AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.4.2.4

The pH scale and neutralisation

Mark schemes and examiner comments

Tier	**Foundation**
Question groups	**7**
Available paper years	**2018–2025**

Using this booklet

1. Booklet answer numbers match the question booklet.
2. Use the original question number within marking tables.
3. Examiner comments are included where available.

Name: _____ **Date:** _____

Where a precise marking extract is unavailable, the full source document is included in an appendix. Any missing mark scheme is explicitly identified.

5.4.2.4 The pH scale and neutralisation

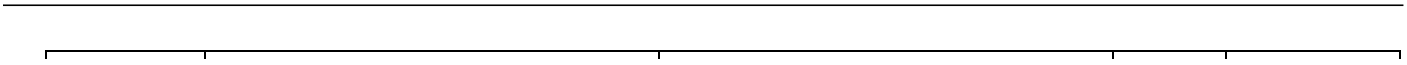
Answer 01 · Mark scheme June 2018 | 8464/C/1F | Original Q3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	H^+		1	AO1 5.4.2.4
03.2	nitric (acid) **or** HNO_3 zinc (oxide) **or** ZnO	this order only	1 1	AO2 5.4.2.3
03.3	dissolved in water		1	AO1 5.1.1.1
03.4	any value from 0 to less than 8		1	AO2 5.4.2.4
03.5	**Level 2:** The method would lead to the production of a valid outcome. Key steps are identified and logically sequenced.		3–4	AO3
	Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.		1–2	AO2
	No relevant content		0	
	Indicative content • add universal indicator **or** wide range indicator indicator turns blue / purple / violet (because pH = 14) **or** has highest pH **or** is an alkali so A is sodium hydroxide indicator turns red (because pH = 2) **or** has lowest pH **or** is an acid so B is phosphorus oxide indicator turns green (because pH = 7) **or** neutral so C is silicon dioxide • add solid to water A and B dissolve; C does not so C is silicon dioxide			5.1.2.3 5.4.2.4
Total			**9**	

5.4.2.4 The pH scale and neutralisation

Answer 01 · Mark scheme

June 2018 | 8464/C/1F | Original Q3



5.4.2.4 The pH scale and neutralisation

Answer 02 · Mark scheme June 2019 | 8464/C/1F | Original Q7

07.1	(aq)	allow aq ignore aqueous ignore formulae	1	AO1 5.2.2.2
07.2	HNO_3		1	AO1 5.1.1.1 5.4.2.2
07.3	red purple **or** blue	allow orange or yellow do **not** accept green allow shades of purple e.g. violet	1 1	AO1 5.4.2.4
07.4	D		1	AO3 5.4.2.4
07.5	 3 × 16 **or** 48 $\frac{48}{80}$ (×100) 60 (%)	an answer of 60 (%) scores **3** marks an answer of 20 (%) scores **2** marks for: $\frac{16}{80}$ (× 100) (1) = 20 (%) (1)	 1 1 1	AO2 5.3.1.2

5.4.2.4 The pH scale and neutralisation

Answer 02 · Mark scheme

Question	Answers	Mark	AO/ Spec. Ref
07.6	**Level 3:** The design/plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	5–6	AO3 AO2
	Level 2: The design/plan would not necessarily lead to a valid outcome. Most steps are identified, but the plan is not fully logically sequenced.	3–4	5.5.1.1
	Level 1: The design/plan would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2	
	No relevant content	0	
	Indicative content **Steps** • use a suitable container e.g. test tube • use insulation • add water • measure the initial water temperature (with a thermometer) • add stated mass e.g. 1g **or** 1 spatula • stir (to dissolve the solid) • measure the final (allow lowest or highest) temperature of the solution • calculate the temperature difference **or** determine graphically • repeat with different masses • repeat with the same volume of water to access level 3 there must be an indication of how the temperature change is determined using different masses dissolved in the same quantity of water		

