AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.4.2.1

Reactions of acids with metals

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**34**
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.

4.4.2.1 Reactions of acids with metals

Answer 01 · Mark scheme

January 2008 | CHY2H | Original Q5 | Legacy

The full source mark scheme begins on page 64. 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**

Answer 03 · Mark scheme

March 2009 | CHY1AP | Original Q9 | Legacy

Nine	**2**	**2**	**3**	**1**

Answer 04 · Mark scheme

June 2009 | CHY1AP | Original Q7 | Legacy

Seven	**4**	**1**	**4**	**1**

4.4.2.1 Reactions of acids with metals

Answer 05 · Mark scheme

June 2009 | CHY2H | Original Q3 | Legacy

Question 3

question	answers	extra information	mark
3(a)	to speed up the reaction **or** it is a catalyst	allow higher level answers such as to reduce the activation energy ignore cost or yield	1
3(b)(i)	reaction is exothermic	accept reverse reaction is endothermic **or** high temperature causes decomposition of ammonia ignore reference to rate	1
3(b)(ii)	more (gaseous) reactant molecules than (gaseous) product molecules	accept 4 volumes / moles of reactant and 2 volumes / moles of product accept lower volume of products **or** volume lower on right hand side accept 'favours the reaction which produces fewer molecules' ignore incorrect number of moles ignore reference to' amount' of product / reactant ignore reference to rate	1
3(c)	(rate is) too slow / slower owtte	allow catalyst would not work accept at higher temperature the rate is quicker accept at lower temperatures particles do not collide as often **or** fewer particles have the activation energy **or** particles do not have the activation energy ignore reaction would not work ignore optimum / compromise type answers	1

Question 3 continues on the next page…

4.4.2.1 Reactions of acids with metals

CHY2H

Question 3 Continued

question	answers	extra information	mark
3(d)	cooled	allow ammonia / it is turned into a liquid **or** is condensed ignore references to boiling point	1
3(e)	nitric (acid)	allow HNO_3 ignore hydrogen nitrate	1
Total			**6**

4.4.2.1 Reactions of acids with metals

Answer 05 · Mark scheme June 2009 | CHY2H | Original Q3 | Legacy

CHY2H

Answer 06 · Mark scheme November 2009 | CHY1AP | Original Q8 | Legacy

Eight	**1**	**1**	**3**	**4**

Answer 07 · Mark scheme March 2010 | CHY1AP | Original Q2 | Legacy

Two	**A**	reduction	**4**			
	B	combustion	**2**			
	C	thermal decomposition	**1**			
	D	corrosion	**3**			
	A		**B**	**C**	**D**	

Answer 08 · Mark scheme March 2010 | CHY1AP | Original Q6 | Legacy

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

Answer 09 · Mark scheme November 2010 | CHY1AP | Original Q1 | Legacy

Question	Key		
One	**A**	uses another metal	**3**
	B	does **not** use a chemical reaction	**2**
	C	could be done in a blast furnace	**4**
	D	is called electrolysis	**1**

4.4.2.1 Reactions of acids with metals

Answer 10 · 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**

4.4.2.1 Reactions of acids with metals

Answer 10 · Mark scheme

January 2011 | CHY2H | Original Q3 | Legacy

CHY2H

4.4.2.1 Reactions of acids with metals

Answer 11 · Mark scheme

June 2011 | CHY1H | Original Q3 | Legacy

Question 3

question	answers	extra information	mark
3(a)		any mention of molecules / compounds = max **1** allow ions for particles throughout it = brass	
	brass is an alloy **or** brass is a mixture (of metals) **or** brass has different sized / types of atoms / particles	accept brass does not have a regular structure **or** has a disrupted / irregular structure	1
	or in copper all the atoms / particles are the same **or** are the same size / type	accept copper has a regular structure	
	(so) in brass layers / atoms / particles cannot (easily) slide **or** in copper layers / atoms / particles can slide (more easily)	ignore moves easier	1
3(b)(i)	(thermal) decomposition	accept endothermic (reaction) do not accept combustion / burning	1
	by heating	accept in a furnace / kiln	1
3(b)(ii)		they = zinc or lead	
	carbon is more reactive than lead / zinc		1
	(so) lead / zinc oxide is reduced **or** oxygen is removed (by carbon)	accept so lead / zinc oxide reacts with carbon / carbon monoxide accept carbon displaces zinc / lead (from their oxide) allow carbon reacts with the oxygen accept word equation **or** balanced symbol equation	1

Question 3 continues on the next page . . .

4.4.2.1 Reactions of acids with metals

CHY1H

Question 3 continued . . .

question	answers	extra information	mark
3(b)(iii)	(zinc separates / escapes because) zinc boils / turns to a gas (at the temperature of the furnace) **or** the boiling point of zinc is below the temperature of the furnace	ignore density ignore evaporates	1
	lead separates because it melts but does not boil **or** the temperature of the furnace is above the melting point of lead but below its boiling point	ignore density accept lead is molten for lead melts	1
		if no other mark awarded allow **1** mark for they (zinc and lead) have different boiling points **or** zinc's boiling point is lower than lead's or vice versa	
Total			**8**

4.4.2.1 Reactions of acids with metals

Answer 11 · Mark scheme

June 2011 | CHY1H | Original Q3 | Legacy

CHY1H

4.4.2.1 Reactions of acids with metals

Answer 12 · 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

4.4.2.1 Reactions of acids with metals

Answer 13 · Mark scheme June 2014 | CH1HP | Original Q4 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
4(a)(i)	phytomining		1	1 / 1.3.1g	G
4(a)(ii)	*(the land contains)* very little copper	*allow low grade ore **or** large amounts of waste* *ignore quarrying / benefits of using plants*	1	3 / 1.3.1f/g	E
	uneconomical	*accept (smelting) uses a lot of energy / fossil fuels* *allow expensive*	1		
4(a)(iii)	Cu **2** $CuO + C \rightarrow$ **2** $Cu + CO_2$	*allow* $2\ CuO + C \rightarrow Cu_2 + CO_2$ *for **1** mark*	1 1	2 / 1.3.1f	E
4(b)(i)	iron is more reactive (than copper) iron is cheap(er than copper)	*allow cheaper **or** uses less energy than electrolysis*	1 1	1 + 2 / 1.3.1h	E
4(b)(ii)	*any **two** from:* • copper / ions move **or** are attracted to the negative electrode / *cathode* • where they are reduced **or** gain (two) electrons • *where they form copper (metal / atoms)*		2	1 / 1.3.1h	E
Total			**9**		

