AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.4.2.2

Neutralisation of acids and salt production

Mark schemes and examiner comments

Tier	**Foundation**
Question groups	**14**
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.

5.4.2.2 Neutralisation of acids and salt production

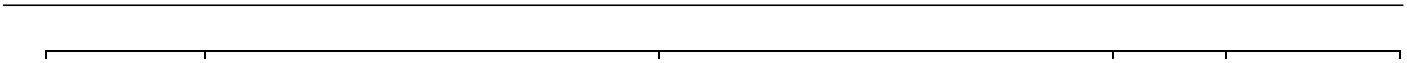
Answer 01 · Mark scheme June 2018 | 8464/C/1F | Original Q3

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**	

5.4.2.2 Neutralisation of acids and salt production

Answer 01 · Mark scheme

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



5.4.2.2 Neutralisation of acids and salt production

Answer 02 · Mark scheme June 2018 | 8464/C/1F | Original Q7

Question	Answers	Mark	AO / Spec. Ref.
07	**Level 3:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.	5–6	AO3
	Level 2: Relevant points (reasons / causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.	3–4	AO3
	Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1–2	AO1
	No relevant content	0	
	Indicative content: • uses sulfuric acid not hydrochloric acid **or** sulfuric acid needed • uses copper carbonate / oxide not calcium carbonate **or** copper carbonate / oxide needed • add solid until solid remains **or** is in excess **or** no more reacts / dissolves so that most / all of the acid reacts • filter to remove excess **or** unreacted carbonate / oxide / solid • heat gently **or** partially evaporate **or** leave until crystals appear **or** to crystallise for **level 3** the correct chemicals must have been selected		5.4.2.3
Total		**6**	

5.4.2.2 Neutralisation of acids and salt production

Answer 03 · Mark scheme June 2019 | 8464/C/1F | Original Q2

02.1	hydrochloric acid		1	AO1 5.4.2.3
02.2	(black) solid remains (after stirring)	allow copper oxide remains allow no more copper oxide reacts	1	AO1 5.4.2.3
02.3	first stage **B** second stage **A** third stage **C** fourth stage **D**	all 4 correct for **2** marks allow **1** mark if either first stage or fourth stage is correct	2	AO1 5.4.2.3
02.4	(negative electrode) copper (positive electrode) chlorine	allow Cu allow Cl_2 / Cl do **not** accept chloride or Cl^- if no other mark awarded allow **1** mark if elements are reversed	1 1	AO2 5.4.3.2

5.4.2.2 Neutralisation of acids and salt production

Answer 03 · Mark scheme

02.5	a reading of an increase in mass correct linked reading of the increase in time correct evaluation of gradient	e.g. 4 (mg) in 10 (mins) scores 2 marks e.g. ($\frac{4}{10}$ =) 0.4 (mg per min) allow correct calculation of gradient from incorrectly determined values for mass and/or time	1 1 1	AO2 5.4.3.4

02.6	cryolite oxide	this order only	1 1	AO1 5.4.3.3

Total			**11**

5.4.2.2 Neutralisation of acids and salt production

Answer 03 · Mark scheme

June 2019 | 8464/C/1F | Original Q2

Question	Answers	Extra information	Mark	AO / Spec.

5.4.2.2 Neutralisation of acids and salt production

Answer 04 · 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

5.4.2.2 Neutralisation of acids and salt production

Answer 04 · Mark scheme

June 2019 | 8464/C/1F | Original Q7

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		

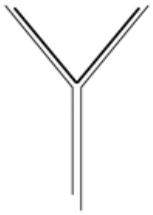
Total			**14**

5.4.2.2 Neutralisation of acids and salt production

Answer 05 · 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

5.4.2.2 Neutralisation of acids and salt production

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**

5.4.2.2 Neutralisation of acids and salt production

Answer 05 · Mark scheme

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

Question	Answers	Extra information	Mark	AO / Spec. Ref.

5.4.2.2 Neutralisation of acids and salt production

Answer 06 · 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

5.4.2.2 Neutralisation of acids and salt production

Answer 06 · Mark scheme

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

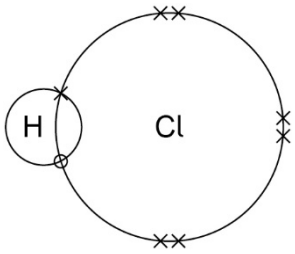
Question	Answers	Mark	AO / Spec. Ref.
07.6	**Level 3:** The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.	5–6	AO1 5.4.2.2 5.4.2.3 RPA8
	Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the 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**	

5.4.2.2 Neutralisation of acids and salt production

Answer 07 · Mark scheme

June 2022 | 8464/C/1F | Original Q2

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	one shared pair in overlap	allow any combination of circles, dots, crosses or $e^{(-)}$	1	AO1 5.1.2.6 5.2.1.4
	6 non-bonding electrons in outer shell of chlorine	do **not** accept extra electron(s) on outer shell of hydrogen ignore any inner shell electrons	1	
		an answer of  scores **2** marks		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	sodium chloride	allow NaCl	1	AO2 5.4.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	5.85 (g)		1	AO2 5.3.1.1 5.4.2.2 5.5.1.1 RPA10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	17.6 (°C)		1	AO2 5.4.2.2 5.5.1.1 RPA10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.5	exothermic (reaction)	allow neutralisation (reaction)	1	AO2 5.5.1.1 RPA10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.6	Na^+ OH^-		1 1	AO1 AO2 5.4.2.2 5.4.2.4 5.5.1.1

