AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.4.2.2

Neutralisation of acids and salt production

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**41**
Available paper years	**2008–2025**

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.

4.4.2.2 Neutralisation of acids and salt production

Answer 01 · Mark scheme

January 2008 | CHY2H | Original Q5 | Legacy

The full source mark scheme begins on page 95. Follow original question 5 in that document.

Answer 02 · Mark scheme

March 2009 | CHY1AP | Original Q2 | Legacy

Two	**A** decomposed		**2**
	B acidified		**3**
	C reduced		**4**
	D extracted		**1**

	A	**B**	**C**	**D**

4.4.2.2 Neutralisation of acids and salt production

Answer 03 · Mark scheme

January 2010 | CHY2H | Original Q2 | Legacy

Question 2

question	answers	extra information	mark
2(a)	gas / g	accept low density / low boiling point **or** weak intermolecular forces **or** small molecules **or** simple molecules **or** simple molecular (structure) accept volatile **or** easy to evaporate ignore very light ignore incorrect name of gas	1
2(b)	filter / filtration	accept filter paper accept decant / centrifuge ignore filter funnel / sieving / drained off / funnelling ignore names of compounds ignore evaporation / heating if after filtration do **not** accept crystallisation	1
2(c)	evaporation / crystallisation	accept heating / boiling accept 'leave for a few days' owtte allow cool do **not** allow freeze ignore filtration	1

Question 2 continues on next page

CHY2H

Question 2 continued

question	answers	extra information	mark
2(d)	candidates can gain marks from any two of the three linked pairs		
	hydrogen chloride escaped / released (into atmosphere) **or** (hydrogen chloride) damaged vegetation / harmful	to get both of these **2** marks hydrogen chloride must be mentioned ignore HCl formed / produced / made	1
	used to make chlorine / bleach	ignore sale of hydrogen chloride	1
	unpleasant smell (of calcium sulfide) **or** waste of calcium (sulfide)	ignore calcium sulphide alone allow calcium / calcium sulfate for calcium sulphide to get both of these 2 marks calcium (sulphide) must be mentioned	1
	converted to sulfur **or** used to make sulfuric acid	ignore sale of calcium sulfide	1
	unreacted coal (1) recycled / burnt / used / sold (1)	must be linked to first coal point	
Total			**7**

4.4.2.2 Neutralisation of acids and salt production

Answer 03 · Mark scheme

January 2010 | CHY2H | Original Q2 | Legacy

CHY2H

Answer 04 · Mark scheme

March 2010 | CHY1AP | Original Q6 | Legacy

Six	**4**	**1**	**3**	**4**

4.4.2.2 Neutralisation of acids and salt production

Answer 05 · Mark scheme

January 2011 | CHY2H | Original Q3 | Legacy

Question 3

question	answers	extra information	mark
3(a)	• made of layers / rows (atoms / ions / particles) • which can slide / slip (over each other) **or** particles / ions / atoms can slide over each other	ignore free / delocalised electrons reference to incorrect particles / covalency / intermolecular forces = max **1** ignore malleable / ductile / weak bonds	1 1
3(b)(i)	sulfuric	accept sulphuric ignore formula ignore hydrogen sulfate	1
3(b)(ii)	any **two** from: • (hydrogen) gas produced (or any indication of a gas such as bubbles etc.) • magnesium / solid disappears / goes into solution • gets hot	list principle applies for incorrect observations ignore just hydrogen produced ignore cloudiness / colour changes accept magnesium / magnesium sulfate / solid / it dissolves accept forms a liquid / solution allow exothermic ignore floats	2
3(b)(iii)	crystallisation **or** evaporation / heating / boiling / cooling	accept detailed answers such as: evaporate to half volume and then allow the solution to crystallise. ignore any references to filter	1
Total			**6**

4.4.2.2 Neutralisation of acids and salt production

Answer 05 · Mark scheme

January 2011 | CHY2H | Original Q3 | Legacy

CHY2H

4.4.2.2 Neutralisation of acids and salt production

Answer 06 · Mark scheme

June 2011 | CHY1H | Original Q2 | Legacy

Question 2

question	answers	extra information	mark
2(a)(i)	heat / high temperature / hot / vaporise	if (fractional) distillation / hydrogenation mentioned as the method = max 1 allow thermal decomposition ignore evaporation do **not** accept 'burns' do **not** accept temperature < 100	1
	catalyst **or** silica / alumina / porous pot **or** steam	ignore other named catalyst allow heat (the vapour) to a very high temperature / >800°C for **2** marks	1
2(a)(ii)	C_2H_3Cl	ignore attempts to balance equation	1
2(a)(iii)	single bonds between C – H, C – Cl **and** C – C	do **not** accept symbols outside the bracket	1
2(b)(i)	so that the amount of plasticiser / (sample of) PVC is the independent / only variable that affects the bending / flexibility of the samples	allow because different sizes would give different results accept because size is a control variable ignore references to reliability / precision etc	1
2(b)(ii)	to improve the reliability (of the investigation)	accept to calculate a mean accept to check for anomalous results **or** to check the range of results ignore accuracy / precision etc	1

Question 2 continues on the next page . . .

4.4.2.2 Neutralisation of acids and salt production

Answer 06 · Mark scheme

June 2011 | CHY1H | Original Q2 | Legacy

CHY1H

Question 2 continued . . .

question	answers	extra information	mark
2(b)(iii)	23	correct answer with or without working = **2** marks if answer is incorrect allow $\frac{22+23+24}{3}$ **or** 21 for **1** mark	2
2(b)(iv)	(PVC) sample had been stretched / used / tested in first three tests	accept higher temperature allow worn **or** become weaker ignore (human) error ignore more flexible / softer ignore intermolecular forces	1
2(c)	does not bend (easily / much) **or** it is not flexible **or** it is rigid	ignore non-biodegradable / low maintenance ignore sturdy / stronger / harder	1
Total			**10**

4.4.2.2 Neutralisation of acids and salt production

Answer 06 · Mark scheme

June 2011 | CHY1H | Original Q2 | Legacy

CHY1H

4.4.2.2 Neutralisation of acids and salt production

Answer 07 · Mark scheme

January 2012 | CH1HP | Original Q6 | Legacy

Question 6

question	answers	extra information	mark
6(a)	limewater **or** calcium hydroxide solution		1
	(reacts with carbon dioxide and) turns cloudy / milky	linked to first point if no other mark awarded 'puts out lighted splint' gains **1** mark	1
6(b)(i)	any **two** from: • same volume / amount of the acids • concentration of the acids • temperature • same surface area / size / mass / amount of calcium carbonate • same measuring equipment		2

Question 6 continues on the next page…….

4.4.2.2 Neutralisation of acids and salt production

CH1HP

Question 6 cont'd…

question	answers	extra information	mark
6(b)(ii)	any **three** from: • (after about 4 minutes) the sulfuric acid stops reacting **or** nitric acid continues to react • (initially) the reaction with sulfuric acid is faster • (the reaction stops) because calcium sulfate is a solid • (the reaction continues) because calcium nitrate is soluble / in solution / aqueous • because the calcium sulfate prevents the sulfuric acid reacting with the calcium carbonate • (the rate is faster) because sulfuric acid contains two hydrogens	accept more CO_2 with nitric acid at any time after 4 minutes allow sulfuric acid produces a solid allow nitric acid produces an (aqueous) solution	3
Total			**7**

4.4.2.2 Neutralisation of acids and salt production

Answer 07 · Mark scheme

January 2012 | CH1HP | Original Q6 | Legacy

CH1HP

4.4.2.2 Neutralisation of acids and salt production

Answer 08 · Mark scheme

June 2012 | CH2HP | Original Q2 | Legacy

Question 2

question	answers	extra information	mark
2(a)	Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information on page 2, and apply a 'best-fit' approach to the marking.		6

0 marks	Level 1 (1-2 marks)	Level 2 (3-4 marks)	Level 3 (5-6 marks)
No relevant content.	There is a simple description of a laboratory procedure for obtaining potassium chloride.	There is a clear description of a laboratory procedure for obtaining potassium chloride from potassium hydroxide solution and hydrochloric acid that does not necessarily allow the procedure to be completed successfully by another person. The answer must include the use of an indicator / pH meter **or** a method of obtaining crystals.	There is a detailed description of a laboratory procedure for obtaining potassium chloride from potassium hydroxide solution and hydrochloric acid that can be followed by another person. The answer must include the use an indicator / pH meter **and** a method of obtaining crystals

examples of the chemistry points made in the response:

- One reagent in beaker (or similar)
- Add (any named) indicator
- Add other reagent
- Swirl **or** mix
- Add dropwise near end point
- Stop addition at change of indicator colour
- Note volume of reagent added
- Repeat without indicator, adding same volume of reagent **or** remove indicator using charcoal
- Pour solution into basin / dish
- Heat (using Bunsen burner)
- Leave to crystallise / leave for water to evaporate / boil off water

Accept any answers based on titration

Question 2 continues on the next page . .

CH2HP

Question 2 cont'd…

question	answers	extra information	mark
2(b)	nitric (acid)	allow HNO_3 ignore incorrect formula	1
2(c)(i)	because it is a fertiliser / helps plants grow	allow plant food do **not** accept pesticide / herbicide / neutralising soil	1
2(c)(ii)	tick by: 'Should farmers stop using ammonium nitrate on their land?' any **two** from: • cannot be done by experiment • based on opinion / view • ethical **or** economic issue	 accept difficult to get / not enough evidence allow must be done by survey if top box ticked allow **1** mark for drinking water varies from place to place	1 2
Total			**11**

4.4.2.2 Neutralisation of acids and salt production

Answer 08 · Mark scheme

June 2012 | CH2HP | Original Q2 | Legacy

CH2HP

4.4.2.2 Neutralisation of acids and salt production

Answer 09 · Mark scheme

January 2013 | CH2HP | Original Q1 | Legacy

question	answers	extra information	mark
1(a)	because sulfur / S forms which is insoluble / a solid / a precipitate		1 1
1(b)(i)	32	correct answer with or without working gains **2** marks accept evidence of 31 + 33 / 2 for **1** mark allow 35 for **1** mark	2
1(b)(ii)	reaction rate increases because of more particles (per unit volume) and because there is an increase in frequency of collisions	if incorrect reference to energy = max **2** allow because particles are closer together accept because particles are more likely to collide **or** higher chance of collision ignore more (successful) collisions	1 1 1
Total			**7**

4.4.2.2 Neutralisation of acids and salt production

Answer 09 · Mark scheme

January 2013

CH2HP

4.4.2.2 Neutralisation of acids and salt production

Answer 10 · Mark scheme

January 2013 | CH2HP | Original Q2 | Legacy

question	answers	extra information	mark
2(a)(i)	because they are positively charged	accept they are positive / H^+ accept oppositely charged **or** opposites attract ignore they are attracted	1
2(a)(ii)	gains one / an electron	accept $H^+ + e^- \rightarrow H$ or multiples allow gains electrons	1
2(b)	3 bonding pairs 1 lone pair	 accept 2 non-bonding electrons on outer shell of nitrogen	1 1
2(c)(i)	hydroxide / OH^-	do **not** accept sodium hydroxide	1
2(c)(ii)	$H^+ + OH^- \rightarrow H_2O$	ignore state symbols ignore word equation	1

4.4.2.2 Neutralisation of acids and salt production

January 2013

CH2HP

question	answers	extra information	mark
2(d)	Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5.		6

0 marks	Level 1 (1-2 marks)	Level 2 (3-4 marks)	Level 3 (5-6 marks)
No relevant content.	There are basic descriptions of advantages or disadvantages of the electrolysis cells.	There are clear descriptions of environmental or economic advantages or disadvantages of the electrolysis cells. Comparisons may be implied.	There are detailed descriptions of environmental and economic advantages and disadvantages, comparing the electrolysis cells.

examples of chemistry points made in the response:

Accept converse where appropriate.

- mercury cell is more expensive to construct
- mercury is recycled but membranes must be replaced
- mercury is toxic but membrane / polymer is not
- removing traces of mercury from waste is expensive
- mercury cell uses more electricity
- mercury cell produces chlorine that is purer
- mercury cell produces higher concentration / better quality of sodium hydroxide (solution)

Total			12

4.4.2.2 Neutralisation of acids and salt production

Answer 10 · Mark scheme

January 2013

CH2HP

4.4.2.2 Neutralisation of acids and salt production

Answer 11 · Mark scheme

June 2013 | CH2HP | Original Q2 | Legacy

Question 2

question	answers	extra information	Mark
2(a)	any **two** from: • effervescence / bubbles / fizzing • magnesium disappears / dissolves • heat given off / exothermic • change in pH	 allow gas / hydrogen is given off allow volume of gas allow magnesium floats allow change in mass of magnesium allow temperature change do **not** accept temperature decreases do **not** accept pH decreases	2

2(b)	Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5.		6
0 marks	**Level 1 (1-2 marks)**	**Level 2 (3-4 marks)**	**Level 3 (5-6 marks)**
No relevant content.	A simple plan without reference to changing any variable but should include an attempt at measuring rate **or** an attempt at fair testing	A plan including change of concentration / 'volume' of acid **and** should include an attempt at measuring rate **and / or** an attempt at fair testing	A workable plan including change of concentration **and** measurement of rate **and** fair testing

examples of chemistry points made in the response could include:

Plan:

- add magnesium to acid
- time reaction / 'count bubbles' / measure volume of gas
- change concentration / 'volume' of acid

Control Variables:

- amount / mass / length / same 'size' of magnesium
- volume / amount of acid

Total			8

4.4.2.2 Neutralisation of acids and salt production

Answer 12 · Mark scheme

June 2013 | CH2HP | Original Q4 | Legacy

Question 4

question	Answers	extra information	Mark
4(a)(i)	current / charge couldn't flow	allow could not conduct (electricity)	1
	because the ions / particles couldn't move **or** (salt) needs to be molten / dissolved (to conduct electricity) (1)	do **not** accept electrons/ molecules / atoms	1
	so that the ions / particles can move (1)	do **not** accept electrons / molecules / atoms	
4(a)(ii)	he had status **or** he had evidence / proof	accept he had authority **or** experience accept the experiment could be repeated	1
4(b)	hydrogen / H_2	do **not** allow hydrogen ions	1
	the ions are positive	accept because opposite (charges) attract	1
	potassium is more reactive (than hydrogen)	accept potassium ions are less easily discharged (than hydrogen) **or** potassium ions are less easily reduced (than hydrogen)	1
4(c)(i)	gain electron(s)	accept fully balanced correct equation for **2** marks	1
	one electron	if no other marks awarded allow (potassium ions) reduced for **1** mark	1
4(c)(ii)	$\mathbf{2}Cl^- \rightarrow Cl_2 + \mathbf{2e^-}$	must be completely correct, including charge on electron accept correct multiples	1
4(c)(iii)	2, 8, 8	accept any combination of dots, crosses, "e" or any other relevant symbol ignore any charges if given	1
Total			**10**

4.4.2.2 Neutralisation of acids and salt production

Answer 13 · Mark scheme

June 2013 | CH3HP | Original Q5 | Legacy

Question 5

question	Answers	extra information	Mark
5(a)(i)	place sample in flame	accept flame test accept any workable method allow burn ignore heat	1
	sodium: yellow (flame)	allow orange	1
	potassium: lilac (flame)	allow purple	1
5(a)(ii)	(lilac) colour (of potassium) obscured by (yellow) colour of sodium	allow difficult to see two colours allow sodium colour is brighter allow colours mix	1
5(b)	acidify (with nitric acid)	do **not** accept if acidified with anything other than nitric acid	1
	add silver nitrate (solution)		1
	white precipitate	depends on second marking point allow white solid ignore silver chloride ignore solution goes cloudy / milky	1
5(c)(i)	add excess (sodium hydroxide)	allow add sodium hydroxide	1
	aluminium (ions / hydroxide) (re)dissolve	depends on first marking point allow if aluminium, (white) precipitate / solid dissolves allow magnesium (ions / hydroxide) do not (re)dissolve	1
5(c)(ii)	place sample in flame	accept flame test accept any workable method allow burn ignore heat	1
	flame does not go red	accept calcium (ions / hydroxide would produce) red flame allow magnesium (ions / hydroxide) (produce) no flame colour	1
Total			11