Total			14

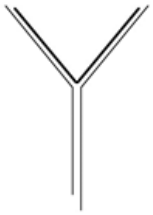
5.4.2.4 The pH scale and neutralisation

Answer 03 · Mark scheme November 2020 | 8464/C/1F | Original Q1

01.1	1		1	AO1 5.4.2.4
01.2	hydrochloric acid		1	AO1 5.4.2.1 5.4.2.2
01.3	salt		1	AO1 5.4.2.1 5.4.2.2
01.4	sodium hydroxide		1	AO2 5.4.2.2
01.5	CuO		1	AO2 5.1.1.1
01.6	any **one** from: • increase the concentration of the acid • increase the surface area of the copper oxide • warm / heat the mixture	allow use powdered copper oxide ignore increase room temperature allow add catalyst ignore stir	1	AO1 5.4.2.2 5.4.2.3 RPA8
01.7	in excess		1	AO1 5.1.1.2 5.4.2.3 RPA8

5.4.2.4 The pH scale and neutralisation

Answer 03 · Mark scheme

01.8			1	AO1 5.1.1.2 5.4.2.3 RPA8

01.9	crystallisation	allow evaporation	1	AO1 5.4.2.2 5.4.2.3 RPA8

Total			**9**

5.4.2.4 The pH scale and neutralisation

Answer 03 · Mark scheme

November 2020 | 8464/C/1F | Original Q1

Question	Answers	Extra information	Mark	AO / Spec. Ref.

5.4.2.4 The pH scale and neutralisation

Answer 04 · Mark scheme November 2021 | 8464/C/1F | Original Q7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	green to red		1	AO1 5.4.2.4
07.2	decreases		1	AO1 5.4.2.4
07.3	(aq)	allow aq ignore aqueous ignore HNO_3	1	AO1 5.2.2.2
07.4	any **two** from: • (white) solid disappears • fizzing **or** bubbles (of gas) **or** effervescence • (then) stops fizzing • (white) solid left at the end / bottom	allow a gas is produced ignore colourless solution	2	AO3 5.4.2.2 5.4.2.3
07.5	$Zn(NO_3)_2$		1	AO2 5.1.1.1 5.4.2.2

5.4.2.4 The pH scale and neutralisation

Answer 04 · Mark scheme

November 2021 | 8464/C/1F | Original Q7

Question	Answers	Mark	AO / Spec. Ref.
07.6	**Level 3:** The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.	5–6	AO1 5.4.2.2 5.4.2.3 RPA8
	Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced.	3–4	
	Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2	
	No relevant content	0	
	Indicative Content: • react hydrochloric acid • (with) copper oxide • in a suitable container • warm (hydrochloric) acid • add copper oxide • until is in excess **or** until solid remains • stir • filter excess copper oxide • pour solution / filtrate into evaporating basin • use of water bath **or** use of electric heater • to heat gently **or** partially evaporate • leave to cool / crystallise For level 3 the correct chemicals must have been selected.		
Total		**12**	

5.4.2.4 The pH scale and neutralisation

Answer 05 · Mark scheme

June 2022 | 8464/C/1F | Original Q5

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	any **three** from: • green solid / powder • colourless solution • blue solution formed • copper carbonate disappears • fizzing / effervescence **or** bubbles (of gas) • stops fizzing • solid / powder left at the end **or** copper carbonate left at the end	 ignore green copper carbonate allow colour (of solution) changes allow solid disappears ignore gas allow fizzing slows down allow (container) gets hot **or** allow temperature increases	3	AO2 AO3 5.4.2.2 5.4.2.3 RPA8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	filtration **or** filter		1	AO1 5.4.2.3 RPA8

5.4.2.4 The pH scale and neutralisation

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	7		1	AO1 5.4.2.3 5.4.2.4 RPA8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	neutralisation	allow exothermic	1	AO1 5.4.2.2 5.4.2.4 RPA8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5	83 (g at 80 °C)	allow a value in range 82–84 (g at 80 °C)	1	AO2
	32 (g at 20 °C)	allow a value in range 32–33 (g at 20 °C)	1	AO2
	(83–32 =) 51 (g)	allow a correct calculation using incorrectly read values for mass at 80 °C and/or 20 °C	1	AO3 5.4.2.3

