

# Exemplar work with commentary



**GCSE (9-1) Chemistry**

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Pearson Edexcel Level 1/Level 2 GCSE (9-1) in Chemistry (1CH0)

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# GCSE (9–1) Chemistry Exemplars

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# Introduction

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This guide has been put together using student responses to our sample assessment materials in GCSE (9-1) Chemistry. We have grouped the answers according to the overall themes that developed through the marking process, and hope that this will give you more information on key development areas for students studying for this qualification.

The assessment of practical skills covers both knowledge of core practicals, and candidates' ability to apply that knowledge to new contexts, or to apply investigative skills to scenarios presented in the examinations. These scientific enquiry skills are something candidates will need to practice, such as questions which focus on knowledge and understanding of specific methods in practicals and drawing conclusions based on practical work. It is important to note that questions set in a practical context but testing the theoretical knowledge and understanding will not count towards the 15% marks allocated to practical skills. Questions that are assigned to this percentage will be ones where candidates are at an advantage if they have carried out the core practical.

There is a set percentage of maths marks (20%) to be met in these papers. When looking at maths content to be assessed, there are two factors that need to be considered. Firstly, the breadth of maths to be covered (which can be found in Appendix 1 in the specification) and secondly the level of maths as specified by Ofqual. In general, candidates will need to practice answering maths questions in the same way as they do now. Practicing answering these types of questions will help to minimise the minor calculation errors or mistakes that are made. It is also important to highlight the importance of checking their answers, particularly when reading data from a graph or table, using an equation to substitute given numbers in a question, or giving answers to a set number of significant figures.

The extended open response questions (6 mark questions) test candidates' ability to construct a sustained line of reasoning. Questions assessing this are marked with an asterisk. As these items are more open ended, they are marked using a levels-based mark scheme. Our 2011 qualifications contained 6 mark questions, and candidates generally respond well to them. The general areas to develop and focus on when answering these questions are still focused on ensuring candidates answer the whole question and are able to make links both using information given in the question, and using their own knowledge. They should be able to draw conclusions, and make arguments or analyse information (backed up with their own knowledge) if the question requires it.

The question examples in this guide will give you a range of answers relating to the themes highlighted above to show you the varied answers candidates may give. There are also detailed examiner comments for each answer to explain how the marks have been allocated, and the merits or development points for each answer.

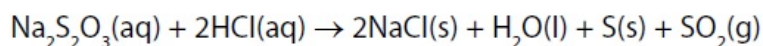
## Practical skills

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### Combined Science (Foundation)

#### Example 1 – Question 5e

- (e) Sodium thiosulfate solution,  $\text{Na}_2\text{S}_2\text{O}_3$ , reacts with dilute hydrochloric acid as shown in the equation.



The rate of this reaction can be investigated by mixing the reactants and finding the time taken for a precipitate of sulfur to become visible.

A student wants to investigate the effect of changing the temperature on the rate of this reaction.

Devise a method the student could use to find out how the time taken for the precipitate of sulfur to become visible changes with temperature.

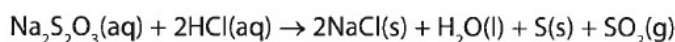
(3)

#### Mark scheme

Question number	Answer	Mark
5(e)	An answer that combines the following points to provide a method: <ul style="list-style-type: none"> <li>• suitable method of warming the solutions, e.g. water bath, Bunsen burner with tripod and gauze and measure the temperature of each solution using a thermometer (1)</li> <li>• use the same volumes of the solutions in each experiment (1)</li> <li>• measure the time for the precipitate to form (and obscure a cross placed under the reaction vessel) using a stop watch/clock (1)</li> </ul>	(3)

## Student answers

- (e) Sodium thiosulfate solution,  $\text{Na}_2\text{S}_2\text{O}_3$ , reacts with dilute hydrochloric acid as shown in the equation.



The rate of this reaction can be investigated by mixing the reactants and finding the time taken for a precipitate of sulfur to become visible.

A student wants to investigate the effect of changing the temperature on the rate of this reaction.

Devise a method the student could use to find out how the time taken for the precipitate of sulfur to become visible changes with temperature.

(3)

The student could do many test at different temperatures and use a stop watch to time how long it ~~took~~ <sup>takes</sup> for a precipitate of sulfur to become visible.

## Examiner's comments

The candidate appeared to understand the experiment but has failed to provide any detail of how the solution was warmed and the need to control the volume. The candidate has only indicated how the time would be measured.

Marks awarded = 1

## Example 2 – Question 7ci

- (c) Paper chromatography was used to separate a mixture of blue and red inks. A spot of the mixture was placed on chromatography paper as shown in Figure 10.

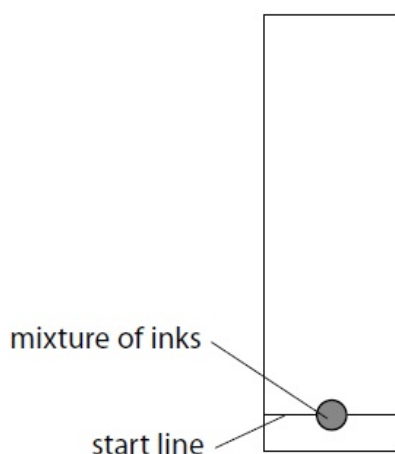


Figure 10

- (i) Give a reason why the start line is drawn in pencil rather than in ink.

(1)

Mark scheme

Question number	Answer	Mark
7(c)(i)	pencil is insoluble in the solvent (but chromatography would separate the ink in an ink line)	(1)

Student answers

(i) Give a reason why the start line is drawn in pencil rather than in ink.

(1)

Because if it was in ink it would more/separate when the chromatography begins-

**Examiner's comments**

This candidate describes why an ink line should not be used but the question asks why a pencil line is used.

Marks awarded = 0

**Example 3 – Question 7dii**

(d) P, Q, R and S are mixtures of food colourings.

They are investigated using paper chromatography.

Figure 13 shows the chromatogram at the end of the experiment.

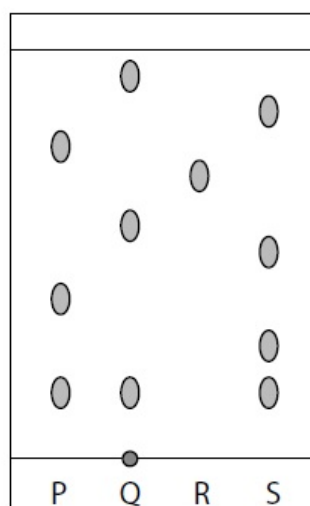


Figure 13

(iii) Explain, by referring to Figure 13, which mixture is separated into the greatest number of soluble food colourings by this chromatography experiment.

(2)

## Mark scheme

Question number	Answer	Mark
7(d)(iii)	an explanation that combines identification via a judgement (1 mark) to reach a conclusion via justification/reasoning (1 mark): <ul style="list-style-type: none"> <li>• mixture S (1)</li> <li>• because it gives the greatest number of spots/gives four spots (1)</li> </ul>	(2)

## Student answers

(iii) Explain, by referring to Figure 13, which mixture is separated into the greatest number of soluble food colourings by this chromatography experiment.

(2)

Mixture S has been seperated into the greatest number of soluble food colourings because, it has made the most separations.

**Examiner's comments**

The candidate chose the correct mixture but did not clearly indicate that this was the correct food colouring because it produced the greatest number of spots.

Marks awarded = 1

## Combined and Separate Chemistry (Higher)

**Example 1 – Question 5d (i) and (ii)**

(d) Sodium hydroxide solution is used to identify some cations present in compounds.

(i) Sodium hydroxide solution is warmed with a solution of ammonium ions. Ammonia gas is given off.

Describe the test to show the gas is ammonia.

(2)

(ii) Sodium hydroxide solution is also used to distinguish between iron(II) ions,  $\text{Fe}^{2+}$  and iron(III) ions,  $\text{Fe}^{3+}$ , in solution.

You are given a solution containing iron(II) ions and another solution containing iron(III) ions.

Describe what is seen when sodium hydroxide solution is added to each of these solutions.

(2)

Mark scheme

Question number	Answer	Additional guidance	Mark
5(d)(i)	An answer that provides a description by making reference to: <ul style="list-style-type: none"> <li>test gas with moist (red) litmus paper (1)</li> <li>turns blue (1)</li> </ul>	Allow universal indicator paper/pH paper and yellow to blue/purple	(2)
5(d)(ii)	An answer that provides a description by making reference to: <ul style="list-style-type: none"> <li>iron(II) – green/pale green/grey-green <b>and</b> precipitate /solid (1)</li> <li>iron(III) – red-brown/brown <b>and</b> precipitate /solid (1)</li> </ul>	Allow two correct colours (1)	(2)

Student answers

(d) Sodium hydroxide solution is used to identify some cations present in compounds.

(i) Sodium hydroxide solution is warmed with a solution of ammonium ions. Ammonia gas is given off.

Describe the test to show the gas is ammonia.

(2)

Ammonia is an alkaline gas so to test for it you would hold damp red litmus paper above the test tube, and if it turns blue, ammonia is present

**Examiner's comments**

Like the vast majority of answers, this clearly indicates the test and its positive result.

Marks awarded = 2

- (ii) Sodium hydroxide solution is also used to distinguish between iron(II) ions,  $\text{Fe}^{2+}$  and iron(III) ions,  $\text{Fe}^{3+}$ , in solution.

You are given a solution containing iron(II) ions and another solution containing iron(III) ions.