4.4.2.2 Neutralisation of acids and salt production

Answer 14 · Mark scheme June 2014 | CH2HP | Original Q3 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
3(a)	O_2 in correct space		1	2 / 2.4	E
	correct balancing	accept multiples	1		
3(b)(i)		*incorrect reference to energy = max **2***		1 / 2.4.1d	E
		ignore references to equilibrium			
	rate increases		1		
	because particles are closer together	accept because there are more particles (per unit volume)	1		
		allow particles have less space / room to move around			
	so frequency of collisions increases	*accept particles are more likely to collide*	1		
		ignore more collisions			
		ignore more successful collisions			
3(b)(ii)	has a greater surface area		1	3 / 2.4.1f/g	E
	so the reaction is faster	*accept so more frequent collisions*	1		
3(c)	the (minimum) amount of energy (particles must have) to react ***or*** *to start a reaction*	accept the energy needed to break bonds	1	1 / 2.4.1b	E
		ignore references to heat			
3(d)(i)	(potassium is) too / *very* reactive	*ignore potassium is a Group 1 / alkali metal*	1	1 + 2 / 2.6.1b	E
	so dangerous / *violent reaction*	accept hydrogen produced rapidly	1		
3(d)(ii)		accept products in either order		2 / 2.6.2b	E
		ignore names of substances			
		*do **not** accept brackets or charges in the formulae*			
	$ZnSO_4$		1		
	H_2		1		

4.4.2.2 Neutralisation of acids and salt production

3(d)(iii)	any **one** from: • increase concentration (of sulfuric acid) • increase temperature **or** heat it • increase surface area of zinc		1	1 / 2.4.1	E
Total			**13**		

4.4.2.2 Neutralisation of acids and salt production

Answer 14 · Mark scheme

June 2014 | CH2HP | Original Q3 | Legacy



4.4.2.2 Neutralisation of acids and salt production

Answer 15 · Mark scheme June 2014 | CH3HP | Original Q4 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
4(a)(i)	calcium (carbonate) **or** magnesium (carbonate)	allow $CaCO_3$ allow $MgCO_3$	1	1 / 3.2.1b	E
4(a)(ii)	carbon dioxide	allow CO_2	1	1 / 3.4.1d	G
4(b)	– COOH group correctly displayed		1	1 / 3.6	E
4(c)(i)	 because hydrochloric acid is a strong(er) acid which ionises more	allow converse *throughout* 'it' refers to hydrochloric acid *allow because hydrochloric acid has lower pH* accept produces / has more hydrogen ions / H^+ ions	 1 1	1 + 3 / 3.6.2b	E
4(c)(ii)	corrosive	allow reacts with *heating* element / kettle *ignore dissolves*	1	3 / 3.6.2b	E
4(d)	0.2288	correct answer gains **3** marks with or without working accept 0.229 ***or*** *0.23* if answer is incorrect 28.6 x 0.2 ÷ 1000 (=0.00572) gains **1** mark 0.00572 x 1000 ÷ 25 or ecf gains **1** mark ***or*** 28.6 x 0.2 ÷ 25 gains **2** marks	3	2 / 3.4.1h	E
Total			**9**		

4.4.2.2 Neutralisation of acids and salt production

Answer 15 · Mark scheme

June 2014 | CH3HP | Original Q4 | Legacy



4.4.2.2 Neutralisation of acids and salt production

Answer 16 · Mark scheme

June 2015 | CH1HP | Original Q2 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
2(a)(i)	(calcium) carbonate	ignore $CaCO_3$	1	1 / 1.2.1a
2(a)(ii)	(thermal) decomposition		1	1 / 1.2.1b
2(a)(iii)	water	allow H_2O allow hydrogen oxide	1	1 / 1.2.1d
2(a)(iv)	alkali	allow base	1	1 / 1.2.1d
2(b)(i)	straight line through the first, second and fourth points straight line through the last four points	 allow a straight line through the last three points if the first straight line extrapolates below point four	1 1	2+3 / 1.2.1g
2(b)(ii)	repeat the experiment (at each mass of aggregate) (use the results to) calculate a mean/average value (for each mass of aggregate)	do not allow repeat at other masses	1 1	3 / 1.2.1g

4.4.2.2 Neutralisation of acids and salt production

Answer 16 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
2(b)(iii)	line drawn to y axis showing extrapolation		1	2+3 / 1.2.1g
	correct value read from graph	allow +/- one small square do not allow 0 award 1 mark for a value of 34-40 if no extrapolation shown	1	
2(b)(iv)	at first, the force needed to break a concrete beam increases	allow values allow at first the statement is correct	1	3 / 1.2.1g
	but the force needed to break a concrete beam then decreases	allow values	1	
	mention of 400 g as the point at which the force needed changes or value from graph	allow 400g if there is no intercept on graph	1	
Total			**13**	

4.4.2.2 Neutralisation of acids and salt production

Answer 16 · Mark scheme

June 2015 | CH1HP | Original Q2 | Legacy



4.4.2.2 Neutralisation of acids and salt production

Answer 17 · Mark scheme June 2015 | CH3HP | Original Q8 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
8(a)(i)	any **one** from • incorrect measurement of temperature or volume • incorrect recording of temperature • failure to stir • heat loss	ignore faulty equipment	1	**AO3** 3.1.3.c
8(a)(ii)	32 - 33		1	**AO2** 3.1.3.c
8(a)(iii)	55		1	**AO2** 3.1.3.c
8(a)(iv)	20		1	**AO2** 3.1.3.c
8(a)(v)	4620 J / joules	allow 4.62 kJ for **2 marks** allow kJ if evidence of dividing by 1000 mark independently, but if a numerical answer has been divided by 1000 must be kJ. allow ecf from their answers to 8(a)(iii) and 8(a)(iv)	1 1	**AO2** 3.3.1.b/c
8(b)	twice as much energy released but twice as much water to heat	allow more energy released but more water to heat for **2 marks** if no other mark awarded, allow twice the amount of hydrochloric acid used for **1 mark**	1 1	**AO3** 3.3.1.c
Total			**8**	

4.4.2.2 Neutralisation of acids and salt production

Answer 18 · Mark scheme June 2016 | CH2HP | Original Q2 | Legacy

Question	Answers	Extra information	Mark	AO / SpecRef
2(a)	endothermic		1	AO1 2.5.1d
2(b)	82 (%)	correct answer with working gains **3** marks if 17 or 34 not shown in working **max 2** marks accept 82.4 accept 82.35 to full calculator display (82.35294...) correctly rounded to at least 2 sf if no answer or incorrect answer, then (M_r =) 17 gains **1** mark **or** 14/17 gains **2** marks **OR** ($2M_r$ =) 34 gains **1** mark **or** 28/34 gains **2** marks **OR** 14/their M_r shown gains **1** mark **or** correct calculation of 14/their M_r gains **2** marks	3	AO2 2.3.3a, 2.3.1f
2(c)(i)	7 / seven		1	AO1 2.6.2d
2(c)(ii)	$H^+ + OH^- \rightarrow H_2O$		1	AO1 2.6.2e
2(c)(iii)	ammonium chloride	allow NH_4Cl ignore an incorrect formula	1	AO1 2.6.2b

Question 2 continues on the next page

Answer 18 · Mark scheme

June 2016 | CH2HP | Original Q2 | Legacy

Question 2 continued

Question	Answers	Extra information	Mark	AO / SpecRef
2(d)			6	2AO2 / 4AO3 2.6.2c

Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5 and apply a 'best-fit' approach to the marking.

0 marks	Level 1 (1–2 marks)	Level 2 (3–4 marks)	Level 3 (5–6 marks)
No relevant content.	Suggestion with a reference to a graph.	Suggestion with reasons referring to more than one graph.	Suggestion with reasons from all three graphs, and linking of ideas which may explain a compromise.

Examples of chemistry points made in response:

A reasonable suggested amount of fertiliser would be in the region of 200 kg (per ha). Accept any suggestion from about 180 kg (per ha) to 500 kg (per ha).

Yield:

- Using fertiliser improves yield.
- Yield improved most up to about 200 kg (per ha) of fertiliser.
- Yield only increased slightly above about 200 kg (per ha).

Profit:

- About 200 kg of fertiliser gives the most profit.
- Above about 200 kg (per ha) of fertiliser profit declines.

Run off:

- Run off is at low levels until about 300 kg (per ha) of fertiliser.
- Above about 300 kg (per ha) of fertiliser, run off increases.

Examples of linking of ideas:

- Overall 200 kg gives high crop yield and most profit.
- In conclusion 200 kg gives high crop yield and low run off.
- 200 kg gives most profit and low run off.

Examples of compromise:

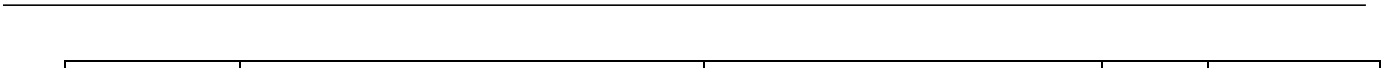
- Profits go down after about 200 kg (per ha) of fertiliser because cost of fertiliser is not covered by increased yield.
- 200 kg gives the highest profit although it is not the highest yield.
- 500 kg gives the best yield but has the most runoff.

Total			13

4.4.2.2 Neutralisation of acids and salt production

Answer 18 · Mark scheme

June 2016 | CH2HP | Original Q2 | Legacy



Answer 19 · Mark scheme

June 2017 | CH2HP | Original Q4 | Legacy

The full source mark scheme begins on page 110. Follow original question 4 in that document.

4.4.2.2 Neutralisation of acids and salt production

Answer 20 · Mark scheme June 2017 | CH3HP | Original Q4 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
4(a)(i)	2 (K +) 2 (H_2O →) 2 (KOH) + H_2	allow multiples allow H_2 for 1 mark allow 2 (K +) 2 (H_2O →) 2 (KOH) + 2H for 1 mark	2	**AO1** **AO2** 3.1.3a
4(a)(ii)	any **two** from: • potassium reacts more quickly / vigorously • potassium moves around more quickly • more bubbles from potassium • potassium melts • potassium produces a (lilac) flame	accept converse for Li allow dissolves more quickly allow more gas / hydrogen from potassium allow potassium catches fire	2	**AO1** **AO3** 3.1.3a
4(b)	add alkali to acid from burette until indicator changes colour take reading of volume at start and end repeat (and find mean) any **one** from • swirl / stir • add dropwise / slowly • white tile • rinse apparatus • meniscus • read at eye level	allow alternative apparatus for measuring volume allow appropriate use of pH probe allow record the volume used	1 1 1 1 1	**AO1** **AO3** 3.4.1g

4.4.2.2 Neutralisation of acids and salt production

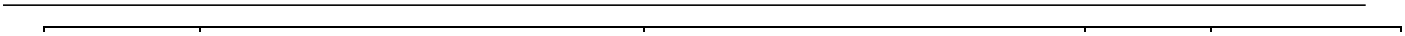
Answer 20 · Mark scheme

4(c)	0.21	if incorrect, 26.25 x 0.2/1000 or 0.00525 for 1 mark their moles x 1000/25.00 or their moles x 40 for 1 mark correct evaluation for 1 mark 0.19(0476…) gains only 1 mark with or without working	3	**AO2** 3.4.1h
Total			**12**	

4.4.2.2 Neutralisation of acids and salt production

Answer 20 · Mark scheme

June 2017 | CH3HP | Original Q4 | Legacy



4.4.2.2 Neutralisation of acids and salt production

Answer 21 · Mark scheme June 2017 | CH3HP | Original Q5 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
5(a)(i)	high temp increases rate	allow converse for low temperature	1	**AO1** **AO2** **AO3** 3.5.1d,e,f,h
	but decreases yield	allow shifts equilibrium to the left	1	
	because (forward) reaction is exothermic **or** so this (temperature) is a compromise	this mark dependent on M2 this mark dependent on both M1 and M2	1	
5(a)(ii)	high pressure increases yield	allow converse for low pressure allow shifts equilibrium to the right	1	**AO1** **AO2** 3.5.1d,g,h
	(because) more moles / molecules of gas on LHS	allow (because) greater volume of gas on LHS If no other mark gained, allow 1 mark for high pressure increase rate because molecules closer together **or** increased frequency of collisions.	1	
5(a)(iii)	any **one** from: • less risk of explosion/safer • less energy required • less likely to leak.	allow converse for high pressure ignore cost / strength of plant	1	**AO3** 3.5.1g

4.4.2.2 Neutralisation of acids and salt production

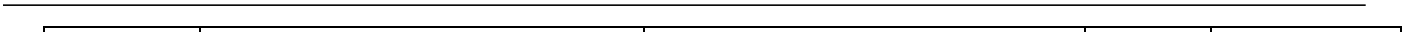
Answer 21 · Mark scheme

5(b)	white precipitate (forms) with aluminium, the ppt dissolves in excess **or** with magnesium, the ppt does not dissolve in excess		1 1	**AO1** 3.4.1b
Total			**8**	

4.4.2.2 Neutralisation of acids and salt production

Answer 21 · Mark scheme

June 2017 | CH3HP | Original Q5 | Legacy



4.4.2.2 Neutralisation of acids and salt production

Answer 22 · Mark scheme

June 2019 | 8462/1H | Original Q2

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	H^+		1	AO1 4.4.2.4
02.2	hydrochloric (acid) water	allow HCl allow H_2O	1 1	AO2 4.4.2.2
02.3	burette	do **not** accept biuret	1	AO1 4.4.2.5
02.4	27.6 (cm^3)	allow 27.60 (cm^3)	1	AO2 4.4.2.5

Question 2 continued

Question	Answers	Mark	AO/ Spec. Ref
02.5	**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 AO1
	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	AO1 x 2
	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	AO1 x 2
	No relevant content	0	
	Indicative content allow converse using acid added to alkali Key steps • measure the volume of acid • add indicator to the acid • add sodium hydroxide solution • until the colour changes • record volume of sodium hydroxide solution added • repeat procedure with the other acid Use of results • compare the two volumes of sodium hydroxide solution to find which sample **P** or **Q** is more concentrated Other points • pipette to measure volume of acid • use a few drops of indicator • swirl • use a white tile • rough titration to find approximate end point • add dropwise near the endpoint • read volume from bottom of meniscus • repeat and take a mean		4.4.2.5

Total			11	

4.4.2.2 Neutralisation of acids and salt production

Answer 23 · Mark scheme

November 2020 | 8462/1H | Original Q9

Question 9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.1	didn't stir (the solution enough)	allow measured the temperature before the temperature stopped falling allow measured the temperature too soon	1	AO3 4.5.1.1 RPA 4
09.2	the temperature decreases (initially) because energy is taken in (by the reaction from the solution)	allow temperature decreases (initially) because the reaction is endothermic	1	AO2 AO3 4.5.1.1 RPA 4
	when 1.5 g (of citric acid) is added the sodium hydrogencarbonate has all reacted **or** from 1.5 g the citric acid is in excess **or** when 1.5 g (of citric acid) is added the reaction is complete	allow when the temperature reaches 11.6 °C the sodium hydrogencarbonate has all reacted allow after the temperature reaches 11.6 °C the citric acid is in excess allow when the temperature reaches 11.6 °C the reaction is complete	1	
	(so) the temperature increases as energy is transferred from the room to the solution	allow (so) the temperature increases as energy is transferred from the excess citric acid to the solution	1	

Answer 23 · Mark scheme

Question 9 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.3	less steep line starting at 16.8 °C **and** reaching 1.00 g (of citric acid)	ignore any part of the line drawn beyond 1.00 g	1	AO3 4.2.2.8 4.5.1.1 RPA 4
	(as) metal is a better conductor	allow (as) polystyrene is a better insulator	1	
	(so) more energy is absorbed (from the surroundings)	allow (so) more heat is absorbed (from the surroundings)	1	
09.4	(M_r citric acid =) 192		1	AO2 4.3.2.5 4.3.4
	(moles = $\frac{250}{1000}$ × 0.0500) = 0.0125		1	
	(mass = 0.0125 × 192 =) 2.4 (g)	allow correct use of an incorrectly calculated M_r allow correct use of an incorrectly calculated number of moles	1	
	alternative approach:			
	(M_r citric acid =) 192 (1)			
	(concentration = 0.0500 × 192) = 9.6 (g/dm^3) (1)	allow correct use of an incorrectly calculated M_r		
	(mass = $\frac{250}{1000}$ × 9.6 =) 2.4 (g) (1)	allow correct use of an incorrectly calculated concentration in g/dm^3		

Answer 23 · Mark scheme

Question 9 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.5	add the citric acid (to the flask) until there is a (permanent) colour change	ignore colours of indicator	1	AO1 4.4.2.5 RPA 2
	measure / record the volume (of citric acid) added	allow take the final (and initial) burette reading	1	
	any **one** from: • swirl • use a white tile • add the citric acid dropwise (near the end-point) • repeat **and** calculate a mean	allow add the citric acid slowly (near the end-point)	1	
09.6	any **two** from: • can add (the citric acid) in small increments	allow can add (the citric acid) drop by drop allow can add (the citric acid) slowly	2	AO1 4.4.2.5 RPA 2
	• can measure variable volumes	allow has a scale		
	• more accurate than a measuring cylinder			