Total Question 5		9

5.4.2.4 The pH scale and neutralisation

Answer 06 · Mark scheme

June 2023 | 8464/C/1F | Original Q6

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	hydrogen / H^+		1	AO1 5.4.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2		MP2 is dependent upon MP1 being awarded		AO1 5.4.2.4
	(indicator) universal	ignore pH meter	1	
	(result) (green to) red / orange / yellow		1	
	OR			
	(indicator) (blue) litmus (1)			
	(result) (turns) red (1)			
	OR			
	(indicator) methyl orange (1)			
	(result) (turns) red (1)			

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	the solubility decreases		1	AO3 5.3.2.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	pH of the solution increases		1	AO3 5.3.2.5 5.4.2.4

5.4.2.4 The pH scale and neutralisation

Answer 06 · Mark scheme

June 2023 | 8464/C/1F | Original Q6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.5	(I)		1	AO2 5.2.2.2 AO2.2

Question	Answers	Mark	AO / Spec. Ref.
06.6	**Level 3:** The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	5–6	AO3 5.3.1.3 5.4.2.2
	Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the plan is not fully logically sequenced.	3–4	
	Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2	
	No relevant content	0	
	Indicative Content: • measure a (stated) mass of calcium carbonate • use a balance • add calcium carbonate into a conical flask • measure a (stated) volume of hydrochloric acid • use a measuring cylinder • add hydrochloric acid to the conical flask • immediately place the stopper (and delivery tube) in the conical flask • record the total volume of carbon dioxide gas **or** record volume of carbon dioxide collected in set time **or** time taken to collect fixed volume of gas • collected in the gas syringe • repeat • repeat method with different masses of calcium carbonate		

Total Question 6	12

5.4.2.4 The pH scale and neutralisation

Answer 07 · Mark scheme June 2025 | 8464/C/1F | Original Q5

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	any **two** from: • measure the volume of the alkali • repeat **and** calculate a mean • stir / swirl the mixture • use universal indicator solution	ignore references to safety allow use a measuring cylinder (to measure the alkali) allow use a burette (to measure the alkali) allow use a pH probe	2	AO3 5.4.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	7		1	AO1 5.4.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	neutralisation		1	AO1 5.4.2.2

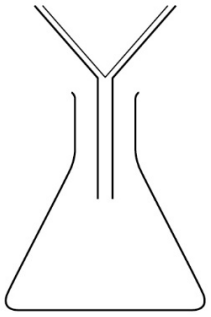
Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	H^+		1	AO1 5.4.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5	nitric (acid)	allow HNO_3	1	AO2 5.4.2.2

5.4.2.4 The pH scale and neutralisation

Answer 07 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.6	(**A**) overall energy change		1	AO1 5.5.1.2
	(**B**) progress of reaction		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.7	filter funnel with filter paper inside		1	AO1 5.4.2.3 RPA8
	a container to collect the filtrate		1	
		an answer of  scores **2** marks		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.8	zinc	allow Zn	1	AO2 5.4.2.1

Total Question 5	**11**

5.4.2.4 The pH scale and neutralisation

Answer 01 · Examiner comments June 2018 | 8464/C/1F | Original Q3

Question 3 (low & standard demand)

No reportable questions.

Answer 04 · Examiner comments November 2021 | 8464/C/1F | Original Q7

Question 7 (standard demand)

07.1 Approximately one quarter of students were able to give the colour change, 'green to red', as the observed change when nitric acid is added to a mixture of universal indicator and water.

07.2 Many students appeared to confuse the increase in acidity when nitric acid is added to water with an increase in pH, which proved to be a strong distractor.

07.3 Very few students were able to give (aq) as the state for a substance dissolved in water.

07.4 The required practical activity of making a soluble salt starts by reacting either an insoluble metal oxide or metal carbonate with an acid. The word equation was provided to help students with this question although many students found difficulty in making links between this and the resulting observations. Since carbon dioxide is produced, initial observations would be fizzing and white solid disappearing. Excess zinc carbonate would result in all the nitric acid reacting; fizzing would stop and excess solid would collect at the bottom. Just under one fifth of students gained a mark.