4.4.2.1 Reactions of acids with metals

Answer 13 · Mark scheme

June 2014 | CH1HP | Original Q4 | Legacy



4.4.2.1 Reactions of acids with metals

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		

4.4.2.1 Reactions of acids with metals

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**		

4.4.2.1 Reactions of acids with metals

Answer 14 · Mark scheme

June 2014 | CH2HP | Original Q3 | Legacy



4.4.2.1 Reactions of acids with metals

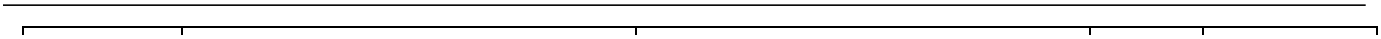
Answer 15 · Mark scheme June 2015 | CH2HP | Original Q5 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
5(a)(i)	silver nitrate	allow $AgNO_3$	1	**AO3** 2.6.1d
5(a)(ii)	potassium carbonate **or** sodium carbonate	allow K_2CO_3 allow Na_2CO_3	1	**AO3** 2.6.1d
5(b)	base	allow ionic ignore insoluble or soluble ignore alkali	1	**AO1** 2.6.2a
5(c)(i)	evaporate **or** crystallise	allow heat or boil or leave (to evaporate) allow cool ignore filtration unless given as an alternative do **not** accept freeze or solidify	1	**AO1** 2.6.1c
5(c)(ii)	2 (HNO_3)	accept multiples	1	**AO2** 2.6.1b
5(c)(iii)	9	accept nine	1	**AO2** 2.6.1b 2.1.1a
5(d)	6.21/207 0.72/16 = 0.03 = 0.045 2 3 Pb_2O_3	**1** mark for dividing mass by A_r **1** mark for correct proportions (allow multiples) **1** mark for correct whole number ratio (allow multiples). Can be awarded from formula. allow O_3Pb_2 **ecf** allowed throughout if sensible attempt at step 1 correct formula with no working gains **1** mark	1 1 1 1	**AO2** 2.3.3b
Total			**10**	

4.4.2.1 Reactions of acids with metals

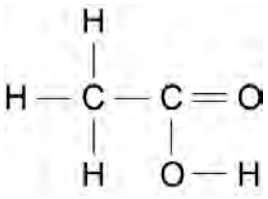
Answer 15 · Mark scheme

June 2015 | CH2HP | Original Q5 | Legacy



4.4.2.1 Reactions of acids with metals

Answer 16 · Mark scheme June 2016 | CH3HP | Original Q1 | Legacy

Question	Answers	Extra information	Mark	AO / SpecRef
1(a)(i)	fizz / effervescence / bubbles	allow calcium carbonate decreases in size or dissolves	1	AO2/AO3 3.4.1d, 3.6.2b
	because carbon dioxide produced / released	allow because gas produced / released	1	
	limewater turns cloudy / milky / white		1	
	because (a precipitate of or solid) calcium carbonate forms	allow because of carbon dioxide if not already credited	1	
1(a)(ii)		allow –OH do not allow lower case 'h'	1	AO1 3.6.2a
1(a)(iii)	acid	must be in this order ignore any name of an acid	1	AO1 3.6.2b
	ester(s)		1	
1(b)	white (precipitate) no change no change no change	all four correct 2 marks any two correct 1 mark	2	AO2 3.4.1e,f
1(c)(i)	lilac red	must be in this order allow purple	1 1	AO1 3.4.1a
1(c)(ii)	colours are masked / changed by each flame colour		1	AO3 3.4.1a
Total			12	

4.4.2.1 Reactions of acids with metals

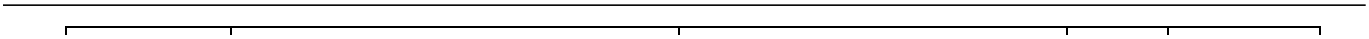
Answer 16 · Mark scheme

<table>
<tr><th>Question</th><th>Answers</th><th>Extra information</th><th>Mark</th><th>AO / SpecRef</th></tr>
<tr><td>2</td><td></td><td></td><td>6</td><td rowspan="6">2AO1 / 3AO2 / 1AO3 3.4.1g</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 content.</td><td>There is a simple description of using some of the apparatus.</td><td>There is a description of an experimental method including addition of acid to alkali which may include an indicator or colour change and may include a measurement of volume.</td><td>There is a description of titrations that would allow a comparison to be made between the two solutions of hydrochloric acid.</td></tr>
</table></td></tr>
<tr><td colspan="4">examples of chemistry points made in the response could include:
• acid in burette or flask
• alkali/sodium hydroxide or acid in burette or flask
• volume of acid or alkali measured using the pipette
• indicator in flask
• white tile under the flask
• slow addition
• swirling/mixing
• colour change of indicator
• burette volume measured</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>Total</td><td></td><td></td><td>6</td><td></td></tr>
</table>

4.4.2.1 Reactions of acids with metals

Answer 16 · Mark scheme

June 2016 | CH3HP | Original Q1 | Legacy



4.4.2.1 Reactions of acids with metals

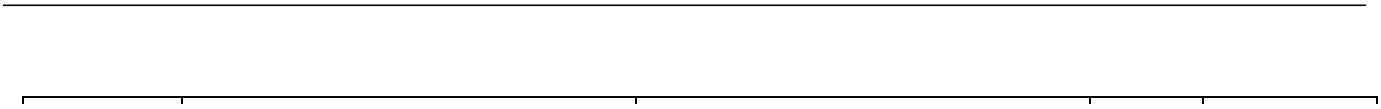
Answer 17 · Mark scheme June 2017 | CH1HP | Original Q1 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1(a)(i)	same number of protons **or** 12 protons in each	ignore electrons ignore it is the same element do **not** allow same number of neutrons	1	AO2 1.1.1f,g
1(a)(ii)	(the mass number is) the sum of the protons and neutrons (so the atoms contain) different numbers of neutrons	ignore electrons in shells do **not** allow electrons in nucleus allow 12, 13 and 14 neutrons for two marks if no other mark awarded allow one mark for isotopes	1 1	AO1 AO2 1.1.1g
1(b)(i)	3 / three		1	AO2 1.1.3a,b
1(b)(ii)	7 / seven		1	AO2 1.1.3a,b
1(c)	319 g($CuSO_4$) and 36 g(H_2O)		1	AO3 1.1.3b,c
1(d)	any **two** changes from: • limewater turns cloudy • solution turns blue • mass decreases • copper carbonate **or** (green) solid disappears • bubbles / fizzing / effervescence explanation: because carbon dioxide is produced **or** copper sulfate is produced **or** calcium carbonate is produced	allow milky / white allow weight decreases explanation must be linked to their observation	2 1	AO1 AO2 AO3 1.2.1e,f
Total			**9**	

4.4.2.1 Reactions of acids with metals

Answer 17 · Mark scheme

June 2017 | CH1HP | Original Q1 | Legacy



4.4.2.1 Reactions of acids with metals

Answer 18 · Mark scheme June 2018 | 8462/1H | Original Q1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	any **one** from: • metal • (metal) hydroxide • (metal) carbonate • alkali	allow named example allow correct formula ignore base allow ammonium hydroxide allow ammonium carbonate allow soluble base allow ammonia	1	AO1 4.4.2.1 4.4.2.2 4.4.2.3
01.2	$Ca(NO_3)_2$	allow $Ca^{2+}(NO_3^-)_2$	1	AO2 4.4.2.2

