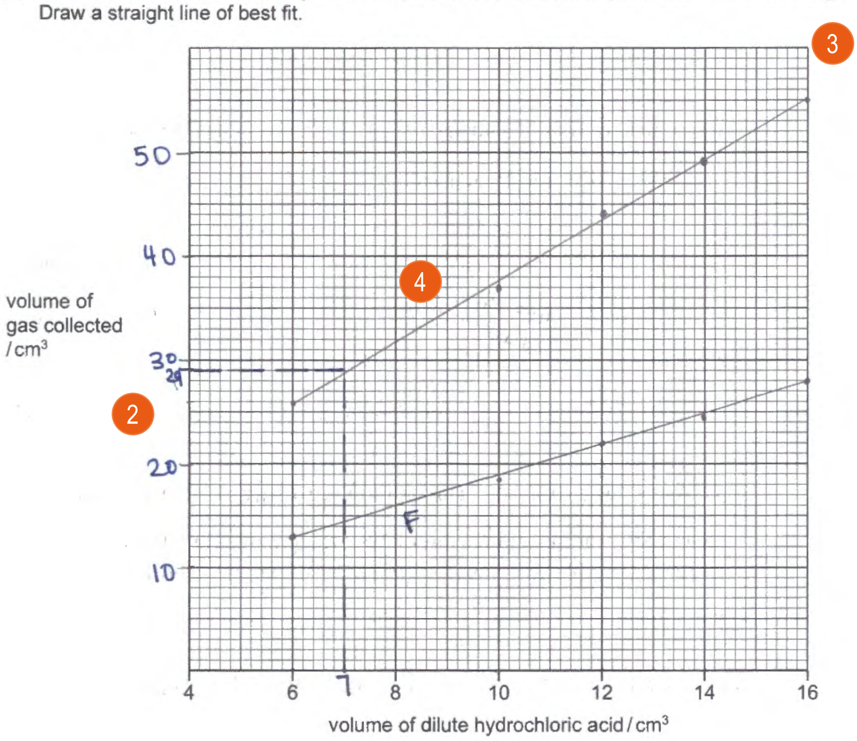
(a) Use the information in the description of the experiments and the inverted measuring cylinder diagrams to complete the table.

experiment	volume of dilute hydrochloric acid / cm^3	inverted measuring cylinder diagram	volume of gas collected / cm^3
1	16		56
2	14		49
3	12		44
4	10		37
5	6		26 (1)

(1) All five volumes of dilute hydrochloric acid are correct, as are the five readings from the measuring cylinders. All three marks are awarded.
Mark for (a) = 3 out of 3

Example Candidate Response – middle, continued

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



[4]

(c) (i) **From your graph**, deduce the volume of gas that would be collected if 7 cm^3 of dilute hydrochloric acid was used.

Show clearly **on the grid** how you worked out your answer.

5

29 .... cm^3 [2]

(ii) The volume of gas made per cm^3 of dilute hydrochloric acid can be calculated using the equation shown.

4.333 49/14

$$\text{volume of gas per cm}^3\text{ of acid} = \frac{\text{volume of gas collected in cm}^3}{\text{volume of acid in cm}^3}$$

Use this equation and your answer to **(c)(i)** to calculate the volume of gas made per cm^3 of dilute hydrochloric acid.

$\frac{49}{14} = 3.5$

6

3.5 .... [1]

Examiner comments

2 The graph scale is suitable, the scale has each large grid square = 10 cm^3 (recommended scales are where each large grid square = 1, 2 or 5 x 10^n). Hence marking point M1 is awarded. Had there been any points at below 10 cm^3 or above 50 cm^3 of acid, we would expect the graph scale to be extended down to 0 cm^3 or up to 60 cm^3.

3 Four of the five points have been plotted correctly. However, the point at (16, 56) has been plotted at (16,55) and so M2 is awarded but not M3. The candidate needs to check their plotting, one way of doing this is, after plotting the points, to read off from the graph where the points are and check the values against those in the table.

4 The line is a suitable best-fit straight line. The points do not lie on a perfect straight line but there are approximately equal numbers of points above and below the line. M4 is awarded.
Mark for (b) = 3 out of 4

5 The working is shown clearly on the graph and the reading obtained is correct for the line drawn. Both M1 and M2 are awarded.
Mark for (c)(i) = 2 out of 2

6 The calculation is incorrect as it uses the data for Experiment 2 rather than the values in (c)(i). The mark is not awarded.
Mark for (c)(ii) = 0 out of 1

Example Candidate Response – middle, continued

(d) The bung was removed and then replaced immediately after the sodium carbonate was added to the boiling tube.

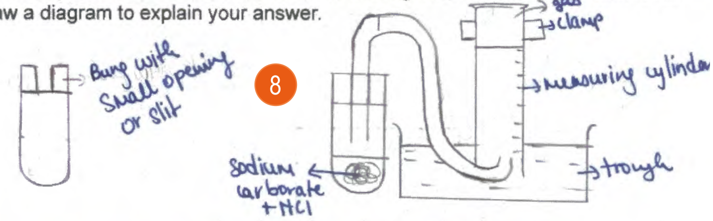
(i) Explain why the bung must be replaced immediately after the sodium carbonate is added to the boiling tube.

