AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.4.2.3

Soluble salts

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**7**
Available paper years	**2018–2024**

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.

5.4.2.3 Soluble salts

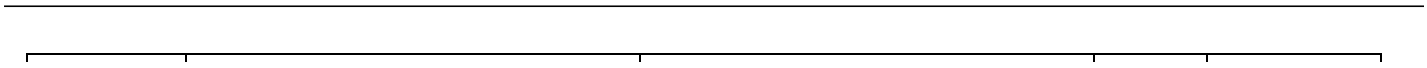
Answer 01 · Mark scheme June 2018 | 8464/C/1H | Original Q3

Question	Answers	Mark	AO / Spec. Ref.
03	**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**	

5.4.2.3 Soluble salts

Answer 01 · Mark scheme

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



5.4.2.3 Soluble salts

Answer 02 · Mark scheme June 2019 | 8464/C/1H | Original Q2

02.1	(aq)	allow aq ignore aqueous ignore formulae	1	AO1 5.2.2.2
02.2	HNO_3		1	AO1 5.1.1.1 5.4.2.2
02.3	red purple **or** blue	allow orange or yellow do **not** accept green allow shades of purple eg violet	1 1	AO1 5.4.2.4
02.4	D		1	AO3 5.4.2.4
02.5	 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

5.4.2.3 Soluble salts

Answer 02 · Mark scheme

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

Question	Answers	Mark	AO/ Spec. Ref
02.6	**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 eg test tube • use insulation • add water • measure the initial water temperature (with a thermometer) • add stated mass eg 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

5.4.2.3 Soluble salts

Answer 02 · Mark scheme

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

Question	Answers	Extra information	Mark	AO / Spec. Ref.

5.4.2.3 Soluble salts

Answer 03 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	green to red		1	AO1 5.4.2.4
02.2	decreases		1	AO1 5.4.2.4
02.3	(aq)	allow aq ignore aqueous ignore HNO_3	1	AO1 5.2.2.2
02.4	any **two** from: • (white) solid disappears • fizzing **/** bubbles / 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
02.5	$Zn(NO_3)_2$		1	AO2 5.1.1.1 5.4.2.2

5.4.2.3 Soluble salts

Answer 03 · Mark scheme

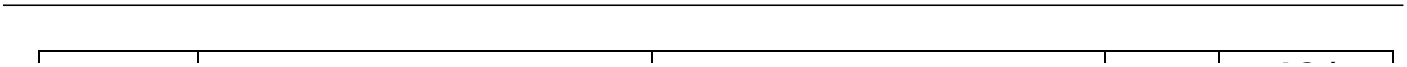
November 2021 | 8464/C/1H | Original Q2

Question	Answers	Mark	AO / Spec. Ref.
02.6	**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**	

5.4.2.3 Soluble salts

Answer 03 · Mark scheme

November 2021 | 8464/C/1H | Original Q2



5.4.2.3 Soluble salts

Answer 04 · Mark scheme

June 2022 | 8464/C/1H | Original Q1

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	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.
01.2	filtration **or** filter		1	AO1 5.4.2.3 RPA8

5.4.2.3 Soluble salts

Answer 04 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	7		1	AO1 5.4.2.3 5.4.2.4 RPA8

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

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5	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 1		**9**

5.4.2.3 Soluble salts

Answer 05 · Mark scheme

Question 2

<table>
<tr><th>Question</th><th>Answers</th><th>Mark</th><th>AO / Spec. Ref.</th></tr>
<tr><td rowspan="3">02.1</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="3">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></td><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><td></td></tr>
</table>

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

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	(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 2		10

5.4.2.3 Soluble salts

Answer 06 · Mark scheme

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

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	filter (to remove excess magnesium) (then) crystallisation (of magnesium chloride solution)	 allow (then) evaporation (of water from magnesium chloride solution)	1 1	AO1 5.1.1.2 5.4.2.1 5.4.2.3 RPA8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	(magnesium atoms are) oxidised (because the atoms) lose (two) electrons		1 1	AO2 5.4.1.4 5.4.2.1 5.4.2.3 RPA8