Question 9 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.7	(moles citric acid = $\frac{13.3}{1000}$ × 0.0500) = 0.000665		1	AO2 4.3.4 4.4.2.5 RPA 2
	(moles NaOH = 3 × 0.000665) = 0.001995	allow correct use of an incorrectly calculated number of moles of citric acid	1	
	(conc = $\frac{1000}{25}$ × 0.001995) = 0.0798 (mol/dm^3)	allow 0.08 or 0.080 (mol/dm^3) allow correct use of an incorrectly calculated number of moles of NaOH	1	
	alternative approach: $\frac{25.0 \times \text{conc NaOH}}{13.3 \times 0.0500} = \frac{3}{1}$ (1) (conc NaOH =) 3 × $\frac{13.3 \times 0.0500}{25.0}$ (1) = 0.0798 (mol/dm^3) (1)	allow $\frac{13.3 \times 0.0500}{25.0 \times \text{conc NaOH}} = \frac{1}{3}$ allow 0.08 or 0.080 (mol/dm^3)		

Total			18

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	potassium chloride	allow KCl	1	AO1 4.4.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	$H^+ + OH^- \rightarrow H_2O$	ignore state symbols	1	AO1 4.1.1.1 4.4.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	copper carbonate and copper oxide only		1	AO1 4.4.1.2 4.4.2.2 4.4.2.3 RPA1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	(Step 2) to speed up the reaction (Step 5) to make sure all the (hydrochloric) acid reacts (Step 6) to remove the excess magnesium oxide	 ignore to remove impurities	1 1 1	AO1 4.4.2.3 RPA1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5	using a (boiling) water bath **or** using an electric heater		1	AO1 4.4.2.3 RPA1

Question 5 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.6	(moles Fe = $\frac{14}{56}$ =) 0.25 (mol)		1	AO2 4.3.2.1 4.3.2.2 4.3.5
	(moles Cl_2 = $\frac{3}{2}$ × 0.25 =) 0.375 (mol)	allow correct use of an incorrectly calculated number of moles of Fe	1	
	(volume Cl_2 = 24 × 0.375) = 9.0 (dm^3)	allow correct use of an incorrectly calculated number of moles of Cl_2	1	

Total			**10**

4.4.2.2 Neutralisation of acids and salt production

Answer 25 · Mark scheme

November 2021 | 8462/1H | Original Q7

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1		allow voltage for electricity allow potential difference for electricity allow (electrical) current for electricity		AO1 4.4.3.1 4.5.2.1
	electrolysis uses electricity to produce a chemical reaction	allow electrolysis uses electricity to decompose a compound / electrolyte	1	
	(but) cells use a chemical reaction to produce electricity		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	$2\,Br^- \rightarrow Br_2 + 2\,e^-$	allow multiples allow **1** mark for Br_2 **and** e^-	2	AO2 4.1.1.1 4.4.3.1 4.4.3.2 4.4.3.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3				AO2 4.4.1.2 4.4.3.4 RPA3

Salt solution	Product at positive electrode	Product at negative electrode	Mark
(copper nitrate)	oxygen (1)	(copper)	1
(potassium iodide)	iodine (1)	hydrogen (1)	2

Question 7 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	filter the mixture wash and dry the copper / residue weigh the copper collected add to the increase in mass of the electrode		1 1 1 1	AO3 4.1.1.2 4.4.3.4 RPA3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.5	(for given current) straight line through the origin	allow (for given current) when time doubles, mass doubles	1	AO3 4.4.3.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.6	(for given time) when current doubles, mass doubles with supporting data		1	AO3 4.4.3.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.7	copper ions are discharged (from the solution)	allow the solution becomes less concentrated allow copper ions are removed (from the solution) allow copper ions are used up (from the solution)	1	AO3 4.4.3.1

Answer 25 · Mark scheme

November 2021 | 8462/1H | Original Q7

Question 7 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.8	(number of moles = $\frac{0.24}{63.5}$ =) 3.78×10^{-3} **or** 0.00378		1	AO2 4.3.2.1
	(number of atoms =) $0.00378 \times 6.02 \times 10^{23}$	allow correct use of an incorrectly calculated number of moles	1	
	$= 2.28 \times 10^{21}$	allow a correct evaluation to 3 significant figures of an incorrect expression which involves only a mass from the graph, the A_r of copper and the Avogadro constant	1	

Total			17

4.4.2.2 Neutralisation of acids and salt production

Answer 26 · Mark scheme

November 2021 | 8462/1H | Original Q9

Question 9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.1	a dilute solution of a strong acid		1	AO2 4.3.2.5 4.4.2.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.2	1.0 mol/dm^3 hydrogen chloride solution		1	AO2 4.4.2.4 4.4.2.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.3	any **two** from: • swirl (the solution) • white tile (under the flask) • add (ethanedioic) acid dropwise (near the endpoint) • repeat **and** calculate mean		2	AO3 4.4.2.5 RPA2

4.4.2.2 Neutralisation of acids and salt production

Answer 26 · Mark scheme

November 2021 | 8462/1H | Original Q9

Question 9 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.4	(concentration = 90 × 0.0480 =) 4.32 (g/dm^3)		1	AO2 4.3.2.1 4.3.2.5 4.3.4
	(mass = 4.32 × $\frac{250}{1000}$) = 1.08 (g)	allow correct use of an incorrectly calculated value of concentration in g/dm^3	1	
	alternative approach: (moles = 0.0480 × $\frac{250}{1000}$ =) 0.012 (mol) (1)			
	(mass = 0.012 × 90) = 1.08 (g) (1)	allow correct use of an incorrectly calculated value of number of moles		

4.4.2.2 Neutralisation of acids and salt production

Answer 26 · Mark scheme

November 2021 | 8462/1H | Original Q9

Question 9 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.5	(moles $H_2C_2O_4 = \frac{15.0}{1000} \times 0.0480$) = 0.00072 (mol)		1	AO2 4.3.4 4.4.2.5 RPA2
	(moles NaOH = moles $H_2C_2O_4 \times 2$ =) 0.00144 (mol)	allow correct use of an incorrectly calculated value of number of moles of $H_2C_2O_4$	1	
	(concentration= $\frac{0.00144}{25.0} \times 1000$) = 0.0576 ($mol/dm^3$)	allow 0.058 (mol/dm^3) allow correct use of an incorrectly calculated value of number of moles of NaOH	1	
	alternative approach: $\frac{\text{volume} \times \text{conc (acid)}}{\text{volume} \times \text{conc (NaOH)}} = \frac{1}{2}$ (1)	allow inverse		
	(conc NaOH =) $2 \times \frac{15.0 \times 0.0480}{25.0}$ (1)	allow correct use of incorrect mole ratio		
	= 0.0576 (mol/dm^3) (1)			

Total			9

4.4.2.2 Neutralisation of acids and salt production

Answer 27 · Mark scheme

November 2021 | 8462/2H | Original Q5

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	ammonium phosphate potassium nitrate		1 1	AO2 4.10.4.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	(nitric acid) calcium nitrate (phosphoric acid) (calcium) triple superphosphate **or** calcium dihydrogenphosphate		1 1	AO1 4.10.4.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	 (industrial process) (is) large(er) scale (is) quicker (is a) continuous process reasoned judgement	allow converse for laboratory process ignore references to cost / energy ignore large mass produced	 1 1 1 1	AO3 4.10.4.2

Total			8

4.4.2.2 Neutralisation of acids and salt production

Answer 28 · Mark scheme

June 2022 | 8462/1H | Original Q4

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	(zinc oxide) solid remaining	allow (zinc oxide) solid no longer disappears ignore references to colour / effervescence	1	AO1 4.2.2.2 4.4.2.2 4.4.2.3 RPA 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	(excess) zinc oxide can be filtered off	allow converse statements for hydrochloric acid allow separation / removal of (excess) zinc oxide is easier ignore to ensure all the (hydrochloric) acid is used up	1	AO1 4.4.2.2 4.4.2.3 RPA 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	any **one** from: • zinc hydroxide • zinc carbonate	allow $Zn(OH)_2$ allow $ZnCO_3$	1	AO1 4.4.2.2 4.4.2.3 RPA1

4.4.2.2 Neutralisation of acids and salt production

Answer 28 · Mark scheme

June 2022 | 8462/1H | Original Q4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	heat (the solution) until crystallisation point is reached	allow heat (the solution) until crystals start to form allow heat (the solution) to reduce the volume allow heat (the solution) to evaporate (some of the water)	1	AO1 4.4.2.3 RPA 1
	leave the solution (to cool / crystallise)		1	
		if no other mark is awarded allow **1** mark for heat the solution to dryness		

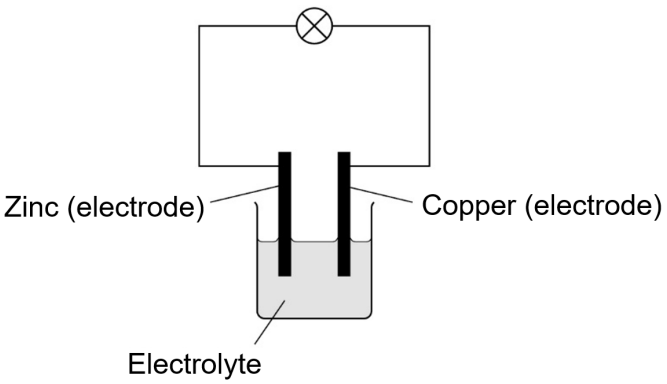
Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	$Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$	ignore state symbols	1	AO2 4.4.1.2 4.4.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.6	zinc (atoms) lose (2) electrons	do **not** accept references to oxygen	1	AO2 4.4.1.2 4.4.1.4

4.4.2.2 Neutralisation of acids and salt production

Answer 28 · Mark scheme

June 2022 | 8462/1H | Original Q4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.7	(a diagram showing) solution in a container zinc electrode **and** copper electrode both inserted into solution complete circuit that would function as an electrochemical cell including a labelled electrolyte an answer of  scores **3** marks	ignore voltmeter / ammeter regardless of location ignore labels ignore polarities on electrodes allow a named electrolyte in solution allow a named molten electrolyte do **not** accept cell / battery in external circuit do **not** accept a wire between the electrodes	 1 1 1	AO1 4.5.2.1

Total Question 4		10

4.4.2.2 Neutralisation of acids and salt production

Answer 29 · Mark scheme

June 2022 | 8462/1H | Original Q6

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	$Na^+ + e^- \rightarrow Na$		1	AO2 4.4.3.2 4.4.3.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	so the products do not react (to reform sodium chloride)		1	AO3 4.4.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	ion		1	AO3 4.4.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	hydrogen / H^+ (ions) hydroxide / OH^- (ions)		1 1	AO1 4.4.3.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.5	sodium hydroxide	allow NaOH	1	AO2 4.4.3.4

4.4.2.2 Neutralisation of acids and salt production

Answer 29 · Mark scheme

June 2022 | 8462/1H | Original Q6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.6	sodium ions and hydroxide ions are left (in solution)		1	AO2 4.4.3.4
	(because) hydrogen ions are discharged / reduced (at the negative electrode to form hydrogen)	allow (because) hydrogen ions gain electrons (at the negative electrode to form hydrogen) allow (because at the negative electrode) $2\ H^+ + 2\ e^- \rightarrow H_2$	1	
	(and because) chloride ions are discharged / oxidised (at the positive electrode to form chlorine)	allow (and because) chloride ions lose electrons (at the positive electrode to form chlorine) allow (and because at the positive electrode) $2\ Cl^- \rightarrow Cl_2 + 2\ e^-$	1	

Total Question 6		9

4.4.2.2 Neutralisation of acids and salt production

Answer 30 · Mark scheme

June 2022 | 8462/1H | Original Q8

Question 8

Question	Answers	Mark	AO/ Spec. Ref
08.1	**Level 3:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.	3-4	AO1 4.3.2.5 4.4.2.4 4.4.2.6
	Level 2: Relevant points (reasons / causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.	1-2	
	No relevant content	0	
	Indicative content <u>General principle</u> • pH depends on H^+ ion concentration • the higher the concentration of H^+ ions the lower the pH <u>Strength</u> • the stronger an acid the greater the ionisation / dissociation (in aqueous solution) • (so) the stronger the acid the lower the pH <u>Concentration</u> • the higher the concentration of an acid the more acid / solute in the same volume (of solution) • (so) the higher the concentration of the acid the lower the pH		

4.4.2.2 Neutralisation of acids and salt production

Answer 30 · Mark scheme

June 2022 | 8462/1H | Original Q8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.2	the mean of titration numbers 2 to 5 values is calculated	allow identification of titration by titration number or volume	1	AO3 4.4.2.5 RPA2
	(because) 23.90 (cm^3) is an anomalous result	allow (because) 23.90 (cm^3) is not concordant allow (because) 23.90 (cm^3) is too high a value allow (because) the first titration is a rough value	1	
		allow for **2** marks an answer of (because) the mean is taken of the values within 0.10 (cm^3)		
		allow for **2** marks an answer of (because) the mean is taken of the concordant values		

4.4.2.2 Neutralisation of acids and salt production

Answer 30 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.3	(moles $Ba(OH)_2$ = $\frac{23.50}{1000} \times 0.100$) = 0.00235		1	AO2 4.3.4 4.4.2.5 RPA2
	(moles HCl = 0.00235 × 2 =) 0.00470	allow correct use of an incorrectly calculated number of moles of $Ba(OH)_2$	1	
	(concentration =) $0.00470 \times \frac{1000}{25.0}$	allow correct use of an incorrectly calculated number of moles of HCl	1	
	= 0.188 (mol/dm^3)		1	
	alternative approach:			
	$\left(\text{ratio } \frac{\text{moles HCl}}{\text{moles Ba(OH)}_2} = \right)$	allow inverted expression		
	$\frac{2}{1} = \frac{25.0 \times \text{concentration}}{23.50 \times 0.100}$ (**2**)	allow **1** mark for the expression with an incorrect mole ratio		
	(concentration =) $\frac{2 \times 23.50 \times 0.100}{25.00}$ (1)	allow correct use of the expression with an incorrect mole ratio		
	= 0.188 (mol/dm^3) (1)			

4.4.2.2 Neutralisation of acids and salt production

Answer 30 · Mark scheme

June 2022 | 8462/1H | Original Q8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.4	there are no ions that are free to move	allow there are no ions in solution allow there are no ions free to carry the charge	1	AO3 4.2.2.3 4.4.2.2 4.4.2.4 4.4.2.5
	(because) barium sulfate is solid / insoluble		1	
	(and) hydrogen ions have reacted with hydroxide ions to produce water	allow (and) water is a covalent / molecular substance	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.5	the mixture (now) contains barium ions and hydroxide ions that are free to move	allow excess barium hydroxide solution contains ions	1	AO3 4.2.2.3 4.4.2.2 4.4.2.4 4.4.2.5

Total Question 8		14

Answer 31 · Mark scheme

June 2023 | 8462/1H | Original Q3

Question 3

Question	Answers	Mark	AO/ Spec. Ref
03.1	**Level 3:** The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.	5–6	AO1 4.4.2.2 4.4.2.3 RPA1
	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 • use zinc carbonate and hydrochloric acid • **add zinc carbonate to the (hydrochloric) acid** • in a beaker • stir • **continue adding until the zinc carbonate is in excess** • shown by excess solid • and no more effervescence • **filter (the reaction mixture)** • to remove the excess zinc carbonate • **heat the solution** • using a water bath or electric heater • to crystallisation point • **leave the solution to crystallise** • pat crystals dry with filter paper		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	any **two** from: • zinc • zinc oxide • zinc hydroxide	allow Zn allow ZnO allow $Zn(OH)_2$	2	AO2 4.4.2.3

Total Question 3	8

4.4.2.2 Neutralisation of acids and salt production

Answer 32 · Mark scheme

June 2023 | 8462/1H | Original Q5

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	(the acid is only) partially ionised (in aqueous solution)		1	AO1 4.4.2.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	the mass of acid dissolved is doubled and the volume of the solution is halved		1	AO2 4.3.2.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	methyl orange from yellow to red / orange / pink **OR** phenolphthalein (1) from pink to colourless (1) **OR** litmus (1) from blue to red (1)	MP2 is dependent on the award of MP1 if no other marks awarded, allow **1** mark for universal indicator turns from purple / blue to green / yellow / orange / red	1 1	AO1 4.4.2.5 RPA2