4.4.2.1 Reactions of acids with metals

Answer 18 · Mark scheme

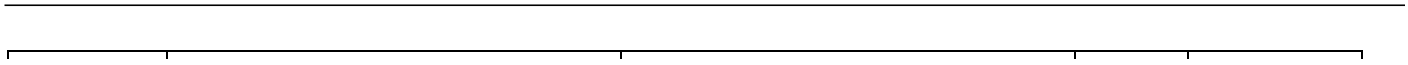
June 2018 | 8462/1H | Original Q1

Question	Answers	Mark	AO / Spec. Ref.
01.3	**Level 3:** The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	5–6	AO1 4.4.2.3
	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 magnesium oxide and sulfuric acid • add sulfuric acid to a beaker • warm sulfuric acid • add magnesium oxide • stir • continue adding until magnesium oxide is in excess • filter • using a filter paper and funnel • to remove excess magnesium oxide • heat solution in an evaporating basin • to crystallisation point • leave to crystallise • pat dry with filter paper credit may be given for diagrams		
Total			**8**

4.4.2.1 Reactions of acids with metals

Answer 18 · Mark scheme

June 2018 | 8462/1H | Original Q1



4.4.2.1 Reactions of acids with metals

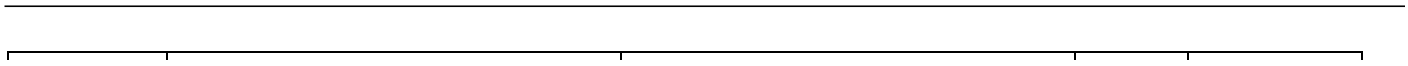
Answer 19 · Mark scheme June 2018 | 8462/2H | Original Q8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	a gas is produced	allow carbon dioxide is produced do **not** accept an incorrect gas	1	AO2 4.3.1.3 4.6.1.1
	(which) escapes	**max 1** mark if evaporation mentioned	1	
08.2	all eight points plotted correctly	allow a tolerance of ± half a small square. allow six or seven points plotted correctly for **1** mark	2	AO2 4.6.1.1
	line of best fit		1	
08.3		an incorrect answer for one step does not prevent allocation of marks for subsequent steps		AO2 4.6.1.1
	correctly drawn tangent at 0.95 g		1	
	correct value for x step **and** y step from tangent	allow evidence of use of two points on tangent either on the graph or in the text	1	
	(rate =) $\frac{\text{value for y step}}{\text{value for x step}}$		1	
	correctly evaluated and rounded to 2 sig figs	allow (rate =) $\frac{\text{value for x step}}{\text{value for y step}}$ (ie inverted division) correctly evaluated and rounded to 2 sig figs	1	
Total			**9**	

4.4.2.1 Reactions of acids with metals

Answer 19 · Mark scheme

June 2018 | 8462/2H | Original Q8



4.4.2.1 Reactions of acids with metals

Answer 20 · Mark scheme

June 2019 | 8462/2H | Original Q2

Question 2

Question	Answers	Mark	AO/ Spec. Ref
02.1	**Level 3**: The design/plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	5–6	AO1 4.8.2.3 4.8.3.1 4.8.3.3
	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	
	Level 1: The design/plan would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2	
	No relevant content	0	
	Indicative content lithium: • crush tablets or dissolve tablet (in water or acid) • clean wire • place on wire • place in (roaring / blue / non-luminous) flame • observe flame colour • crimson flame carbonate: • add hydrochloric acid • effervescence / fizzing • bubble gas through limewater • limewater becomes cloudy		
02.2	formulation(s)	1	AO1 4.8.1.2

4.4.2.1 Reactions of acids with metals

Answer 20 · Mark scheme

02.3		an answer of 58.3333333 (%) correctly rounded to at least 2 significant figures scores **3** marks		AO2 4.8.1.2
	1.20 g = 1200 mg **or** 700 mg = 0.700 g		1	
	$\frac{700}{1200} \times 100$ **or** $\frac{0.700}{1.20} \times 100$	allow correct use of incorrectly or not converted values from step 1	1	
	= 58.3 (%)	allow 58.3333333 (%) correctly rounded to at least 2 significant figures	1	
Total			**10**	

4.4.2.1 Reactions of acids with metals

Answer 21 · Mark scheme

June 2019 | 8462/2H | Original Q3

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	(aq)	allow aqueous / aq	1	AO1 4.2.2.1 4.2.2.2
03.2	(gas) syringe stopclock / stopwatch	allow measuring cylinder (and water trough) allow balance allow timer / clock / watch	1 1	AO1 4.6.1.1
03.3	all points plotted correctly line of best fit	allow a tolerance of ± ½ a small square allow at least 3 points plotted correctly for **1** mark. allow correctly drawn line of best fit for incorrectly plotted points	2 1	AO2 4.6.1.1
03.4	(rate) decreases (rate decreases) more slowly as time increases (rate) becomes zero at 60 s	allow slows down allow (rate decreases) at a non-linear rate allow the reaction stops at 60 s allow ecf from question **03.3**	1 1 1	AO3 4.6.1.1
03.5	more bubbles were produced in the first 10 seconds the magnesium was used up more quickly		1 1	AO2 4.6.1.2
Total			**11**	

4.4.2.1 Reactions of acids with metals

Answer 22 · Mark scheme

November 2020 | 8462/1H | Original Q2

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	they form ions with different charges they have high melting points		1 1	AO1 4.1.3.1 4.1.3.2
02.2	the (grey) crystals are silver the copper ions (produced) are blue (because) copper displaces silver	 allow the copper nitrate / compound (produced) is blue 	1 1 1	AO3 4.4.1.2

4.4.2.1 Reactions of acids with metals

Question 2 continued

Question	Answers	Mark	AO/ Spec. Ref
02.3	**Level 2:** The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.	3–4	AO1 AO3 4.4.1.2 4.5.1.1 RPA 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 **Key steps** • add the metals to (dilute) hydrochloric acid • measure temperature change **or** compare rate of bubbling **or** compare colour of resulting solution for copper: • no reaction • shown by no temperature change **or** shown by no bubbles for magnesium and iron: • magnesium increases in temperature more than iron **or** magnesium bubbles faster than iron **or** magnesium forms a colourless solution and iron forms a coloured solution **Control variables** • same concentration / volume of hydrochloric acid • same mass / moles of metal • same particle size of metal • same temperature (of acid if comparing rate of bubbling)		

4.4.2.1 Reactions of acids with metals

Question 2 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	$\frac{(203 \times 30) + (205 \times 70)}{100}$ **or** $\frac{6090 + 14\,350}{100}$ = 204.4	 ignore units	1 1	AO2 4.1.1.6
Total			**11**	