5.4.2.3 Soluble salts

Answer 06 · Mark scheme

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

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	(moles Mg =) $\frac{0.72}{24}$		1	AO2 5.3.1.1 5.3.2.2 5.4.2.1 5.4.2.3 RPA8
	= 0.03		1	
	(moles Mg = moles $MgCl_2$) (so mass $MgCl_2$ =) 0.03 × 95	allow a correct calculation using an incorrectly calculated value of moles of magnesium allow a correct calculation using an incorrectly calculated value of moles of magnesium chloride	1	
	= 2.85 (g)		1	
	(100.0 cm^3 = 0.100 dm^3 concentration = $\frac{\text{mass}}{\text{volume}}$)			
	= $\frac{2.85}{0.100}$	allow correct use of incorrectly calculated mass of magnesium chloride	1	
	= 28.5 (g/dm^3)		1	

Total Question 6	10

5.4.2.3 Soluble salts

Answer 07 · Mark scheme

June 2024 | 8464/C/1H | Original Q2

Question 2

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

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	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.
02.3		ignore references to filtration		
	heat the solution (to remove some of the water)	allow evaporate some of the water / solution	1	AO1 5.1.1.2 5.4.2.3 RPA8
	leave to cool / crystallise		1	

5.4.2.3 Soluble salts

Answer 07 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	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.
02.5	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 2	**8**

5.4.2.3 Soluble salts

Answer 01 · Examiner comments

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

Question 3 (standard demand)

03 This was an 'extended response question' that was based around Required Practical Activity 8. The quality of responses ranged from near perfect plans that achieved six marks to those which merely repeated the stem of the question and gained zero.

The question stated that the method contains several errors and does not produce copper sulfate crystals. It was quite common for students to miss that the wrong two chemicals were being used in the question stem. And although some students could see that a copper compound needed to be used, they didn't recognise that sulfuric acid would be needed to produce a sulfate.

Common improvements that gained no credit included quoting volume and masses, while some responses just changed the apparatus, or expanded the method and still included the errors.

In many cases students mentioned an improvement but failed to explain the reason for the change. For example, many students:

- mentioned the need to filter but failed to state that filtering removed the excess copper carbonate
- stated that excess base was added but did not justify that this was to ensure all the acid was neutralised.

This question discriminated between students well with 31% of students achieving a level 2 or 3 mark. Students generally found it tough, with 2% achieved full marks, and 22% of gaining no credit.

5.4.2.3 Soluble salts

Answer 02 · Examiner comments — June 2019 | 8464/C/1H | Original Q2

Question 2

This question was common with the Foundation paper and included an extended response question based around Required Practical Activity 10. Each item was at standard demand.

02.1 This question was poorly answered where only a quarter of students gained the mark. A wide range of incorrect responses were seen. Many students wrote a chemical formula of ammonium nitrate instead of the state symbol. Students should know that state symbols are lower case only which are written in brackets.

02.2 Around two-thirds of students identified the correct formula of nitric acid. The next most common response was the alkali NH_4OH

02.3 This recall question was generally well answered with more than half the students gaining both marks. Two colours were often listed eg red/orange or blue/purple when only one colour was required. The most common incorrect responses included green, black and colourless.

Answer 02 · Examiner comments — June 2019 | 8464/C/1H | Original Q2

02.4 Approximately one-third of students identified the correct pH change when nitric acid was added to ammonia solution. The three incorrect responses were selected in approximately equal amounts. A large number of students did not follow the rubric of the question which required them to tick one box only.

02.5 This question discriminated well. Two-thirds of students gained all three marks for an answer of 60%. A very common error was to carry out the calculation for only one oxygen atom, leading to an answer of 20%, which gained two marks. Some students started the calculation correctly by calculating 48 for three oxygen atoms, but then subtracted that from the given relative formula mass to give 32, which was then used in a percentage calculation.