4.4.2.2 Neutralisation of acids and salt production

Answer 32 · Mark scheme

June 2023 | 8462/1H | Original Q5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	OH^-		1	AO1 4.4.2.4

4.4.2.2 Neutralisation of acids and salt production

Answer 32 · Mark scheme

June 2023 | 8462/1H | Original Q5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5	(moles $Na_2CO_3 = \frac{25.0}{1000} \times 0.124$) = 0.0031(0)		1	AO2 4.3.4 4.4.2.5 RPA2
	(moles $HNO_3 = 2 \times 0.0031(0)$) = 0.0062(0)	allow correct use of an incorrectly determined number of moles of Na_2CO_3	1	
	(concentration =) $\frac{0.0062(0)}{23.6} \times 1000$	allow correct use of an incorrectly determined number of moles of HNO_3	1	
	= 0.262711864		1	
	= 0.263 (mol/dm^3)	allow an answer correctly rounded to 3 significant figures from an incorrect calculation which uses all the data in the question	1	
	alternative approach:			
	$\left(\text{ratio } \frac{\text{moles } HNO_3}{\text{moles } Na_2CO_3} = \right)$	allow inverted expression		
	$\frac{2}{1} = \frac{23.6 \times \text{concentration}}{25.0 \times 0.124}$ (2)	allow **1** mark for the expression with an incorrect mole ratio		
	(concentration =) $\frac{2 \times 25.0 \times 0.124}{23.6}$ (1)	allow correct use of the expression with an incorrect mole ratio		
	= 0.262711864 (1)			
	= 0.263 (mol/dm^3) (1)	allow an answer correctly rounded to 3 significant figures from an incorrect calculation which uses all the data in the question		

4.4.2.2 Neutralisation of acids and salt production

Answer 32 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.6	3.16×10^{-3} (mol/dm^3)		1	AO2 4.4.2.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.7	argon / Ar		1	AO2 4.1.2.4 4.2.1.2

Total Question 5	**12**

4.4.2.2 Neutralisation of acids and salt production

Answer 33 · Mark scheme

June 2023 | 8462/2H | Original Q10

Question 10

Question	Answers	Mark	AO/ Spec. Ref
10.1	**Level 3:** A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.	3–4	AO3 4.10.1.1 4.10.2.2 4.10.4.2
	Level 2: Some logically linked reasons are given. There may also be a simple judgement.	1–2	
	No relevant content	0	
	Indicative content **reasons** • compound **A** (potassium chloride) only contains potassium • compound **A** (potassium chloride) is the only source of potassium so is needed. • compound **B** (ammonium nitrate) only contains nitrogen • compound **B** (ammonium nitrate) contains more nitrogen than compound **C** (diammonium hydrogen phosphate) so is preferable • compound **B** (ammonium nitrate) contains more nitrogen and is cheaper than compound **C** (diammonium hydrogen phosphate) and so is more cost effective • compound **C** (diammonium hydrogen phosphate) contains phosphorus which is not needed **judgement** • none of the compounds contain both nitrogen and potassium so a mixture is needed • (both) compound **A** (potassium chloride) and **B** (ammonium nitrate) should be used • (both) compound **A** (potassium chloride) and **C** (diammonium phosphate) could be used		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.2	mining	allow quarrying	1	AO1 4.10.4.2

4.4.2.2 Neutralisation of acids and salt production

Answer 33 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.3	potassium sulfate	ignore potassium chloride allow potassium nitrate allow any other named potassium salt	1	AO1 4.10.4.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.4	ammonia	allow water	1	AO1 4.10.4.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.5	(phosphate rock is) insoluble (in water)	allow (phosphate rock) cannot be absorbed as a solid	1	AO3 4.10.4.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.6	(sulfuric acid) calcium sulfate (phosphoric acid) calcium phosphate	allow single superphosphate allow calcium phosphate allow triple superphosphate	1 1	AO1 4.10.4.2

Total Question 10	10

4.4.2.2 Neutralisation of acids and salt production

Answer 34 · Mark scheme

June 2024 | 8462/1H | Original Q1

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	copper sulfate water	allow $CuSO_4$ allow H_2O	1 1	AO2 AO1 4.4.2.2 4.4.2.3 RPA1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	solid remains (in the mixture) **or** no more effervescence / bubbles / fizzing	ignore references to colours allow copper carbonate remains (in the mixture)	1	AO1 4.4.2.3 RPA1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	to remove copper carbonate	allow to remove excess (copper carbonate)	1	AO1 4.1.1.2 4.4.2.3 RPA1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	electric heater **or** water bath	ignore Bunsen burner	1	AO1 4.4.2.3 RPA1

4.4.2.2 Neutralisation of acids and salt production

Answer 34 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5	$92.8 = \frac{\text{mass produced}}{12.5} \times 100$	allow mass produced = $\%\text{ yield} \times \frac{\text{max theoretical mass}}{100}$	1	AO2 4.3.3.1
	$(\text{mass produced}) = \frac{92.8}{100} \times 12.5$		1	
	= 11.6 (g)		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.6	(copper) does not react with (sulfuric) acid	allow is unreactive allow will not displace hydrogen allow is below hydrogen in the reactivity series ignore is not reactive enough	1	AO1 AO3 4.4.1.2 4.4.2.3
	(sodium) could explode **or** could get too hot	allow (the reaction is) dangerous	1	

Total Question 1	10

4.4.2.2 Neutralisation of acids and salt production

Answer 35 · Mark scheme

June 2024 | 8462/1H | Original Q2

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	(similarity) both have one outer (shell) electron	allow energy level for shell allow same number of outer (shell) electrons	1	AO1 4.1.2.1
	(difference) sodium has 3 shells but potassium has 4 shells	allow potassium has more shells allow (different) number of shells	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	any **two** from: • effervescence / bubbles / fizzing • (potassium) floats • (potassium) moves around • (potassium) becomes smaller • (potassium) melts • flame • explosion	ignore gas produced allow (potassium) forms a ball ignore colour of flame	2	AO1 4.1.2.5 4.4.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	blue / violet / purple		1	AO2
	(the solution is) alkaline	allow (the solution) contains OH^- (ions) allow (the solution) contains hydroxide ions allow the solution is basic	1	AO1 4.1.2.5 4.4.2.4

4.4.2.2 Neutralisation of acids and salt production

Answer 35 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	all five points correctly plotted	allow a tolerance of ± ½ a small square allow **1** mark for three or four points correctly plotted	2	AO2 4.1.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.5	3.4 (mg/cm^3)	allow a value in the range 3.0 to 3.8 (mg/cm^3)	1	AO3 4.1.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.6	chlorine and potassium bromide		1	AO2 4.1.2.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.7	relative molecular mass increases and boiling point increases		1	AO1 4.1.2.6

Total Question 2	**11**

Question 9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.1	(an acid which) is partially ionised	allow (an acid which) is partially dissociated	1	AO1 4.4.2.4 4.4.2.6
	in aqueous solution	allow (when dissolved) in water MP2 is dependent on the award of MP1	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.2	pH increases		1	AO2 4.4.2.6
	(because) the concentration of hydrogen ions decreases		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.3	use a (volumetric) pipette to add the alkali		1	AO1 4.4.2.5 RPA2
	any **two** from: • into a conical flask • add an indicator (to the alkali) • take the initial burette reading • use a white tile (under a conical flask)	ignore beaker allow named indicator do **not** accept add universal indicator	2	

4.4.2.2 Neutralisation of acids and salt production

Answer 36 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.4	(volume of HCl = $\frac{0.0045}{0.15}$) = 0.030 (dm^3)		1	AO2 4.3.4 4.4.2.5 RPA2
	(conversion 0.030 dm^3 =) 30 (cm^3)	allow correct conversion of an incorrectly determined volume in dm^3	1	
	alternative approach			
	$\left(\text{concentration} = \frac{0.15}{1000} =\right)$ 0.00015 (mol/cm^3) (1)			
	$\left(\text{volume} = \frac{0.0045}{0.00015} =\right)$ 30 (cm^3) (1)	allow correct use of an incorrectly determined concentration in mol/cm^3		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.5		allow converse arguments in terms of magnesium allow energy level for shell		AO2 4.1.2.3 4.2.1.2 4.4.1.2
	(calcium's) outer shell / electrons are further from the nucleus	allow calcium has more shells ignore calcium atoms are larger	1	
	(so) the outer electrons are less strongly attracted to the nucleus	allow (so) the outer electrons are more shielded from the nucleus	1	
	(so) positive ions are formed more easily	allow (so) electrons are more easily lost	1	

Total Question 9	12

4.4.2.2 Neutralisation of acids and salt production

Answer 37 · Mark scheme

June 2024 | 8462/2H | Original Q1

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	(test) flame test (result) yellow (flame) **OR** (test) flame emission spectroscopy (1) (result) lines match sodium spectrum (1)	 allow FES	1 1	AO1 4.8.3.1 RPA7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	(test) (add acidified) silver nitrate (solution) (result) white precipitate	 MP2 is dependent upon the award of MP1	1 1	AO1 4.8.3.4 RPA7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	to ensure that all the water has evaporated		1	AO3 4.10.1.2 RPA8

4.4.2.2 Neutralisation of acids and salt production

Answer 37 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	mass of evaporating dish and dry contents − mass of empty evaporating dish		1	AO1 4.10.1.2 RPA8

4.4.2.2 Neutralisation of acids and salt production

Answer 37 · Mark scheme

June 2024 | 8462/2H | Original Q1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5	(mean concentration of NaCl =) $\frac{35.2 + 34.6 + 36.4 + 33.8}{4}$ **or** $\frac{140}{4}$ = 35.0 (g/dm^3)	allow **1** mark for $\frac{35.2 + 34.6 + 33.8}{3} = 34.5$	1 1	AO2 4.10.1.2 RPA8
	(mean concentration of Na$^+$ =) $35.0 \times \frac{39.3}{100}$	allow correct use of an incorrectly determined mean concentration of sodium chloride	1	
	= 13.8 (g/dm^3)	allow 13.755 correctly rounded to at least 3 significant figures	1	
	alternative approach 1:			
	(total concentration of NaCl = 35.2 + 34.6 + 36.4 + 33.8 = 140 total concentration of Na+ =) $140 \times \frac{39.3}{100}$ (1) = 55.02 (g/dm^3) (1)	allow **1** mark for (35.2 + 34.6 + 33.8 = 103.6) $103.6 \times \frac{39.3}{100} = 40.71$		
	(mean concentration of Na$^+$ =) $\frac{55.02}{4}$ (1)	allow correct use of an incorrectly determined total concentration of Na$^+$		
	=13.8 (g/dm^3) (1)	allow 13.755 correctly rounded to at least 3 significant figures		

	alternative approach 2: (concentrations of Na^+ =) $35.2 \times \frac{39.3}{100}$ $34.6 \times \frac{39.3}{100}$ $36.4 \times \frac{39.3}{100}$ $33.8 \times \frac{39.3}{100}$ (1) = 13.83 13.60 14.31 13.28 (1) (mean concentration of Na^+ =) $\frac{13.83 + 13.60 + 14.31 + 13.28}{4}$ (1) =13.8 (g/dm^3) (1)	allow **1** mark if a concentration of 36.4 is treated as an anomaly and not used allow correct use of incorrectly determined concentration(s) of Na^+ allow 13.755 correctly rounded to at least 3 significant figures		

Total Question 1	**10**

4.4.2.2 Neutralisation of acids and salt production

Answer 38 · Mark scheme

June 2024 | 8462/2H | Original Q2

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	to recycle (remaining) nitrogen and hydrogen	allow to recycle unreacted gases allow to return nitrogen and hydrogen to the reactor	1	AO1 4.10.4.1

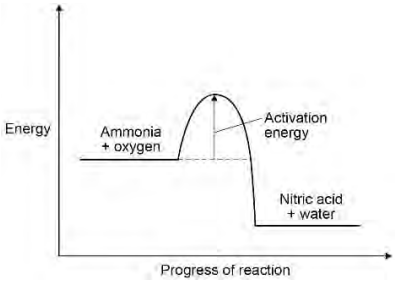
Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	iron	allow Fe	1	AO1 4.6.1.4 4.10.4.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	(test) glowing splint (result) (splint) relights	 MP2 is dependent upon MP1 being awarded	 1 1	AO1 4.8.2.2

4.4.2.2 Neutralisation of acids and salt production

Answer 38 · Mark scheme

June 2024 | 8462/2H | Original Q2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	labelled vertical arrow from dotted line to peak ammonia **and** oxygen on left **and** nitric acid **and** water on right	ignore arrow heads allow NH_3 for ammonia allow O_2 for oxygen allow HNO_3 for nitric acid allow H_2O for water an answer of  scores **2** marks	1 1	AO2 4.6.1.4 4.10.4.1 4.10.4.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.5	the line would reach a higher peak		1	AO1 4.6.1.4 4.10.4.1 4.10.4.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.6	fertilisers	allow explosives allow sports injury packs	1	AO3 4.10.4.1 4.10.4.2

Total Question 2	8

4.4.2.2 Neutralisation of acids and salt production

Answer 39 · Mark scheme

June 2024 | 8462/2H | Original Q7

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1		ignore (hydrochloric / nitric / sulfuric) acid		AO1 4.8.3.5
	(test) add barium chloride (solution)	allow add barium nitrate (solution)	1	
	(result) white precipitate		1	
		MP2 is dependent upon MP1 being awarded		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	the yield is smaller at higher temperatures because the reaction is exothermic		1	AO2 4.6.2.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3		allow converse		AO2 4.6.2.7
	there are more moles / molecules (of gas) on the left	ignore particles	1	
	(so the position of) equilibrium shifts to the right		1	

4.4.2.2 Neutralisation of acids and salt production

Answer 39 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	any **two** from: • the yield is already high • more energy required • risk of explosion is increased • higher income from increased yield is outweighed by the extra expenditure • increased cost of safety precautions	allow requires stronger vessels allow requires thicker walls	2	AO3 4.6.2.7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.5	vanadium (V)		1	AO3 4.1.3.2

Total Question 7	**8**

4.4.2.2 Neutralisation of acids and salt production

Answer 40 · Mark scheme

June 2025 | 8462/1H | Original Q8

Question 8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	OH^-		1	AO1 4.4.2.4

4.4.2.2 Neutralisation of acids and salt production

Answer 40 · Mark scheme

June 2025 | 8462/1H | Original Q8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.2	any **two** from: (improvement) use phenolphthalein (instead of universal indicator) (reason) so that the colour change is sharp **or** (improvement) use a pH probe (reason) so the pH probe shows a sharper endpoint (than universal indicator) **OR** (improvement) add the sodium hydroxide solution drop by drop (near the end point) (reason) the volume (of sodium hydroxide solution) used is more accurate **OR** (improvement) read burette at eye level (reason) the volume (of sodium hydroxide solution) used is more accurate **OR** (improvement) rinse burette with sodium hydroxide **and** pipette with acid (reason) remove contaminants	**1** mark for improvement, **1** mark for reason reason must be linked to the corresponding improvement allow methyl orange for phenolphthalein allow any named single change indicator for phenolphthalein allow universal indicator changes colour too gradually allow universal indicator has too many colour changes ignore specific colour changes allow add the alkali drop by drop (near the end point) allow so the end point is more accurate allow read (volume) at the bottom of the meniscus allow to reduce parallax error	4	AO3 4.4.2.5 RPA 2

4.4.2.2 Neutralisation of acids and salt production

Answer 40 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.3	24.70 (cm^3)	allow 24.7 (cm^3)	1	AO2 4.4.2.5 RPA 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.4	$\left(\text{moles acid} = \frac{25.0 \times 0.216}{1000} =\right)$ 0.00540		1	AO2 4.3.2.5 4.4.2.5 RPA 2
	(moles alkali = 0.00540 × 2 =) 0.0108	allow correct use of incorrectly determined number of moles of acid	1	
	(concentration =) $0.0108 \times \frac{1000}{11.25}$	allow correct use of incorrectly determined number of moles of alkali	1	
	= 0.960 (mol/dm^3)	allow = 0.96 (mol/dm^3)	1	
	alternative approach:			
	$\left(\frac{\text{moles acid}}{\text{moles alkali}} =\right)$			
	$\frac{2}{1} = \frac{11.25 \times \text{conc}}{25.0 \times 0.216}$ (2)	allow inverted expression allow **1** mark for the expression with an incorrect mole ratio		
	(concentration =) $\frac{2 \times 25.0 \times 0.216}{11.25}$ (1)	allow correct use of the expression with incorrect mole ratio		
	= 0.960 (mol/dm^3) (1)	allow = 0.96 (mol/dm^3)		