The bung becomes contaminated so a new bung has to be used so that there are no impurities [1]

(7)

(ii) Explain how the apparatus could be altered so that the bung does **not** have to be removed. You may draw a diagram to explain your answer.

(8)



The bung can have a small opening or slit so that sodium carbonate can be added and then a capillary tube of the same thickness of slit can be put to make it as airtight as possible [2]

(e) State **one** advantage of using a burette rather than a measuring cylinder to measure the volume of the dilute hydrochloric acid.

It is more accurate than the measuring ~~eye~~ cylinder [1]

(9)

(f) In Experiments 1 to 5, the sodium carbonate was in excess.

Sketch **on the grid** the graph you would expect if all of the experiments were repeated using dilute hydrochloric acid of half the concentration.

Label your line **F**. (10) [2]

[Total: 16]

Examiner comments

(7) This answer is an attempt to explain why a replacement bung should be used for each experiment. However, this is not what the question asks and so no marks are awarded. It is important that candidates read the whole of the question.
Mark for (d)(i) = 0 out of 1

(8) The candidate's plan is to pull the glass tube out of the bung rather than the bung out of the boiling tube. The suggestion made does not solve the problem caused by removing the bung. No marks are awarded.
Mark for (d)(ii) = 0 out of 2

(9) This is a correct answer, and the mark is awarded.
Mark for (e) = 1 out of 1

(10) The line drawn is fully correct and so both marks are awarded. When drawing sketch lines, candidates are not expected to plot points on the grid (as they have no data to plot). However, in this case, the candidate realises that the gas volumes will halve and so plots half the volumes shown in the table. Both marks are awarded.
Mark for (f) = 2 out of 2

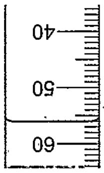
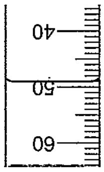
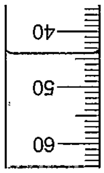
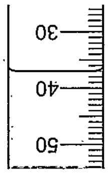
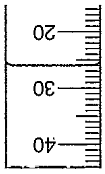
Total mark awarded = 11 out of 16

How the candidate could have improved their answer

- **(a)** All the data has been recorded correctly and so all three marks have been awarded.
- **(b)** The graph scale was suitable, each large grid square = 10 cm^3 (recommended scales are where each large grid square = 1, 2 or 5 x 10^n). Hence M1 was awarded. However, if any of the points had been below 10 cm^3 or above 50 cm^3 of acid, then the scale should have been extended to 0 cm^3 and 60 cm^3. Four of the five points were plotted correctly, the point for (16, 56) being plotted incorrectly at (15, 55) and so M2 but not M3 were awarded. The candidate used crosses (X) to represent each point; this is the recommended symbol to use. The line drawn was an acceptable best-fit line. The points are not on a perfect straight line but there were approximately equal numbers of points above and below the line, so M4 was awarded.
- **(c)(i)** There was very clear working on the graph and the value read from the graph was correct for the candidate's line, so both marks were awarded.
- **(c)(ii)** The calculation was incorrect. Rather than use the data from **(c)(i)**, the candidate has used the data for Experiment 2 and so the mark was not awarded; it is important to read instructions carefully to avoid making errors of this type.
- **(d)(i)** The candidate did not read the question carefully and rather than explain why the bung must be replaced immediately after adding the sodium carbonate to the boiling tube, they have tried to explain why the bung must be replaced by a new bung after each experiment; again, reading the question carefully is important.
- **(d)(ii)** The candidate described removing the delivery tube from the bung as an alternative to removing the bung from the boiling tube. This does not avoid the problem of gas loss and so the mark was not awarded.
- **(e)** The answer was correct and a mark was awarded.
- **(f)** The sketched line was shown at half the gas volumes of the line from the original experiment and so both marks were awarded. When sketching graphs, candidates are not expected to plot points as they have no data, but it is understandable why, in this case, the candidate has plotted points at half of the values shown in the results table.

Example Candidate Response – low

(a) Use the information in the description of the experiments and the inverted measuring cylinde diagrams to complete the table.

experiment	volume of dilute hydrochloric acid / cm^3	inverted measuring cylinder diagram	volume of gas collected / cm^3
1	16		~~[crossed out]~~ 58
2	14		~~[crossed out]~~ 48
3	12		~~[crossed out]~~ 43
4	10		~~[crossed out]~~ 36
5	6 (1)		~~[crossed out]~~ 25 (2)