Total Question 2		**8**

5.4.2.2 Neutralisation of acids and salt production

Answer 08 · 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

5.4.2.2 Neutralisation of acids and salt production

Answer 08 · Mark scheme

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

5.4.2.2 Neutralisation of acids and salt production

Answer 09 · Mark scheme

June 2022 | 8464/C/2F | Original Q7

Question 7

<table>
<tr><th>Question</th><th>Answers</th><th>Mark</th><th>AO / Spec. Ref.</th></tr>
<tr><td rowspan="4">07.1</td><td>Level 2: Scientifically relevant features are identified, the way(s) in which they are similar / different is made clear and (where appropriate) the magnitude of the similarity / difference is noted.</td><td>4–6</td><td rowspan="4">AO1
5.10.1.3</td></tr>
<tr><td>Level 1: Relevant features are identified and differences noted.</td><td>1–3</td></tr>
<tr><td>No relevant content</td><td>0</td></tr>
<tr><td>Indicative content
<table>
<tr><th>ground water</th><th>waste water</th></tr>
<tr><td>easier to obtain</td><td>more difficult to obtain</td></tr>
<tr><td>fewer processes</td><td>more processes</td></tr>
<tr><td>takes less time</td><td>takes more time</td></tr>
<tr><td>filtered through filter beds

to remove insoluble particles</td><td>screening and grit removal

to remove large particles</td></tr>
<tr><td></td><td>sedimentation

to produce sewage sludge and effluent</td></tr>
<tr><td></td><td>aerobic biological treatment of effluent

to reduce solid waste</td></tr>
<tr><td>sterilised

using chlorine, ozone or uv light

to kill bacteria</td><td>and then sterilised

using chlorine, ozone or uv light

to kill bacteria</td></tr>
<tr><td></td><td>sludge is anaerobically digested

by specific bacteria

to remove organic matter</td></tr>
</table></td><td></td></tr>
</table>

5.4.2.2 Neutralisation of acids and salt production

Answer 09 · Mark scheme

June 2022 | 8464/C/2F | Original Q7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	distillation		1	AO1 5.10.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3	(conversion) ($\frac{150}{1000}$ =) 0.15 (dm^3) (concentration =) $\frac{2.40}{0.15}$ = 16 (g/dm^3) **OR** (conversion) $\frac{1000}{150}$ (1) = 6.67 (1) (6.67 × 2.4) = 16 (g/dm^3) (1) **OR** (concentration =) $\frac{2.4}{150}$ (1) = 0.016 (1) (conversion) (0.016 × 1000) = 16 (g/dm^3) (1)	allow correct use of incorrect / no conversion	1 1 1	AO2 5.3.2.5

Total Question 7		10

5.4.2.2 Neutralisation of acids and salt production

Answer 10 · 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

Answer 10 · Mark scheme

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

5.4.2.2 Neutralisation of acids and salt production

Answer 11 · Mark scheme June 2024 | 8464/C/1F | Original Q5

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	hydrogen		1	AO1 5.4.1.2 5.4.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	$MgCl_2(l)$		1	AO2 5.1.1.1 5.2.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	(negative electrode) magnesium (positive electrode) chlorine	allow Mg allow Cl_2 allow **1** mark if both elements are reversed	1 1	AO2 5.4.3.1 5.4.3.2

5.4.2.2 Neutralisation of acids and salt production

Answer 11 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	(most reactive metal) magnesium (iron) copper (least reactive metal) any **two** from: • magnesium reacts with both copper chloride solution and iron chloride solution • iron only reacts with copper chloride solution • copper does not react with either magnesium chloride solution or iron chloride solution	 allow Mg allow Fe allow Cu allow magnesium has two / most reactions allow iron has one reaction allow copper does not react	 1 2	AO3 5.4.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5	1.6 (g)		1	AO2 5.4.3.1 5.4.3.2

5.4.2.2 Neutralisation of acids and salt production

Answer 11 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.6	(conversion 30.0 cm^3 =) 0.030 dm^3		1	AO2 5.3.2.5
	(mass =) 0.030 × 180	allow correct use of incorrect / no conversion of volume	1	
	= 5.4 (g)		1	
	OR			
	1000 cm^3 contains 180 g $MgCl_2$ (1)			
	30 cm^3 contains $\frac{180}{1000}$ × 30 (g) (1)			
	(30 cm^3 contains) 5.4 (g) (1)			
	OR			
	(ratio of volume $\frac{1000}{30}$ =) 33.3 (1)			
	(so ratio of mass) = $\frac{180}{33.3}$ (1)			
	= 5.4 (g) (1)			

Total Question 5	11

5.4.2.2 Neutralisation of acids and salt production

Answer 12 · Mark scheme

June 2024 | 8464/C/1F | Original Q7

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	H_2SO_4		1	AO2 5.4.2.2 5.4.2.3 RPA8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	so all the acid reacts	allow so all the acid is used up	1	AO1 5.4.2.3 RPA8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3		ignore references to filtration		AO1 5.1.1.2 5.4.2.3 RPA8
	heat the solution (to remove some of the water)	allow evaporate some of the water / solution	1	
	leave to cool / crystallise		1	

5.4.2.2 Neutralisation of acids and salt production

Answer 12 · Mark scheme

June 2024 | 8464/C/1F | Original Q7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	all points correctly plotted	allow a tolerance of ± ½ a small square allow **1** mark for 3 or 4 points correctly plotted	2	AO2
	line of best fit		1	AO3 5.3.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.5	a gas escapes (from the test tube)	allow carbon dioxide escapes (from the test tube) ignore copper carbonate thermally decomposes	1	AO1 5.3.1.3