4.4.2.1 Reactions of acids with metals

Answer 23 · Mark scheme

November 2020 | 8462/1H | Original Q6

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	the (minimum) energy needed for particles to react **or** the (minimum) energy needed for a reaction to occur	allow the (minimum) energy needed to start a reaction	1	AO1 4.5.1.2
06.2	(M_r of Fe_2O_3 =) 160		1	AO2 4.3.1.2 4.3.2.1 4.3.2.2 4.3.2.4
	(moles $Fe_2O_3 = \frac{3000}{160}$ =) 18.75 (mol)	allow correct use of incorrectly calculated M_r	1	
	(moles Al $= \frac{1000}{27}$ =) 37.0 (mol)	allow 37.037037 (mol) correctly rounded to at least 2 significant figures if both MP2 and MP3 are not awarded allow **1** mark for 0.01875 mol Fe_2O_3 **and** 0.037 mol Al	1	
	(aluminium is limiting because) 37.0 mol is less than the (2 x 18.75 =) 37.5 mol (aluminium needed) **or** iron oxide is in excess because 18.75 mol is more than the ($\frac{37.0}{2}$ =) 18.5 mol (iron oxide needed)	allow correct use of incorrect number of moles from steps 2 and/or 3	1	

Answer 23 · Mark scheme

November 2020 | 8462/1H | Original Q6

Question 6 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2 ctd	**alternative approaches:** **approach 1:** **(finding required mass of aluminium by moles method)** (M_r of Fe_2O_3 =) 160 (1) (moles $Fe_2O_3 = \frac{3000}{160}$ =) 18.75 (mol) (1) (moles Al needed =18.75 × 2 =) 37.5 (mol) **and** (mass Al needed = 37.5 × 27 =) 1012.5 (g) **or** 1.0125 kg (1) (so) 1.00 kg of aluminium is not enough (1) **approach 2:** **(finding required mass of aluminium by proportion method)** (M_r of Fe_2O_3 =) 160 (1) (3.00 kg Fe_2O_3 needs) $\frac{3.00}{160}$ × 2 × 27 (kg Al) (1) (=) 1.0125 (kg) (1) (so) 1.00 kg of aluminium is not enough (1)	 allow correct use of incorrectly calculated M_r allow correct use of incorrectly calculated moles of iron oxide allow correct use of incorrectly calculated moles of aluminium needed dependent on calculated mass of aluminium needed being greater than 1.00 (kg) allow correct use of incorrectly calculated M_r dependent on calculated mass of aluminium needed being greater than 1.00 (kg)		AO2 4.3.1.2 4.3.2.1 4.3.2.2 4.3.2.4

Answer 23 · Mark scheme

November 2020 | 8462/1H | Original Q6

Question 6 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2 ctd	**alternative approaches:** **approach 3:** **(finding required mass of iron oxide by moles method)** M_r of Fe_2O_3 =) 160 (1) (moles Al $= \frac{1000}{27}$ =) 37.0 (mol) (1) (moles Fe_2O_3 needed) $= \frac{37.0}{2}$) = 18.5 (mol) **and** (mass Fe_2O_3 needed = 18.5 × 160 =) 2960 (g) **or** 2.96 (kg) (1) (so) 3.00 kg of iron oxide is an excess (1) **approach 4:** **(finding required mass of iron oxide by proportion method)** (M_r of Fe_2O_3 =) 160 (1) (1.00 kg Al needs) $\frac{1.00}{2 \times 27} \times 160$ (kg Fe_2O_3) (1) (=) 2.96 (kg) (1) (so) 3.00 kg of iron oxide is an excess (1)	allow 37.037037 (mol) correctly rounded to at least 2 significant figures allow correct use of incorrectly calculated moles of aluminium allow correct use of incorrectly calculated moles of iron oxide needed allow correct use of incorrectly calculated M_r dependent on calculated mass of iron oxide needed being less than 3.00 (kg) allow correct use of incorrectly calculated M_r dependent on calculated mass of iron oxide needed being less than 3.00 (kg)		AO2 4.3.1.2 4.3.2.1 4.3.2.2 4.3.2.4

4.4.2.1 Reactions of acids with metals

Answer 23 · Mark scheme

November 2020 | 8462/1H | Original Q6

Question 6 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	$Mg(s) + Zn^{2+}(aq) \rightarrow Mg^{2+}(aq) + Zn(s)$	allow multiples allow **1** mark for $Mg^{2+} + Zn$ with missing or incorrect state symbols	2	AO2 4.1.1.1 4.2.2.2 4.4.1.4
06.4	magnesium (atoms) are oxidised because they lose electrons (and) zinc (ions) are reduced because they gain electrons	 if no other marks awarded allow **1** mark for magnesium (atoms) lose electrons and zinc (ions) gain electrons	1 1	AO2 4.4.1.4
Total			**9**	

4.4.2.1 Reactions of acids with metals

Answer 24 · Mark scheme

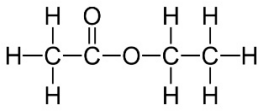
November 2020 | 8462/2H | Original Q7

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	HCOOH propanoic acid	allow HCO_2H	1 1	AO1 4.7.2.4
07.2	incomplete / partial ionisation (because) reaction is reversible	allow incomplete / partial dissociation allow (because) reaction is in equilibrium	1 1	AO3 4.7.2.4
07.3	mass (of flask and contents) decreases (because) carbon dioxide is produced (and) carbon dioxide escapes (from the flask)	allow **1** mark for the gas produced escapes (from the flask)	1 1 1	AO1 AO2 AO2 4.3.1.3 4.7.2.4
07.4	 ($0.01\ mol/dm^3$) methanoic acid has a lower pH (so $0.01\ mol/dm^3$) methanoic acid has a higher concentration of hydrogen ions (therefore) more collisions per unit time	allow converse argument for ethanoic acid allow ($0.01\ mol/dm^3$) methanoic acid is a stronger acid	 1 1 1	AO2 AO2 AO3 4.6.1.2 4.6.1.3 4.7.2.4
07.5	ethyl ethanoate		1	AO1 4.7.2.4

4.4.2.1 Reactions of acids with metals

Question 7 (continued)

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.6			1	AO2 4.7.2.4 4.7.3.2

Total			12

4.4.2.1 Reactions of acids with metals

Answer 25 · Mark scheme

November 2021 | 8462/2H | Original Q9

Question 9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.1	(delivery) tube is in (sulfuric) acid		1	AO3 4.6.1.2 RPA5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.2	reaction has stopped (because a) reactant is used up	allow no more gas produced allow named reactants	1 1	AO2 4.6.1.1 RPA5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.3	any **one** from: • the line (for 0.05 mol/dm^3 sulfuric acid) is less steep • (0.05 mol/dm^3 sulfuric acid) produces less gas in a fixed time • the reaction (using 0.05 mol/dm^3 sulfuric acid) takes longer to finish	allow converse statements about 0.10 mol/dm^3 sulfuric acid ignore produces less gas do **not** accept produces less gas in total	1	AO1 4.6.1.1 RPA5