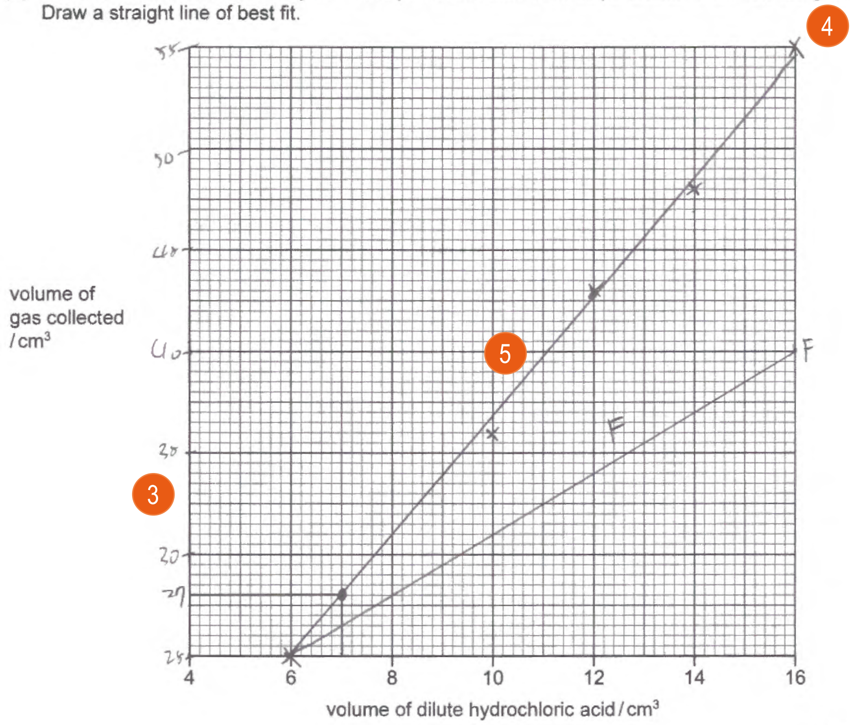
Examiner comments

(1) The volumes of dilute hydrochloric acid are correct and so M1 is awarded.

(2) The candidate has read the top rather than the bottom of the meniscus in every case, so every reading is 1 cm^3 less than it should be. Neither M2 nor M3 are awarded.
Mark for (a) = 1 out of 3

Example Candidate Response – low, continued

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



[4]

(c) (i) **From your graph**, deduce the volume of gas that would be collected if 7 cm^3 of dilute hydrochloric acid was used.

Show clearly **on the grid** how you worked out your answer.

27 cm^3 [2]

(ii) The volume of gas made per cm^3 of dilute hydrochloric acid can be calculated using the equation shown.

$$\text{volume of gas per cm}^3 \text{ of acid} = \frac{\text{volume of gas collected in cm}^3}{\text{volume of acid in cm}^3}$$

Use this equation and your answer to **(c)(i)** to calculate the volume of gas made per cm^3 of dilute hydrochloric acid.

3.86 per cm^3 of acid [1]

Examiner comments

3 The graph scale is suitable for the data the candidate has recorded in the table. The scale has each large grid square = 5 cm^3 (recommended scales are where each large grid square = 1, 2 or 5 x 10^n). Hence marking point M1 is awarded. However, the candidate needs to be careful with their handwriting as some of the '5's (in 25, 25 and 45) could be misread as '8's.

4 Although all of the gas volumes recorded in the table are incorrect, those incorrect numbers have all been plotted correctly. Each data point is shown by an 'x'; this is as recommended. M2 and M3 are awarded.

5 The line is a suitable best-fit straight line. The points do not lie on a perfect straight line but there are approximately equal numbers of points above and below the line. M4 is awarded.
Mark for (b) = 4 out of 4

6 The working is shown clearly on the graph and so M1 is awarded. However, the volume of gas shown on the graph is 28 cm^3 rather than 27 cm^3 and so M2 is not awarded.
Mark for (c)(i) = 1 out of 2

7 Although the volume in (c)(i) is incorrect, it has been correctly divided by 7 and the answer then rounded correctly and so the mark is awarded.
Mark for (c)(ii) = 1 out of 1

Example Candidate Response – low, continued

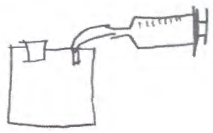
(d) The bung was removed and then replaced immediately after the sodium carbonate was added to the boiling tube.

(i) Explain why the bung must be replaced immediately after the sodium carbonate is added to the boiling tube.

8

The product gas may escape the set up, lowering the reliability of the experiment [1]

(ii) Explain how the apparatus could be altered so that the bung does **not** have to be removed. You may draw a diagram to explain your answer.



9

By using a gas syringe to measure the amount of gas, the bung doesn't have to be removed. [2]

(e) State **one** advantage of using a burette rather than a measuring cylinder to measure the volume of the dilute hydrochloric acid.

10

The burette ~~is~~ is better at measuring small amounts than the measuring cylinder. [1]

(f) In Experiments 1 to 5, the sodium carbonate was in excess.

Sketch **on the grid** the graph you would expect if all of the experiments were repeated using dilute hydrochloric acid of half the concentration.

Label your line **F**. 11 [2]

[Total: 16]

Examiner comments

8 The candidate correctly identifies that the gas made will escape. The mark is awarded.
Mark for (d)(i) = 1 out of 1

9 Collecting the gas in a gas syringe instead of the inverted measuring cylinder will not prevent the bung from needing to be removed to add the sodium carbonate. As the change does not work, no marks are awarded.
Mark for (d)(ii) = 0 out of 2

10 The term 'better' is too vague, it does not necessarily mean it is more accurate. The mark is not awarded.
Mark for (e) = 0 out of 1

11 The line shown on the graph is not awarded any marks. If the concentration of the acid is halved, then, as the sodium carbonate is in excess, the volumes of gas produced will be half of those made in the original five experiments. One mark is available for a qualitative change (a line that shows all of the gas volumes are lower than in the original experiment) and a second mark for a quantitative change (a line that shows all of the gas volumes are half of the original experiment). In this answer, the lines touch and so at one point, the gas volumes are the same, so no marks are awarded.
Mark for (f) = 0 out of 2