Total Question 7	**8**

5.4.2.2 Neutralisation of acids and salt production

Answer 13 · 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

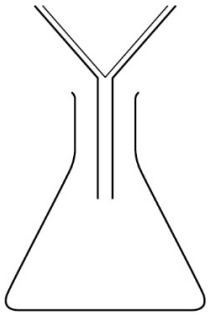
Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	H^+		1	AO1 5.4.2.4

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

5.4.2.2 Neutralisation of acids and salt production

Answer 13 · 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

5.4.2.2 Neutralisation of acids and salt production

Answer 14 · Mark scheme

June 2025 | 8464/C/2F | Original Q2

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	balance	allow (weighing) scales	1	AO1 5.6.1.2 RPA11

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	42 (cm^3)		1	AO2 5.6.1.2 RPA11

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	concentration of hydrochloric acid		1	AO1 5.6.1.2 RPA11

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	to reduce loss of gas	allow carbon dioxide for gas do **not** accept to stop loss of gas	1	AO3 5.6.1.2 RPA11

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.5	calcium hydroxide solution		1	AO1 5.8.2.3

5.4.2.2 Neutralisation of acids and salt production

Answer 14 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.6	time in s(econds) volume (of gas collected) in cm^3 time values in correct order volume values in correct order	if neither mark awarded allow **1** mark for headings of time **and** volume	1 1 1 1	AO2 5.6.1.1 5.6.1.2 RPA11

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.7	$(\text{mean rate of reaction} =) \frac{18}{30}$ = 0.6 cm^3/s		1 1 1	AO2 5.6.1.1 RPA11

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.8	the particles are closer together the particles collide more frequently		1 1	AO1 5.6.1.2 5.6.1.3

Total Question 2	**14**

5.4.2.2 Neutralisation of acids and salt production

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

Question 3 (low & standard demand)

No reportable questions.

Answer 02 · Examiner comments

June 2018 | 8464/C/1F | Original Q7

Question 7 (standard demand)

07 Students found this 'extended response' question, based around Required Practical Activity 8, difficult to answer. Most of the correct responses (33%) were at level 1. Those students that just repeated the stem of the question gained no marks.

The question stated that the method contains several errors and does not produce copper sulfate crystals. Most students missed that the wrong two chemicals were being used in the stem of the question. Common improvements that gained no credit included quoting volume or masses, while some responses just changed the apparatus, expanded the method or included safety issues.

In a few cases students mentioned a correct improvement but failed to explain the reason for the change. For example, students:

- mentioned the need to filter but failed to state that filtering removed the excess solid
- stated add more solid but did not justify that this was to ensure all of the acid reacts.

42% of students gained no credit for an answer, while a further 18% of students did not make an attempt to answer at all.

Use of statistics

Statistics used in this report may be taken from incomplete processing data. However, this data still gives a true account on how students have performed for each question.

Mark Ranges and Award of Grades

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

5.4.2.2 Neutralisation of acids and salt production

Answer 06 · 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.

Answer 06 · Examiner comments

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.

5.4.2.2 Neutralisation of acids and salt production

Answer 06 · Examiner comments

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

Mark Ranges and Award of Grades

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

5.4.2.2 Neutralisation of acids and salt production

Answer 07 · Examiner comments — June 2022 | 8464/C/1F | Original Q2

Question 2 (Low demand)

02.1 More than a third of students correctly drew a dot and cross diagram for hydrogen chloride. The most commonly awarded mark was for the two shared electrons in the overlap between the atoms. Many failed to show that there are six unshared electrons.

02.2 Only 20% of students gained this mark for correctly identifying sodium chloride as one of the products of the reaction between hydrochloric acid and sodium hydroxide. The most common error was identifying the product as sodium chlorine. Some students also attempted to add other products to the equation.

02.3 Only 20% of students gained the mark for calculating the correct mass. Many students added the three masses together rather than recognising that in a reaction the mass of reactants equals the mass of products.

02.4 More than three-quarters of the students correctly read the temperature reading on the thermometer scale.

Answer 07 · Examiner comments — June 2022 | 8464/C/1F | Original Q2

02.5 Just under a quarter of students knew that when the temperature of a reaction increases an exothermic reaction is taking place. The most common error described the reaction as endothermic.

02.6 30% of students correctly identified that Na^+ and OH^- ions are present in sodium hydroxide.

5.4.2.2 Neutralisation of acids and salt production

Answer 08 · 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.

5.4.2.2 Neutralisation of acids and salt production

Answer 09 · Examiner comments

June 2022 | 8464/C/2F | Original Q7

Question 7

The topic of water purification was generally not well known.

07.1 Over 60% of students were able to score at least 1 mark comparing the methods of treatment of ground and wastewater to make potable water. This was usually for a simple statement that both waters need to be filtered. Responses were lacking in specific detail in this recall question. The idea that both waters need to be distilled was very commonly seen, mistaking this with sea water.

07.2 About one third of students were able to identify distillation to desalinate sea water. The most common incorrect response was filtration.

07.3 About a quarter of students were able to score two of the three marks on this item, the conversion of cm^3 to dm^3 being the most likely mark missed.

5.4.2.2 Neutralisation of acids and salt production

Answer 09 · Examiner comments

June 2022 | 8464/C/2F | Original Q7

Use of statistics

Statistics used in this report may be taken from incomplete processing data. However, this data still gives a true account on how students have performed for each question.

Mark Ranges and Award of Grades

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

5.4.2.2 Neutralisation of acids and salt production

Answer 10 · 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.

Answer 10 · 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 11 · Examiner comments

June 2024 | 8464/C/1F | Original Q5

Question 5 (low demand)

05.1 Just over two thirds of students knew that hydrogen gas is produced when a metal reacts with an acid. A quarter of students selected the distractor nitrogen.