Question 9 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.4	tangent drawn at 80 s on 0.05 mol/dm^3 curve (from tangent) value for *x*-step **and** value for *y*-step (rate =) $\frac{\text{value for } y\text{-step}}{\text{value for } x\text{-step}}$ calculation of rate answer to 2 significant figures	 allow a tolerance of ± ½ a small square allow correct use of incorrectly determined values from tangent for *x*-step and/or *y*-step allow an answer correctly calculated to 2 significant figures from an incorrect calculation of rate	1 1 1 1 1	AO2 4.6.1.1 RPA5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.5	Cu^{2+}		1	AO2 4.1.3.2 4.6.1.4

Total			10

4.4.2.1 Reactions of acids with metals

Answer 26 · 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

4.4.2.1 Reactions of acids with metals

Answer 26 · Mark scheme

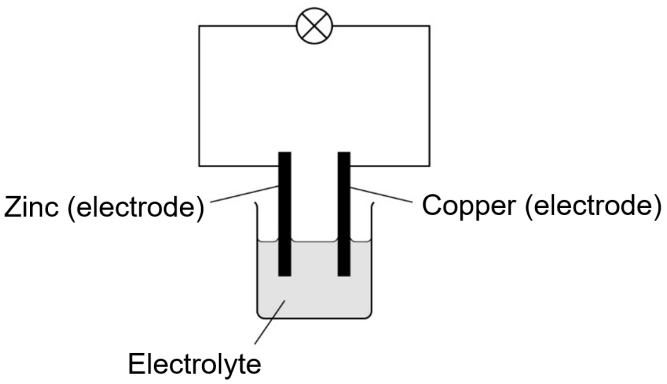
Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	heat (the solution) until crystallisation point is reached	allow heat (the solution) until crystals start to form allow heat (the solution) to reduce the volume allow heat (the solution) to evaporate (some of the water)	1	AO1 4.4.2.3 RPA 1
	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

4.4.2.1 Reactions of acids with metals

Answer 26 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.7	(a diagram showing)	ignore voltmeter / ammeter regardless of location		AO1 4.5.2.1
	solution in a container	ignore labels	1	
	zinc electrode **and** copper electrode both inserted into solution	ignore polarities on electrodes	1	
	complete circuit that would function as an electrochemical cell including a labelled electrolyte	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	
	an answer of  scores **3** marks			

Total Question 4		**10**

4.4.2.1 Reactions of acids with metals

Answer 27 · 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

4.4.2.1 Reactions of acids with metals

Answer 28 · Mark scheme

June 2023 | 8462/2H | Original Q1

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	to reduce the escape of gas		1	AO3 4.6.1.1 RPA5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	(mean rate =) $\frac{0.78 + 0.81 + 0.81}{3}$	allow $\frac{0.78 + 0.81 + 0.68 + 0.81}{4}$	1	AO3
	0.80 (cm^3/s)	= 0.77 (cm^3/ s) for **1** mark	1	AO2
	$0.80 = \frac{20}{\text{mean time taken}}$	allow correct use of incorrectly determined mean rate	1	AO2
	(mean time taken =) $\frac{20}{0.80}$		1	AO2
	= 25 (s)		1	AO2 4.6.1.1 RPA5
	alternative approach: $0.78 = \frac{20}{\text{time}}$ **or** $0.81 = \frac{20}{\text{time}}$ (1)			
	(trial 1 time = $\frac{20}{0.78}$ =) 25.6 (1)			
	(trial 2 and 4 time = $\frac{20}{0.81}$ =) 24.7 (1)			

	(mean time =) $\frac{25.6 + (2 \times 24.7)}{3}$ (1) = 25 (s) (1)	allow correct use of incorrectly determined value(s) for time allow $\frac{25.6 + 29.4 + (2 \times 24.7)}{4}$ = 26.1 (s) for **1** mark		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	use a lower temperature use sulfuric acid of a lower concentration		1 1	AO1 4.6.1.2 RPA5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	(test) burning / lit splint (result) burns with a (squeaky) pop sound	MP2 is dependent upon MP1 being awarded allow flame do **not** accept glowing splint allow pops	 1 1	AO1 4.8.2.1

Total Question 1	10

4.4.2.1 Reactions of acids with metals

Answer 29 · Mark scheme

June 2023 | 8462/2H | 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 4.8.3.1 4.8.3.4 RPA7
	Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the plan is not fully logically sequenced.	3–4	
	Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2	
	No relevant content	0	
	Indicative content (potassium ions) • **place sample on (clean metal) wire** • **introduce into (blue / non-luminous) flame** • using (Bunsen) burner • **observe lilac flame colour** • which shows presence of potassium (ions) (bromide ions) • **dissolve sample** • in (distilled) water • in test tube • add (dilute) nitric acid • **add silver nitrate (solution)** • using (dropping) pipette • **observe cream precipitate (formed after addition of silver nitrate solution)** • which shows presence of bromide (ions)		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	flame emission spectroscopy		1	AO1 4.8.3.7

4.4.2.1 Reactions of acids with metals

Answer 29 · Mark scheme June 2023 | 8462/2H | Original Q3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	any **one** from: • (more) accurate • (more) sensitive • fast(er) • determine the concentration of ions present	allow requires a small(er) sample	1	AO1 4.8.3.6

Total Question 3	**8**

4.4.2.1 Reactions of acids with metals

Answer 30 · 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

4.4.2.1 Reactions of acids with metals

Answer 30 · 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
	(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

4.4.2.1 Reactions of acids with metals

Answer 31 · Mark scheme

June 2024 | 8462/1H | Original Q9

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	ignore beaker	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)	allow named indicator do **not** accept add universal indicator	2	

4.4.2.1 Reactions of acids with metals

Answer 31 · Mark scheme

June 2024 | 8462/1H | Original Q9

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

4.4.2.1 Reactions of acids with metals

Answer 32 · 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

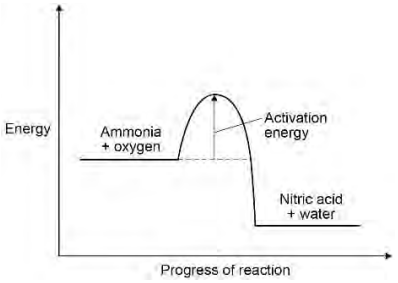
Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	iron	allow Fe	1	AO1 4.6.1.4 4.10.4.1

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

4.4.2.1 Reactions of acids with metals

Answer 32 · 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

4.4.2.1 Reactions of acids with metals

Answer 33 · Mark scheme

June 2024 | 8462/2H | Original Q9

Question 9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.1	(some) hydrogen / gas escapes (from the flask) (because the reaction starts) before the stopper is put in	 allow (because) stopper cannot be inserted instantly allow for **1** mark some air (from the conical flask) is collected **or** allow some hydrogen remains in the conical flask **or** allow some hydrogen remains in the delivery tube	1 1	AO3 4.6.1.2 RPA5