Total mark awarded = 8 out of 16

How the candidate could have improved their answer

- **(a)** The candidate was awarded M1 for five correct volumes of dilute hydrochloric acid. Neither M2 nor M3 were awarded as the candidate read the top of the meniscus in the measuring cylinder diagrams rather than the bottom. This resulted in all the gas volumes being 1 cm^3 too small.
- **(b)** The graph scale was suitable for the gas volumes recorded in the table, each large grid square = 5 cm^3 (recommended scales are where each large grid square = 1, 2 or 5 x 10^n). Hence, M1 was awarded. However, the candidate needed to take care with their writing as the numbers 25, 35 and 45 could easily be misread as 28, 38 and 48. The candidate plotted all five (incorrect) points from the table correctly and so M2 and M3 were awarded. The candidate used crosses (X) to represent each point; this is the recommended symbol to use. The line drawn was an acceptable best-fit line, the points are not on a perfect straight line but there were approximately equal numbers of points above and below the line, so M4 was awarded.
- **(c)(i)** The candidate showed correct working on their graph but has read the gas volume incorrectly, their graph shows a volume of 28 cm^3 so only one of the two marks available was awarded.
- **(c)(ii)** The calculation has been completed correctly and the answer rounded correctly, so the mark was awarded.
- **(d)** The candidate has correctly stated that gas may escape and so was awarded the mark in **(d)(i)**, but in **(d)(ii)**, they have given a change that would not work, the bung would still need to be removed to add the sodium carbonate. Changing the method of collecting the gas does not prevent the need to remove the bung. Hence no marks were awarded.
- **(e)** This answer was too vague to score the mark. Just saying the burette 'is better' is not sufficient, the candidate needed to refer to the improved accuracy.
- **(f)** The sketched line should have shown that the gas volume would have been halved if the concentration of the acid was halved. The candidate has drawn the lines touching at 6 cm^3 of acid, this is incorrect, and no marks were awarded.

Common mistakes candidates made in this question

- **(a)** Some candidates subtracted the measuring cylinder reading from 100 and so ended up with gas volumes that increased as the volume of acid decreased.
- **(b)** Those candidates who did not score M4 for the graph line often drew straight lines from one point to the next. This resulted in the overall line not being straight.
- **(c)(i)** The working was sometimes not shown on the graph.
- **(d)(ii)** The most common answer was to just replace the measuring cylinder with a gas syringe. This does not work, and no marks are gained. Another common error was to add the acid using a burette (or similar) through the bung. This gained one of the two marks as, although it does mean the bung does not need to be removed, it will not give accurate results as the air in the boiling tube is displaced into the measuring cylinder as the acid is added.
- **(f)** The most common error was to have the sketched line touching the experimental results line at one end.

Question 3

Example Candidate Response – high

3 Solution **G** and solid **H** were analysed.

tests on solution G

tests	observations
Solution **G** was divided into three equal portions in three test-tubes.	
test 1 Sodium hydroxide was added dropwise and then in excess to the first portion of solution **G**.	white precipitate which did not dissolve in excess
test 2 About 1 cm^3 of dilute nitric acid followed by a few drops of aqueous silver nitrate were added to the second portion of solution **G**.	yellow precipitate
test 3 About 10 cm^3 of aqueous hydrogen peroxide was added to the third portion of solution **G**. The gas produced was tested.	the mixture became brown and bubbled; the gas relit a glowing splint

(a) Identify the gas produced in **test 3**. (1)

oxygen gas [1]

(b) Use the results of **test 1** and **test 2** to identify solution **G**. (2)

Ca^{2+} ions give a white precipitate that doesn't re-dissolve in excess in NaOH. Iodide ions give a yellow precipitate → solution G is CaI_2, calcium iodide [2]

Examiner comments

(1) This correct conclusion is awarded a mark.
Mark for (a) = 1 out of 1

(2) This is an excellent answer and gains both marks, although there is no need for the candidate to explain their conclusion, unless the question specifically asks for this.
Mark for (b) = 2 out of 2

Example Candidate Response – high, continued	Examiner comments
tests on solid H Solid **H** was hydrated copper(II) sulfate. Complete the expected observations. **(c)** About half of solid **H** was placed in a boiling tube and heated using a Bunsen burner. observations colourchange from blue to white (3) since water turns copper(II)sulfate blue. [2] **(d)** A flame test was carried out on solid **H**. observations (4) green flame colour [1] The remaining solid **H** was placed in a boiling tube. About 10 cm^3 of distilled water was added to the boiling tube. The tube was shaken to dissolve solid **H** and form solution **H**. Solution **H** was divided into two approximately equal portions in two test-tubes. **(e)** Aqueous ammonia was added dropwise and then in excess to the first portion of solution **H**. (5) observations blue precipitate formed when ammonia is added dropwise and precipitate redissolve into blue solution when ammonia is added in excess [3] **(f)** Approximately 1 cm^3 of dilute nitric acid followed by a few drops of aqueous barium nitrate were added to the second portion of solution **H**. observations (6) white precipitate forms [1] [Total: 10]	(3) One mark is awarded for the colour change from blue to white. The second mark available is not awarded as, although the answer suggests the candidate knows water will be lost, they do not give an observation related to this (such as the formation of condensation at the top of the tube). Mark for (c) = 1 out of 2 (4) Green is an acceptable flame colour for copper(**II**) ions and so a mark is awarded. Mark for (d) = 1 out of 1 (5) One of the three marks available is not gained for this answer as both the precipitate and the final solution are the same colour (blue). To gain the third mark, the candidate needs to make it clear that the solution formed is a darker blue than the precipitate. This can be done by either describing the precipitate as 'light blue' or the final solution as 'dark blue'. Mark for (e) = 2 out of 3 (6) The mark is gained for this correct observation for a positive sulfate ion test. Mark for (f) = 1 out of 1 **Total mark awarded = 8 out of 10**