Describe what is seen when sodium hydroxide solution is added to each of these solutions.

(2)

With Iron II the colour created is green  
and Iron III is brown

#### Examiner's comments

This answer does not describe all that is seen. It indicates the correct colours but fails to say that precipitates or solids are formed.

Marks awarded = 1

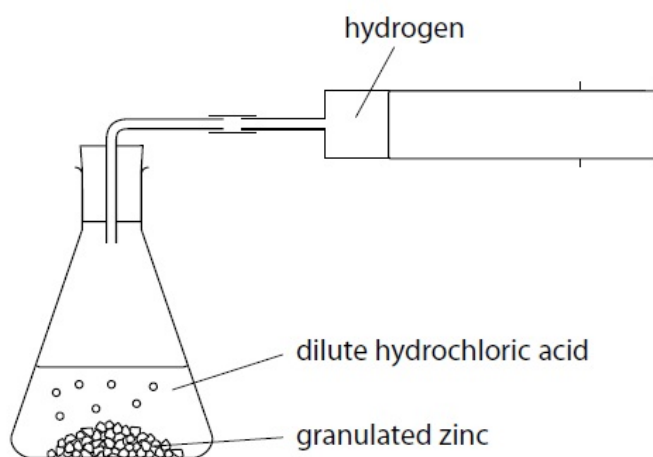
## Maths skills

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### Combined Science (Foundation)

#### Example 1 – Question 5b

- 5 A student used the equipment in Figure 6 to investigate the rate of reaction between zinc and excess dilute hydrochloric acid.



**Figure 6**

The student uses the following method:

- place a known mass of granulated zinc into the conical flask
- pour 25 cm<sup>3</sup> of dilute hydrochloric acid (an excess) into the conical flask and fit the bung quickly into the neck of the flask
- measure the volume of gas produced every 20 seconds until after the reaction finishes.

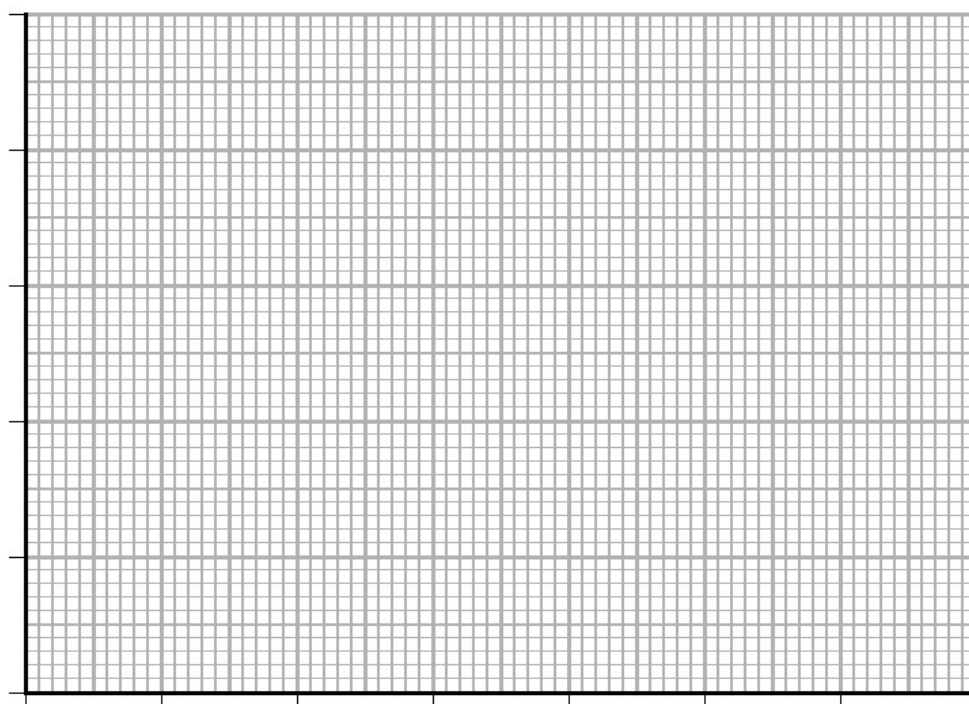
Figure 7 shows the results.

time / s	volume of hydrogen / cm <sup>3</sup>
0	0
20	42
40	66
60	75
80	80
100	82
120	82
140	82

**Figure 7**

(b) Draw a graph of the volume of hydrogen gas produced against time using the grid.

(3)

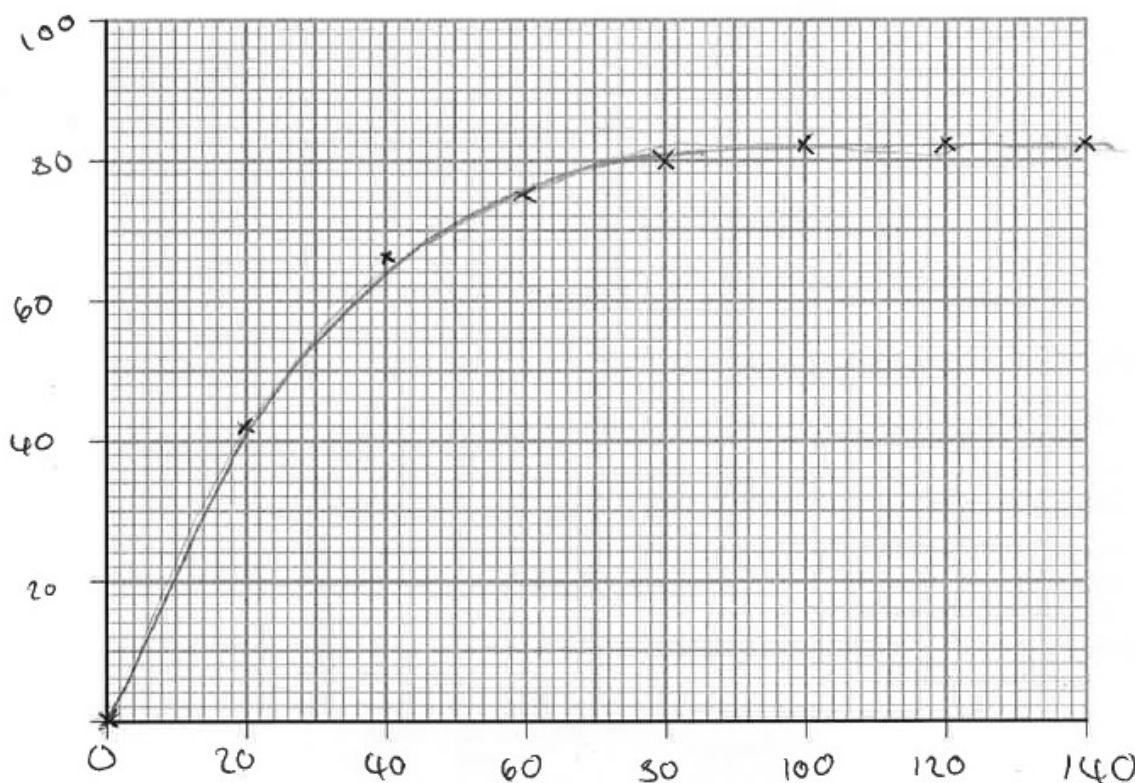


Mark scheme

Question number	Answer	Additional guidance	Mark
5(b)	<ul style="list-style-type: none"> <li>axes with linear scale that use more than half of each edge of the grid and labelled with units from the table (1).</li> <li>all points correctly plotted to <math>\pm</math> half a square (1).</li> <li>single straight line passing through all points and the origin (1).</li> </ul>	7 points plotted correctly (i.e. one error) (1) allow ecf from plotting error.	(3)

Student answers

(b) Draw a graph of the volume of hydrogen gas produced against time using the grid. (3)



**Examiner's comments**

Points correctly plotted, scales correctly chosen but axes unlabelled, therefore one mark lost.

Marks awarded = 2

Some candidates did not draw the curve, they just plotted the points. Some candidates did not choose a scale to use the full height and width of the grid.

**Example 2 – Question 5d**

(d) The student repeated the experiment keeping all conditions the same but using the same mass of powdered zinc instead of granulated zinc.

On the grid above sketch the graph you would expect when the experiment is repeated using powdered zinc.