4.4.2.1 Reactions of acids with metals

Answer 33 · Mark scheme

June 2024 | 8462/2H | Original Q9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.2	(volume = 39 − 25 =) 14 (cm^3)		1	AO2 4.3.5
	(14 cm^3 =) 0.014 (dm^3)	allow correct use of an incorrectly determined volume	1	4.6.1.1 RPA5
	(moles of hydrogen =) $\frac{0.014}{24}$	allow correct use of an incorrectly determined volume allow correct use of an incorrect / no conversion of volume	1	
	= 5.8 x 10^{-4} (mol)	allow 5.833333 x 10^{-4} correctly rounded to at least 2 significant figures allow 0.00058 (mol)	1	
	alternative approach 1:			
	(24 dm^3 =) 24 000 (cm^3) (1)			
	(volume = 39 − 25 =) 14 (cm^3) (1)			
	(moles of hydrogen =) $\frac{14}{24000}$ (1)	allow correct use of an incorrectly determined volume allow correct use of an incorrect / no conversion of volume		
	= 5.8 x 10^{-4} (mol) (1)	allow 5.833333 x 10^{-4} correctly rounded to at least 2 significant figures allow 0.00058 (mol)		

4.4.2.1 Reactions of acids with metals

Answer 33 · Mark scheme

June 2024 | 8462/2H | Original Q9

	alternative approach 2: (24 dm^3 =) 24 000 (cm^3) (1) (moles of hydrogen at 100 s = $\frac{39}{24000}$ =) 0.001625 **and** (moles of hydrogen at 40 s = $\frac{25}{24000}$ =) 0.00104 (1) (moles 100 s – moles 40 s =) 0.001625 – 0.00104 (1) = 5.8 x 10^{-4} (mol) (1) **alternative approach 3:** (39 cm^3 =) 0.039 (dm^3) **and** (25 cm^3 =) 0.025 (dm^3) (1) (moles of hydrogen at 100 s = $\frac{0.039}{24}$ =) 0.001625 **and** (moles of hydrogen at 40 s = $\frac{0.025}{24}$ =) 0.00104 (1) (moles 100 s – moles 40 s =) 0.001625 – 0.00104 (1) = 5.8 x 10^{-4} (mol) (1)	allow correct use of an incorrect / no conversion of volume allow correct use of an incorrectly determined number of moles allow 5.833333 x 10^{-4} correctly rounded to at least 2 significant figures allow 0.00058 (mol) allow correct use of an incorrect / no conversion of volume allow correct use of an incorrectly determined number of moles allow 5.833333 x 10^{-4} correctly rounded to at least 2 significant figures allow 0.00058 (mol)		

4.4.2.1 Reactions of acids with metals

Answer 33 · Mark scheme

June 2024 | 8462/2H | Original Q9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.3	tangent drawn at 45 s		1	AO2 4.6.1.1 RPA5
	correct values for *y* step **and** *x* step from tangent	allow correct use of an incorrectly drawn tangent allow a tolerance of ± ½ a small square for each coordinate	1	
	(rate =) $\frac{\text{value for } y \text{ step}}{\text{value for } x \text{ step}}$	allow correct use of incorrectly determined value(s) from the tangent for *y* step and/or *x* step	1	
	correct calculation of rate (mol/s)		1	
	rate given in standard form (mol/s)	allow a correctly calculated answer in standard form from an incorrect attempt at rate determination	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.4	line starting at 0,0.000 and less steep than existing line		1	AO2 4.3.2.4 4.3.4 4.6.1.1 RPA5
	becomes level at 0.0084 mol	allow a tolerance of ± ½ a small square	1	

4.4.2.1 Reactions of acids with metals

Answer 33 · Mark scheme

June 2024 | 8462/2H | Original Q9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.5	(increasing the temperature) increases the rate of reaction		1	AO1 4.6.1.2 4.6.1.3
	(because) particles have more energy	allow (because) particles move faster	1	
	(so) the frequency of collisions increases	allow (so) a greater proportion of collisions have enough energy to react ignore successful	1	

Total Question 9	16

4.4.2.1 Reactions of acids with metals

Answer 34 · Mark scheme

June 2025 | 8462/2H | Original Q6

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	calcium (ions) **or** magnesium (ions)	allow Ca^{2+} (ion) allow Mg^{2+} (ion) allow zinc / Zn^{2+} (ion)	1	AO1 4.8.3.2 RPA7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	(test) add excess sodium hydroxide (solution) (result) with sodium hydroxide the (white) precipitate dissolves	 allow with sodium hydroxide a colourless solution is produced	1 1	AO1 4.8.3.2 RPA7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	Ca^{2+}	ignore calcium	1	AO1 4.2.1.2 4.8.3.1 RPA7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	Cl^-	ignore chloride	1	AO1 4.2.1.2 4.8.3.4 RPA7

4.4.2.1 Reactions of acids with metals

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.5	(test) (bubble the gas through) limewater	allow (bubble the gas through) calcium hydroxide solution	1	AO1 4.8.2.3 4.8.3.3 RPA7
	(result) (which) turns milky / cloudy	MP2 is dependent upon MP1 being awarded	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.6		allow converse argument		
	(using ethanoic acid) the rate of reaction is lower		1	
	(because) ethanoic acid is a weak(er) acid		1	
	(so) the concentration of hydrogen ions is lower	allow (so) ethanoic acid is (only) partially ionised	1	
	(and) the frequency of collisions is lower		1	

Total Question 6	11

Version 1.0: 0108

ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Secondary Education

Additional Science 4463 / Chemistry 4421

CHY2H Unit 2 Chemistry

Mark Scheme

2008 examination – January series

4.4.2.1 Reactions of acids with metals

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

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.

Further copies of this Mark Scheme are available to download from the AQA Website: www.aqa.org.uk

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4.4.2.1 Reactions of acids with metals

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.

4.4.2.1 Reactions of acids with metals

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.

4.4.2.1 Reactions of acids with metals

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

4.4.2.1 Reactions of acids with metals

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

4.4.2.1 Reactions of acids with metals

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

4.4.2.1 Reactions of acids with metals

CHY2H

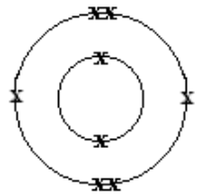
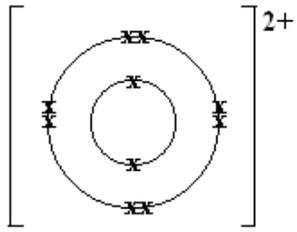
Question 4

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

4.4.2.1 Reactions of acids with metals

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…

4.4.2.1 Reactions of acids with metals

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

4.4.2.1 Reactions of acids with metals

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

4.4.2.1 Reactions of acids with metals

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…

4.4.2.1 Reactions of acids with metals

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…

4.4.2.1 Reactions of acids with metals

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** • <u>escape</u> of dangerous / harmful chemicals / gases (owtte) • <u>danger</u> 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…

4.4.2.1 Reactions of acids with metals

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

4.4.2.1 Reactions of acids with metals

Answer 18 · Examiner comments

June 2018 | 8462/1H | Original Q1

Question 1 (standard demand)

01.1 This question was well answered, with 70% of students able to give a different type of substance. Many suggested a base, but as metal oxides are themselves bases, this was not another type of substance and was ignored. Named examples of correct types of substance were accepted.