How the candidate could have improved their answer

- **(a)** The candidate correctly identified the gas as oxygen and so the mark was awarded.
- **(b)** The answer given was very clear and fully correct and so both marks were awarded. Although it should be noted that candidates are not expected to explain their conclusions unless this is specifically asked for in the question.
- **(c)** The answer the candidate gave suggested strongly that they understood that water was being lost. However, as they gave no observation related to steam being formed (such as condensation forming at the top of the tube) only one mark was awarded; this being for the correct colour change.
- **(d)** The correct flame colour was awarded one mark; (dark) green or blue-green are acceptable flame colours for copper(**II**) ions.
- **(e)** Only two of the three marks were awarded, the error was one of omission since, from the answer, it was not clear that the solution formed was darker than the initial precipitate. The third mark would have been awarded if the precipitate had been described as 'light blue" or the final solution as 'dark blue'.
- **(f)** The mark for the correct observation in a positive sulfate ion test was awarded.

Example Candidate Response – middle

3 Solution **G** and solid **H** were analysed.

tests on solution G

tests	observations
Solution **G** was divided into three equal portions in three test-tubes.	
test 1 Sodium hydroxide was added dropwise and then in excess to the first portion of solution **G**.	white precipitate which did not dissolve in excess
test 2 About 1 cm^3 of dilute nitric acid followed by a few drops of aqueous silver nitrate were added to the second portion of solution **G**.	yellow precipitate
test 3 About 10 cm^3 of aqueous hydrogen peroxide was added to the third portion of solution **G**. The gas produced was tested.	the mixture became brown and bubbled; the gas relit a glowing splint

(a) Identify the gas produced in **test 3**.

oxygen (1) [1]

(b) Use the results of **test 1** and **test 2** to identify solution **G**.

~~calcium iodide~~

~~zinc iodide~~ (2)

aluminium iodide [2]

Examiner comments

(1) This correct conclusion is awarded a mark.
Mark for (a) = 1 out of 1

(2) One mark is awarded for the identification of the iodide ion. From the three attempts the candidate makes at identifying the metal ion, it is clear they know which cations form a white precipitate with aqueous sodium hydroxide but are not sure which one does not redissolve in excess.
Mark for (b) = 1 out of 2

Example Candidate Response – middle, continued	Examiner comments
tests on solid H Solid **H** was hydrated copper(II) sulfate. Complete the expected observations. (3) **(c)** About half of solid **H** was placed in a boiling tube and heated using a Bunsen burner. observations ....blue hydrated copper sulfate turn white and ....become anhydrous.... [2] **(d)** A flame test was carried out on solid **H**. (4) observations ....blue ~~blue~~ ~~green~~ flame.... [1] The remaining solid **H** was placed in a boiling tube. About 10 cm^3 of distilled water was added to the boiling tube. The tube was shaken to dissolve solid **H** and form solution **H**. Solution **H** was divided into two approximately equal portions in two test-tubes. **(e)** Aqueous ammonia was added dropwise and then in excess to the first portion of solution **H**. (5) observations ....blue precipitate, then it dissolves which create blue solution.... .... [3] **(f)** Approximately 1 cm^3 of dilute nitric acid followed by a few drops of aqueous barium nitrate were added to the second portion of solution **H**. (6) observations ....white precipitate.... [1] [Total: 10]	(3) One mark is awarded for the correct colour change. To gain the second mark, the candidate needs to give an observation that shows that water is given off, such as the formation of condensation at the top of the tube. Mark for (c) = 1 out of 2 (4) As in (b), the candidate shows some indecision. No mark is awarded for the colour being blue. The correct colour is blue-green. Although green alone is acceptable, blue alone is not. Mark for (d) = 0 out of 1 (5) One of the three marks available is not gained for this answer as both the precipitate and the final solution are the same colour (blue). To gain the third mark, the candidate needs to make it clear that the solution formed is a darker blue than the precipitate. This can be done by either describing the precipitate as 'light blue' or the final solution as 'dark blue'. The answer could also be clearer by stating the precipitate forms when the aqueous ammonia is added dropwise, and then dissolves when it is added in excess. Mark for (e) = 2 out of 3 (6) The mark is gained for this correct observation for a positive sulfate ion test. Mark for (f) = 1 out of 1 **Total mark awarded = 6 out of 10**