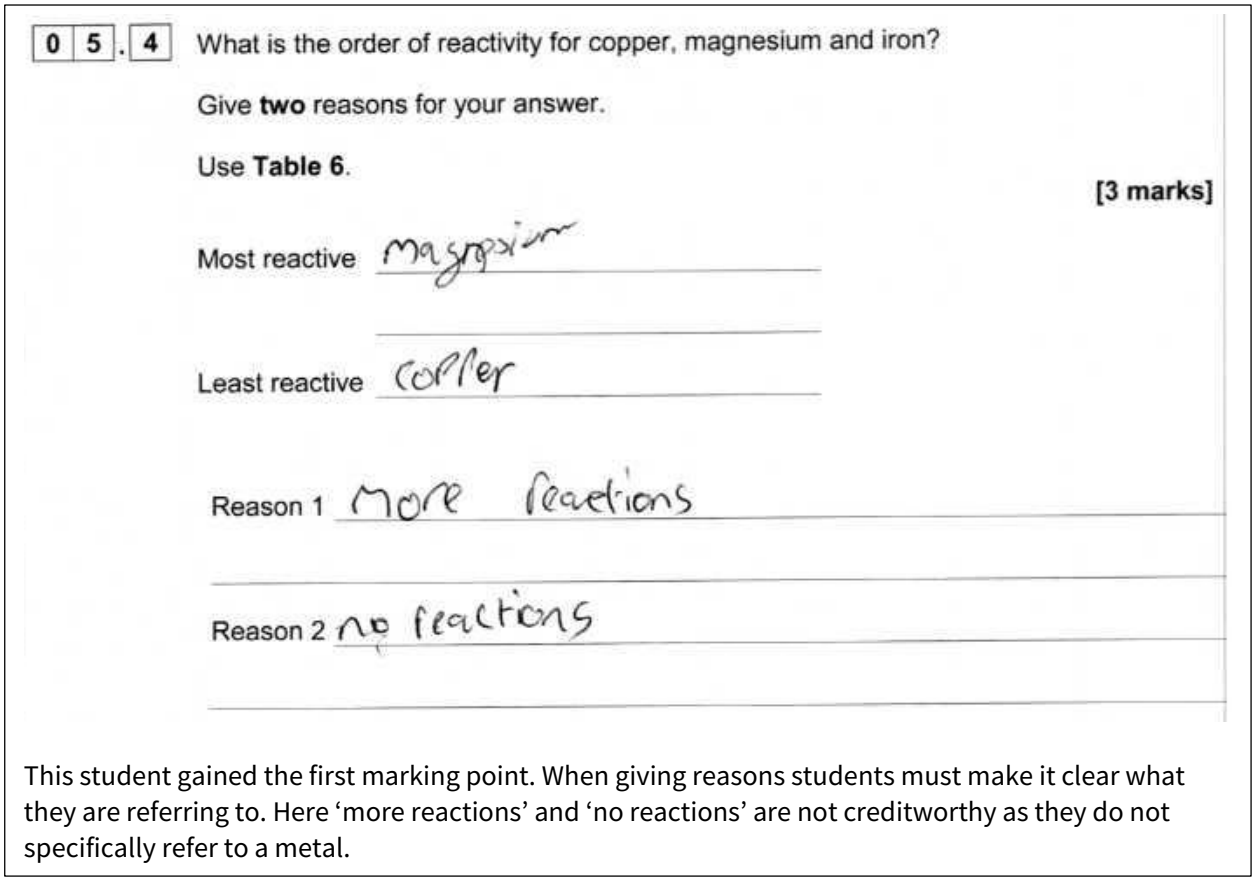
05.2 Nearly two-thirds of students knew molten magnesium chloride is a liquid, which is represented by the state symbol (l). A quarter of students incorrectly selected (g) as the state symbol.

05.3 10% of students gained both marks and students were awarded 1 mark if both elements were correct but reversed. Chlor*ide* is not creditworthy although was a common response.

Many students wrote the formula of the ions that were attracted to the electrodes rather than the element that is discharged. Nearly 20% of students did not attempt this question.

05.4 More than half of students gained 2 or 3 marks for correctly deducing the order of reactivity, with magnesium being the most reactive and copper the least reactive and giving one or two reasons. Students were able to give a reason associated with each metal eg iron only reacts with copper chloride solution or copper does not react.

Common incorrect responses included magnesium reacts with both metals (rather than both metal chloride solutions) or reasons which were not clearly linked to a metal (see example below).


0 5 . 4 What is the order of reactivity for copper, magnesium and iron?

Give **two** reasons for your answer.

Use **Table 6**.

[3 marks]

Most reactive magnesium

Least reactive copper

Reason 1 More reactions

Reason 2 no reactions

This student gained the first marking point. When giving reasons students must make it clear what they are referring to. Here 'more reactions' and 'no reactions' are not creditworthy as they do not specifically refer to a metal.

© 2024 AQA and its licensors. All rights reserved.