01.2 38% of students could write the correct formula for calcium nitrate. Many didn't know what to do with the nitrate ion even if they worked out the ratio as 1:2.

01.3 This question discriminated well, with marks across the range being spread fairly equally. Whilst there were many excellent answers, a lot of students concentrated on the crystallisation phase, without saying how the magnesium sulfate solution would be produced.

Some started by adding magnesium sulfate to an acid. A few students mixed unspecified quantities of magnesium oxide and sulfuric acid in an evaporating basin and then evaporated to dryness, sometimes stating that the acid was being evaporated off. Even when an oxide is correctly added in excess and the excess filtered off, evaporation to dryness will not yield crystals.

Answer 19 · Examiner comments

June 2018 | 8462/2H | Original Q8

Question 8 (standard / high & high demand)

08.1 Most students recognised that a gas is given off by the reaction. Sometimes it was incorrectly identified as hydrogen.

The 'escape' mark was less commonly awarded either because the students thought it was sufficient to state that a gas is given off or because they thought that the gas 'evaporated'.

43% of students achieved full marks.

08.2 The points on the graph were almost invariably correctly drawn within tolerance. Most found the question easy although there were a significant number who omitted the point at 0,0.

The line of best fit was problematic for a number of students. A significant number assumed that the line of best fit was a straight line rather than a curve. Other students were penalised for 'double lines' or not extending the curve over the whole range of points.

83% of students were able to achieve at least two marks here.

08.3 A significant number of students did not draw a tangent at 0.95 g but used 0.95 g to calculate the **mean** rate over the first 0.95 g lost. Such students were able to score the third and fourth marking points. A small number of students drew the tangent in the wrong place choosing the other number (50) quoted in the question.

Some students had difficulty with the scales on the graph either by:

- forgetting that the *y*-axis intervals were 0.1 and calculating the difference as a whole number rather than the actual difference eg 18 rather than 0.18
- counting the number of squares on the *y*-axis or the *x*-axis eg 1.00 − 0.8 = 10 (squares) rather than 0.2

Many students were able to state that the gradient of the tangent is calculated by the *y* value divided by the *x* value and calculate a value correctly. But some students neglected to quote their answer to two significant figures. 25% of students achieved full marks.

4.4.2.1 Reactions of acids with metals

Answer 22 · Examiner comments — November 2020 | 8462/1H | Original Q2

Question 2 (standard demand)

02.1 Nearly all students scored at least one mark. The most commonly seen incorrect response was 'they form colourless compounds'.

02.2 Whilst many students realised that copper was displacing silver, most were unable to deduce that the grey crystals were silver and the blue solution was copper nitrate or a copper compound. There were many poorly worded answers which did not gain credit, such as 'it displaced silver', or 'copper is blue in solution'. It was not uncommon for the grey crystals to be described as copper nitrate crystallising from the solution.

02.3 Whilst many students included a control variable in their plan, few actually said how they would identify each metal as magnesium, iron or copper, so were unable to access the higher levels.

02.4 This calculation was very well done by most students.

Answer 23 · Examiner comments — November 2020 | 8462/1H | Original Q6

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

06.1 Most students were able to express the idea that activation energy is the minimum energy required to start a reaction. One common error was to say that it is the energy needed to make particles collide.

06.2 A variety of approaches was seen. The majority of students calculated the number of moles of both aluminium and of iron oxide and then attempted with varying degrees of success to explain why the number of moles of aluminium was insufficient for the iron oxide. Common errors were to omit to convert the mass from kilograms to grams, and/or using 54 as the 'M_r' of aluminium. Of those who did correctly calculate the number of moles of each reactant, some had difficulty in expressing clearly the idea of 2 moles of aluminium being needed to react with 1 mole of iron oxide, and therefore 37.0 moles of aluminium is less than the 37.5 moles required, or that 18.75 moles of iron oxide is more than the 18.5 moles required. Other students started with the mass of one reagent and calculated the required mass of the other, either by the moles method or by proportion. These students found it easier to express why there was insufficient aluminium or excess iron oxide.

06.3 Few students scored both marks. Aqueous zinc was often seen as a response. Many students did not understand the idea of an ionic equation and tried to include the sulfate ion.

06.4 Only a third of students scored both marks, but a lot of students were confused about which species gained electrons and which lost them. Definitions of oxidation and reduction in terms of gain and loss of oxygen were not appropriate here and were not credited.

4.4.2.1 Reactions of acids with metals

Answer 24 · Examiner comments November 2020 | 8462/2H | Original Q7

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

07.1 Propanoic acid was named correctly much more often than a correct formula was given for methanoic acid. CHCOOH was a commonly seen error here.

07.2 Many students scored at least one mark here. A common misconception was that incomplete / partial ionisation means that each CH_3COOH molecule produces only one H^+ ion, i.e. that the three hydrogen atoms in the CH_3COO^- ion would also form H^+ ions if ionisation were complete.

Answer 24 · Examiner comments November 2020 | 8462/2H | Original Q7

07.3 This part was quite well answered. Most students stated that the mass decreases. Not all of the students who identified carbon dioxide as a product of the reaction went on to explain that it is the escape of this gas that causes the mass to decrease.

07.4 This part was poorly answered by many students. Many recognised that the pH of methanoic acid was lower but far fewer made the link to hydrogen ion concentration. Only a small proportion of students referred to collisions between particles and, of those that did, a significant minority referred to 'more collisions', which was insufficient for the mark, or incorrectly justified the increased collision frequency in terms of the particles having more energy.

07.5 A minority of students were able to name ethyl ethanoate.

07.6 A majority of students were able to identify the displayed structural formula of ethyl ethanoate.

4.4.2.1 Reactions of acids with metals

Answer 25 · Examiner comments November 2021 | 8462/2H | Original Q9

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

09.1 Only around a third of students knew this, which may reflect a lack of practical experience.

09.2 Many students were able to say that the reaction had stopped but only a much smaller number could explain why.

09.3 Around half of the students were able to explain this in a valid way, usually by reference to the slope of the line.

09.4 There was a wide spread of marks here. There is still confusion between mean and instantaneous rate of reaction, so students who approached this as a mean reaction rate usually only scored one mark for giving an answer to 2 significant figures. Amongst the better responses, the first mark was sometimes dropped because the tangent was not close enough to 80 seconds. Some students were able to obtain all 5 marks.

09.5 Around one-third of students identified copper(II) as the only transition metal amongst the choices and therefore more likely to have a catalytic effect.

Answer 26 · 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.

4.4.2.1 Reactions of acids with metals

Answer 26 · 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 27 · 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 27 · 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.

4.4.2.1 Reactions of acids with metals

Answer 28 · Examiner comments June 2023 | 8462/2H | Original Q1

Question 1 (standard demand)

01.1 Fewer than a quarter of students scored a mark here, with most suggesting incorrectly that no gas at all would escape. The idea of minimising escape was key to gaining the mark.