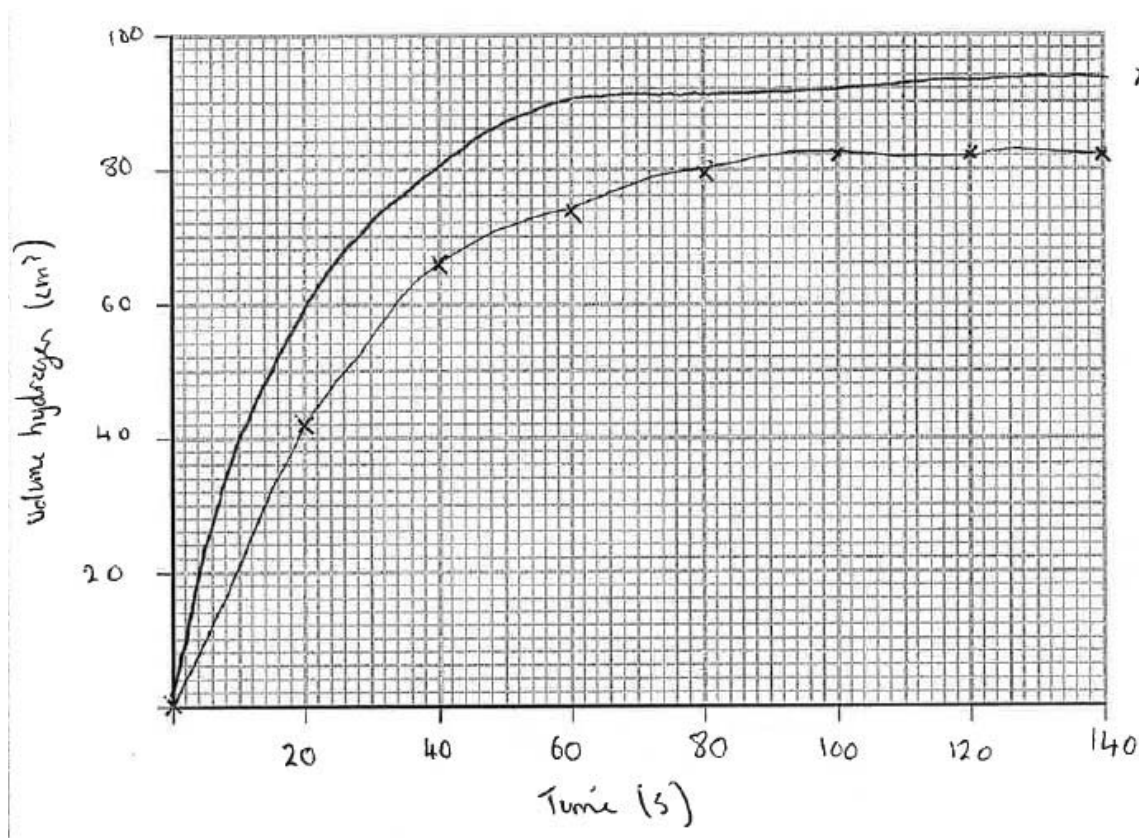
Label your line **A**.

(2)

**Mark scheme**

Question number	Answer	Mark
5(d)	Line A on graph: <ul style="list-style-type: none"> <li>• steeper curve/curve drawn to left of original (1)</li> <li>• levelling off at 82 cm<sup>3</sup> (1)</li> </ul>	(2)

**Student answers**



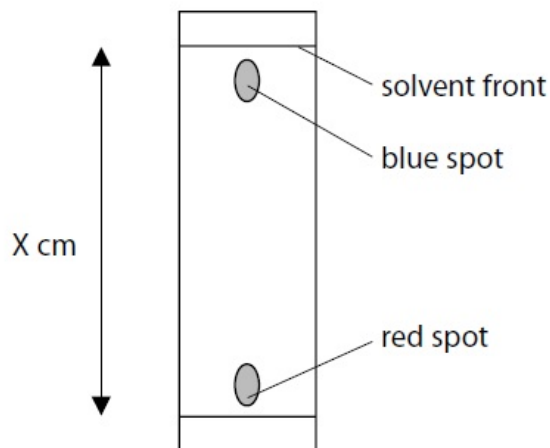
**Examiner's comments**

The candidate gained one mark for drawing a line above the original curve to show faster rate of reaction but did not recognise the final volume would be the same in both cases, so did not score the second mark.

Marks awarded = 1

**Example 3 – Question 7ciii**

(iii) The chromatography was carried out and the result is shown in Figure 12.



**Figure 12**

The blue spot had moved 14.5 cm and the solvent front had moved 15.3 cm.

Calculate the  $R_f$  value of the substance in the blue spot, giving your answer to 2 significant figures.

$$R_f \text{ value} = \frac{\text{distance travelled by a dye}}{\text{distance travelled by solvent front}}$$

(2)

**Mark scheme**

Question number	Answer	Additional guidance	Mark
7(c)(iii)	<ul style="list-style-type: none"> <li><math>R_f = 14.5 / 15.3 = 0.9477</math> (1)</li> <li><math>= 0.95</math> answer to 2 significant figures (1)</li> </ul>	Award full marks for correct numerical answer without working.	(2)

**Student answers**

Calculate the  $R_f$  value of the substance in the blue spot, giving your answer to 2 significant figures.

$$R_f \text{ value} = \frac{\text{distance travelled by a dye}}{\text{distance travelled by solvent front}}$$

$$R_f = \frac{14.5 \text{ cm}}{15.3 \text{ cm}} = 0.9477124183$$

$$R_f \text{ value} = 0.95$$

(2)

**Examiner's comments**

This is an ideal answer. Candidate shows steps in working and final answer.

Marks awarded = 2

Calculate the  $R_f$  value of the substance in the blue spot, giving your answer to 2 significant figures.

$$R_f \text{ value} = \frac{\text{distance travelled by a dye}}{\text{distance travelled by solvent front}}$$

(2)

$$R_f \text{ value} = \underline{0.5}$$

**Examiner's comments**

This candidate shows no working and obtains the wrong answer, therefore cannot even score 1 out of 2.

Marks awarded = 0

## Combined Science (Higher)

### Example 1 – Question 7b (i) and (ii)

- (b) The student investigated the rate by using different sizes of marble chips. In their investigation, the same mass of marble chips was used in each experiment.

The volume of gas given off was measured.

The graph in Figure 8 shows the results.

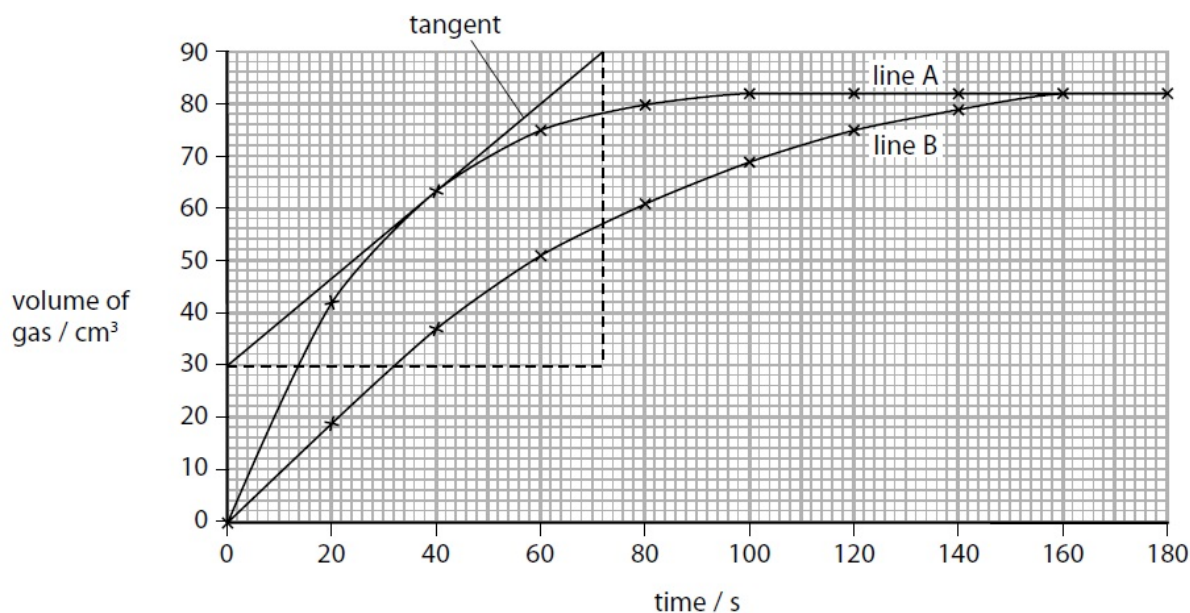


Figure 8

- (i) State how the graph shows that line B gives the results for the larger marble chips. (1)
- (ii) A tangent has been drawn on line A.  
Calculate the rate of reaction at this point. (2)

Mark scheme

Question number	Answer	Mark
7(b)(i)	(line B) less steep/(line B) flattens later (1)	(1)
7(b)(ii)	<ul style="list-style-type: none"> <li>Slope = <math>60 \div 72</math> (1)</li> <li>= <math>0.83(3)</math> (<math>\text{cm}^3 \text{ s}^{-1}</math>) (1)</li> </ul>	(2)

Student answers to (i)

- (i) State how the graph shows that line B gives the results for the larger marble chips. (1)

The reaction took longer to occur (the line isn't as steep / gradient is more shallow)

Examiner's comments

This part requires candidates to understand relevant maths to enable them to deduce how this type of graph shows a rate.

Marks awarded = 1

**Student answers to (ii)**

(ii) A tangent has been drawn on line A.

Calculate the rate of reaction at this point.

$$\text{rate of reaction} = \text{gradient of tangent} = \frac{\Delta y}{\Delta x}^{(2)}$$

$$\frac{60}{72}$$

rate of reaction = 0.83 cm<sup>3</sup>s<sup>-1</sup>

**Examiner's comments**

The mathematical requirements for the specification require candidates to be able to draw tangents and use them to calculate the gradient of the graph at a point.

Marks awarded = 2

**Example 2 – Question 9c**

(c) 50 cm<sup>3</sup> of potassium hydroxide solution of concentration 40 g dm<sup>-3</sup> is needed for an experiment.

Calculate the mass of potassium hydroxide that must be dissolved in water to make 50 cm<sup>3</sup> of solution of this concentration.

(2)

**Mark scheme**

Question number	Answer	Additional guidance	Mark
9(c)	mass = $50 \times \frac{40}{1000}$ (1) = 2 (g) (1)	Award full marks for correct numerical answer without working.	(2)

**Student answers**

(c) 50 cm<sup>3</sup> of potassium hydroxide solution of concentration 40 g dm<sup>-3</sup> is needed for an experiment.