5.4.2.2 Neutralisation of acids and salt production

Answer 11 · Examiner comments June 2024 | 8464/C/1F | Original Q5

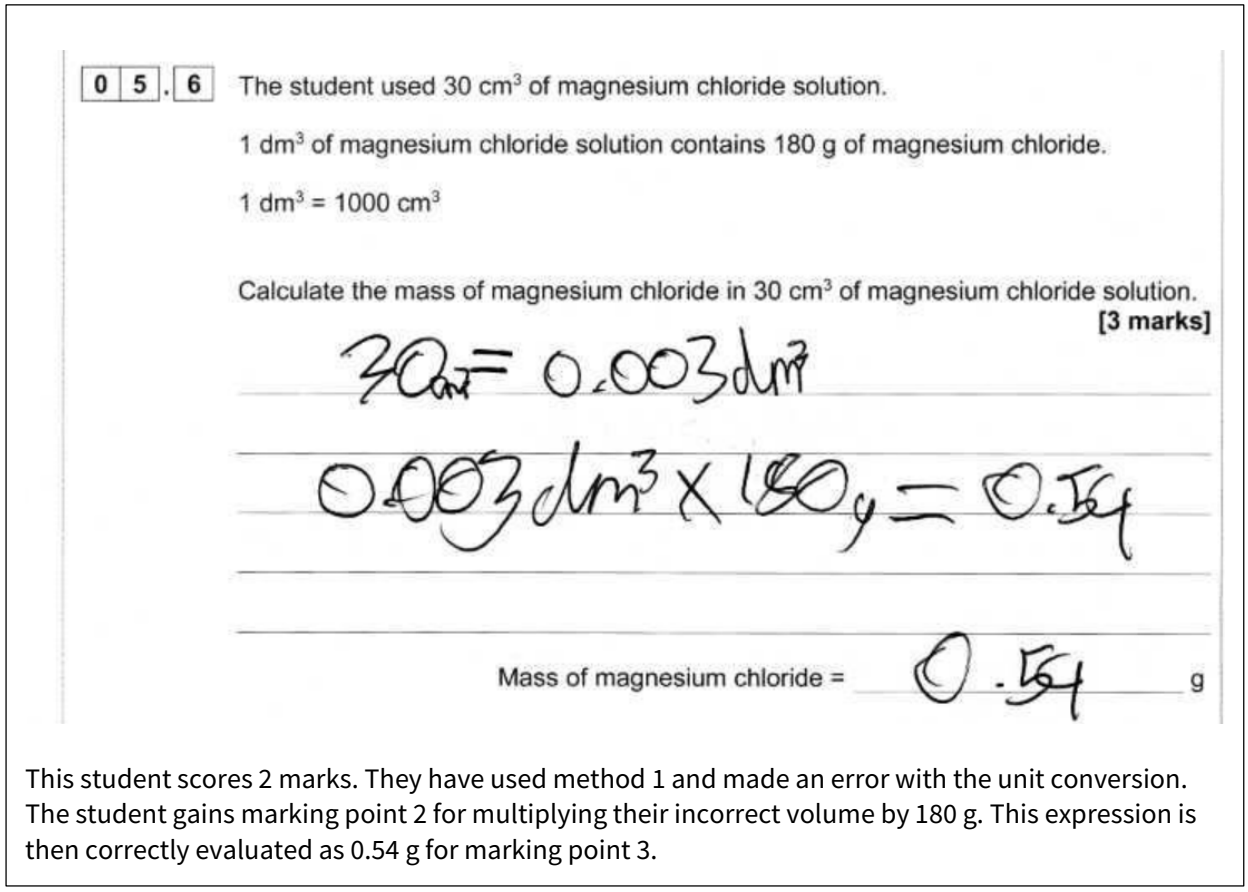
05.5 The law of conservation of mass states that the mass of reactants equals the mass of products. In this question a third of students correctly evaluated that the mass of iron oxide that reacts with 0.72 g of magnesium.

Common incorrect responses were 1.67 (multiplying 0.72 by 2.32) together with 3.2 and 0.31 (evaluated by dividing 2.32 by 0.72 or 0.72 by 2.32 respectively).

05.6 This question required a unit conversion as data is given in dm^3 and needed to be converted to cm^3. This conversion factor was given to lower the demand of the question.

Nearly 30% of students gained all 3 marks. Approximately 10% of students gained 2 marks usually for either not using the conversion factor, for multiplying rather than dividing by 1000 or for using an incorrect factor (eg dividing by 100 rather than 1000). A further 10% of students who gained 1 mark usually calculated the volume correctly in dm^3 but then did not multiply their answer by 180 g or used method 3 in the mark scheme and calculated the ratio of volume as 33.3 but then incorrectly multiplied this by 180 g.

17% of students did not attempt this question.



0 5 . 6 The student used 30 cm^3 of magnesium chloride solution.

1 dm^3 of magnesium chloride solution contains 180 g of magnesium chloride.

1 dm^3 = 1000 cm^3

Calculate the mass of magnesium chloride in 30 cm^3 of magnesium chloride solution. **[3 marks]**

30cm = 0.003dm³

0.003dm³ x 180g = 0.54

Mass of magnesium chloride = 0.54 g

This student scores 2 marks. They have used method 1 and made an error with the unit conversion. The student gains marking point 2 for multiplying their incorrect volume by 180 g. This expression is then correctly evaluated as 0.54 g for marking point 3.

© 2024 AQA and its licensors. All rights reserved.