07.5 Zn_2NO_3 proved a more commonly seen response than $Zn(NO_3)_2$, the correct answer. Just under one quarter of students answered this correctly.

07.6 Students had difficulty in describing the essential steps of the method of making a soluble salt from an insoluble metal oxide and an acid. Most failed to select the correct chemicals, copper oxide and hydrochloric acid, without these the method would not lead to a valid outcome. Just under one third of students gave a level one answer and very few got into level two.

5.4.2.4 The pH scale and neutralisation

Concluding Remarks

The demand of this paper was similar to those previously set for this specification. Students should note that two-mark questions require two answer points and so on.

15% of marks are based upon the required practical activities; students should question 'what and why' is happening in each step of these procedures. Answers should be chemically accurate, e.g. crystals are produced from salt solutions when the solution is heated (partially evaporated to produce a more concentrated solution) and then left to crystallise, rather than implying that 'all the water was evaporated'.

In chemistry 20% are marks are for questions assessing mathematical skills. In these questions, students should show their working for each step. If an error is made, such as an incorrect evaluation of values in the question, credit can be awarded for each correct step shown. Students should be encouraged to think about their answers; in **01.5** a small number gave percentages in excess of 100. In **01.7** students did not always disregard the anomalous result but were able to get a mark for the correct division of all four values. A few were unable to give the answer to two significant figures. In **02.6** students needed to use all the data provided and to use the ratio of volumes to evaluate the mass. In **04.4** a minority of students multiplied, rather than adding, the relative atomic masses. In **06.5** not all students used all the data provided to evaluate the relative atomic mass, a weighted mean of the mass numbers.

5.4.2.4 The pH scale and neutralisation

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.

5.4.2.4 The pH scale and neutralisation

Answer 05 · Examiner comments June 2022 | 8464/C/1F | Original Q5

Question 5 (Standard demand)

05.1 Students were asked to state observations made when copper carbonate is added to sulfuric acid. Many students appeared to misunderstand what an observation is and instead either wrote instructions on how to carry out the preparation of copper sulfate or stated what to look for such as ‘check the pH level’ or ‘did anything change’. Just over a quarter gave at least one correct observation. The most common responses were ‘colour changes’ or ‘fizzing’.

05.2 More than a third of students knew that filtration is used to separate unreacted copper carbonate after a reaction between sulfuric acid and excess copper carbonate.

05.3 Just over 20% of students knew the pH of the solution after a reaction between sulfuric acid and excess copper carbonate.

05.4 Just over 10% of students knew that the reaction between sulfuric acid and copper carbonate is neutralisation.

05.5 The question required students to read the masses of ammonium nitrate that dissolve at 80 °C and 20 °C from a graph and to then carry out a subtraction to determine the mass of solid that crystallises on cooling. Just over 15% of students were able to gain all 3 marks.

Answer 06 · Examiner comments June 2023 | 8464/C/1F | Original Q6

Question 6 (standard demand)

06.1 Students found identifying the ion which makes a solution acidic very difficult. Carbon was a very common incorrect response.

06.2 Just over 25% of the students named an indicator (usually universal indicator) that could be used to test if a solution is acidic. About half of these then gave the correct colour in the acid solution. Common incorrect responses were pH paper, strips, solution or meter.

5.4.2.4 The pH scale and neutralisation

Answer 06 · Examiner comments June 2023 | 8464/C/1F | Original Q6

06.3 More than three-quarters of students deduced that the solubility of carbon dioxide decreases as the temperature of water increases. The solubility increases proved to be the most popular distractor.

06.4 Just over a third of students deduced that the pH of the solution increases as the temperature of water increases. The pH of the solution decreases was selected by nearly as many students.

06.5 More than 40% of students knew that the state symbol of water is (l). The other three distractors were selected in similar numbers.