Calculate the mass of potassium hydroxide that must be dissolved in water to make 50 cm<sup>3</sup> of solution of this concentration.

(2)

$$n = c \times V$$

$$n = \frac{40}{1000} \times \frac{50}{1000} = 2$$



$$m = 2 \times 56 = 112 \text{ g}$$

mass of potassium hydroxide = 112 g

**Examiner's comments**

This answer has no words of explanation, it is not clear what the expressions and figures represent and the final answer written in the space provided is wrong, hence 0 marks. With some words of explanation, this answer would probably have scored at least 1 out of 2. In addition, a relative formula mass has been calculated but candidates should realise that if this had been relevant, relative atomic masses would have been given in the question.

Marks awarded = 0

- (c) 50 cm<sup>3</sup> of potassium hydroxide solution of concentration 40 g dm<sup>-3</sup> is needed for an experiment.

Calculate the mass of potassium hydroxide that must be dissolved in water to make 50 cm<sup>3</sup> of solution of this concentration.

(2)

$$\text{Concentration} = \frac{\text{mass}}{\text{Volume}}$$

$$\text{mass} = \text{Volume} \times \text{concentration}$$

$$40 \times \frac{50}{1000} = 2$$

mass of potassium hydroxide = ..... 2 ..... g

**Examiner's comments**

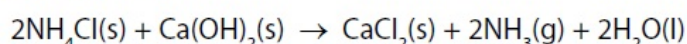
This answer explains and shows intermediate steps and the final answer.

Marks awarded = 2

**Separate Chemistry (Higher)**

**Example 1 – Question 10a, bi and c**

- 10 (a) In an experiment, ammonia gas is made by heating a mixture of ammonium chloride and calcium hydroxide.



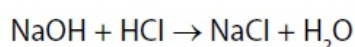
10.0 g of ammonium chloride is added to an excess of calcium hydroxide.

Calculate the maximum volume of ammonia gas that could be formed.

(relative atomic mass H = 1.00, N = 14.0, O = 16.0 and Ca = 40.0; one mole of any gas occupies 24 dm<sup>3</sup> at room temperature and pressure)

(2)

- (b) Sodium hydroxide solution reacts with hydrochloric acid.

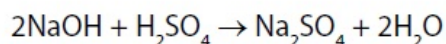


- (i) 25.0 cm<sup>3</sup> of 0.100 mol dm<sup>-3</sup> sodium hydroxide, NaOH, solution is added to 35.0 cm<sup>3</sup> of 0.0750 mol dm<sup>-3</sup> dilute hydrochloric acid, HCl.

Use the information to determine which reagent is in excess.

(3)

- (c) In another titration, 25.0 cm<sup>3</sup> of a different sodium hydroxide solution is titrated with 0.200 mol dm<sup>-3</sup> sulfuric acid, H<sub>2</sub>SO<sub>4</sub>.



24.80 cm<sup>3</sup> of acid are required to neutralise 25.0 cm<sup>3</sup> of the sodium hydroxide solution.

Calculate the concentration of the sodium hydroxide solution, NaOH, in mol dm<sup>-3</sup>.

(4)

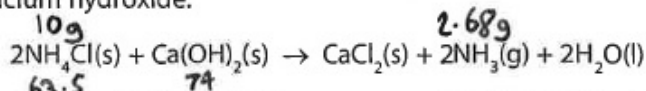
### Mark scheme

Question number	Answer	Additional guidance	Mark
10(a)	Formula mass ammonium chloride $= 14.0 + 4.00 + 35.5 = 53.5$  moles of ammonium chloride $= \frac{10.0}{53.5} = 0.187 \text{ (1)}$  volume ammonia $= 0.187 \times 24$ $= 4.49 \text{ dm}^3 \text{ (1)}$ or <ul style="list-style-type: none"> <li>• <math>2 \times 53.5 = 107 \text{ g}</math> ammonium chloride produces <math>2 \times 24 = 48 \text{ dm}^3</math> ammonia (1)</li> <li>• 10.0 g ammonium chloride produces  <math>\frac{10.0}{2 \times 53.5} \times 2 \times 24 = 4.49 \text{ dm}^3</math>                ammonia (1)</li> </ul>	Award full marks for correct numerical answer without working.	(2)
10(b)(i)	$25 \div 1000 \times 0.1 = 0.0025 \text{ (1)}$  $35 \div 1000 \times 0.075 = 0.002625 \text{ (1)}$  The acid is in excess (1)	Third mark only awarded as conclusion from calculated data.	(3)

Question number	Answer	Additional guidance	Mark
10(c)	mol of acid = $24.80 \div 1000 \times 0.200$ (= 0.004 96 mol) (1) mol NaOH = $2 \times 0.004 96$ (= 0.009 92) (1) conc. of NaOH = $0.009 92 \div 25.0 \times 1000$ (1) = 0.3968/0.397 (mol dm <sup>-3</sup> ) (1) or (25.00 × conc NaOH) ÷ 2 = 24.80 × 0.200 (2) conc NaOH = $2 \times 24.80 \times 0.200 \div 25.00$ (1) = 0.3968/0.397 (mol dm <sup>-3</sup> ) (1)	Award full marks for correct numerical answer without working.  Allow max 3 marks if missing '2 ×' in step 2.	(4)

**Student answers to part (a)**

10 (a) In an experiment, ammonia gas is made by heating a mixture of ammonium chloride and calcium hydroxide.



10.0 g of ammonium chloride is added to an excess of calcium hydroxide.

Calculate the maximum volume of ammonia gas that could be formed.

(relative atomic mass H = 1.00, N = 14.0, O = 16.0 and Ca = 40.0; one mole of any gas occupies 24 dm<sup>3</sup> at room temperature and pressure)

Handwritten student solution:

$\frac{\text{mass}}{\text{mol / RFM}}$       RFM(NH<sub>4</sub>Cl) = 14 + 4 + 35.5 = 53.5      RFM(Ca(OH)<sub>2</sub>) = 40 + (2 × 17) = 74      (2)

$\downarrow$   
 moles =  $\frac{10}{53.5} = 0.187 \dots$  (A)

RFM(NH<sub>3</sub>) = 14 + 3 = 17

$\downarrow$   
 moles(NH<sub>3</sub>) = same

$\text{mass(NH}_3\text{)} = 0.187 \times 17 = 3.179$

$\text{Vol} = \text{mol} \times 24$   
 $= 3.179 \times 24 = 76.296$   
 $= 76.3$

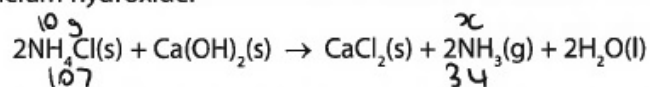
volume = 76.3 dm<sup>3</sup>

**Examiner's comments**

A correct answer with steps and explanation shown, so that, if the answer had been incorrect, part marks could have been awarded.

Marks awarded = 2

- 10 (a) In an experiment, ammonia gas is made by heating a mixture of ammonium chloride and calcium hydroxide.



10.0g of ammonium chloride is added to an excess of calcium hydroxide.

Calculate the maximum volume of ammonia gas that could be formed.

(relative atomic mass H = 1.00, N = 14.0, O = 16.0 and Ca = 40.0; one mole of any gas occupies 24 dm<sup>3</sup> at room temperature and pressure)

(2)

$$\text{moles of } 2\text{NH}_4\text{Cl} = \frac{10}{107} = 0.093 \text{ moles}$$

$$\therefore 2\text{NH}_3 = 0.093 \text{ moles (1:1) ratio}$$

$$24 \times 0.093 = 2.24 \text{ dm}^3$$

$$\text{volume} = 2.24 \text{ dm}^3 \text{ dm}^3$$

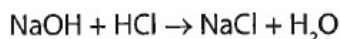
**Examiner's comments**

Sufficient explanation to enable one mark to be awarded even though the final answer is incorrect. The error made was calculating the relative mass of 2NH<sub>4</sub>Cl rather than of NH<sub>4</sub>Cl.

Marks awarded = 1

**Student answers to part (bi)**

(b) Sodium hydroxide solution reacts with hydrochloric acid.



- (i) 25.0 cm<sup>3</sup> of 0.100 mol dm<sup>-3</sup> sodium hydroxide, NaOH, solution is added to 35.0 cm<sup>3</sup> of 0.0750 mol dm<sup>-3</sup> dilute hydrochloric acid, HCl.

Use the information to determine which reagent is in excess.

(3)

$$\begin{aligned} \text{moles NaOH} &= 0.025 \times 0.100 \\ &= 2.5 \times 10^{-3} \text{ mol} \\ \text{moles HCl} &= 0.0350 \times 0.0750 \\ &= 0.02625 \end{aligned}$$

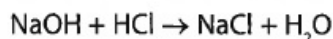
$\therefore$  HCl in excess as more moles of it.

**Examiner's comments**

A clearly laid-out answer showing the calculation of number of moles of sodium hydroxide and of hydrochloric acid and a clear statement showing which reagent is in excess.

Marks awarded = 3

(b) Sodium hydroxide solution reacts with hydrochloric acid.



- (i) 25.0 cm<sup>3</sup> of 0.100 mol dm<sup>-3</sup> sodium hydroxide, NaOH, solution is added to 35.0 cm<sup>3</sup> of 0.0750 mol dm<sup>-3</sup> dilute hydrochloric acid, HCl.