Answer 12 · Examiner comments

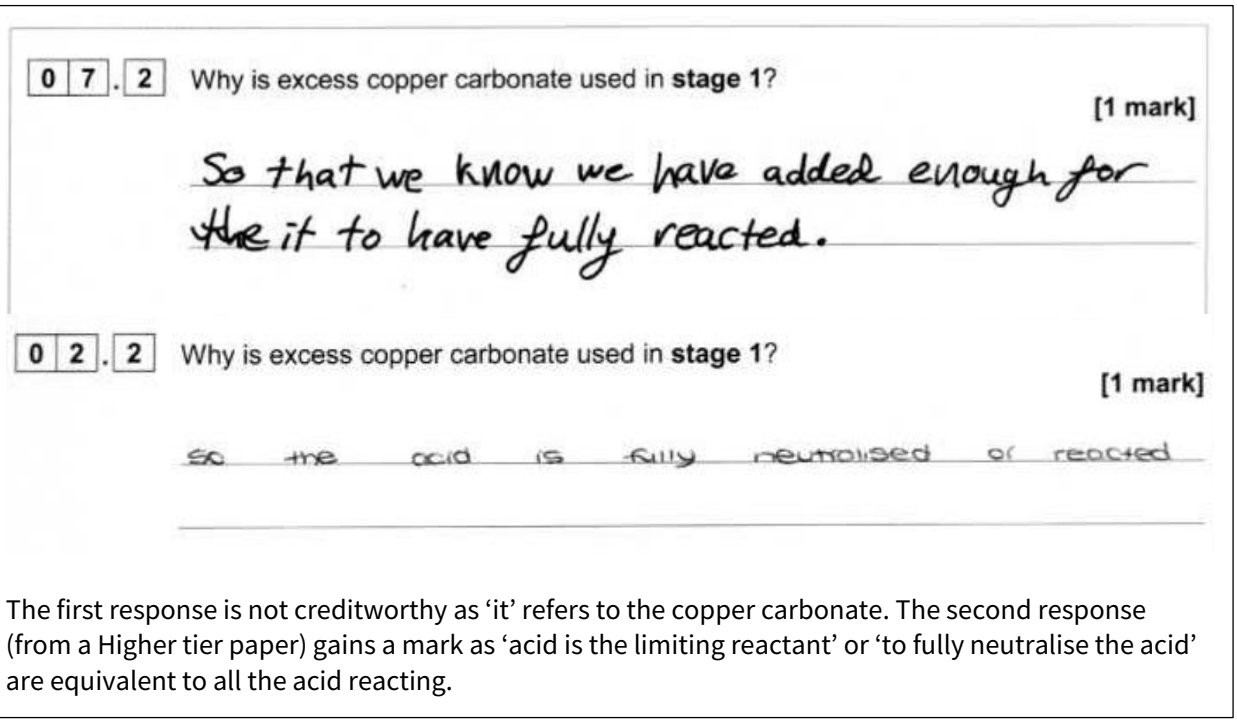
June 2024 | 8464/C/1F | Original Q7

Question 7 (standard demand)

07.1 By selecting H_2SO_4 more than half of students answered correctly. HCl was the most common incorrect response.

07.2 Excess copper carbonate is used to ensure all the acid reacts. Very few students stated this.

Common incorrect responses included that copper carbonate needs to dissolve, to make sure all the copper carbonate reacted (rather than the acid), to get the most product, so everything had reacted or in terms of the rate of reaction. In responses 'it' refers to copper carbonate.



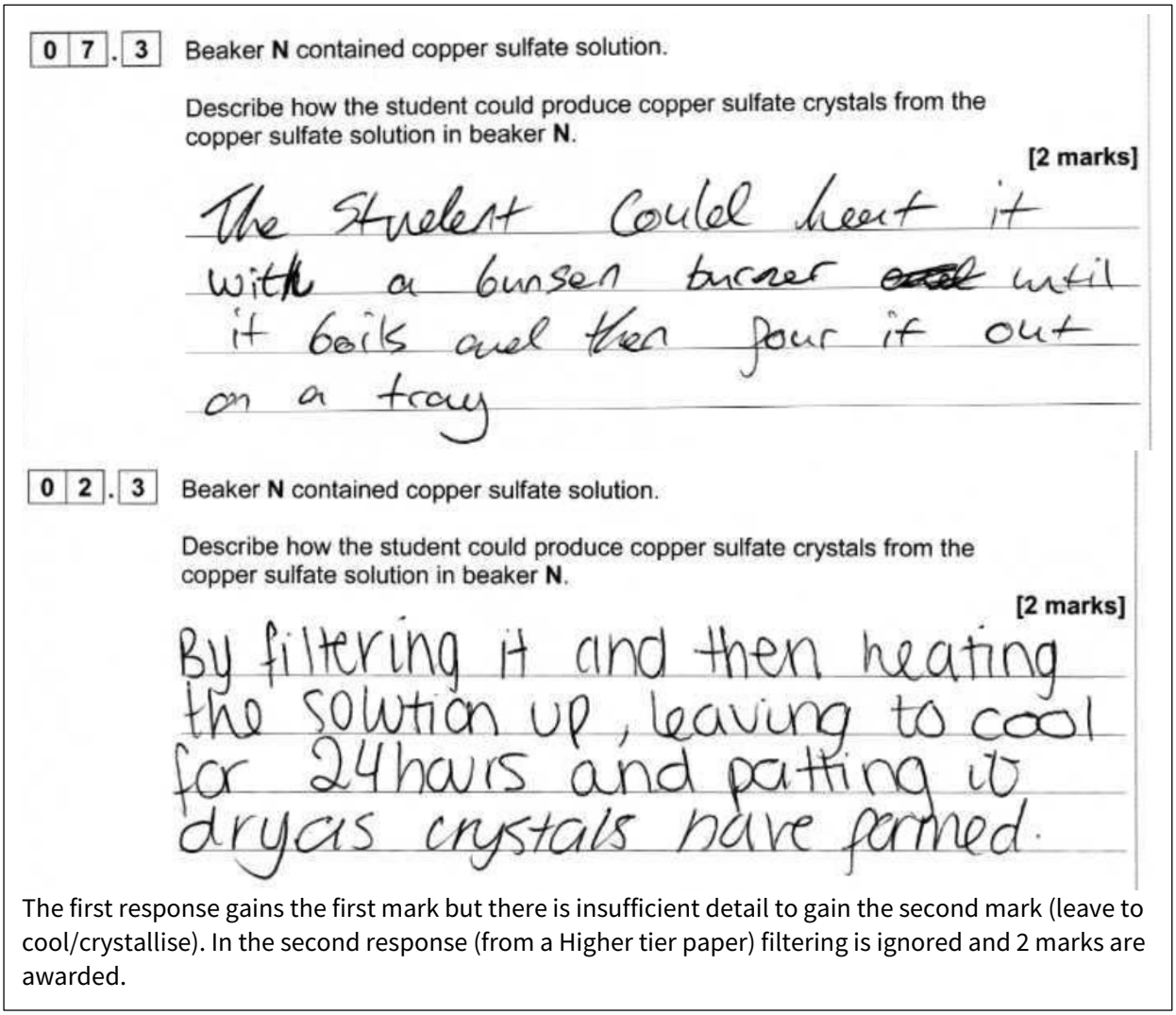
The first response is not creditworthy as 'it' refers to the copper carbonate. The second response (from a Higher tier paper) gains a mark as 'acid is the limiting reactant' or 'to fully neutralise the acid' are equivalent to all the acid reacting.