01.2 The vast majority of students used the main approach on the mark scheme. Around three-quarters of students scored all the marks. Of those who didn't, the majority scored 4 marks by failing to discard the anomalous result in MP1. Weaker responses typically calculated the mean rate of 0.80 cm^3/s but were able to take the process further and gained two marks.

01.3 This closed question was answered completely correctly by two-thirds of students, whilst more than 80% scored one mark. Of these, there was usually a conflict between a factor which would speed the reaction up and one which would slow it down.

01.4 Around three-quarters of the students gained both marks. Uncreditworthy responses usually included the squeaky pop test as a description of the test without reference to flames or burning splints, or described the use of a glowing splint.

Answer 29 · Examiner comments June 2023 | 8462/2H | Original Q3

Question 3 (standard demand)

Answer 29 · Examiner comments

June 2023 | 8462/2H | Original Q3

03.1 This extended response question used the command word 'plan', which was well understood by most students.

A simplistic approach to the level descriptors might be:

Level 3 – will produce the expected outcomes.
Level 2 – might produce the expected outcomes with additions or modifications.
Level 1 – will not produce the expected outcomes.

However**,** the marking of extended response questions must always be holistic, so a best-fit approach must always be followed.

Key steps were shown in the indicative content in **bold**.

In general, most students were familiar with the analytical tests required for this method and wrote coherent plans that would lead to valid outcomes. The flame test for potassium ions was better known.

Many students added value to their responses by describing the use of acid to treat the nichrome wire before use. However, a few omitted to introduce the wire into the flame of the Bunsen burner (as opposed to just holding the wire over the Bunsen burner without stating that the burner was alight) or by using the orange or 'safety' flame for the test.

The halide test was slightly less well known.

Many students assumed that the medicine sample was in solution, and if this was apparent in their response (for example referring to drops of the medicine), this was credited.

Most students added both dilute nitric acid and silver nitrate solution to their sample, although acidification was not strictly necessary as a key step. Some students incorrectly referred to bromine ions, or a slightly incorrect result such as a cream solution. Unfortunately, a very small number of students failed to score any marks at all as despite correctly describing some tests and results, they failed to mention testing the medicine sample and so their methods would not lead to a valid outcome. The minority of students who clearly did not know the tests involved also usually failed to score any marks, as use of reagents and techniques had to be placed in the correct context in order to be creditworthy.

Around 45% of students gave a Level 3 response, whilst more than 20% provided a Level 2 response

03.2 In this question, knowledge of the name of an instrumental method, flame emission spectroscopy, was being tested. The full name was required for the mark. A substantial proportion of students did not know the name of this method. The abbreviation F.E.S. was not creditworthy. Around one third of students gained this mark.

03.3 This question was generally answered well, with 'more accurate' being the most common correct advantage of flame emission spectroscopy given. However, a minority of students answered the question in terms of disadvantages of other methods such as flame tests and this was not creditworthy. Some students suggested incorrectly that this instrumental method was more precise. A few students referred to the identification of multiple ions in a sample, but this was not considered to be a sufficiently creditworthy advantage. More than half of students gained credit here.

4.4.2.1 Reactions of acids with metals

Answer 30 · 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 30 · 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.

4.4.2.1 Reactions of acids with metals

Answer 31 · 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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4.4.2.1 Reactions of acids with metals

Answer 31 · Examiner comments June 2024 | 8462/1H | Original Q9

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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4.4.2.1 Reactions of acids with metals

Answer 31 · 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.

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4.4.2.1 Reactions of acids with metals

Answer 32 · 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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4.4.2.1 Reactions of acids with metals

Answer 33 · Examiner comments

June 2024 | 8462/2H | Original Q9

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

09.1 The idea that gas is lost was well understood but the reason why was less well known. Incorrect responses referred to the solubility of hydrogen in water and faulty apparatus. Around 15% of students gained both marks.

09.2 This question was awarded all four marks to around 20% of the students but a significant number of students did not recognise that the volume of the gas should be converted into dm^3. A small number of students believed that 1 cm^3 = 1000 dm^3 resulting in an answer 10^6 times too large.

09.3 Most students were able to construct a tangent at 45 s. The scale on the *y*-axis posed a problem for a significant number of the students. The calculation of the rate was well done, and most were able to convert their answer into standard form. A small number calculated the mean rate between 0 s and 45 s by drawing a single pair of construction lines which met the curve. Such students were only able to gain a mark for an answer correctly expressed in standard form. Just over half of the students scored five marks.

09.4 The vast majority of the students recognised that the curve started at 0,0 and rose less steeply than the curve shown, but only a minority were able to show that the curve levelled off at 0.0084 mol. Some students lost the first mark by shadowing the existing line for a significant time before becoming less steep. While around 20% of students scored both marks, more than four-fifths scored one.

09.5 This question was quite well done by a large proportion of the students, with nearly half of the students gaining all three marks. The idea that an increase in temperature increased the energy of the particles and therefore increased the rate of reaction was well understood by most students but the increase in collision frequency was less well known. A significant proportion of the students simply stated that there is an increase in the number of collisions with no reference

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4.4.2.1 Reactions of acids with metals

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to time. A 'successful' collision was considered insufficient to describe particles whose energy of collision exceeded the activation energy.

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4.4.2.1 Reactions of acids with metals

Answer 33 · Examiner comments

June 2024 | 8462/2H | Original Q9

Mark Ranges and Award of Grades

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

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Question 6

06.1 Three quarters of students correctly identified either calcium or magnesium. A few students gained credit for zinc.

06.2 Just over a quarter of students scored both marks on this item. Many students repeated the information given to them in the stem of the question, stating that they would add sodium hydroxide and observe a white precipitate, which did not gain marks. Some described adding more sodium hydroxide, without specifying that this should be until excess and whilst these students were not awarded the first marking point, they still had access to the second marking point.
Descriptions of the result were often vague. Some responses stated that 'the precipitate would dissolve' but failed to identify the reagent. Others simply said, 'it' will redissolve, become clear, or turn colourless, which was insufficient. There was a misconception that the aluminium dissolves, rather than the precipitate.

06.3 Both the correct symbol and the charge on the ion were required to gain the mark for this item. A quarter of students did this. Many others wrote the name, or the symbol without a charge.

06.4 As with 06.3, both the symbol and the charge on the ion were needed to gain the mark. As with 06.3, a quarter of students answered this correctly. Similar mistakes, writing the name or a symbol without a charge were commonly seen.

06.5 Around two thirds of students gained both marks on this item. A small number of students described adding limewater to solution C, rather than bubbling the gas produced through limewater.

06.6 Around half of students identified ethanoic acid as a weak acid and stated that the rate of reaction was lower. Fewer students were able to describe a lower concentration of hydrogen ions, with some describing fewer hydrogen ions without making any reference to volume. Credit was given to those who described ethanoic acid as partially ionised, however, there was the misconception that less hydrogen ions were ionised. Only a minority of students made a correct reference to the frequency of collisions.