4.4.2.2 Neutralisation of acids and salt production

Answer 40 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.5	the HCl is a more dilute and stronger acid than the HCN		1	AO2 4.4.2.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.6	(HCl has a) higher concentration of hydrogen ions	allow HCN has a lower concentration of hydrogen ions	1	AO2 4.3.2.5 4.4.2.6
	(because) concentration of hydrogen ions in HCl is 0.1 (mol/dm^3) **and** concentration of hydrogen ions in HCN is 0.0002 (mol/dm^3)		1	

Total Question 8	**13**

4.4.2.2 Neutralisation of acids and salt production

Answer 41 · Mark scheme

June 2025 | 8462/1H | Original Q9

Question 9

Question	Answers	Mark	AO / Spec. Ref.
09.1	**Level 3:** The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.	5–6	AO3 4.1.1.2 4.4.2.3 RPA1
	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 **dissolve iodine in ethanol** • in a beaker **add zinc to iodine solution** • stir **continue adding until zinc is in excess** • shown by solid remaining **filter (the reaction mixture)** • to remove the excess zinc **heat the solution** • using a water bath **or** using an electric heater • to evaporate off some of the ethanol • cool / leave remaining solution to crystallise		

4.4.2.2 Neutralisation of acids and salt production

Answer 41 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.2	$\left(\text{moles } I_2 = \frac{6.35}{254} =\right)$ 0.025		1	AO2 4.3.1.1 4.3.2.1 4.3.2.2 4.3.3.1
	(moles ZnI_2 = 0.025 theoretical mass ZnI_2 = 0.025 × 319 =) 7.975 (g)	allow (moles Zn = 0.025 mass of Zn = 0.025 × 65 = 1.625 g theoretical mass ZnI_2 = 1.625 + 6.35 =) 7.975 (g) allow correct use of an incorrectly determined number of moles of I_2	1	
	(% yield =) $\frac{6.29}{7.975} \times 100$	allow correct use of an incorrectly determined theoretical mass of ZnI_2	1	
	= 78.871 (%)		1	
	= 78.9 (%)	allow an answer correctly rounded to 3 significant figures from an incorrect calculation which uses both mass values in the question	1	
	alternative approach 1: $\left(\text{moles } I_2 = \frac{6.35}{254} =\right)$ 0.025 (1) $\left(\text{moles } ZnI_2 = \frac{6.29}{319} =\right)$ 0.019717868 (1) (% yield =) $\frac{0.019717868}{0.025} \times 100$ (1) = 78.871 (%) (1) = 78.9 (%) (1)	allow correct use of an incorrectly determined number of moles of I_2 and/or ZnI_2 allow an answer correctly rounded to 3 significant figures from an incorrect calculation which uses both mass values in the question		

Answer 41 · Mark scheme

	alternative approach 2: (moles ZnI_2 = $\frac{6.29}{319}$ =) 0.019717868 (1) (moles I_2 reacted = 0.019717868 mass I_2 reacted = 0.019717868 × 254 =) 5.0083 (g) (1) (% yield =) $\frac{5.0083}{6.35}$ × 100 (1) = 78.871 (%) (1) = 78.9 (%) (1)	allow correct use of an incorrectly determined number of moles of ZnI_2 allow correct use of an incorrectly determined mass of I_2 reacted allow an answer correctly rounded to 3 significant figures from an incorrect calculation which uses both mass values in the question		

Total Question 9	**11**

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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Secondary Education

Additional Science 4463 / Chemistry 4421

CHY2H Unit 2 Chemistry

Mark Scheme

2008 examination – January series

4.4.2.2 Neutralisation of acids and salt production

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It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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4.4.2.2 Neutralisation of acids and salt production

MARK SCHEME

Information to Examiners

1. General

The mark scheme for each question shows:

- the marks available for each part of the question
- the total marks available for the question
- the typical answer or answers which are expected
- extra information to help the Examiner make his or her judgement and help to delineate what is acceptable or not worthy of credit or, in discursive answers, to give an overview of the area in which a mark or marks may be awarded.

The extra information is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.

At the beginning of a part of a question a reminder may be given, for example: where consequential marking needs to be considered in a calculation; or the answer may be on the diagram or at a different place on the script.

In general the right hand side of the mark scheme is there to provide those extra details which confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent.

2. Emboldening

2.1 In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following lines is a potential mark.

2.2 A bold **and** is used to indicate that both parts of the answer are required to award the mark.

2.3 Alternative answers acceptable for a mark are indicated by the use of **or**. (Different terms in the mark scheme are shown by a / ; eg allow smooth / free movement.)

3. Marking points

3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which candidates have provided extra responses. The general principle to be followed in such a situation is that 'right + wrong = wrong'.

Each error/contradiction negates each correct response. So, if the number of error/contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (indicated as * in example 1) are not penalised.

4.4.2.2 Neutralisation of acids and salt production

Example 1: What is the pH of an acidic solution? (1 mark)

Candidate	Response	Marks awarded
1	4,8	0
2	green, 5	0
3	red*, 5	1
4	red*, 8	0

Example 2: Name two planets in the solar system. (2 marks)

Candidate	Response	Marks awarded
1	Pluto, Mars, Moon	1
2	Pluto, Sun, Mars, Moon	0

3.2 Use of chemical symbols / formulae

If a candidate writes a chemical symbol / formula instead of a required chemical name, full credit can be given if the symbol / formula is correct and if, in the context of the question, such action is appropriate.

3.3 Marking procedure for calculations

Full marks can be given for a correct numerical answer, as shown in the column 'answers', without any working shown.

However if the answer is incorrect, mark(s) can be gained by correct substitution / working and this is shown in the 'extra information' column;

3.4 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

3.5 Errors carried forward

Any error in the answers to a structured question should be penalised once only.

Papers should be constructed in such a way that the number of times errors can be carried forward are kept to a minimum. Allowances for errors carried forward are most likely to be restricted to calculation questions and should be shown by the abbreviation e.c.f. in the marking scheme.

3.6 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited **unless** there is a possible confusion with another technical term.

3.7 Brackets

(…..) are used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

3.8 Unexpected Correct Answers not in the Mark Scheme

The Examiner should use professional judgement to award credit where a candidate has given an unexpected correct answer which is not covered by the mark scheme. The Examiner should consult with the Team Leader to confirm the judgement. The Team Leader should pass this answer on to the Principal Examiner with a view to informing all examiners.

4.4.2.2 Neutralisation of acids and salt production

CHY2H

Question 1

question	answers	extra information	mark
(a)	sensible line of best fit which goes through or close to all the points **except** the anomalous point	allow wobbly / short double lines ± ½ square	1
(b)	loss of gas / loss of CO_2	idea of gas produced / formed	1
(c)	7		1
(d)(i)	steeper line from around the same starting point and left of the points levelling off at 99	allow crosses if they are fully correct for **1** mark accept short level line at 99 ± ½ square	1 1
(d)(ii)	any **three** from: • particles / molecules / atoms/ ions have more energy • move faster • collide <u>more</u> often **or** <u>more</u> chance of collisions **or** bump into each other <u>more</u> • collide with <u>more</u> force / energy **or** <u>more</u> particles have the activation energy **or** <u>more</u> collisions result in reaction **or** <u>more</u> collisions are successful	 allow given / gain / get energy ignore move about more ignore vibrate more / faster ignore collide quicker / faster	3
total			8

4.4.2.2 Neutralisation of acids and salt production

CHY2H

Question 2

question	answers	extra information	mark
(a)	any **one** from: • they are made of layers • atoms / ions / particles / layers (of atoms) can slide over each other	 do **not** accept line / rows / lattice	1
(b)	any **one** from: • smaller / tiny **or** very small • correct size range 1 to 100 nanometres • a few hundred atoms in size	 do **not** allow small alone if they state smaller and give a size outside range ignore size if it is less than 20,000	1
(c)	harder plus **one** from: • so does not wear as quickly / erode as quickly • less vulnerable to damage owtte • because they have a high surface area to volume ratio **or** stronger (1) plus **one** from: (1) • less likely to break / do not break • not as vulnerable to damage owtte • do not bend out of shape • because they have a high surface area to volume ratio	 ignore corrode harder to wear down = **1** mark accept withstand pressure harder and stronger alone gains **1** mark	1 1
total			4

4.4.2.2 Neutralisation of acids and salt production

CHY2H

Question 3

question	answers	extra information	mark
(a)	N_2O		1
(b)	13.8 to 14	gains full marks without working if answer incorrect 13 gains **1** mark **or** 14/101 × 100 gains **1** mark	2
total			3

4.4.2.2 Neutralisation of acids and salt production

CHY2H

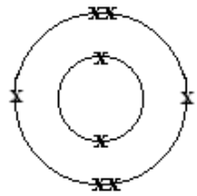
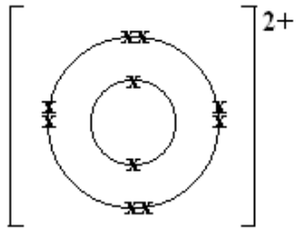
Question 4

question	answers	extra information	mark
(a)	electric current / electricity		1
	plus **one** from:		1
	• is passed through ionic compound / substance / electrolyte • passed through molten/aqueous compound / substance	must be linked to electricity allow liquid compound / substance do **not** allow solution / liquid alone	
	• causing decomposition	accept split up / breakdown / breaking up owtte ignore separated accept elements are formed ignore new substances form	
(b)	hydrogen	accept H_2 do **not** accept H / H^2	1
(c)	one electron from each atom	accept each carbon is bonded to three other carbon atoms leaving one (unbonded) electron owtte	1
	is delocalised / free (to move)	must be linked to electrons answers of delocalised / free electrons only, gains **1** mark accept each carbon is bonded to three other carbon atoms leaving delocalised / free electrons = **2** marks **maximum 1** mark if graphite described as a metal / giant ionic lattice	1
total			5

4.4.2.2 Neutralisation of acids and salt production

CHY2H

Question 5

question	answers	extra information	mark
(a)	any **one** from: • gives out heat / energy • transfers energy from a substance to the surroundings • ΔH / energy change / enthalpy change is negative	accept releases / gives off owtte ignore references to light	1
(b)	$2Mg + O_2 \rightarrow 2MgO$	accept correct multiples / fractions	1
(c)		electrons do not need to be paired accept dots / circles / e instead of crosses do **not** allow 2.6 without diagram	1
(d)		electrons do not need to be paired allow without brackets must have the charge accept dots / circles / e instead of crosses ignore extra empty outer shells ignore nucleus do **not** allow $[2.8]^{2+}$ without diagram	1

continued…

4.4.2.2 Neutralisation of acids and salt production

CHY2H

Question 5 continued…

question	answers	extra information	mark
(e)	oppositely charged (ions / atoms)	allow positive and negative(ions / atoms)	1
	(they) attract	must be in correct context accept held by electrostatic forces ignore ionic bonding **maximum 1** if they refer to intermolecular forces / attractions / covalent bonds	1
(f)	magnesium chloride	accept $MgCl_2$ (if correctly written)	1
total			7

4.4.2.2 Neutralisation of acids and salt production

CHY2H

Question 6

question	answers	extra information	mark
(a)	**Compound A** any **one** from: • sodium bromide • potassium bromide • ammonium bromide • hydrogen bromide • any metal bromide except silver and lead. **Compound B** silver nitrate	accept correct formulae accept silver sulfate	1 1
(b)	the silver compound will decompose / silver ions be reduced to silver (owtte)	accept film would darken owtte accept any idea of light changing silver bromide / silver ions / silver nitrate / silver sulfate allow 'forms a black solid' / it would turn black	1
(c)	precipitation	accept descriptions of precipitation reactions accept double decomposition accept precipitate do **not** allow displacement	1
(d)	electrons are gained	 the second mark **must** be linked to electrons accept it / silver / silver ions gains electrons for **both** marks ignore references to oxygen	1 1
total			6

4.4.2.2 Neutralisation of acids and salt production

CHY2H

Question 7

question	answers	extra information	mark
(a)	1213.8 to 1214.3 correct answer not given then check working 1) moles of N_2 = $\frac{1000}{28}$ = 35.7 mol 2) moles of NH_3 = 2 × (answer from (1)) = 71.4 mol 3) mass of NH_3 = (answer from 2) × 17 = 71.4 × 17 = 1214 g **or** • 28g of N_2 → 34g of NH_3 • 1g of N_2 → $\frac{34}{28}$ = 1.214g NH_3 • 1000 g of N_2 → 1000 × 1.214 = 1214g **or** • $1000 \times \frac{34}{28}$ **or** **other correct methods**	gains **3** marks without working **1** mark for each correct step do **not** penalise rounding errors in this part **1** mark for each correct step do **not** penalise rounding errors in this part allow error carried forward eg gains **2** marks if correct answer not given $1000 \times \frac{28}{34}$ gains **1** mark, **2** marks if correctly calculated (823.5g) $1000 \times \frac{28}{17}$ gains **1** mark if calculated correctly (1647.05g) look for the key ideas in the methods above	3

continued…

4.4.2.2 Neutralisation of acids and salt production

CHY2H

Question 7 continued…

question	answers	extra information	mark
(b)	25 / 25.035 **or** ecf from (a)	gains **2** marks even when there is no working incorrect answer then 304/(their answer from (a)) × 100 gains **1** mark	2
	or using figures from part (b)		
	27.6 / 28	gains **2** marks even when there is no working accept 27 for **1** mark if answers incorrect then304/1100 × 100 gains **1** mark	
(c)(i)	increase yield		1
	reaction is exothermic		1
	or		
	allow decreased yield because rate of reaction is slower / fewer collisions for **2** marks	**must** get both points for **2** marks	
(c)(ii)	increase yield		1
	plus **one** from: • more (gaseous) reactant molecules than (gaseous) product molecules (owtte) • increased rate of reaction / more collisions	accept greater volume on the left than the right owtte	1

continued…

4.4.2.2 Neutralisation of acids and salt production

CHY2H

Question 7 continued…

question	answers	extra information	mark
(d)	any **one** from: **economic** • large town provides workforce • workers do not have to travel far to the factory. (owtte) • transport infrastructure already in place for large town. (owtte) • factory brings prosperity to town (owtte) • factory provides employment • reduced tourism • reduction in local house prices • any other sensible economic factor linked to town		1
	any **one** from: **safety** • escape of dangerous / harmful chemicals / gases (owtte) • danger of increased traffic • risk of explosion.(owtte) /danger of high pressure • consequences of an accident could be severe if the town is close • any other sensible safety idea	do **not** allow polluting gases unqualified	1

continued…

4.4.2.2 Neutralisation of acids and salt production

CHY2H

Question 7(d) continued…

question	answers	extra information	mark
	any **one** from: **environmental** • factory might be unsightly (owtte) • screening of factory (owtte) • loss of habitats (owtte) • plant trees/ hedges etc on and around plant site • pollution of water / air / soil could harm plants / animals **or** noise pollution • CO_2 is produced by burning fuels / heating • CO_2 causes global warming / any effect of global warming • eye sore • any other sensible environmental factor	must be explained	1
total			12

4.4.2.2 Neutralisation of acids and salt production

GCSE

Additional Science / Chemistry

CH2HP
Final Mark scheme

4408 / 4402
June 2017

Version/Stage: v1.0

4.4.2.2 Neutralisation of acids and salt production

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this mark scheme are available from aqa.org.uk

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4.4.2.2 Neutralisation of acids and salt production

Information to Examiners

1. General

The mark scheme for each question shows:

- the marks available for each part of the question
- the total marks available for the question
- the typical answer or answers which are expected
- extra information to help the Examiner make his or her judgement and help to delineate what is acceptable or not worthy of credit or, in discursive answers, to give an overview of the area in which a mark or marks may be awarded
- the Assessment Objectives and specification content that each question is intended to cover.

The extra information is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.
At the beginning of a part of a question a reminder may be given, for example: where consequential marking needs to be considered in a calculation; or the answer may be on the diagram or at a different place on the script.
In general the right-hand side of the mark scheme is there to provide those extra details which confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent.

2. Emboldening and underlining

2.1 In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following bullet points is a potential mark.

2.2 A bold **and** is used to indicate that both parts of the answer are required to award the mark.

2.3 Alternative answers acceptable for a mark are indicated by the use of **or**.
Different terms in the mark scheme are shown by a / ; eg allow smooth/free movement.

2.4 Any wording that is underlined is essential for the marking point to be awarded.

3. Marking points

3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which students have provided extra responses. The general principle to be followed in such a situation is that 'right + wrong = wrong'.

Each error/contradiction negates each correct response. So, if the number of error/contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (indicated as * in example 1) are not penalised.

Example 1: What is the pH of an acidic solution?