02.6 Most students had a good understanding of the requirements of this question which was based upon Required Practical Activity 10. They could appreciate the need to control variables, although the most common errors were to not mention a constant volume of water when starting each experiment or not taking the temperature of the water before the ammonium nitrate was added. The descriptions were often poorly organised with statements relating to a constant volume of water or measuring the starting temperature appearing at the end of the response. Some students carried out the experiment in one container, adding successive masses to the same beaker in the same way they could have done a heat of neutralisation experiment. This question discriminated well with approximately a fifth of students achieving level 3 and a half achieving level 2.

5.4.2.3 Soluble salts

Answer 03 · Examiner comments

November 2021 | 8464/C/1H | Original Q2

Question 2 (standard demand)

02.1 Just under half of students correctly choose ‘green to red’ as the colour change observed when nitric acid is added to a mixture of universal indicator and water.

02.2 Just over one half of students knew that the pH of water decreases when nitric acid was added.

Answer 03 · Examiner comments

November 2021 | 8464/C/1H | Original Q2

02.3 Few students were able to give (aq) as the state for a substance dissolved in water.

02.4 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. Very few students scored two marks.

02.5 Students found difficulty in determining the formula for zinc nitrate. Just over one third of students gained the mark.

02.6 Students had difficulty in describing the essential steps of the required practical activity of making a soluble salt from an insoluble metal oxide and an acid. Many failed to select the correct chemicals, copper oxide and hydrochloric acid; without these the method would not lead to a valid outcome. Very few students got into level three. Approximately four fifths of students produced a level one answer.

5.4.2.3 Soluble salts

Answer 04 · Examiner comments — June 2022 | 8464/C/1H | Original Q1

Question 1 (Standard demand)

01.1 Students were asked to state observations when copper carbonate is added to sulfuric acid. 30% of students gave at least two correct observations. The most common responses were ‘colour changes’ or ‘fizzing’. 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 gave vague comments such as ‘there was a reaction’, or ‘it stopped reacting’, along with describing the reaction with comments such as carbon dioxide gas was given off. Some students referred to copper carbonate as either copper or copper oxide which are different chemicals.

01.2 Nearly three quarters of students knew that filtration is used to separate unreacted copper carbonate after a reaction between sulfuric acid and excess copper carbonate.

01.3 Just under half the students knew the pH of the solution at the end of the reaction between sulfuric acid and excess copper carbonate.

01.4 Just over a third of students knew that the reaction between sulfuric acid and copper carbonate was neutralisation.

Answer 04 · Examiner comments — June 2022 | 8464/C/1H | Original Q1

01.5 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 40% of students were able to gain all 3 marks. There were a minority of students who failed to show any working except for small crosses on the graph.

5.4.2.3 Soluble salts

Answer 05 · Examiner comments June 2022 | 8464/C/2H | Original Q2

Question 2

The topic of water purification was generally not well known.

02.1 Over 50% of students were able to score at least 3 marks comparing the methods of treatment of ground and wastewater to make potable water. This was for simple statements that both waters need to be filtered and/or sterilised, and that ground water is easier to treat than wastewater. The idea that both waters need to be distilled was very commonly seen, mistaking this with sea water.

02.2 About 70% of students were able to identify distillation to desalinate sea water. The most common incorrect response was filtration.

02.3 Over half of students were able to score two marks on this item, with the conversion of cm^3 to dm^3 being the most likely mark missed. 1 in 5 students gained 3 marks here.

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

Question 6 (standard/high and high demand)

06.1 Students found difficulty in describing how to obtain magnesium chloride from the reaction solution. Just over one third of students gained at least one mark. A number of students did not filter out the excess magnesium before crystallising the solution and many referred to magnesium displacing hydrogen.