Use the information to determine which reagent is in excess.

(3)

$$\begin{aligned} 25 \times \frac{25}{1000} \times 0.1 &= 2.5 \times 10^{-3} \text{ mols} \\ 35 \times \frac{35}{1000} \times 0.075 &= 2.625 \times 10^{-3} \text{ mols} \end{aligned}$$

Sodium hydroxide is  
in excess

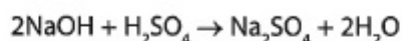
**Examiner's comments**

The calculations are correct but the conclusion is incorrect. Is this because the candidate did not identify the numbers of moles with the substances they represented?

Marks awarded = 2

**Student answers to part (c)**

- (c) In another titration, 25.0 cm<sup>3</sup> of a different sodium hydroxide solution is titrated with 0.200 mol dm<sup>-3</sup> sulfuric acid, H<sub>2</sub>SO<sub>4</sub>.



24.80 cm<sup>3</sup> of acid are required to neutralise 25.0 cm<sup>3</sup> of the sodium hydroxide solution.

Calculate the concentration of the sodium hydroxide solution, NaOH, in mol dm<sup>-3</sup>.

$$\begin{aligned} \text{moles (H}_2\text{SO}_4) &= 0.0248 \times 0.2 && (4) \\ &= 0.00496 \text{ moles} \end{aligned}$$

2 moles of NaOH required for each mole of H<sub>2</sub>SO<sub>4</sub>.

$$2 \times 0.00496 = 0.00992 \text{ moles}$$

$$\begin{aligned} \text{concentration (mol dm}^{-3}\text{)} &= \frac{\text{moles}}{\text{volume (dm}^{-3}\text{)}} \\ &= \frac{0.00992}{0.025} \\ &= 0.3968 \text{ mol dm}^{-3} \end{aligned}$$

$$\text{concentration} = \underline{0.3968} \text{ mol dm}^{-3}$$

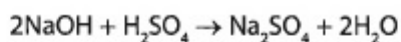
**Examiner's comments**

This answer is set out with clear reasoning, leading to a correct answer and full marks.

Marks awarded = 4

Maths skills

- (c) In another titration, 25.0 cm<sup>3</sup> of a different sodium hydroxide solution is titrated with 0.200 mol dm<sup>-3</sup> sulfuric acid, H<sub>2</sub>SO<sub>4</sub>.



24.80 cm<sup>3</sup> of acid are required to neutralise 25.0 cm<sup>3</sup> of the sodium hydroxide solution.

Calculate the concentration of the sodium hydroxide solution, NaOH, in mol dm<sup>-3</sup>.

$$\text{H}_2\text{SO}_4 = 0.200 \text{ mol dm}^{-3} \quad 24.80 \quad \frac{0.00248}{0.200} \quad (4)$$

$$\text{H}_2\text{SO}_4 = \frac{0.00248}{0.2} = 0.0124$$

$$\begin{aligned} \text{NaOH} &= 0.0248 \times 0.0025 && 0.2 \text{ mol dm}^{-3} \\ &= 6.2 \times 10^{-5} && \text{Sulphuric acid} \\ &&& \text{Under} \\ 0.2 \times 2 &= \text{NaOH moles} \end{aligned}$$

$$\text{concentration} = \frac{0.4}{0.00062} \text{ mol dm}^{-3}$$

**Examiner's comments**

This answer does not score any part-marks because no line of reasoning is provided to indicate what the figures are supposed to represent.

Marks awarded = 0

## Extended open response

### Combined Science (Foundation)

#### Example 1 – Question 9c

\*(c) Figure 18 shows the ability of different substances to conduct electricity.

substance	conducts electricity
solid calcium chloride	no
molten calcium chloride	yes
diamond	no
zinc	yes

**Figure 18**

Explain these results by referring to the structures of the substances.

(6)

#### Mark scheme

Question number	Indicative content
*9(c)	<p>Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme.</p> <p>The indicative content below is not prescriptive and candidates are not required to include all the material that is indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <p style="text-align: center;"><b>AO2 (6 marks)</b></p> <ul style="list-style-type: none"> <li>• solid calcium chloride contains ions/cations/anions which are charged particles</li> <li>• solid calcium chloride does not conduct because charged particles are not free to move because they are held together by strong electrostatic forces/ionic bonds in lattice</li> <li>• molten calcium chloride solution conducts because ions/cations/anions are present which are charged particles and are free to move</li> <li>• the ions have separated and move to electrode of opposite charge</li> <li>• diamond does not conduct because it is giant molecular covalent with no free electrons</li> <li>• outer electrons of carbon atoms used in bonding</li> <li>• zinc metallic structure consists of delocalised free electrons which can move between layers of metals atoms/cations</li> </ul>

Extended open response

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1-2	<ul style="list-style-type: none"> <li>The explanation attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question. (AO2)</li> <li>Lines of reasoning are unsupported or unclear. (AO2)</li> </ul>
Level 2	3-4	<ul style="list-style-type: none"> <li>The explanation is mostly supported through linkage and application of knowledge and understanding of scientific ideas, some logical connections made between elements in the context of the question. (AO2)</li> <li>Lines of reasoning mostly supported through the application of relevant evidence. (AO2)</li> </ul>
Level 3	5-6	<ul style="list-style-type: none"> <li>The explanation is supported throughout by linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of the question. (AO4)</li> <li>Lines of reasoning are supported by sustained application of relevant evidence. (AO2)</li> </ul>

Student answers

\*(c) Figure 18 shows the ability of different substances to conduct electricity.

substance	conducts electricity
solid calcium chloride	no
molten calcium chloride	yes
diamond	no
zinc	yes

Figure 18

Explain these results by referring to the structures of the substances.

(6)

Diamond is a giant covalent bond. It has extremely strong bonds. A covalent bond contains a metal and a non-metal. Every carbon atom is bonded to four others making it extremely strong. Molten Calcium Chloride is ionic and conducts electricity as the ions can move freely due to the molten (liquid) state. Solid Calcium chloride is also ionic bonding but it cannot conduct electricity due to the ions being in a fixed state and they cannot move freely (intermolecular used). Zinc is a metallic bond, it contains delocalised electrons allowing it to conduct electricity, the ions can also move freely.

**Examiner's comments**

This is a Level 3 answer, scoring 5 out of 6, because the candidate gave excellent accounts of the calcium chloride in both states and of the zinc but the answer relating to diamond, although attempted, was not clear.

Marks awarded = 5

\*(c) Figure 18 shows the ability of different substances to conduct electricity.

substance	conducts electricity
solid calcium chloride	no
molten calcium chloride	yes
diamond	no
zinc	yes

Figure 18

Explain these results by referring to the structures of the substances.

(6)

Solid calcium chloride is unable to conduct electricity because there are no free electrons. However, when it is in its molten state, the solid is able to move freely and therefore it has free electrons enabling it to conduct.

Due to diamond's giant covalent structure, it does not have any free electrons as the bonds are very strong.

Zinc is a metal and has free delocalised electrons enabling it to be able to conduct.

#### Examiner's comments

This is a Level 1 answer. Like many other candidates, this candidate thinks that electrical conduction is only the result of moving electrons. As this is only the case for the metal zinc, the answer cannot gain credit for either of the other substances.

Marks awarded = 2

## Combined Science (Higher)

## Example 1 – Question 9d

\*(d) Salts of metals can be made by reacting one of the metal's compounds with the appropriate acid.

Plan an experiment to prepare pure, dry crystals of magnesium sulfate,  $\text{MgSO}_4$ , by reacting a suitable magnesium compound with a suitable acid.

You may use equations if you wish.

(6)

## Mark scheme

Question Number	Indicative content
9(d)	<p>Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme.</p> <p>The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <p style="text-align: center;"><b>A02 (3 marks)</b></p> <ul style="list-style-type: none"> <li>• suitable acid: sulfuric acid</li> <li>• suitable substance : magnesium oxide / magnesium carbonate / magnesium hydroxide / magnesium</li> <li>• equation for reaction:  <math>\text{MgO} + \text{H}_2\text{SO}_4 \rightarrow \text{MgSO}_4 + \text{H}_2\text{O}/</math>  <math>\text{Mg}(\text{OH})_2 + \text{H}_2\text{SO}_4 \rightarrow \text{MgSO}_4 + 2\text{H}_2\text{O}/</math>  <math>\text{MgCO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{MgSO}_4 + \text{H}_2\text{O} + \text{CO}_2/</math>  <math>\text{Mg} + \text{H}_2\text{SO}_4 \rightarrow \text{MgSO}_4 + \text{H}_2</math></li> </ul> <p style="text-align: center;"><b>A03 (3 marks)</b></p> <ul style="list-style-type: none"> <li>• add solid to warmed acid until in excess solid remains (oxide and hydroxide) / add solid a little at a time until no more bubbles (carbonate/metal)</li> <li>• filter off the excess solid, pour remaining solution into an evaporating basin</li> <li>• {heat solution / leave the water to evaporate}</li> <li>• until pure salt crystals form and then dry salt crystals with absorbent paper/leave to dry.</li> </ul>

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1-2	<ul style="list-style-type: none"> <li>The plan attempts to link and apply knowledge and understanding of scientific enquiry, techniques and procedures, flawed or simplistic connections made between elements in the context of the question. (AO2)</li> <li>Analyses the scientific information but understanding and connections are flawed. An incomplete plan that provides limited synthesis of understanding. (AO3)</li> </ul>
Level 2	3-4	<ul style="list-style-type: none"> <li>The explanation is mostly supported through linkage and application of knowledge and understanding of scientific enquiry, techniques and procedures, some logical connections made between elements in the context of the question. (AO2)</li> <li>Analyses the scientific information and provides some logical connections between scientific enquiry, techniques and procedures. A partially completed plan that synthesises mostly relevant understanding, but not entirely coherently. (AO3)</li> </ul>
Level 3	5-6	<ul style="list-style-type: none"> <li>The explanation is supported throughout by linkage and application of knowledge and understanding of scientific enquiry, techniques and procedures, logical connections made between elements in the context of the question. (AO2)</li> <li>Analyses the scientific information and provide logical connections between scientific concepts throughout. A well-developed plan that synthesises relevant understanding coherently. (AO3)</li> </ul>

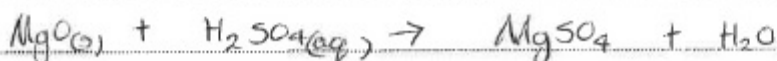
### Student answers

\*(d) Salts of metals can be made by reacting one of the metal's compounds with the appropriate acid.