[1 mark]

Student	Response	Marks awarded
1	green, 5	0
2	red*, 5	1
3	red*, 8	0

Example 2: Name two planets in the solar system.

[2 marks]

Student	Response	Marks awarded
1	Pluto, Mars, Moon	1
2	Pluto, Sun, Mars, Moon	0

3.2 Use of chemical symbols/formulae

If a student writes a chemical symbol/formula instead of a required chemical name, full credit can be given if the symbol/formula is correct and if, in the context of the question, such action is appropriate.

3.3 Marking procedure for calculations

Full marks can be given for a correct numerical answer, without any working shown. However, if the answer is incorrect, mark(s) can be gained by correct substitution/working and this is shown in the 'extra information' column or by each stage of a longer calculation.

3.4 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

3.5 Errors carried forward

Any error in the answers to a structured question should be penalised once only. Papers should be constructed in such a way that the number of times errors can be carried forward are kept to a minimum. Allowances for errors carried forward are most likely to be restricted to calculation questions and should be shown by the abbreviation 'ecf' in the marking scheme.

3.6 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited **unless** there is a possible confusion with another technical term.

3.7 Brackets

(…..) are used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

3.8 Accept/allow

Accept is used to indicate an equivalent answer to that given on the left-hand side of the mark scheme. Allow is used to denote lower-level responses that just gain credit.

3.9 Ignore/Insufficient/Do not allow

Ignore or insufficient is used when the information given is irrelevant to the question or not enough to gain a marking point. Any further correct amplification could gain the marking point.
Do **not** allow means that this is a wrong answer which, even if the correct answer is given, will still mean that the mark is not awarded.

4 Quality of Written Communication and levels marking

In Question 2 students are required to produce extended written material in English, and will be assessed on the quality of their written communication as well as the standard of the scientific response.

Students will be required to:
- use good English
- organise information clearly
- use specialist vocabulary where appropriate.

The following general criteria should be used to assign marks to a level:

Level 1: Basic

- Knowledge of basic information.
- Simple understanding.
- The answer is poorly organised, with almost no specialist terms and their use demonstrating a general lack of understanding of their meaning, little or no detail.
- The spelling, punctuation and grammar are very weak.

Level 2: Clear

- Knowledge of accurate information.
- Clear understanding.
- The answer has some structure and organisation, use of specialist terms has been attempted but not always accurately, some detail is given.
- There is reasonable accuracy in spelling, punctuation and grammar, although there may still be some errors.

Level 3: Detailed

- Knowledge of accurate information appropriately contextualised.
- Detailed understanding, supported by relevant evidence and examples.
- Answer is coherent and in an organised, logical sequence, containing a wide range of appropriate or relevant specialist terms used accurately.
- The answer shows almost faultless spelling, punctuation and grammar.

4.4.2.2 Neutralisation of acids and salt production

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1(a)(i)	a smooth curve through or close to all points except (30,12)		1	AO2 2.4
1(a)(ii)	correct reading from the curve in 1(a)(i) (cm^3)	allow a tolerance of +/- 0.5 cm^3	1	AO2 2.4
1(a)(iii)	45-50 (seconds)		1	AO3 2.4
1(a)(iv)	line becomes less steep because gas is produced more slowly	ignore line levels out or plateaus allow examples with figures, eg 12 cm^3 gas from 0 to 20s but 1.5 cm^3 gas in last 20s ignore reaction has stopped or no more gas produced	1 1	AO3 2.4
1(a)(v)	0.6 (cm^3 per second)	allow 0.55 to 0.65	1	AO2 2.4
1(b)(i)	 temperature volume (of hydrogen peroxide)	concentration of hydrogen peroxide = max **1** ignore amount (of hydrogen peroxide)	 1 1	AO3 2.4
1(b)(ii)	 rate increases because more particles (in the same volume) so frequency of collisions increases	incorrect reference to energy = max **2** accept particles closer together allow greater chance of collisions ignore more collisions	 1 1 1	AO1 2.4.1e

4.4.2.2 Neutralisation of acids and salt production

1(c)	(increasing the amount of catalyst) increases rate same final volume of gas	accept steeper graph or graph levels off earlier	1 1	**AO2** 2.4.1g
Total			**13**	

4.4.2.2 Neutralisation of acids and salt production

<table>
<tr><th>Question</th><th>Answers</th><th>Extra information</th><th>Mark</th><th>AO / Spec. Ref.</th></tr>
<tr><td>2</td><td></td><td></td><td>6</td><td rowspan="6">AO1
2.1.1h
2.2.4b,c
2.2.5a,b</td></tr>
<tr><td colspan="4">Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5 and apply a ‘best-fit’ approach to the marking.</td></tr>
<tr><td colspan="4"><table>
<tr><th>0 marks</th><th>Level 1
(1–2 marks)</th><th>Level 2
(3–4 marks)</th><th>Level 3
(5–6 marks)</th></tr>
<tr><td>no relevant information given</td><td>a statement about the structure or a property of a metal
or
a statement about the structure or a property of a polymer</td><td>a statement about the structure or a property of a metal
and
a statement about the structure or a property of a polymer</td><td>a statement about the structure or a property of a metal
and
a statement about the structure or a property of a polymer
and
at least one statement linking structure and property</td></tr>
</table></td></tr>
<tr><td colspan="4">Statements shown as HT only are credited on both FT and HT.
However, HT only means that these statements are not expected in a FT answer.</td></tr>
<tr><td colspan="4">Examples of chemistry points made in response

Metal:

Properties
shiny
hardness
(tensile) strength
melting point/boiling point
density
malleable/flexible
ductile
conduct electricity or thermal energy</td></tr>
</table>

4.4.2.2 Neutralisation of acids and salt production

Structure • metals contain atoms /((positive) ions HT only) • (the atoms/(positive) ions/particles are) closely packed / in a regular pattern / in a giant structure/in layers / in a lattice • strong bonds/(electrostatic attractions HT only) • (metal has delocalised electrons HT only) **Polymer:** **Properties** • flexible • melting/boiling point • density • can be shaped/moulded • poor conductor of electricity or thermal energy **Structure** • polymer consists of chains • polymer chains may be tangled • polymer has no cross links. • (polymer has weak intermolecular forces HT only) **Level 3:** **Examples of linked statements:** • metal can be bent and shaped because the layers can slide • some metals are soft because layers can slide • some metals are hard because they have strong bonds and/ or (the atoms/(positive) ions/particles) are closely packed / in a regular pattern / in a giant structure/ in a lattice • metal has high melting/boiling point because they have strong bonds and/ or (the atoms/(positive) ions/particles) are closely packed / in a regular pattern / in a giant structure / in a lattice • metal is strong because of strong bonds • some metals are dense because the atoms are closely packed • (metal can conduct thermal energy and electricity because metal has delocalised electrons HT only) • thermosoftening polymer melts when heated because it has no cross-links (or has weak intermolecular forces HT only) • thermosoftening polymer is flexible because the chains can move over each other	

Total			**6**

4.4.2.2 Neutralisation of acids and salt production

Question	Answers	Extra Information	Mark	AO / Spec. Ref
3(a)(i)	2 bonding pairs 4 unbonded electrons on each atom	accept dots, crosses, e, - or any combination ignore any electrons on any inner shells if no other mark awarded allow **1** mark for 1 bonding pair and 6 unbonded electrons on each atom	1 1	**AO2** 2.1.1g
3(a)(ii)	covalent	allow convalent and covelant ignore single or double ignore shared, shared bond or sharing	1	**AO1** 2.1.1g
3(a)(iii)	weak intermolecular forces require little energy to overcome	reference to weak covalent or weak ionic bonds = **0** accept weak intermolecular bonds MP2 dependent on MP1 if no other mark awarded allow 1 mark for simple/small molecules	1 1	**AO1** **AO2** 2.2.1a,b

4.4.2.2 Neutralisation of acids and salt production

3(b)(i)	**2** Mg + O_2 → **2** MgO	accept multiples	1	**AO2** 2.2.2
3(b)(ii)		reference to incorrect particles **or** incorrect bonding **or** incorrect structure = max **2**		**AO1** **AO2** 2.1.1a,b,c,f
	magnesium loses (electrons) **and** oxygen gains (electrons)		1	
	two (electrons transferred)		1	
	noble gas structure **or** 8 electrons in outer shells **or** (electrostatic) attraction between ions **or** forms ionic bonds	accept full outer shell (of electrons)	1	
3(b)(iii)	particles 1-100 nm in size	accept contain a few hundred atoms/ions accept have a high surface area to volume ratio ignore reference to (very) small particles do **not** accept smaller than an atom/ion	1	**AO1** 2.2.6a

4.4.2.2 Neutralisation of acids and salt production

3(c)	has a high melting point	allow will not melt allow a lot of energy needed to melt ignore boiling point reference to incorrect particles or incorrect bonding or incorrect structure = max **1** from MP2 and MP3	1	**AO1** **AO2** 2.2.3a
	because all atoms linked to other atoms	allow giant structure/lattice ignore many bonds	1	
	by covalent bonds	allow strong bonds allow a lot of energy needed to break bonds accept giant covalent structure for MP2 and MP3	1	
Total			**13**	

4.4.2.2 Neutralisation of acids and salt production

Question	Answers	Extra Information	Mark	AO / Spec. Ref
4(a)	add copper oxide and (sulfuric) acid		1	AO1 AO2 2.6.1b,c
	excess (copper oxide)		1	
	filter (to remove excess)	ignore impurities	1	
	heat /boil / evaporate / leave (to crystallise)	do **not** accept to dryness	1	
4(b)	(M_r CuO =) 79.5		1	AO2 2.3.3c
	24.95/249.5 **or** 0.1 **OR** 79.5/249.5 **or** 0.3186…	allow ecf for M_r CuO from step 1 allow correct rounding to min 2SF	1	
	(24.95/249.5 x 79.5=) 7.95	allow ecf for M_r CuO from step 1 allow ecf from step 2 of incorrect calculation/ rounding of correct ratio allow correct rounding to min 2SF correct answer with or without working gains 3 marks	1	
4(c)(i)	as wealth decreases, ethene production decreases (with the exception of country C or D)	accept converse	1	AO2 AO3 2.6
	sulfuric acid production is not linked to wealth		1	

4.4.2.2 Neutralisation of acids and salt production

4(c)(ii)	use of products of ethene has increased	allow use of polymers / plastics / ethanol / poly(ethene) has increased ignore use of ethene as a (bio)fuel ignore cost	1	**AO3** 2.2.5
Total			**10**	

4.4.2.2 Neutralisation of acids and salt production

Question	Answers	Extra Information	Mark	AO / Spec. Ref
5(a)(i)	draw line on paper put (dots of) inks on line place (bottom of) paper in solvent / water any **one** from: line drawn in pencil allow dots of ink to dry line above solvent lid		1 1 1 1	**AO1** 2.3.2b
5(a)(ii)	any **two** from: • A has 3 colours **and** B has 4 colours • 2 colours are the same • **A** has 1 colour not in **B and B** has 2 colours not in **A**	accept 3 colours are different if no other mark awarded allow **one** more colour in ink **B** than in ink **A** (or converse)	2	**AO3** 2.3.2b
5(b)(i)	substances carried by gas through column / tube / coil (packed with solid) (different substances move through the column) at different speeds	 accept (different) substances come out at different times or have different retention times	1 1 1	**AO1** 2.3.2c
5(b)(ii)	(relative) molecular mass	allow (relative) formula mass allow RFM, RMM, M_r	1	**AO1** 2.3.2c
Total			**10**	

4.4.2.2 Neutralisation of acids and salt production

Question	Answers	Extra Information	Mark	AO / Spec. Ref
6(a)(i)	tick (✓) by: the initial temperature reading was too low		1	AO3 2.5
6(a)(ii)	the reaction is exothermic	allow energy is given out	1	AO3 2.5.1b
6(b)(i)	(positive/hydrogen) ions gain electrons hydrogen is below sodium in the reactivity series so hydrogen / H_2 is produced	accept (positive/hydrogen) ions are reduced accept reference to high reactivity of sodium If no other mark awarded allow hydrogen (and sodium) ions **or** positive ions are attracted to negative electrode for **1** mark	1 1 1	AO1 AO2 2.7.1c,f,i
6(b)(ii)	**2** (Cl^-) → **Cl_2 + 2e^-**	must be completely correct allow multiples	1	AO1 2.7.1g
6(b)(iii)	solution is alkaline because sodium hydroxide / NaOH is produced **or** sodium hydroxide / NaOH is left over	accept hydroxide (ions) / OH^- is produced **or** hydroxide (ions) / OH^- is left over	1 1	AO1 AO2 2.7.1i; 2.6.2d
Total			**8**	

4.4.2.2 Neutralisation of acids and salt production

Answer 22 · Examiner comments — June 2019 | 8462/1H | Original Q2

Question 2 (standard demand)

02.1 Approximately 80% of students correctly identified H^+ as the ion produced by all acids in aqueous solution.

The most common incorrect response was OH^-

02.2 Almost 60% of students scored both marks for completing the word equation.

The name of the acid was more widely known than the name of the missing product.

A common incorrect response for the product was hydrogen.

Answer 22 · Examiner comments — June 2019 | 8462/1H | Original Q2

02.3 The name 'burette' was well known. Phonetic equivalents of this word also scored the mark but not 'biuret' (as this is a reagent used in biology).

Other common incorrect responses included:

- pipette
- syringe
- measuring cylinder.

02.4 Approximately 70% of students were able to take a correct reading from the burette scale.

The most common incorrect answer was 28.4 cm^3.

02.5 Students appeared to be well prepared for this extended response question which drew on their experience of a required practical activity.

Approximately 60% of students achieved a Level 3 mark by identifying and logically sequencing all the key steps for this titration.

The most common key steps to be omitted were:

- measuring the volume of the acid
- adding an indicator.

4.4.2.2 Neutralisation of acids and salt production

Answer 23 · Examiner comments

November 2020 | 8462/1H | Original Q9

Question 9 (standard, standard / high and high demand)

09.1 A third of students scored this mark; some realised that the most likely error was lack of stirring; fewer suggested that the temperature was measured too early, before the temperature had stopped falling. Many suggestions contradicted the information given.

09.2 Students had great difficulty in expressing their answers using correct terminology, often using energy and temperature interchangeably. They generally find endothermic reactions difficult; they do not seem to realise that the energy taken in is not staying as thermal energy but is being converted to chemical energy. Some students gained the mark for saying that the temperature initially falls because energy is being taken in, showing an endothermic reaction. A few noted that when 1.5 g of citric acid had been added the reaction had finished and that the citric acid was in excess from there on. However, it was very rare for a correct explanation for the subsequent rise in temperature to be given. Some thought the reaction suddenly became exothermic, or that it suddenly reversed (showing a lack of understanding of reversible reactions).

09.3 Many students realised that the difference was due to the better thermal conductivity of the metal. However, many of those merely referred to the metal as a good conductor, without comparing the metal to polystyrene. The majority of students drew a steeper line, stating that the metal would lose heat more quickly. Of those who drew the correct shallower line, few could explain that the metal would conduct thermal energy in from the surroundings more quickly, reducing the temperature drop in this endothermic reaction.

09.4 Many students were able to score all three marks. Common errors were to confuse concentration with number of moles and to fail to convert 250 cm^3 to 0.25 dm^3 correctly. The symbol ‘m’ for number of moles was commonly seen instead of ‘n’ – students consequently became confused between mass and number of moles. Students who set out their working step by step were able to gain partial credit, but those who simply had a jumble of numbers, with no explanation as to what the numbers represented, were not.

09.5 Most students scored at least two marks Some students referred to ‘amount’ of acid added rather than volume, and many failed to take any burette readings at all. It was not uncommon to see a conical flask placed ‘under’ a white tile rather than on one.

09.6 This was not well answered. Most students who scored a mark did so for stating that the acid could be added drop by drop, or that the rate of flow could be controlled. Few stated that the burette could measure variable volumes (unlike a pipette). Many stated that a burette was ‘more accurate’ but did not say what they were comparing it to. Of those who

did, most said it was more accurate than a pipette, which is not true. Some students confused a volumetric pipette with a dropping pipette.

09.7 This titration calculation was well done by many students. To gain full credit, working needed to be correct as well as the final answer. Students therefore need to show their working step by step in a way that can be followed by the examiner. Common errors were to omit to convert volumes to dm^3, to attempt to do so but incorrectly, or to omit the mole ratio of citric acid to sodium hydroxide. As with question 09.4, students who incorrectly used the symbol ‘m’ to mean moles often confused themselves; they should be encouraged to use ‘m’ only for mass, and ‘n’ for number of moles.