How the candidate could have improved their answer

- **(a)** The candidate correctly identified the gas as oxygen and so the mark was awarded.
- **(b)** The answer given was only partially correct and one mark was awarded for the identification of the iodide ion. From the attempts the candidate made at the identification of the cation, it is evident that they knew which ions formed white precipitates with aqueous sodium hydroxide but not what happened in excess.
- **(c)** One mark was awarded for the correct colour change. However, to gain the second mark, the candidate needed to give an observation which is the result of steam being given off, such as condensation at the top of the tube.
- **(d)** The flame colour given was not acceptable. The expected answer was blue-green and, while green alone would have been accepted, blue alone was not. From the crossings out in **(b)** and **(d)**, it seems that the candidate was not confident with their knowledge of qualitative ion tests.
- **(e)** Only two of the three marks were awarded. The error was one of omission since, from the answer, it was not clear that the solution formed was darker than the initial precipitate. The third mark would have been awarded if the precipitate had been described as 'light blue' or the final solution as 'dark blue'. The answer could also be improved by making it clear that the precipitate formed as a result of adding drops aqueous ammonia and the redissolving occurred with excess aqueous ammonia.
- **(f)** The mark for the correct observation in a positive sulfate ion test was awarded.

Example Candidate Response – low

3 Solution **G** and solid **H** were analysed.

tests on solution G

tests	observations
Solution **G** was divided into three equal portions in three test-tubes.	
test 1 Sodium hydroxide was added dropwise and then in excess to the first portion of solution **G**.	Al^{3+} white precipitate which did not dissolve in excess
test 2 About 1 cm^3 of dilute nitric acid followed by a few drops of aqueous silver nitrate were added to the second portion of solution **G**.	iodine yellow precipitate
test 3 About 10 cm^3 of aqueous hydrogen peroxide was added to the third portion of solution **G**. The gas produced was tested.	the mixture became brown and bubbled; the gas relit a glowing splint ↑

(a) Identify the gas produced in **test 3**.

carbon dioxide (1) .... [1]

(b) Use the results of **test 1** and **test 2** to identify solution **G**.

Aluminium iodide (2) ....

Examiner comments

1 No marks are awarded as the gas is incorrect.
Mark for (a) = 0 out of 1

2 One of the two marks available is awarded. While the identification of solution G as an iodide is correct, it is not an aluminium compound. Aluminium iodide solution would form a white precipitate with aqueous sodium hydroxide, but that precipitate would redissolve in excess.
Mark for (b) = 1 out of 2

Example Candidate Response – low, continued	Examiner comments
tests on solid H Solid **H** was hydrated copper(II) sulfate. Complete the expected observations. **(c)** About half of solid **H** was placed in a boiling tube and heated using a Bunsen burner. observations ....anhydrous copper (II) sulfate.... (3) .... [2] **(d)** A flame test was carried out on solid **H**. observations ....green flame.... (4) .... [1] The remaining solid **H** was placed in a boiling tube. About 10 cm^3 of distilled water was added to the boiling tube. The tube was shaken to dissolve solid **H** and form solution **H**. Solution **H** was divided into two approximately equal portions in two test-tubes. **(e)** Aqueous ammonia was added dropwise and then in excess to the first portion of solution **H**. observations ....green precipitate , colourless gas formed ~~and~~ placed in damp red litmus paper turns blue.... (5) .... [3] **(f)** Approximately 1 cm^3 of dilute nitric acid followed by a few drops of aqueous barium nitrate were added to the second portion of solution **H**. observations ....no changes.... (6) .... [1] [Total: 10]	(3) This answer gives the name of the product rather than describes the observations expected, and so no marks are awarded. It is important to read questions carefully so that the answer given fits the question asked. Mark for (c) = 0 out of 2 (4) Green is an acceptable flame colour for copper(II) ions and so a mark is awarded.# Mark for (d) = 1 out of (5) While the candidate correctly states that a precipitate forms, the colour of the precipitate is incorrect and so M1 is not awarded. No gas forms and so the remainder of the answer does gain any marks. Mark for (e) = 0 out of 3 (6) This answer is incorrect and so no mark is awarded. At the top of the page, candidates are told that the compound is a sulfate, and they should recognise this as the sulfate test. Mark for (f) = 0 out of 1 **Total mark awarded = 2 out of 10**

Common mistakes candidates made in this question

- **(a)** The candidate identified the gas incorrectly and so the mark was not awarded. Candidates need to be familiar with the qualitative gas tests.
- **(b)** The answer the candidate gave was only partially correct and one mark was awarded for the identification of the iodide ion. The cation was identified as aluminium and while this does give a white precipitate with aqueous sodium hydroxide, the precipitate would redissolve in excess.
- **(c)** The candidate gave a correct identity of the solid product formed. However, the question asked for observations and not an identity and, as no observations were given, no marks were awarded.
- **(d)** The correct flame colour was awarded a mark; (dark) green or blue-green are acceptable flame colours for copper(**II**) ions.
- **(e)** Although the candidate correctly stated that a precipitate formed, the colour of the precipitate was incorrect and so M1 was not awarded. The remainder of the answer in **(e)** also did not gain any marks as the candidate said a gas is formed (which is incorrect and even if a gas had been formed, that statement is not an observation as a colourless gas cannot be seen, it would have been effervescence that was observed) and then went on to test that gas.
- **(f)** The candidate did not link the fact that they were told at the top of the page that the substance was a sulfate with the sulfate ion test being carried out, no mark was awarded.