Plan an experiment to prepare pure, dry crystals of magnesium sulfate,  $\text{MgSO}_4$ , by reacting a suitable magnesium compound with a suitable acid.

You may use equations if you wish.

(6)  $\text{H}_2\text{SO}_4$   
~~Add~~ Add magnesium oxide,  $\text{MgO}$ , to a beaker of sulfuric acid, stirring constantly and adding spatulas of the magnesium oxide until it no longer dissolves in the sulfuric acid ~~and~~ and stays a solid on the bottom since it is in excess. Then filter the mixture formed using filter paper into another beaker to get rid of the excess magnesium oxide. Then either heat the solution over a bunsen burner or leave in an evaporating dish to allow the water to evaporate off, leaving pure, dry crystals of magnesium sulfate.



### Examiner's comments

## Extended open response

This is a Level 3 answer and fully covers the requirements of AO2 and AO3 as shown on the indicative content of the mark scheme, linking together the relevant points.

Marks awarded = 6

\*(d) Salts of metals can be made by reacting one of the metal's compounds with the appropriate acid.

Plan an experiment to prepare pure, dry crystals of magnesium sulfate,  $\text{MgSO}_4$ , by reacting a suitable magnesium compound with a suitable acid.

You may use equations if you wish.

(6)



Add magnesium to warm sulfuric acid, and stir until it all disappears. Add more magnesium, a little at a time with stirring, until an excess is left over.

Filter to remove the excess magnesium. Evaporate the water from the solution, leaving magnesium sulfate crystals behind. The more slowly this is done, the larger the crystals will be.

### Examiner's comments

This is a Level 2 answer. Magnesium metal instead of a magnesium compound is used as the reactant but subsequent points have been allowed consequentially. The description of formation of crystals is unclear.

Marks awarded = 3

## Separate Chemistry (Higher)

### Example 1 – Question 9b

\*(b) Polymers are addition or condensation polymers.

Polymers can be formed by using the monomers shown in Figure 12.

monomer	structure
chloroethene	$  \begin{array}{c}  \text{H} \quad \text{Cl} \\  \diagdown \quad / \\  \text{C} = \text{C} \\  / \quad \diagdown \\  \text{H} \quad \text{H}  \end{array}  $
ethane-1,2-diol	$  \begin{array}{c}  \text{H} \quad \text{H} \\    \quad   \\  \text{HO}-\text{C}-\text{C}-\text{OH} \\    \quad   \\  \text{H} \quad \text{H}  \end{array}  $
ethanedioic acid	$  \begin{array}{c}  \text{O} \quad \text{O} \\  // \quad // \\  \text{C} - \text{C} \\  / \quad \backslash \\  \text{HO} \quad \text{OH}  \end{array}  $

Figure 12

Explain, using appropriate monomers from Figure 12, how different polymers can be formed.

(6)

## Mark scheme

Question number	Indicative content	Mark
*9(b)	<p>Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme.</p> <p>The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <p>Candidates choose appropriate monomers to illustrate the formation of different polymers.</p> <ul style="list-style-type: none"> <li>• polymer molecules are long chains</li> <li>• made up of simple repeating units</li> <li>• use chloroethene (only)</li> <li>• to form poly(chloroethene)</li> <li>• which is addition polymerisation</li> <li>• use ethane-1,2-diol and ethanedioic acid</li> <li>• to form a polyester</li> <li>• which is condensation polymerisation</li> </ul>	

## Extended open response

	<ul style="list-style-type: none"> <li>• one of the bonds in the double bond in chloroethene molecule breaks</li> <li>• and chloroethene molecules join together to form a long chain molecule</li> <li>• equation</li> </ul> $n \begin{array}{c} \text{H} & & \text{Cl} \\ & \diagdown & / \\ & \text{C} = \text{C} \\ & / & \diagdown \\ \text{H} & & \text{H} \end{array} \longrightarrow \left[ \begin{array}{c} \text{H} & \text{Cl} \\   &   \\ -\text{C} & - & \text{C}- \\   &   \\ \text{H} & \text{H} \end{array} \right]_n$ <ul style="list-style-type: none"> <li>• identification of repeat unit</li> </ul>	
	<ul style="list-style-type: none"> <li>• alcohol group combines with a carboxylic acid group</li> <li>• and an ester (link) formed</li> <li>• with a water (molecule) eliminated</li> <li>• equation</li> </ul> $\begin{array}{c} \text{O} & & \text{O} \\    & &    \\ \text{HO}-\text{C} & - & \text{C}-\text{OH} \end{array} + \begin{array}{c} \text{H} & \text{H} \\   &   \\ \text{HO}-\text{C} & - & \text{C}-\text{OH} \\   &   \\ \text{H} & \text{H} \end{array} \longrightarrow \begin{array}{c} \text{O} & \text{O} & \text{H} & \text{H} \\    &    &   &   \\ -\text{C} & - & \text{C}-\text{O} & - & \text{C} & - & \text{C}-\text{O}- \\ & &   &   \\ & & \text{H} & \text{H} \end{array} + \text{H}_2\text{O}$ <ul style="list-style-type: none"> <li>• ester link shown</li> <li>• identification of repeat unit</li> </ul>	<b>(6)</b>

Level	Mark	Descriptor
	0	No awardable content.
Level 1	1–2	<ul style="list-style-type: none"> <li>• The explanation attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question. (AO2)</li> <li>• Lines of reasoning are unsupported or unclear. (AO2)</li> </ul>
Level 2	3–4	<ul style="list-style-type: none"> <li>• The explanation is mostly supported through linkage and application of knowledge and understanding of scientific ideas, some logical connections made between elements in the context of the question. (AO2)</li> <li>• Lines of reasoning mostly supported through the application of relevant evidence. (AO2)</li> </ul>
Level 3	5–6	<ul style="list-style-type: none"> <li>• The explanation is supported throughout by linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of the question. (AO2)</li> <li>• Lines of reasoning are supported by sustained application of relevant evidence. (AO2)</li> </ul>

## Student answers

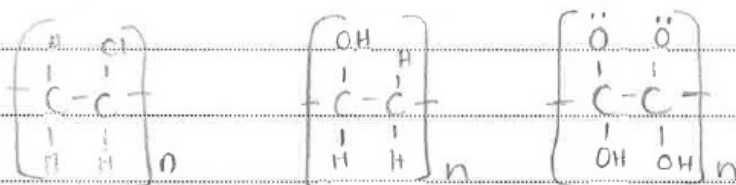
Explain, using appropriate monomers from Figure 12, how different polymers can be formed.

(6)

Chloroethene can produce polymer by addition as the  $C=C$  can be broken to leave a  $C-C$  leaving 2 bonds free to join to other polymer units

Ethane-1,2-diol can produce polymer by condensation as a  $OH$  &  $H$  will be removed leaving 2 bonds free to join to other monomer

Ethanedioic acid can form a polymer by 2 additions at each  $C=O$  to free 2 bonds to join to other polymer units



## Examiner's comments

This is a Level 2 answer because it links the use of substances given to polymers that they produce but fails to give sufficient detail about the formation of a condensation polymer and this would be needed to gain Level 3.

Marks awarded = 4

Explain, using appropriate monomers from Figure 12, how different polymers can be formed.

(6)

Polymers can be formed by joining multiple monomers together, for example, ~~the~~ poly(chloroethene) is produced when the double bond between the carbon atoms is broken and used to join it to another chloroethene monomer.

## Examiner's comments

This is a Level 1 answer, giving a reasonable description of the formation of the addition polymer, poly(chloroethene) but there is no equation present for the formation of the polymer: this would be the minimum for 2 marks.

Marks awarded = 2

## Other examples

### Combined Science (Foundation)

#### Example 1 – Question 9a: Explanation

9 Ionic compounds contain ions.

(a) The numbers of electrons, neutrons and protons in four particles, **W**, **X**, **Y** and **Z**, are shown in Figure 15.

particle	electrons	neutrons	protons
<b>W</b>	9	10	9
<b>X</b>	10	14	12
<b>Y</b>	16	16	16
<b>Z</b>	18	18	16

Figure 15

Explain which particle, **W**, **X**, **Y** or **Z**, is a negative ion.