© 2024 AQA and its licensors. All rights reserved.

5.4.2.2 Neutralisation of acids and salt production

Answer 12 · Examiner comments June 2024 | 8464/C/1F | Original Q7

07.3 The method would work if filtration was carried out immediately before or after heating so was ignored in any response. Few students gained both marks.



0 7 . 3 Beaker **N** contained copper sulfate solution.

Describe how the student could produce copper sulfate crystals from the copper sulfate solution in beaker **N**.

[2 marks]

The Student Could heat it with a bunsen burner ~~and~~ until it boils and then pour it out on a tray

0 2 . 3 Beaker **N** contained copper sulfate solution.

Describe how the student could produce copper sulfate crystals from the copper sulfate solution in beaker **N**.

[2 marks]

By filtering it and then heating the solution up, leaving to cool for 24hours and patting it drycas crystals have formed.

The first response gains the first mark but there is insufficient detail to gain the second mark (leave to cool/crystallise). In the second response (from a Higher tier paper) filtering is ignored and 2 marks are awarded.

07.4 At low demand all points would lie exactly on a 'line of best fit' whereas at standard demand there will be points either side of the line so students need to 'make a decision' when drawing their line. The line of best fit did not need to extend beyond the five points, although extrapolations were allowed and many included the origin (0,0). If students plotted any point(s) incorrectly they could still gain the mark for 'their' line of best fit. A large number of students did not use a ruler and as such were unable to draw an acceptable straight line. Just over a third of students gained all 3 marks and a similar number 2 marks.

07.5 Investigation of mass changes using various apparatus is an opportunity for skill development in the specification, eg thermal decompositions of metal carbonates. This was not well answered on either tier of the paper. Many students incorrectly referred to evaporation or gave answers such as 'some of it escapes', which is insufficient. Some recognised that a gas is made but needed to say that the gas escapes to explain the decrease in mass.

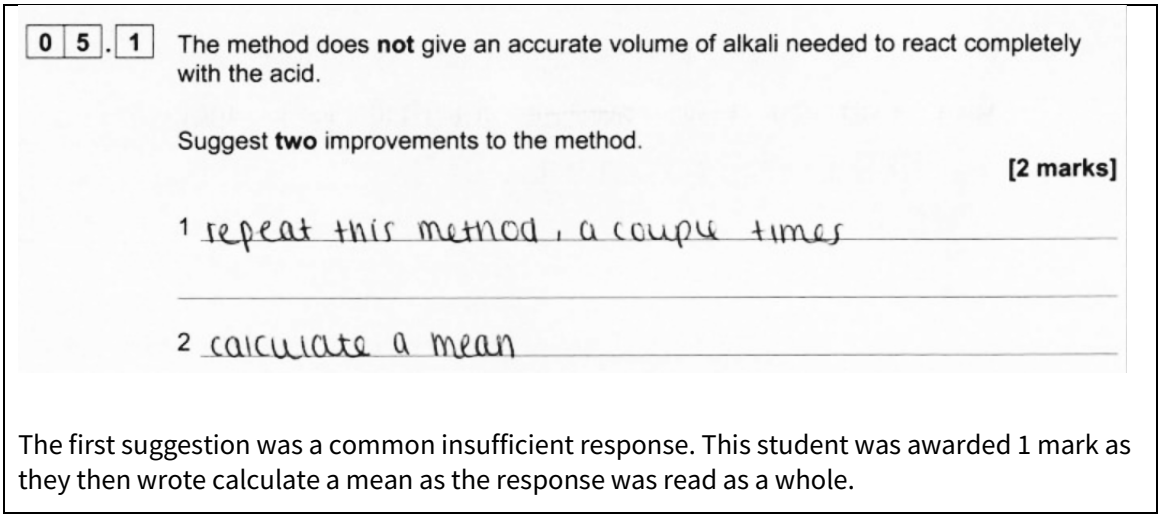
© 2024 AQA and its licensors. All rights reserved.

Answer 13 · 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.