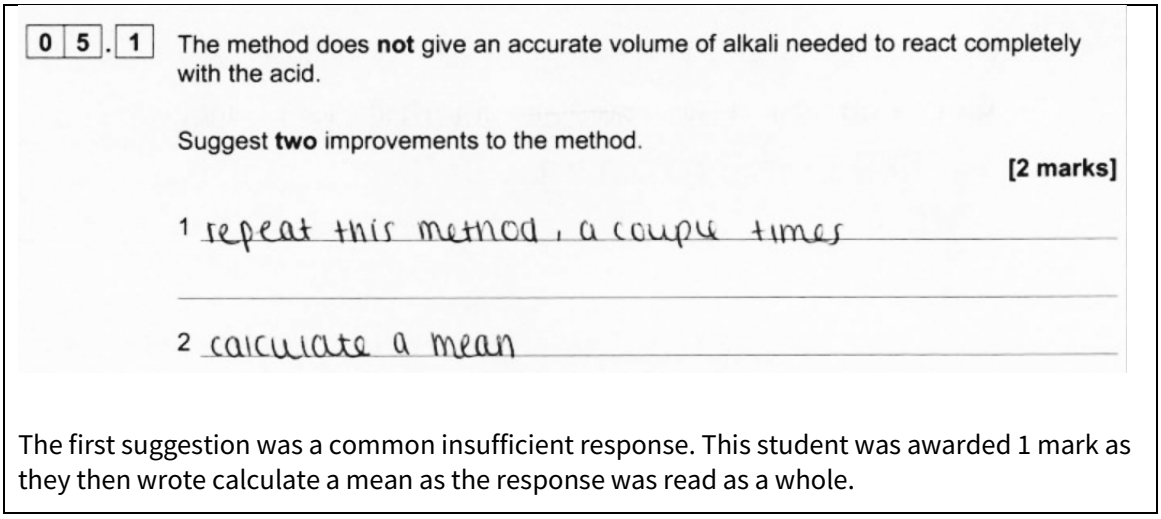
06.6 The majority of students made an attempt at this question which discriminated well with nearly a third of students achieving level two, though few were able to access level 3. Students appreciated the need to mix together quantities of hydrochloric acid and calcium carbonate, then collect the gas evolved. Better answers gave an indication of how this was done. The sticking point was the method of collection of the gas which prevented students from achieving level 3. Many did not specify that the gas syringe needed to be connected to the conical flask. Many students used a beaker for the reaction which prevented successful gas collection. A tiny minority chose to filter and heat the solution with a Bunsen burner.

Answer 07 · Examiner comments

June 2025 | 8464/C/1F | Original Q5

Question 5 (Low and Standard demand)

05.1 Improvements to methods are assessed as AO3 and are often not well attempted. Answers needed to improve the accuracy of measuring the volume of alkali, so creditworthy responses included measuring the volume of the alkali (e.g. with a measuring cylinder), ensuring that the reagents reacted by stirring the mixture or repeating and calculating a mean. This was not a high scoring question. There were many insufficient responses of 'repeat' without the necessary 'mean' included. Many responses used the inadequate terms 'amount' or 'how much' alkali, and others suggested altering the size or weight of the universal indicator paper rather than using a solution. Other uncreditworthy responses included attempting to control the 'time' or using 'more acid'. Others mentioned the need to use a measuring cylinder but referred to the acid and therefore gained no credit.



0 5 . 1 The method does **not** give an accurate volume of alkali needed to react completely with the acid.

Suggest **two** improvements to the method.

[2 marks]

1 repeat this method a couple times

2 calculate a mean

The first suggestion was a common insufficient response. This student was awarded 1 mark as they then wrote calculate a mean as the response was read as a whole.

05.2 Nearly two thirds of students knew that universal indicator paper turns green when pH = 7. The most popular incorrect distractor was pH = 5.

05.3 Nearly two thirds of students knew that neutralisation is the name of the reaction between an acid and an alkali. Combustion was the most common incorrect response.

05.4 Half of students knew that acids contain H^+ ions. The most popular incorrect distractor was Na^+ ions.

05.5 Nitric acid was the unknown acid that reacted with sodium hydroxide to produce sodium nitrate. This was not well known. Common responses that were not awarded the mark were nitrogen, nitrate (possibly because they had appeared earlier in the paper), hydrochloric acid, sulfuric acid and sodium.