Common mistakes candidates made in this question

- **(b)** There was often confusion over which cation that produces a white precipitate with dropwise addition of aqueous sodium hydroxide was present. Zinc and aluminium were common incorrect answers.
- Many candidates did not comment on the formation of steam which would result in droplets of condensation at the top of the tube or a white vapour to come out of the top of the tube.
- **(e)** The most common errors were for the precipitate to either not dissolve in excess or for the final solution not to be a darker blue than the original precipitate.

Question 4

Example Candidate Response – high	Examiner comments
4 The mineral epsomite contains (hydrated magnesium sulfate). When epsomite is heated strongly, it loses water and eventually becomes (anhydrous magnesium sulfate). Plan an investigation to find the percentage by mass of water in a sample of epsomite. Your plan should include how you would calculate the (percentage) by mass of (water) in epsomite. You have access to common laboratory apparatus. (1) Firstly I would take a sample of epsomite and weigh it on a electronic weighing scale. Once I identify the mass in grams I will note it down. (2) Then the epsomite will be strongly heated ~~and placed in a~~ by holding it over a bunsen burner while grabbing it with tongs. All safety precautions will be taken into consideration such as gloves and ~~gog~~ googles (3) will be worn while conducting the heating process. Once this has been completed, the anhydrous magnesium sulphate will be left to cool down (4) a little bit. The mass of the new epsomite will now be measured. Once done I will calculate the change in mass by subtracting the original (5) mass by the new mass. This will give us mass of the water lost during heating. The next step will be to use this formula to directly calculate mass of water in epsomite: (6) $\frac{\text{mass of water lost}}{\text{mass of 1st epsomite}}$ ~~weighment~~ $\times 100 =$ % of water in epsomite	(1) One mark, MP1, is awarded for weighing the sample of epsomite. (2) One mark, MP3, is awarded for heating the sample of epsomite strongly. However, the sample is being held in tongs which may lead to parts of it falling off and being lost. The sample should be placed in a suitable container, such as a crucible. Hence, MP2 is not awarded. (3) Although the candidate says that when the heating process is complete, the final product will be anhydrous magnesium sulfate, they have not said how we know when the process is complete. The idea of heating to constant mass is omitted. Hence, MP5 is not awarded. (4) MP4 is awarded for finding the mass of the mineral after heating. (5) The change in mass is calculated; this change being the mass of water lost. Hence, MP6 is awarded. (6) The final calculation of the percentage water in the sample of epsomite is correct and so MP7 is awarded. **Total mark awarded = 5 out of 6**

Common mistakes candidates made in this question

- The candidate gave the basis of clear method that would have enabled them to find the percentage of water in the epsomite. The steps were in a logical sequence, and this suggested the candidate thought through their answer before writing it down. Marks have been awarded for:
  - weighing the epsomite (line 1)
  - heating the epsomite strongly (line 2)
  - weighing the solid residue after heating (line 8)
  - calculating the mass of water lost (lines 9 and 10)
  - calculating the percentage water (equation at end).
- To improve, the epsomite needs to be placed in a container which will avoid loss of solid during the heating, but allow water to escape as a gas. Holding it with tongs (line 4) is not suitable; a crucible is the ideal receptacle.
- The candidate also gave no indication of how we would know when to stop heating (line 7). The easiest way to be sure all of the water has been removed is to 'heat to constant mass'.

Example Candidate Response – middle

4 The mineral epsomite contains hydrated magnesium sulfate. When epsomite is heated strongly, it loses water and eventually becomes anhydrous magnesium sulfate.

Plan an investigation to find the percentage by mass of water in a sample of epsomite. Your plan should include how you would calculate the percentage by mass of water in epsomite.
You have access to common laboratory apparatus.

(1) • Measure the mass of the epsomite using an electronic balance and record it (2)

• Hold the epsomite using tongs and bring it near a (3) hot flame of a bunsen burner for a few minutes (4)

• Leave the heated epsomite which is now anhydrous magnesium sulfate to dry and cool

• Measure the anhydrous magnesium sulfate using an electronic balance and record it (5)

• To find mass of water use the formula

= Initial mass of epsomite − final mass of heated epsomite (6)

• Once the mass of water is found, use the formula

$\dfrac{\text{Mass of water}}{\text{Initial mass of epsomite}} \times 100$ (7)

• Precautions

→ Ensure to wear gloves when heating the epsomite as it's hot due to being heated by bunsen burner.

(8)

Examiner comments

(1) MP1 is awarded for finding the initial mass of the epsomite.

(2) The sample is being held in tongs. This will lead to the loss of small pieces of the mineral during heating and so is not suitable.
A suitable container, such as a crucible, is required. Hence MP2 is not awarded.

(3) Holding the sample 'near a hot flame' is not sufficient. If the sample is held a few centimetres to the side of the flame, it will not get hot enough to lose water. Hence, MP3 is not awarded.

(4) The candidate makes no suggestion as to how we will know that all the water has been removed; heating for a few minutes is insufficient detail. Hence, MP5 is not awarded. The candidate needs to describe the process of heating to constant mass.

(5) While MP4 is awarded for the use of a balance after heating, the instruction would be improved by stating that the mass of the sample is found.

(6) MP6 is awarded for the clear calculation of the mass of water.