06.2 A common response was that magnesium displaces the hydrogen without any explanation; many students did not appreciate that this is a redox reaction. Students should realise that metals always undergo oxidation which can be related to dot and cross diagrams in ionic bonding. In this question identifying what is oxidised (ie the metal) is easier than identifying what is reduced ie H+ ion (not hydrogen). Magnesium is oxidised during the reaction with hydrochloric acid as magnesium atoms lose two electrons. Students found it challenging to describe what happens to the magnesium atoms with only a quarter gaining more than one mark. Many students who stated that magnesium atoms were oxidised then went on to state it was because they gained oxygen. A common mistake was to say that atoms (not electrons) were lost.

06.3 Students found this calculation challenging but the question proved to be a good discriminator. A third of students gained at least one mark for initially calculating the number of moles of magnesium. About 20% went on to calculate the mass of magnesium chloride produced as 2.85 grams. Only a small percentage of students then went on to determine the concentration of the magnesium chloride solution produced; students struggled with the conversion of 100 cm^3 into dm^3 so a wide variety of answers were seen where a mass of 2.85 grams had been multiplied by ‘some factor of 10’.

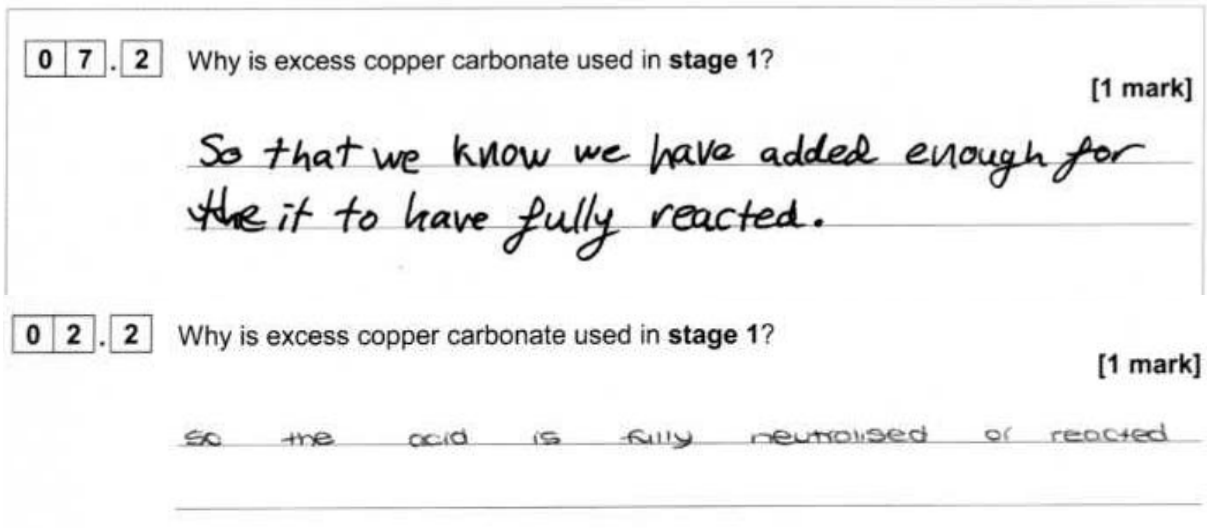
Answer 07 · Examiner comments

June 2024 | 8464/C/1H | Original Q2

Question 2 (standard demand)

02.1 By selecting H_2SO_4 70% of students answered correctly. HCl was the most common incorrect response.

02.2 Excess copper carbonate is used to ensure all the acid reacts. More than a quarter of students answered this correctly. 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.