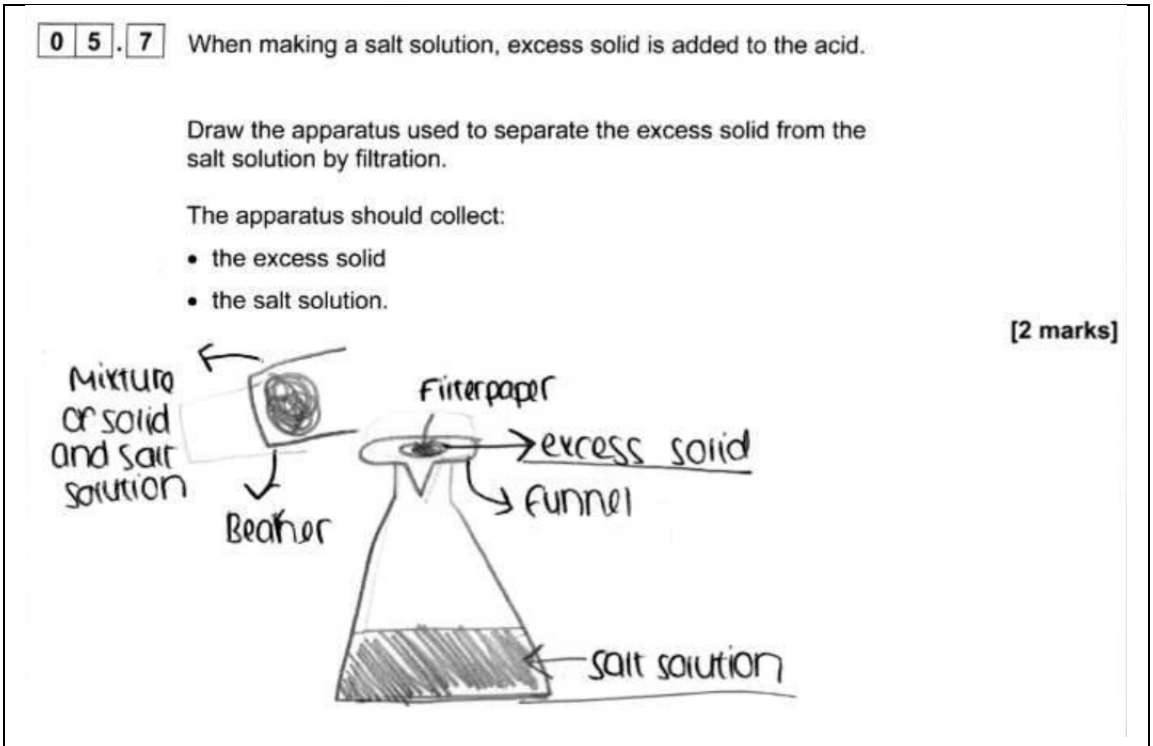
05.6 A third of students were able to select the labels from the box to complete the reaction profile. Reactants and products were common incorrect distractors. Credit was awarded if the student identified the correct answer in the box.

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5.4.2.4 The pH scale and neutralisation

Answer 07 · Examiner comments June 2025 | 8464/C/1F | Original Q5

05.7 Students had to draw apparatus used to separate excess solid from salt solution by filtration. Filter paper inside a filter funnel gained the first mark. Many diagrams had either the funnel or paper missing but those students who clarified their diagrammatic response with labels (for the paper and funnel) were awarded credit even if it was not clear that both pieces of equipment were drawn. The second mark was for any container to collect the filtrate although this could only be accessed if there was some evidence of filtration apparatus even if incorrect. Those students who included additional equipment which would affect the filtrate, for example, a Bunsen burner to heat the collection vessel with were not awarded the second mark. More than a quarter of students did not attempt this question.



Both marking points were awarded. It is not clear that there is filter paper inside a filter funnel but this student has clarified their diagram with two labels. A conical flask after filtration is creditworthy.

05.8 Half the students knew that the zinc reacts with hydrochloric acid to produce zinc chloride and hydrogen gas. Phonetic spellings were credited. Chlorine was the main incorrect response, zinc oxide/hydroxide often appeared, and there were a few other metals e.g. iron, infrequently.

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