(2)

#### Mark scheme

Question number	Answer	Additional guidance	Mark
9(a)	<p>An explanation that combines identification via a judgement (1 mark) to reach a conclusion via justification/reasoning (1 mark):</p> <ul style="list-style-type: none"> <li>a negative ion must have more electrons than protons in the particle (1)</li> <li>therefore Z will have a 2- charge (1)</li> </ul>	Do not allow any comparison involving neutrons.	(2)

#### Student answers

Explain which particle, **W**, **X**, **Y** or **Z**, is a negative ion.

(2)

Particle ~~W~~<sup>Z</sup> is a 2- ion as it has 18 electrons and 16 protons resulting in the charge being 2- as electrons have a -1 charge and protons have a +1 charge

#### Examiner's comments

This candidate has written a very good answer indicating that the particle must have more electrons than protons and that the electrons are negatively charged and the protons positively charged, producing a particle with a 2- charge.

Marks awarded = 2

**Combined Science (Higher)****Example 1 – Question 3ciii: Balancing equations**

- (iii) When decane undergoes complete combustion, a mixture of carbon dioxide and water is formed.

Complete the balanced equation for this reaction.

(2)

**Mark scheme**

Question number	Answer	Mark
3(c)(iii)	$2\text{C}_{10}\text{H}_{22} + 31\text{O}_2 \rightarrow 20\text{CO}_2 + 22\text{H}_2\text{O}$ <ul style="list-style-type: none"> <li>• LHS (1)</li> <li>• RHS both numbers correct (1)</li> </ul>	(2)

**Student answers**

- (iii) When decane undergoes complete combustion, a mixture of carbon dioxide and water is formed.

Complete the balanced equation for this reaction.

(2)

**Examiner's comments**

This candidate scored 1 mark for correctly balancing the right-hand side of the equation, but failed to recognise O<sub>2</sub> on the left-hand side, filling in the number of oxygen atoms rather than oxygen molecules.

Marks awarded = 1

Many candidates scored full marks on this question, showing that they and their teachers appreciated the importance of writing balanced equations on chemistry papers.

**Example 2 – Question 9a(ii): Category 4, give a reason**

- (ii) Give a reason why adding hydroxide ions to an acid solution leads to an increase in pH.

(1)

## Mark scheme

Question number	Answer	Mark
9(a)(ii)	hydroxide ions react with hydrogen ions and reduce the hydrogen ion concentration therefore increase pH (1)	(1)

## Student answers

- (ii) Give a reason why adding hydroxide ions to an acid solution leads to an increase in pH.

(1)

Hydroxide (OH<sup>-</sup>) ions in a solution ~~is~~ turn a solution alkaline, therefore increasing the pH

## Examiner's comments

The answer fails to recognise that added hydroxide ions will react with hydrogen ions in the solution, thereby raising the pH.

Marks awarded = 0

## Example 3 – Question 3ci: Explanation

- (c) Fractions of crude oil contain alkanes.

A sample of decane, C<sub>10</sub>H<sub>22</sub>, cracked using the apparatus in Figure 4.

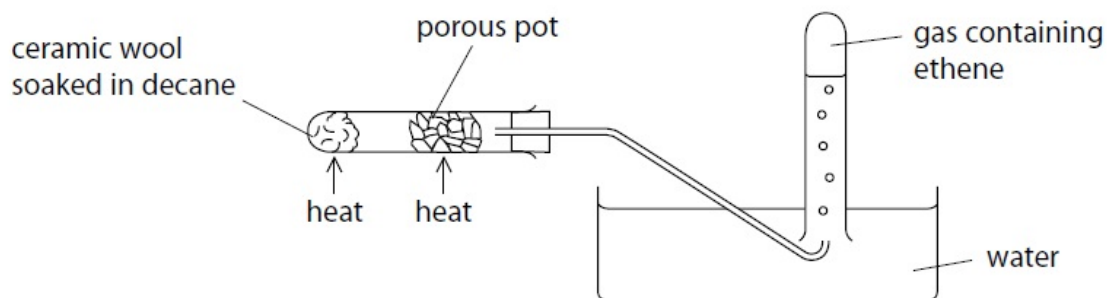


Figure 4

- (i) Explain how ethene is produced using the apparatus in Figure 4.

(3)

## Mark scheme

Question number	Answer	Additional guidance	Mark
3(c)(i)	<p>An explanation that combines identification – application of knowledge (1 mark) and reasoning/justification – application of understanding (2 marks):</p> <ul style="list-style-type: none"> <li>when the decane is heated it vaporises/turns to a gas (1)</li> <li>decane vapour/gas breaks down as it comes in contact with hot porous pot (1)</li> <li>large molecules of decane produce smaller molecules, including ethene (1)</li> </ul>	Do not allow this point if ethane passes over hot porous pot	(3)

## Student answers

(i) Explain how ethene is produced using the apparatus in Figure 4.

(3)

decane is heated and begins to thermally decompose. The porous pot allows for the gas to pass through and the reaction catalysed. This decomposition forms ethene and octane, which pass into the container after being filtered through  $H_2O$

**Examiner's comments**

This answer gains full marks, implying that the gas is produced in the first place and scoring the mark for smaller molecules being produced by stating the names of the products.

Marks awarded = 3

(i) Explain how ethene is produced using the apparatus in Figure 4.

(3)

The ceramic wool is heated which causes the decane is heated and vaporised. Then it passes through the catalyst - the porous pot and then it is cracked into different hydrocarbons

**Examiner's comments**

This candidate scores for the first marking point by indicating that the decane is vaporised but did not score the second marking point as, although 'it passes

## Other examples

through the catalyst' the answer does not indicate the vapour molecules break down when in contact with the hot porous pot. The final marking point is not awarded because there is no indication that the molecules produced are smaller. The candidate failed to appreciate what was required by the word 'explain'.

Marks awarded = 1

### Example 4 – Question 7c: Explanation

(c) During any reaction, reactants are used up and the rate of reaction decreases.

Explain, in terms of particles, why the rate of reaction decreases.

(2)

### Mark scheme

Question number	Answer	Mark
7(c)	An explanation that makes reference to: identification – knowledge (1 mark) and reasoning/justification – knowledge (1 mark): <ul style="list-style-type: none"><li>• fewer particles/as the reactants are used up there will be fewer particles to react/lower concentration of particles (1)</li><li>• this will result in a lower frequency of collisions so fewer particles reacting in a given time (1)</li></ul>	(2)

### Student answers

(c) During any reaction, reactants are used up and the rate of reaction decreases.

Explain, in terms of particles, why the rate of reaction decreases.

(2)

The rate of reaction decreases since the number of particles of each reactant decreases since they react to form the product, which means that collisions between reactant particles become less frequent.

### Examiner's comments

This is a complete answer, recognising the decreasing number of particles and the consequential decrease in frequency of collisions.

Marks awarded = 2

- (c) During any reaction, reactants are used up and the rate of reaction decreases.

Explain, in terms of particles, why the rate of reaction decreases.

(2)

because there are fewer reactant particles to collide with one another as many have already reacted to form products

#### Examiner's comments

The candidate recognises the decreasing number of particles but fails to use this to explain the decreasing rate of reaction.

Marks awarded = 1

#### Example 5 – Question 7e: Explanation

- (e) Two gases, **X** and **Y**, react to give a gaseous product **Z**.

The reaction is carried out under two different sets of conditions in experiments 1 and 2 as shown in Figure 9.

condition	experiment 1	experiment 2
temperature/°C	30	20
pressure/atm	1	2

Figure 9

Explain why it is not possible to predict what the rate of Experiment 2 will be compared with Experiment 1.

(3)

#### Mark scheme

Question number	Answer	Mark
7(e)	<p>An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (2 marks):</p> <ul style="list-style-type: none"> <li>• the decrease in temperature will cause a decrease in rate of reaction (1)</li> <li>• and the increase in pressure will cause an increase in rate of reaction (1)</li> <li>• because the changes have opposite effects on the rate it is not possible which has the greater effect (1)</li> </ul>	(3)

## Other examples

### Student answers

Explain why it is not possible to predict what the rate of Experiment 2 will be compared with Experiment 1.

(3)

Two factors are changed by varying degrees which both affect the rate of reaction in opposite ways as lower temperature slows it but higher pressure increases it so it is impossible to know the extent of each effect and thus the overall effect.

#### Examiner's comments

This candidate recognises the different effects on the rate of temperature and pressure and the way in which they contribute to the overall rate.

Marks awarded = 3

Explain why it is not possible to predict what the rate of Experiment 2 will be compared with Experiment 1.

(3)

because we don't know if it's endothermic or exothermic (so how temperature will affect it) and whether or not an increase in pressure will increase or decrease production of  $Z$  as we don't know the number of molecules on each side.

#### Examiner's comments

This candidate has failed to realise that the question is about rates and is trying to answer the question in terms of equilibrium yields.

Marks awarded = 0

Explain why it is not possible to predict what the rate of Experiment 2 will be compared with Experiment 1.

(3)

Both variables (temperature and pressure) ~~are changing~~  
by ~~not~~ have large effects on the rate of reaction

The temperature and pressure are changing by  
different amounts so it is impossible to tell

#### Examiner's comments

This candidate did not understand what was required by the word 'explain' and did not specify the effect of temperature and pressure on the rate of reaction. The candidate realised that changes in both temperature and pressure caused a problem but failed to explain what the problem was.

Marks awarded = 0

#### Example 6 – Question 9ai: Explanation

- 9 Some acids such as hydrochloric acid are described as strong acids.  
Some acids such as ethanoic acid are described as weak acids.