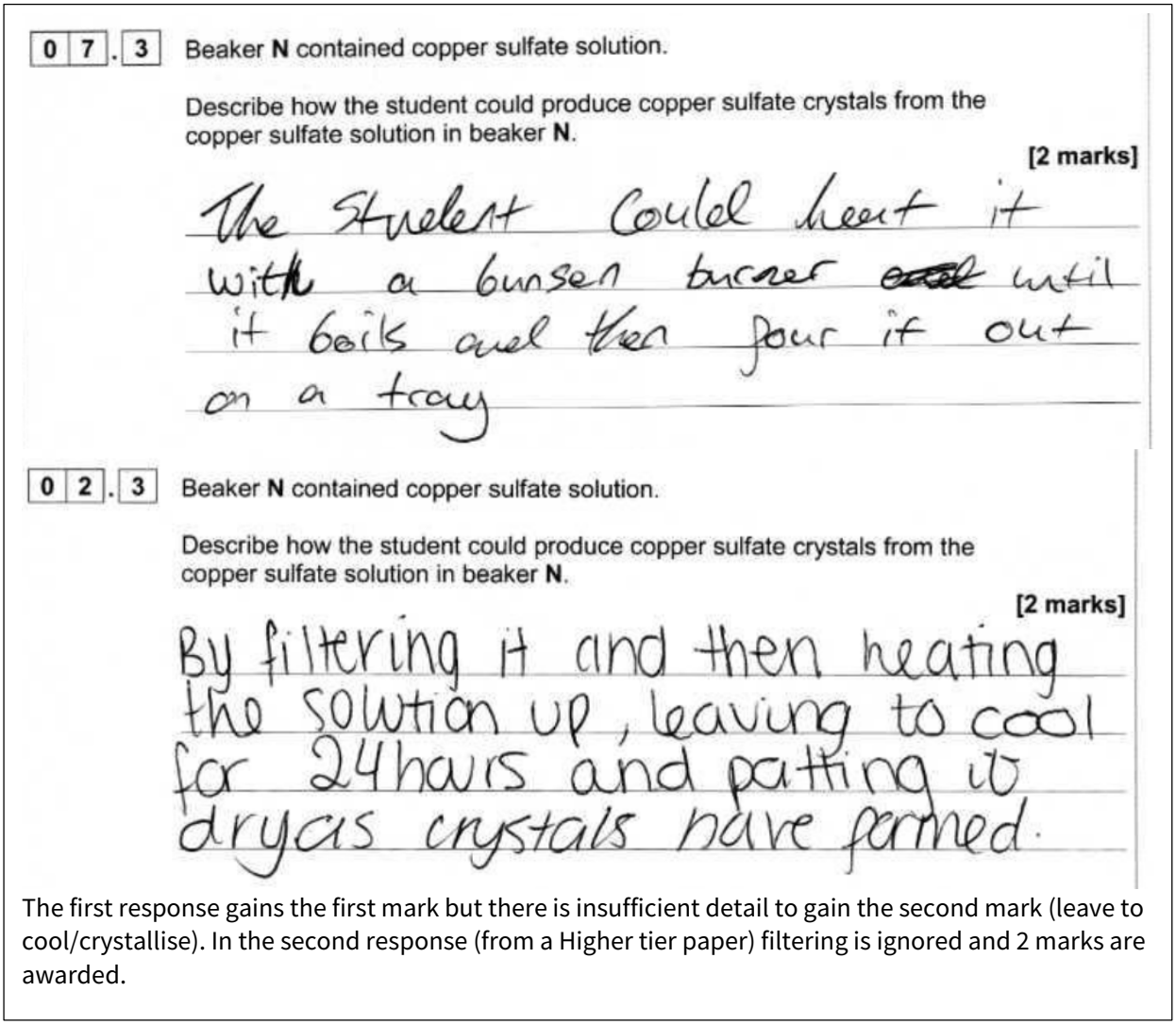
The first response (from a Foundation tier paper) is not creditworthy as 'it' refers to the copper carbonate. The second response gains a mark as 'acid is the limiting reactant' or 'to fully neutralise the acid' are equivalent to all the acid reacting.

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5.4.2.3 Soluble salts

Answer 07 · Examiner comments June 2024 | 8464/C/1H | Original Q2

02.3 The method would work if filtration was carried out immediately before or after heating so was ignored in any response. Just over a third of 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 dry as 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.

02.4 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 as below, 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. Nearly two-thirds of students gained all 3 marks and more than a third 2 marks.

02.5 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 this 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.

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