4.4.2.2 Neutralisation of acids and salt production

Answer 23 · Examiner comments

Mark Ranges and Award of Grades

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

4.4.2.2 Neutralisation of acids and salt production

Answer 24 · Examiner comments November 2021 | 8462/1H | Original Q5

Question 5 (standard, standard / high and high demand)

05.2 This equation, which is given in the specification, was not well known.

05.4 Students found this question difficult. Most students do not know why the acid is heated, and many incorrectly referred to helping the magnesium oxide dissolve. Very few appeared to understand that excess magnesium oxide is needed to ensure that all of the acid reacts. Most students knew that filtration separates solids from liquids or solutions, but many did not refer specifically to removing the excess magnesium oxide.

05.5 Very few students knew that a water bath or an electric heater should be used, despite this being stated in the specification.

Answer 24 · Examiner comments November 2021 | 8462/1H | Original Q5

05.6 Those who followed the method provided in the question were often successful in scoring at least one mark. It was common to see the number of moles of iron calculated by dividing the mass by 112 instead of 56. Those who calculated the number of moles of chlorine often insisted on converting this to a mass and then back again to calculate the volume of chlorine.

Answer 25 · Examiner comments

November 2021 | 8462/1H | Original Q7

Question 7 (standard, standard / high and high demand)

07.1 Very few students picked up on the link between chemical reactions and electricity given in the question. The idea that electrolysis uses electricity to produce a chemical reaction was poorly understood. Many students believe electrolysis is a method of 'separating' compounds, rather than decomposing a compound. Very few realised that a chemical cell uses a reaction to produce electricity, with many making statements about a cell using electricity.

07.2 Many students were unable to write the formula of bromine. Those who could, often scored at least one mark, although the half-equation was not always balanced.

07.3 Students found difficulty in naming all 3 products. Many students did score the mark for iodine, though iodide was a common response. Very few could work out that in the absence of a halide ion, oxygen must be produced at the positive electrode, with many suggesting nitrogen as the product.

4.4.2.2 Neutralisation of acids and salt production

Answer 25 · Examiner comments

November 2021 | 8462/1H | Original Q7

07.4 Of the students who recognised that the copper needed to be filtered from the solution, very few then washed and dried the copper, despite that step having been provided in the method for dealing with the electrode itself. Some said the filtered copper would be measured, rather than specifically that the mass would be measured. Some then said incorrectly that the mass would be added to the mass of the electrode, rather than the mass gain of the electrode. Many wasted time describing steps that had already been done, particularly weighing the electrode before and after the experiment.

07.5 The concept of proportionality is poorly understood. Even those who referred to the lines being straight rarely referred to their passing through the origin. Most simply described how the results showed a positive correlation, or a linear relationship.

07.6 The idea of one variable doubling (or trebling) as did the other variable was known by very few students.

07.7 Very few recognised that the blue colour was due to copper ions, which were being removed from the solution. Copper does not dissolve, and is not blue, so the phrase ‘copper is removed from the solution’ has no merit. Many think that the ions are being separated, rather than discharged.

07.8 Many students could make no progress as they had not calculated the number of moles of copper. Some tried to include the current, the time or both in their calculation, instead of using those values to establish the mass of copper formed from the graph.

Question 9 (standard, standard / high and high demand)

09.3 Many students included reading the bottom of the meniscus at eye level; this is just normal technique rather than an improvement to the method given. Many suggested repeating the titration, but this is pointless unless a mean of the accurate results is taken.

09.4 As with other calculations, students often failed to explain what they were doing, which made it difficult for the examiners to award partial credit. Numbers were scattered around without helpful words such as 'moles =' or 'mass ='. Although most students convert the volume of a solution to dm^3 for a titration calculation, far fewer did in this calculation, so their calculated number of moles was 1000 times the correct value.

09.5 Many students were successful at this straightforward titration calculation. Most used the mole ratio, although some tried to apply this to concentrations or volumes rather than moles. Some students tried to bring relative formula mass into their calculation.

Concluding Remarks

The paper was broadly comparable with previous papers. Students did poorly on the questions on ionic bonding and electrolysis but performed well on the question on extraction of metals. There continues to be a lack of precision when recalling definitions and other statements from the specification.

4.4.2.2 Neutralisation of acids and salt production

Answer 26 · Examiner comments

Mark Ranges and Award of Grades

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

4.4.2.2 Neutralisation of acids and salt production

Answer 27 · Examiner comments November 2021 | 8462/2H | Original Q5

Question 5 (standard / high and high demand)

05.1 Nearly four-fifths of students identified one salt, while more than a third worked out both.

05.2 Around two-thirds of students could identify calcium nitrate.

05.3 Two marks were usually easily scored, often for ideas relating to a quicker or continuous process. Four marks were almost never awarded, because students did not appear to appreciate the need for a reasoned judgement when the command word is 'evaluate'.

Answer 28 · Examiner comments June 2022 | 8462/1H | Original Q4

Question 4 (Standard, standard/high and high demand)

04.1 Only about 40% of students scored this mark. A visible observation was required, such as solid remaining at the bottom of the beaker, or solid no longer disappearing. Merely rewording the idea that zinc oxide is in excess did not gain credit. Many students referred incorrectly to zinc rather than zinc oxide. The idea of a solid appearing was not given credit, as the solid was added in the first place.

04.2 Few students gained this mark. Many students said the reason was to use up all the acid, without considering why that was necessary - answers in terms of ease of removal of the excess reactant were required. Whilst students seem very familiar with the method for making a salt, they appear to be less familiar with the reasons for each step.

04.3 This was answered correctly by just over half of students. Some suggested zinc or chlorine; whilst zinc would work, it is not a compound. Others suggested using salts such as zinc sulfate.

04.4 Many students correctly described the two-step process of heating to crystallisation point, followed by leaving the solution to cool and crystallise. A few students referred to evaporating the zinc chloride, rather than the water, from the solution. Many students restricted themselves to one mark; either they did not heat the solution, they did not give a reason for heating, or they heated to dryness.

4.4.2.2 Neutralisation of acids and salt production

Answer 28 · Examiner comments June 2022 | 8462/1H | Original Q4

04.5 Fewer than a quarter of students answered correctly. Many students tried to incorporate chloride into their equation. Equations were often not balanced in terms of charge.

04.6 This was well answered, with most students referring specifically to zinc in this reaction rather than to oxidation in general.

04.7 This question was well answered. However, some students drew an electrolytic cell rather than a simple chemical cell, with an electrolyte in a beaker and copper and zinc electrodes dipping into it.

Answer 29 · Examiner comments June 2022 | 8462/1H | Original Q6

Question 6 (Standard, standard/high and high demand)

06.1 Two thirds of students selected the correct half equation. A significant number chose a distractor in which Na was present at the start rather than formed in the reaction.

06.2 Most students realised the need to prevent the products from reacting together and reforming sodium chloride. However, a significant minority failed to appreciate that the reverse reaction would occur and instead focused on preventing the products from mixing or ensuring product purity.

4.4.2.2 Neutralisation of acids and salt production

Answer 29 · Examiner comments June 2022 | 8462/1H | Original Q6

06.3 Only 60% of students recognised that ions must pass through the mesh. Nearly all other responses were ‘electrons’. Many students seem to think that an electric current can only be conducted by electrons moving, even through a solution in which there are no free electrons.

06.4 Most students recognised that hydrogen ions would be present in aqueous sodium chloride. However, only just over a half of students also recognised that hydroxide ions were present. Some stated that the fourth ion would be oxygen, showing a lack of understanding of the ionisation of water.

06.5 A majority of students recognised that the alkaline solution must be sodium hydroxide solution.

06.6 This was a high demand question which students found very challenging. The most common mark scored was for the sodium ions and hydroxide ions remaining in solution after the electrode processes. However, many students did not refer to ions. Others thought that hydroxide ions or sodium ions would be made, rather than being in the solution throughout the process. Whilst students often correctly stated the product at each electrode, few described the actual processes occurring at the electrodes as required by the question. Some otherwise creditworthy responses were let down by referring to chlorine ions instead of chloride ions, or by confusing the polarities of anode and cathode, or by confusing oxidation and reduction.

Answer 30 · Examiner comments

June 2022 | 8462/1H | Original Q8

Question 8 (Standard, standard/high and high demand)

08.1 While over a half of students scored one mark on this question, very few scored all four. Many referred to a pH being more or less acidic, without referring to higher or lower pH values. Few students mentioned hydrogen ions, so limited themselves to Level 2. The strength of an acid was explained better than the concentration; very few students could state that the more concentrated the acid, the more of it there is per unit volume. Even those who did know the definition often stated that the concentration of the acid was the number of hydrogen ions per unit volume, rather than the acid molecules. There were vague statements such as the strength of an acid depends on the extent of ionisation, without giving the direction of that dependency. Some otherwise good answers were compromised by incorrect links to pH, such as 'the stronger the acid the higher the pH'. Many students made incorrect statements trying to link strength to concentration, not recognising that they are entirely separate.

08.2 Most students were able to explain that the first titration is anomalous and the mean of the other four titrations is used. Some correctly described this as taking the mean of the concordant results, or the mean of the results within 0.10 cm^3. Incorrect answers included that the value used was the mean of all five results, or that it was the mode or median of the results.

08.3 There were many fully correct answers. Some students use a table approach without showing their working for each entry in the table, so that if an intermediate step is incorrect it is difficult to see what the student has done in subsequent steps. Some students calculated their number of moles incorrectly due to not converting their volume from cm^3 to dm^3; in this case they often repeated the error, obtaining what looked like a correct answer. In a multi-step calculation working must be shown.

4.4.2.2 Neutralisation of acids and salt production

Answer 30 · Examiner comments

08.4 Although many students scored one mark, very few scored all three. There was a lot of confusion evident over the mechanism of conductivity in a solution. Many students stated that ions allow delocalised electrons to be passed from one to another, rather than the flow of ions themselves constituting the electric current. Many of those students who did understand the mechanism only considered the removal of one pair of ions (usually the barium and sulfate ions, but sometimes the hydrogen and hydroxide ions), and few said categorically that there were no longer **any** ions which were mobile in the solution.

08.5 Few students recognized that the excess barium hydroxide provided ions that were free to move in solution. There was confusion evident between neutralised in the context of positive and negative charges, and neutralised in the context of pH. Some stated that OH^- ions contain a delocalised electron.

4.4.2.2 Neutralisation of acids and salt production

Answer 30 · Examiner comments

Use of statistics

Statistics used in this report may be taken from incomplete processing data. However, this data still gives a true account of 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.

4.4.2.2 Neutralisation of acids and salt production

Answer 31 · Examiner comments June 2023 | 8462/1H | Original Q3

Question 3 (standard demand)

03.1 This question discriminated very well, with nearly two fifths of students giving a Level 3 answer, another third reaching Level 2, and nearly all of the others reaching Level 1.

Many students gave excellent descriptions of the salt preparation, although many did not state which acid would be used in order to obtain zinc chloride. Some students only described the crystallisation process, leaving out essential steps such as starting with the acid, adding excess of the zinc carbonate, and filtering out the excess. A few would not have made crystals because they evaporated to dryness by heating. Many students appear to believe that the acid is being evaporated off the solution, rather than water. There were infrequent references to using a water bath of an electric heater for the

Answer 31 · Examiner comments June 2023 | 8462/1H | Original Q3

evaporation; use of a Bunsen burner directly is likely to lead to heating to dryness. A few students seem to think that every practical activity is an investigation, trying inappropriately to name independent, dependent and control variables.

03.2 Many students could name at least one correct substance, with two fifths scoring both marks and another third scoring one mark.

Answer 32 · Examiner comments June 2023 | 8462/1H | Original Q5

Question 5 (standard, standard/high and high demand)

05.1 More than half of the students were able to state that a weak acid is one which is only partially ionised or dissociated in aqueous solution. Common incorrect responses were

Answer 32 · Examiner comments

that the acid is partially ionising (it does not ionise other species) or that hydrogen ions are ionised (it is the acid molecule which ionises to form H^+ ions). Attempted responses in terms of pH were not accepted.

05.2 The great majority of students gave the correct response. The most common distractor was the mass of acid dissolved is halved and the volume of the solution is doubled, which would decrease the concentration. The other two options would not change the concentration.

05.3 Fewer than a third of students could recall the name of an appropriate indicator and the correct colour change from this required practical. Any single acid-base indicator was allowed, with its associated colour change. Phenolphthalein was the most popular choice of indicator; with phonetic spellings accepted. The colour change was often the wrong way round, as acid is being added to the alkali, and some students described the final colour incorrectly as 'clear' rather than colourless.

05.4 About three fifths of students knew that the OH^- ion is responsible. When asked for a formula, an equation is not an appropriate response.

05.5 This question discriminated very well. Some scaffolding was given to help the students and bring the demand of the question down. This resulted in two fifths of students scoring full marks on the question and nearly three quarters scoring at least one mark.

Some intermediate marks were not awarded because students didn't convert the volume into dm^3 when calculating the number of moles of sodium carbonate. A second mark was then often not awarded in calculating the concentration of nitric acid because students divided by a volume in cm^3 instead of dm^3. Those students who tried to bring relative formula masses into the calculation (when no data had been given to enable them to do so) rarely scored more than two marks; one for applying the mole ratio and one for rounding an answer to 3 significant figures if all the data supplied had been used.

A few students did not use the method suggested, but used a ratio method instead. On this occasion full credit was given to these answers. However, students should be aware that purely mathematical methods, which do not demonstrate an understanding of the chemical principles, are not always appropriate.

05.6 Over a third of students scored the mark in this high demand question. As the pH has decreased by a factor of 2, the concentration of hydrogen ions increases by a factor of 10^2. However, many students did not realise this and attempted to calculate a concentration by applying a linear, instead of logarithmic, scale factor. Some students divided by 100 instead of multiplying.

05.7 Only two fifths of the students worked out that the element must be argon. Sulfur was a popular incorrect response (one electron subtracted instead of added), but other halogens were also popular.

4.4.2.2 Neutralisation of acids and salt production

Answer 33 · Examiner comments June 2023 | 8462/2H | Original Q10

Question 10 (standard, standard / high and high demand)

10.1 The command word in this extended response question was ‘evaluate’. Therefore, a reasoned judgement was needed to access Level 3. Level 1 was not used in the mark

Answer 33 · Examiner comments

scheme because of the level of demand of the question overall. Therefore, simple statements without linkages did not contribute to a creditworthy response.

Many students tried to identify a single fertiliser to be used, so were able to gain little credit. Those who did realise that a mixture should be used were often able to choose A and B, but were less able to articulate sufficient linked reasons. Some focused only on the overall percentage figures, without considering what elements those percentages represented; they treated 'N, P and K' as if it were a single entity or compared the percentage of potassium in A with the percentage of nitrogen in B. Many compared the costs of all three, failing to realise that cost was only relevant when comparing B and C in conjunction with their nitrogen content. Some students confused potassium and phosphorus, thinking P was the symbol for potassium. It was clear that many students had not considered all the information given in the question. Only around 10% of students achieved a Level 3 score of 3 or 4 marks.

10.2 Many students thought the process was phytomining. Others gave the source (rocks) rather than the process. Some gave electrolysis, probably thinking about how potassium is extracted from potassium chloride (even though it is not in the specification) instead of answering the question. Just over one-third of students gained a mark.

10.3 This was quite well answered, with most choosing a suitable potassium salt. Over half of students gained this mark.

10.4 Students found this question difficult and water was about as popular a response as ammonia. There were many students who gave oxides of nitrogen, or elements, or non-existent substances.

Many students seemed to know about the production of nitric acid (even though it is not in the specification) and the intermediate compounds in this process were ignored as the compounds needed are those which feed into the Ostwald Process – ammonia and water. Oxygen is not a compound. Less than one-quarter of students gained the mark.

10.5 Many students realised that the lack of solubility was the issue. There were a lot of answers which went no further than the information in the question, stating that the rock needs to be dissolved rather than it cannot be dissolved, or stating that phosphorus cannot be absorbed from rock without explaining why. Many thought that other toxic or harmful substances might be present. Around one-third of students gained this mark.

10.6 There were very many incorrect answers which attempted to name compounds starting with 'phosphorus'. The answers which were correct tended to split into two camps; those who used their knowledge of fertilisers to name single superphosphate and triple superphosphate, and those who used their knowledge of acids and salts to name calcium sulphate and calcium phosphate. Around 5% of students gained both marks.