(a) (i) Explain the difference between a strong acid and a weak acid.

(2)

#### Mark scheme

Question number	Answer	Mark
9(a)(i)	<p>An explanation that makes reference to: identification – knowledge (1 mark) and reasoning /justification – knowledge (1 mark):</p> <ul style="list-style-type: none"> <li>• a strong acid is completely ionised in solution/exists completely as ions (1)</li> <li>• but a weak acid is only partly ionised/exists mainly as molecules with very few ions present (1)</li> </ul>	(2)

## Other examples

### Student answers

- 9 Some acids such as hydrochloric acid are described as strong acids.  
Some acids such as ethanoic acid are described as weak acids.

(a) (i) Explain the difference between a strong acid and a weak acid.

(2)

A strong acid has a lower pH as it completely ionizes, releasing more  $H^+$  ions into the solution, whereas a weak acid only partially ionizes and therefore releases less  $H^+$  ions so the pH would be higher.

#### Examiner's comments

This answer clearly states the difference between the acids in terms of the fundamentally important dissociation into ions.

Marks awarded = 2

- 9 Some acids such as hydrochloric acid are described as strong acids.  
Some acids such as ethanoic acid are described as weak acids.

(a) (i) Explain the difference between a strong acid and a weak acid.

(2)

~~Strong acids~~ Strong acids completely ionise whereas weak acids don't in an aqueous solution as strong acids have a higher concentration of  $H^+$  ions.

#### Examiner's comments

The answer makes a clear, correct statement about strong acids but only a negative statement about weak acids and therefore only scores 1 mark.

Marks awarded = 1

## Separate Chemistry (Higher)

### Example 1 – Question 9cii: Category 4, structures

- (c) An alcohol **A**, with molecular formula  $C_2H_5OH$  is oxidised to a compound **B** with molecular formula  $C_2H_4O_2$ .

(ii) Draw the structure of a molecule of compound **A** and a molecule of compound **B**, showing all covalent bonds.

(2)

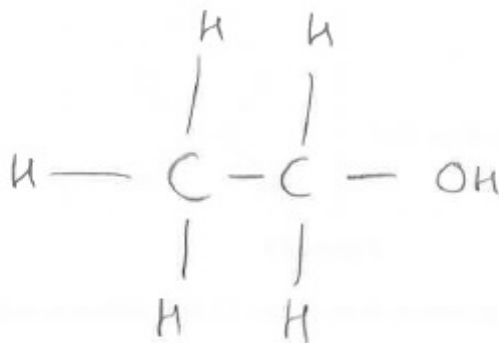
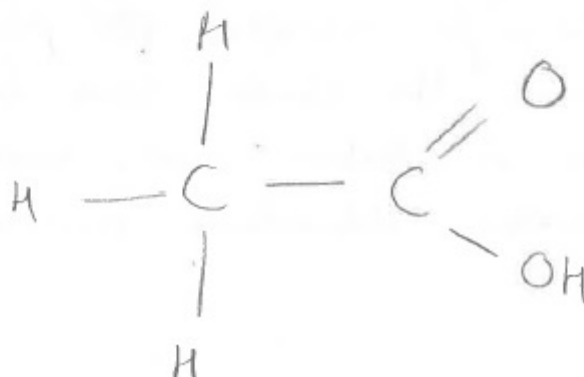
## Mark scheme

Question number	Answer	Marks
9(c)(ii)	<p>A is</p> $\begin{array}{c} \text{H} \quad \text{H} \\   \quad   \\ \text{H}-\text{C}-\text{C}-\text{O}-\text{H} \\   \quad   \\ \text{H} \quad \text{H} \end{array}$ <p>(1)</p> <p>B is</p> $\begin{array}{c} \text{H} \quad \text{O} \\   \quad // \\ \text{H}-\text{C}-\text{C} \\   \quad \backslash \\ \text{H} \quad \text{O}-\text{H} \end{array}$ <p>(1)</p>	(2)

## Student answers

(ii) Draw the structure of a molecule of compound **A** and a molecule of compound **B**, showing all covalent bonds.

(2)

Compound **A**Compound **B****Examiner's comments**

This candidate has failed to follow the instruction to show ALL covalent bonds but because the same error was made on the second structure, one mark was awarded consequentially.

Marks awarded = 1

## Other examples

### Example 2 – Question 5a: Explanation

5 Qualitative tests are used to identify ions.

- (a) A student carries out a flame test on an unknown solid.  
A red flame is seen.  
The student concludes that the solid is lithium carbonate.

Explain why this conclusion is **not** justified.

(2)

### Mark scheme

Question number	Answer	Mark
5(a)	An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (1 mark): <ul style="list-style-type: none"><li>the flame test only confirms the presence of lithium ions/Li<sup>+</sup> (1)</li><li>but another test is needed to confirm the identity of the anion/negative ion/CO<sub>3</sub><sup>2-</sup> (1)</li></ul> OR <ul style="list-style-type: none"><li>the red flame test shows the presence of calcium ions Ca<sup>2+</sup> and not lithium ions/Li<sup>+</sup> (1)</li><li>the student did not test for carbonate ions (1)</li></ul>	(2)

### Student answers

5 Qualitative tests are used to identify ions.

- (a) A student carries out a flame test on an unknown solid.  
A red flame is seen.  
The student concludes that the solid is lithium carbonate.

Explain why this conclusion is **not** justified.

(2)

Calcium gives a red flame also so you cannot be certain it is lithium. Also, no test has been done to prove that <sup>it is a</sup> carbonate.

### Examiner's comments

This answer gains full marks because it indicates that both the conclusions of lithium salt and carbonate are not justified.

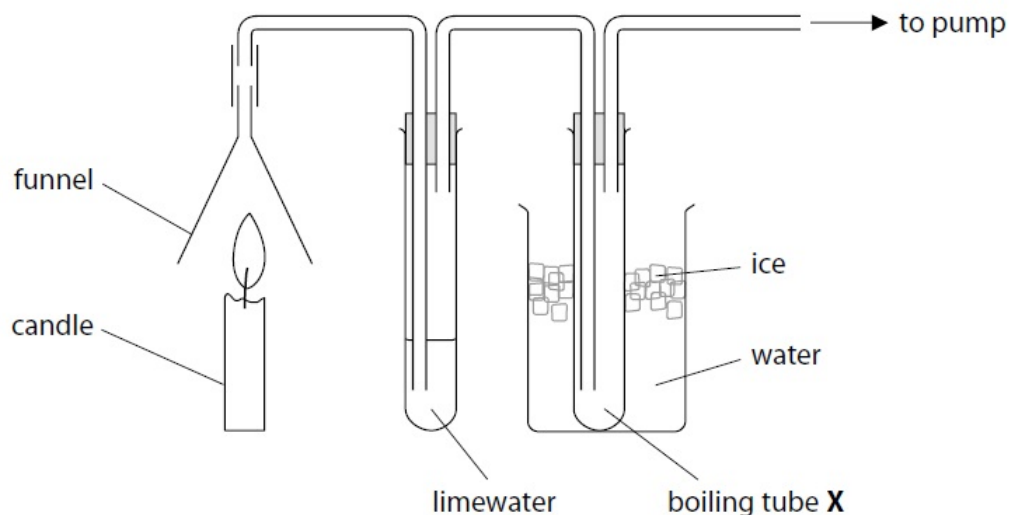
Many candidates identified only one of these as not justified by the experiment.

Marks awarded = 2

**Example 3 – Question 9a: Explanation (also covers Practical)**

- 9 (a) A student carried out an experiment to prove that candle wax, a hydrocarbon, produces carbon dioxide and water vapour when it burns.

The equipment used is shown in Figure 11.



**Figure 11**

The gas produced from the burning candle is drawn through the apparatus. The limewater turned milky showing that carbon dioxide had been formed.

A small amount of a colourless liquid condensed in boiling tube X. The student claimed that this proved that burning candle wax produced water. The teacher said the apparatus had been set up incorrectly and therefore this conclusion about water was not valid.

Explain how the student could modify the equipment to prove that water is produced by burning candle wax.

(2)

**Mark scheme**

Question number	Answer	Mark
9(a)	<p>An explanation that combines identification – improvement of the experimental procedure (1 mark) and justification/reasoning which must be linked to the improvement (1 mark):</p> <ul style="list-style-type: none"> <li>reverse the boiling tubes/pass gas through the tube in ice water first (1)</li> <li>so that if any liquid condenses in the tube it must have come from the burning wax (and not from the limewater) (1)</li> </ul>	(2)

## Other examples

### Student answers

Explain how the student could modify the equipment to prove that water is produced by burning candle wax.

(2)

~~The limewater~~ The limewater is a solution, so it already contains water molecules, so the water may have condensed from here. First, the products could be passed over anhydrous copper sulfate, which turns blue if water is present.

#### Examiner's comments

This answer clearly explains the problem and gives a solution to it.

Marks awarded = 2

Explain how the student could modify the equipment to prove that water is produced by burning candle wax.

(2)

change the position of the boiling tube  
x to before the  $\text{CO}_2$  goes  
through limewater

#### Examiner's comments

This answer states the change needed but does not explain why it is needed.

Marks awarded = 1

Explain how the student could modify the equipment to prove that water is produced by burning candle wax.

(2)

Add anhydrous copper sulfate to boiling tube  
x and it will turn blue from white if water  
is present

#### Examiner's comments

Although this answer shows a correct test for the presence of water, it is not correctly incorporated into an answer for the question.

Marks awarded = 0