(7) MP7 is awarded for the correct formula for calculating the percentage of water.

(8) Throughout the plan, the candidate uses bullet points. This is often seen in answers to the planning question and is perfectly acceptable; the use of bullet points can make writing a multi-step plan much easier.

Total mark awarded = 4 out of 6

Common mistakes candidates made in this question

- The candidate wrote the entire plan as a set of bullet points. This is perfectly acceptable and is often a good way to write a multi-step plan. The steps were in a logical sequence, and this suggested the candidate thought through their answer before writing it down. Marks have been awarded for:
  - finding the mass of the epsomite (line 1)
  - finding the mass of the solid after heating (lines 7 and 8)
  - calculating the mass of water lost (lines 9, 10 and 11)
  - calculating the percentage water (lines 12, 13 and 14).
- To improve on line 3, the sample was held in tongs rather than in a suitable container such as a crucible and, rather than being heated strongly, it was held near a Bunsen flame. This is insufficient as if held a few centimetres to the side, it would not become hot enough to lose water. The candidate also told us that it was held near the Bunsen flame for a few minutes and made no attempt to describe how we would know all the water had been lost. The easiest way to be sure all the water has been removed is to 'heat to constant mass'.

Example Candidate Response – low

4 The mineral epsomite contains hydrated magnesium sulfate. When epsomite is heated strongly, it loses water and eventually becomes anhydrous magnesium sulfate.

Plan an investigation to find the percentage by mass of water in a sample of epsomite. Your plan should include how you would calculate the percentage by mass of water in epsomite.
You have access to common laboratory apparatus.

Measure the volume ~~of~~ and mass of epsomite (1) and add it to a (3) boiling tube (2). Heat strongly (under a Bunsen burner) till it loses water and becomes anhydrous magnesium sulfate (4). Measure volume of (5) ~~the~~ anhydrous magnesium sulfate. Compare both volumes (~~subst~~ (subtract final and initial volumes) Find the relative molecular mass (6) (RMM) of water and use the following equation to find percentage by mass of water in epsomite:

Examiner comments

1 As the task is to plan an investigation to fine the percentage by mass of water in epsomite, there is no point in finding the volume of the epsomite. However, additional unnecessary steps which do not contradict correct steps are ignored. Hence MP1 is awarded for finding the mass of epsomite.

2 MP2 is not awarded as a boiling tube is not a suitable container. Use of a boiling tube would result in the condensation of water droplets on the cooler upper parts of the boiling tube walls and so the water would not be easily lost.

3 It is a relatively common error for a candidate to state that something is heated under a Bunsen rather than over a Bunsen and this error is ignored and MP3 is awarded.

4 There is no indication of how we know when all of the water is driven off and so MP5 is not awarded.

5 Finding the volume of the anhydrous magnesium sulfate is not useful, as the mass has not been found MP4 is not awarded.

6 Rather than fining the mass of water lost, the candidate is calculating the relative molecular mass of water and so MP6 is not awarded.

Example Candidate Response – low, continued	Examiner comments
$\frac{\text{RMM of water}}{\text{Mass of epsomite}} \times 100$ (7) (8)	(7) The method for calculating the percentage of water is incorrect. Use of this equation would mean the larger the starting mass of epsomite, the smaller the percentage water would be. (8) Despite measuring the volumes of epsomite and anhydrous magnesium sulfate, no use has been made of these measurements. The candidate needs to read through there answer, the fact that measurements are made and not used suggests that there is something wrong with the some aspects of the plan. **Total mark awarded = 4 out of 6**

Common mistakes candidates made in this question

- The candidate made some progress with the plan but there were slips and omissions which meant many of the available marks have not been awarded. Marks have been awarded for:
  - finding the mass of the epsomite (line 1). The candidate also found the volume of the epsomite, but this measurement was irrelevant and was ignored.
  - Heating the epsomite strongly (line 2). The candidate said that this should be done 'under a Bunsen burner'. Heating under a Bunsen rather than over a Bunsen is a relatively common error and has been ignored.
- However, on line 2, the candidate told us that the epsomite should be placed in a boiling tube. Use of a boiling tube results in the condensation of water droplets on the cooler upper parts of the boiling tube walls. These droplets then run back down to the bottom of the tube and rehydrate the solid and they can also cause the tube to crack. On line 3, the candidate told us to heat the epsomite until it became anhydrous magnesium sulfate but gave no suggestion as to how we would know when this was. The easiest way to be sure all the water has been removed is to 'heat to constant mass'. On lines 3 and 4, we were told to find the volume of the anhydrous magnesium sulfate, as the aim is to find the percentage by mass of water. Finding the volume of the solid is of no help. In the final calculation, the candidate found the relative molecular mass of the water and then divided that by the mass of the epsomite. This does not find the percentage by mass of water in the sample. If the candidate had read through their answer, they may have noticed that they made no use of the volumes they measured, and that no data obtained after heating was used. This may have made them think there was something wrong with the measurements they have taken and with the calculation performed, and so they could revisit their answer and make appropriate changes.

Common mistakes candidates made in this question

- Not planning out the approach/method before starting to write the answer.
- Heating in a boiling tube or test-tube rather than a crucible.
- Not stating how they could tell when all the water had been removed from the sample of epsomite.
- Missing out the 'x 100' when calculating the final percentage.

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