4.4.2.2 Neutralisation of acids and salt production

Answer 33 · Examiner comments

Mark Ranges and Award of Grades

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

4.4.2.2 Neutralisation of acids and salt production

Answer 34 · Examiner comments

June 2024 | 8462/1H | Original Q1

Question 1 (standard demand)

01.1 Two thirds of students gained both marks, with nearly all scoring one mark. A few incorrect salts were named, such as copper chloride and copper sulfide, and sometimes hydrogen was given as the third product instead of water.

01.2 Nearly three quarters of students were awarded the mark for this question. The question asked for an observation to show that the reaction was complete. Those who stated that the solid would no longer react were simply rewording the question and did not gain credit. A statement of copper carbonate no longer disappearing or still being visible did gain credit, and this was the approach taken by the vast majority of students. The idea of a product forming rather than remaining did not gain credit. Only a few recognised that bubbling would stop.

01.3 More than 3/4 of students were awarded the mark. Most answered correctly in terms of removing the excess copper carbonate. A few gave generalised answers about filtration removing solids that were not specific to this salt preparation and therefore did not gain credit.

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Answer 34 · Examiner comments

June 2024 | 8462/1H | Original Q1

01.4 Students were expected to give one of the two methods in the specification, ie a water bath or an electric heater. Many, however, simply stated that a Bunsen burner would be used. This was an insufficient response unless a beaker of water was also present. Less than half of students scored the mark.

01.5 The great majority of students were able to substitute the values and rearrange the expression to give the correct answer. Some students used their calculator incorrectly, using both the % button and also dividing by 100, giving an answer that was a factor of 100 too low. They seemed unfamiliar with the idea that the symbol '%' means divided by 100. A minority of students tried to incorporate the 50 cm^3 into their calculation.

01.6 This question proved surprisingly difficult, although it did discriminate well. Only a sixth of students scored both marks, with half of students not gaining credit at all.

Students were expected to recognise that copper would not react with an acid, and that the reaction with sodium would be too vigorous to be safe. There were some excellent answers for the lack of reactivity of copper in terms of its position below hydrogen in the reactivity series. However, there were many poorly phrased answers that implied there might be some reaction with copper, and also many that described copper as a transition metal but did not link that to reactivity in any way. There were also some excellent answers in terms of the consequences of the high reactivity of sodium, although some did not go far enough; they simply stated that sodium is too reactive without saying why that is a problem. A minority of students thought that the metal would be displacing sulfur if it reacted.

4.4.2.2 Neutralisation of acids and salt production

Answer 35 · Examiner comments — June 2024 | 8462/1H | Original Q2

Question 2 (standard demand)

02.1 This was very well answered by the majority of students, with nearly two thirds scoring both marks. Most stated that both atoms have one outer shell electron and that potassium has one more shell than sodium. Sometimes the wrong number of shells was given for the two elements; usually 2 shells for sodium and 3 for potassium. Some stated that potassium has more outer shells than sodium. This is not correct as the phrase 'outer shell' is always taken to mean the single outermost shell. Some students gave consequences of the electronic structure rather than referring to the electronic structure itself; this was not given credit. Simply stating that the number of electrons is different did not answer the question; the number of electrons is not the electronic configuration.

02.2 More than two thirds of students gave two correct observations, with bubbling and a flame being the most popular. 'Gas produced' did not gain credit as it is not an observation but a deduction from the observation of bubbling. 'Fizzing' is taken to mean effervescence, so fizzing and bubbling are the same thing rather than two different observations. Credit was not given for any observation requiring extra equipment such as a thermometer or an indicator.

02.3 Well over half of students gave a correct colour and a correct reason, either in terms of the solution being alkaline or containing hydroxide ions. Nearly three quarters of students gained one mark. Some students had evidently seen, and remembered, the experiment done with phenolphthalein in the water, and therefore stated the indicator colour to be pink even though they knew the solution to be alkaline. Some answers were not clearly expressed; 'potassium is an alkali' did not gain credit as it is the potassium hydroxide solution that is alkaline. There were

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Answer 35 · Examiner comments — June 2024 | 8462/1H | Original Q2

also, however, some excellent answers in terms of the hydroxide ion produced causing the solution to be alkaline.

02.4 More than four fifths of students plotted all of their points accurately. Many also drew a line of best fit although this was not required. A few drew their points as small dots instead of crosses, making it very difficult for the examiners to see them on a scanned image. Points do need to be visible, albeit sharp.

02.5 Students could nearly always estimate the density of krypton to within the tolerance allowed. Many used a line of best fit to do so although this was not necessary. In some cases inappropriate methods were used, such as finding the mean of all the other values; this did not gain credit even if it gave a value withing the range allowed.

02.6 Three quarters of students identified the correct pair of solutions, with the spread of incorrect responses being approximately equal.

02.7 Over two thirds of students identified the correct pair of trends. Most of the incorrect responses thought that boiling point decreases down the group.

4.4.2.2 Neutralisation of acids and salt production

Answer 36 · Examiner comments

June 2024 | 8462/1H | Original Q9

Question 9 (standard, standard/high and high demand)

09.1 Over a half of students knew that a weak acid is one which is partially ionised, although many forgot to state that this was in aqueous solution. Some students incorrectly stated that an acid is ionising (ionises other species) rather than ionised (is itself ionised). Some incorrectly stated that it was H^+ ions which are ionised or dissociated, rather than the acid molecules. The H^+ ions are the result of the ionisation or dissociation.

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09.2 Two thirds of students realised that the pH would increase. Some did not give the direction of the change, saying the pH would become 'closer to 7' but not saying from which direction. Far fewer were able to articulate the reason in terms of the decrease in concentration of hydrogen ions. There were, however, some excellent answers in terms of the decrease of the number of hydrogen ions per unit volume.

09.3 Many students gave three or four correct steps in the procedure. However, many omitted to say that the alkali should be measured with a (volumetric) pipette, which is an essential step, so did not gain full marks. Most students remembered to add an indicator, although some suggested using universal indicator, which is not suitable for a titration. Most also suggested using a white tile, and many correctly said that the titration should be carried out in a conical flask. Carrying out the titration in a beaker did not gain credit because of the risk of spillage while swirling. Those who suggested taking the initial burette reading, or filling to a particular reading, often expressed themselves poorly; a burette does not give readings of 'amount.'

09.4 Over two thirds of students scored one mark, but fewer than a half scored both. The most common approach was to calculate the volume in dm^3 and then convert to cm^3. Students who took this approach very often scored at least one mark, either by converting an incorrect volume to cm^3 or getting the first step right but forgetting to convert the units. A common error was to multiply the moles and concentration together.

Students who took the alternative approach, converting the concentration to mol/cm^3 first, were less successful; they often multiplied by 1000 in the first step instead of dividing and then did not know how to use the number of moles.

09.5 This high demand question discriminated well; fewer than a third of students scored all three marks but nearly three quarters scored at least one mark. The best answers picked up on the information that calcium atoms are larger, and applied knowledge about reactivity in Group 1 metals to this unfamiliar context. Imprecise language lost some students credit: 'electrons are further away' mentions neither the outer electrons nor the nucleus; 'force between the outer electrons and the nucleus' does not specify an attractive force; 'more outer shells' is not correct because 'outer' is always taken to mean the one shell furthest from the nucleus. It was not uncommon to see the force between the nucleus and the outer electrons described incorrectly as intermolecular. Some students referred to the larger size of the atom as if this referred to a lump of calcium and tried to answer in terms of larger surface area for the acid to attack giving a higher rate of reaction.

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4.4.2.2 Neutralisation of acids and salt production

Answer 36 · Examiner comments

Mark Ranges and Award of Grades

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4.4.2.2 Neutralisation of acids and salt production

Answer 37 · Examiner comments June 2024 | 8462/2H | Original Q1

Question 1 (standard demand)

01.1 This question was generally well answered by students, with around 60% of the entry gaining both marks.

The specific test and correct result were well known. The most common incorrect responses were a flame not being mentioned and the incorrect flame colour, particularly orange or crimson.

The alternative method of gaining the marks using flame emission spectroscopy was very seldom seen.

01.2 The test for chlorine was not well known. Just over one-third of students gained both marks. If an acid was mentioned it was almost always nitric acid.

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Answer 37 · Examiner comments June 2024 | 8462/2H | Original Q1

Some other tests were chosen with the most common incorrect responses being the addition of barium chloride or sodium hydroxide. A number of students mentioned the test for chlorine gas rather than chloride ions and described the use of damp litmus paper.

The mark for the result of the test was dependent upon a mark being awarded for a correct test.

01.3 Only around a quarter of students were awarded this mark. The use of words such as solution or liquid were common uncreditworthy responses. The removal of **all** the water was also not indicated by many students.

01.4 This multiple-choice question was very well answered, with around 85% of students gaining credit.

01.5 This calculation was generally answered well by most students. Around two-thirds gained all four marks by completing the calculation using one of the approaches given on the mark scheme and usually showing full details of their working. Those who did not complete the calculation usually gained two marks for correctly determining the mean concentration of sodium chloride.

4.4.2.2 Neutralisation of acids and salt production

Answer 38 · Examiner comments June 2024 | 8462/2H | Original Q2

Question 2 (standard demand)

02.1 Around two-fifths of students gained credit on this question. Some students referred to both hydrogen and nitrogen gases being recycled or reused. A few referred to only one of the gases or unspecified unreacted gases.

A number of students referred to excess gases or gases alone. In addition, some students focused their answer on the condenser part of the flow chart and responded with the idea that uncondensed gases needed to be recycled.

02.2 This question was answered well by the majority of students, with roughly two-thirds of students gaining the mark.

02.3 Although this question was answered well, some students referred to a splint being lit initially and then blown out. These students did not often mention the splint was still glowing. The majority of students who stated glowing splint also gained the second marking point. Around three-quarters of students gained both marks; of those who did not, most described the test for hydrogen.

02.4 There were many variations of drawing the arrow for the activation energy. A number of students labelled the activation energy with abbreviations such as E_a. The majority of students correctly named the reactants and products and placed them above and below the lines, with a few using arrows to point out their positions. More than 60% of students gained both marks.

02.5 This multiple-choice question was well answered, with around 70% of students gaining credit. The most popular distractor was that the peak would be lower rather than higher.

02.6 This question was answered extremely well with fertiliser or NPK fertiliser. A small minority stated farming or agricultural use unqualified. Only a handful of students identified its use in explosives or sports injury packs.

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Answer 39 · Examiner comments June 2024 | 8462/2H | Original Q7

Question 7 (standard, standard / high and high demand)

07.1 Around 40% of students scored two marks for this question. However, many students were not able to name the correct reagent for the test. White precipitate was often given as the result of the test, but this answer was not creditworthy unless the correct reagent had been named. Sodium hydroxide and silver nitrate were the most common incorrect reagents. A significant number of students left the answer space blank.

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4.4.2.2 Neutralisation of acids and salt production

Answer 39 · Examiner comments June 2024 | 8462/2H | Original Q7

07.2 This multiple-choice question was well answered with two-thirds of students gaining the mark.

07.3 Around 30% of students scored both the marks on this question. Clear descriptions about the numbers of moles / molecules on each side of the equation and the resulting shift in the position of equilibrium at higher pressure were seen. A number of students failed to score the first marking point because they did not give a comparison of the number of moles or molecules of gas on each side of the equation. Answers that focused on changes in the rate of reaction or particle collisions were not creditworthy, nor were those which stated that the equilibrium shifted to the side with lower pressure.

07.4 This question was not well answered and only around 2% of students were awarded both marks. The most common creditworthy responses were based on the idea that a higher pressure is not used because the yield is already high or because more energy would be required to achieve a higher pressure. Many answers could not be given credit because they were not comparative. Higher risk of explosion or higher cost of safety precautions were creditworthy responses that focused on the consequences of using higher pressure compared to using a lower pressure.

07.5 This multiple-choice question was answered correctly by around a quarter of students who used their periodic table to locate and identify vanadium as a transition metal.

Answer 40 · Examiner comments June 2025 | 8462/1H | Original Q8

Question 8 (standard, standard/high and high demand)

08.1 Three quarters of students could give the correct formula for the hydroxide ion. The most common error was H^+. A surprising number did not attempt to answer.

08.2 This was surprisingly answered less successfully, with fewer than two thirds gaining a single mark and very few scoring all four. Many suggested using phenolphthalein or methyl orange instead of Universal Indicator, but few were able to express the reason

Answer 40 · Examiner comments

in terms of a sharp or sudden colour change rather than the gradual change seen with Universal Indicator. The next most common improvement was to add the sodium hydroxide solution dropwise near the end point, but again the reason was not clear, with 'results' or 'amount' often stated instead of 'volume', and 'precise' instead of 'accurate'. These words are not synonymous.

There were many spurious 'improvements' such as having the acid in the burette and the alkali in the flask; it does not matter which way round the solutions are used. Some think that a measuring cylinder is more accurate than a pipette – they are confusing a pipette used for measuring volume with a dropping pipette.

08.3 The vast majority gave the correct reading. The most common error was 25.3 cm^3.

08.4 This question discriminated well. Nearly a half gave fully correct answers, while two thirds were able to score at least one mark, often for applying the correct mole ratio. A common error was to use the mole ratio the wrong way round, giving an answer of 0.24 mol/dm^3, or to ignore the mole ratio completely, giving an answer of 0.48 mol/dm^3. Sometimes the volumes were not converted to dm^3, leading to incorrect statements such as 'moles acid = 5.4'. Whilst these responses often led to the answer of 0.96 mol/dm^3, they did not gain full credit. Sometimes the volume conversion was attempted but incorrect, eg multiplying cm^3 by 1000. Students who tried to bring masses into the calculation were rarely able to make any progress.

08.5 The vast majority chose the correct statement, but a minority thought that the hydrochloric acid was more concentrated as well as stronger.

08.6 Students struggled with this high demand question, with only one in ten scoring one mark. The question demanded precise use of technical terms and use of the data in the table. Few mentioned the concentration of hydrogen ions, so could not gain credit; they referred to 'number' of hydrogen ions or 'more' hydrogen ions (in an unspecified volume) or concentration of 'acid'. Even fewer calculated the concentration of hydrogen ions in each acid from the data in the table, to back up their argument. Many students seem to think that pH depends only on the strength of an acid. pH depends on the hydrogen ion concentration, which in turn depends on a combination of both the strength and the concentration of acid molecules. Many also seem to think that acids are ionising, rather than ionised.

4.4.2.2 Neutralisation of acids and salt production

Answer 41 · Examiner comments

June 2025 | 8462/1H | Original Q9

Question 9 (standard/high and high demand)

09.1 This question discriminated well. Nearly all were able to reach level 1, with two thirds reaching level 2 and one third reaching level 3; one in six students were awarded full marks. This was an AO3 question which required students to apply techniques they had learned in a required practical to a new situation. There were many excellent answers, with students realising that the first step should be to make a solution of iodine in ethanol and then carry out a normal salt preparation adding excess zinc, filtering, and crystallising the solution. The most common error was to ignore the flammability of ethanol and heat with a direct flame instead of over a water bath or electric heater. Some

Answer 41 · Examiner comments June 2025 | 8462/1H | Original Q9

students ignored the instruction to use zinc and iodine, using zinc oxide, zinc hydroxide or even zinc carbonate. Many students believed that iodine is a liquid or should be used in aqueous solution; this was not penalised as the students' experience of iodine is probably only as a solution. This did lead to problems for some students, however, as they believed that both ethanol and water were present. Those who missed out a key step, such as adding excess zinc or filtering to remove the excess zinc, were limited to level 2. Those who started with the product, zinc iodide, were limited to level 1.

09.2 Nearly a half of students gained full marks in this calculation and over three quarters could make some progress. This was a multi-step calculation, which is classed as an extended response question. As such, the working has to make sense chemically. Those students who managed to put the data together in such a way as to obtain an answer of 78.9%, but whose working made no sense chemically, were often limited to the mark for the correct number of significant figures.

There were many excellent fully correct answers, and many students were able to make some progress by calculating the number of moles of iodine and / or zinc iodide. While most adopted the expected approach, calculating the expected mass of zinc iodide and finding the actual mass as a percentage of that value, two other valid approaches also gained credit. One of these was to find the moles of zinc iodide produced as a percentage of the expected moles. The other, far less commonly seen, was to find the mass of iodine actually reacted and take that as a percentage of the mass provided. Of those who adopted the approach of calculating the expected mass of zinc iodide, many surprisingly calculated the mass of zinc and added that to the mass of iodine, rather than simply multiplying the number of moles by the M_r of ZnI_2, which was provided. Students had little difficulty in rounding correctly to 3 significant figures.

4.4.2.2 Neutralisation of acids and salt production

Answer 41 · Examiner comments

June 2025 | 8462/1H | Original Q9

Mark Ranges and Award of Grades

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