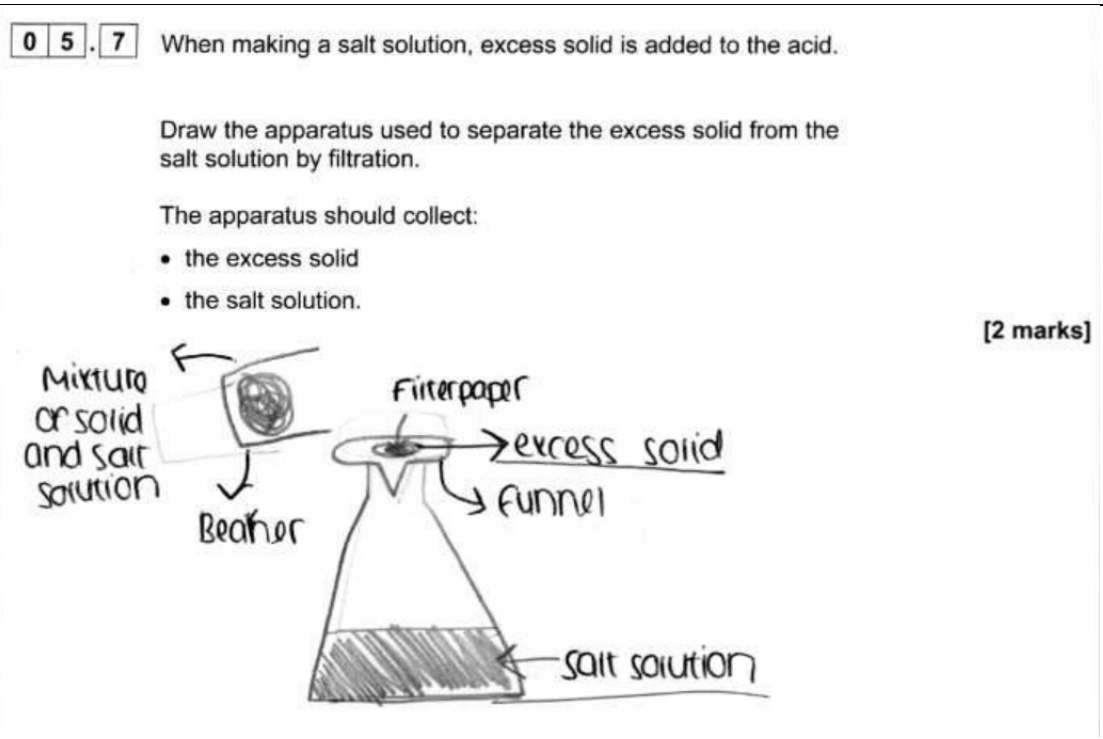
05.6 A third of students were able to select the labels from the box to complete the reaction profile. Reactants and products were common incorrect distractors. Credit was awarded if the student identified the correct answer in the box.

© 2024 AQA and its licensors. All rights reserved.

5.4.2.2 Neutralisation of acids and salt production

Answer 13 · 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.

© 2024 AQA and its licensors. All rights reserved.

5.4.2.2 Neutralisation of acids and salt production

Answer 14 · Examiner comments

June 2025 | 8464/C/2F | Original Q2

Question 2 (Low and Standard demand)

02.1 Just under one third of responses were correct. Correct responses were roughly equally divided between 'balance' and 'scales'. A large number of students stated 'scale' (singular) which is not equivalent to 'scales' and this terminology error resulted in no mark being awarded. The most common incorrect equipment given was 'measuring cylinder'.

02.2 The vast majority of students were able to read the scale correctly as 42.

02.3 Half of all students chose the correct response of concentration of hydrochloric acid.

02.4 The majority of students failed to recognise that the reaction would start immediately and that some gas would inevitably escape from the conical flask. They therefore answered in terms of an absolute such as 'to stop gas escaping' or 'prevent the gas escaping' rather than expressing the fact that the insertion of the bung would 'minimise' or 'reduce' the volume of gas lost. Consequently, less than 10% of students gained this mark.

02.5 Only a third of students knew the chemical name for limewater is calcium hydroxide solution. The most common incorrect response was sodium chloride solution.

02.6 Many students found completing the table difficult. Units were often listed against each number in the table rather than in the headings, although this was given credit if the headings were correct and all the values added to the table had the unit alongside them. Several responses mixed up minutes and seconds and often omitted at least one time or volume. Overall, however

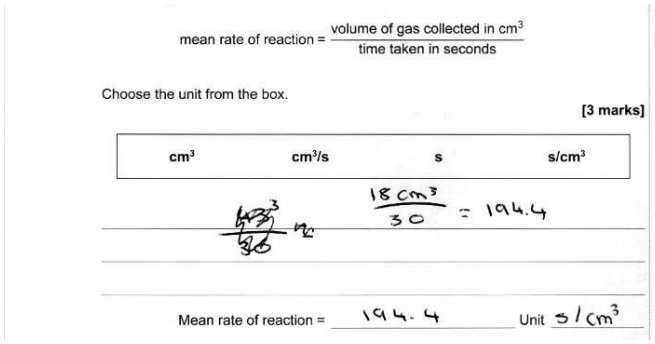
© 2024 AQA and its licensors. All rights reserved.

5.4.2.2 Neutralisation of acids and salt production

Answer 14 · Examiner comments June 2025 | 8464/C/2F | Original Q2

over three quarters of students still gained at least one mark and very few did not attempt the question.

02.7 This was well answered overall. Many students substituted the numbers into the given equation correctly although they sometimes struggled with the units.
A significant number unfortunately used 18^3 rather than 18 cm^3.



This student has substituted the numbers correctly into the given equation but has then carried out an incorrect calculation to arrive at their answer. They have used 18^3. Incorrect units have been chosen. Only the mark for substituting values into the equation can be credited.

02.8 Only about 20% of students could identify both reasons why increasing the concentration increases the rate of reaction. A large number of students included ' the particles move faster' in their response.