AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.3.2.1

Moles (HT only)

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**31**
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.

4.3.2.1 Moles (HT only)

Answer 01 · Mark scheme January 2008 | CHY3H | Original Q5 | Legacy

(a)(ii)	5.6 **or** from their graph		1
(a)(iii)	10 – 5.6 = 4.4	their reading at 15ºC – their (a)(ii) answer from their figures	1 1
(a)(iv)	Yes: the value at 15°C because have values either side owtte **or** No: more error in a smaller number owtte	accept converse answers based on 50°C accept converse answers based on 50°C	1
(b)(i)	balanced view / involving people / debate / gather information / democracy	owtte any sensible answer ignore 'trout might die'	1
(b)(ii)	undue weight / bias may be given to high status and very experienced people **or** less experienced/lower status may reduce status of enquiry	owtte any sensible answer	1

continued…

4.3.2.1 Moles (HT only)

CHY3H

Question 2 continued…

question	answers	extra information	mark
(b)(iii)	(A) Management: any **one** from: • small amounts may be fine • can cope for short periods • could spread throughout the day • fish still getting (enough) oxygen • rate of photosynthesis could be increased to balance loss of oxygen • water will cool down (quickly) (B) Council: any **one** from: • any rise in temperature would reduce / affect (dissolved) oxygen • water will still be too hot • trout will die above 26°C	any sensible answer any sensible answer	1 1
total			9

4.3.2.1 Moles (HT only)

Answer 01 · Mark scheme

CHY3H

Question 3

question	answers	extra information	mark
(a)	scale – (solid) formed when heat decomposes dissolved calcium / magnesium compounds owtte	allow: scale is formed when hard water is heated / boiled (to leave magnesium / calcium compounds)	1
	scale is calcium carbonate / $CaCO_3$ or magnesium carbonate / $MgCO_3$	ignore evaporate	
	scum – (ppt) formed when soap reacts with calcium / magnesium (ions) owtte	allow scum is formed when hard water reacts with soap	1
	scum is calcium stearate / magnesium stearate		
(b)	calcium (ions) / Ca^{2+} / magnesium (ions) / Mg^{2+}		1
	replaced by hydrogen ions / H^+ / sodium ions / Na^+		1
total			4

4.3.2.1 Moles (HT only)

CHY3H

Question 4

question	answers	extra information	mark
(a)(i)	undiscovered elements owtte		1
(a)(ii)	they would be in the wrong group / have the wrong / different properties / don't fit the pattern owtte	allow atomic weights may have been wrong	1
(b)(i)	any **three** from: • elements arranged in proton / atomic number order • group: elements in the same group / column have same number of outer electrons owtte • group: number of shells increase down group • period: elements in the same period / row have the same number of shells / energy levels • period: number of protons / electrons increase across period • atomic number: link of atomic number to number of protons • atomic number gives number of electrons	ignore mass number / atomic weight / neutrons throughout	3
(b)(ii)	it would mean splitting a proton / electron **or** implication of splitting proton / electron		1

continued…

4.3.2.1 Moles (HT only)

CHY3H

Question 4 continued…

(c)		must be a comparison	
	(outer) electron closer (to nucleus)	accept fewer (electron) shells / energy levels fluorine is the smaller/est	1
	stronger/est attraction (to nucleus) owtte **or** less screening (by inner electrons)	do **not** allow magnetic / intermolecular forces	1
	electron gained more easily	need some indication of outer electron shell somewhere in explanation otherwise max of **2** marks	1
total			9

4.3.2.1 Moles (HT only)

CHY3H

Question 5

question	answers	extra information	mark
(a)		**must** be description of a titration no titration = no marks	
	NaOH in burette	do **not** accept biuret etc	1
	add NaOH until (indicator) changes colour	if specific colour change mentioned, must be correct – colourless to pink / red **or** 'goes pink / red' do **not** accept 'clear' for colourless	1
	note (burette) volume used **or** final reading	accept 'work out the volume'	1
	one other point: eg repeat	accept: (white) tile **or** add dropwise / slowly **or** white background **or** swirling / mix **or** read meniscus at eye level **or** wash apparatus	1
(b)	0.054	for **2** marks (0.1 × 13.5)/25 for **1** mark	2
(c)	don't know – insufficient evidence to decide **or** depends on whether acid level is considered safe or unsafe	owtte any sensible answer	1
	yes, safe – acid level low / weak acids / low compared with stomach acid	owtte any sensible answer	
	no, unsafe – acid level (too) high / other substances or bacteria may be present / insufficient evidence to decide	owtte any sensible answer	

continued…

4.3.2.1 Moles (HT only)

CHY3H

Question 5 continued…

question	answers	extra information	mark
(d)	(methyl orange) would have changed colour (well) before the end-point / pH7 / neutral	owtte	1
	weak acid present	weak acid-strong base (titration) allow methyl orange used for strong acid-weak base titration	1
total			9

4.3.2.1 Moles (HT only)

Answer 01 · Mark scheme

January 2008 | CHY3H | Original Q5 | Legacy

CHY3H

4.3.2.1 Moles (HT only)

Answer 02 · Mark scheme

Question 7

question	answers	extra information	mark
7(a)	some mention that a proton is a hydrogen ion / H^+ (as an acid) it / aminoethanoic acid has lost / donated a proton / hydrogen ion (as a base) it / aminoethanoic acid has gained / accepted a proton / hydrogen ion	this mark can be gained in either part	1 1 1
7(b)(i)	0.11(04)	correct answer with or without working = **2** marks if answer incorrect (0.15 × 18.4) / 25 gains **1** mark	2
7(b)(ii)	phenolphthalein	allow any correct single acid-base indicator that changes colour in the appropriate pH range (8 – 10) do **not** accept UI / litmus / methyl orange	1
Total			**7**

4.3.2.1 Moles (HT only)

Answer 02 · Mark scheme January 2010 | CHY3H | Original Q7 | Legacy

CHY3H

4.3.2.1 Moles (HT only)

Answer 03 · Mark scheme

Question 6

question	answers	extra information	mark
6(a)(i)	H^+ and CH_3COO^-	allow H_3O^+ for H^+ allow $CH_3CO_2^-$ for CH_3COO^-	1
6(a)(ii)	not fully ionised / dissociated	accept partially / slightly ionised / dissociated accept does not ionise well ignore (does not produce many ions) do **not** accept ions ionise	1
6(a)(iii)	proton donor(s)	do **not** accept H^+ ions	1
6(b)(i)	colour change in right (pH) range **or** this is a weak acid and strong alkali titration	it = phenolphthalein accept methyl orange does not change colour **or** methyl orange changes in the wrong (pH) range accept methyl orange is for strong acid and weak alkali titration.	1

Question 6 continues on the next page

CHY3H

Question 6 contd

question	answers	extra information	mark
6(b)(ii)		must be description of an acid / alkali titration ie quantitative measures of volume no titration = **0** marks vinegar = ethanoic acid = acid	
	NaOH / alkali in burette	accept phonetic spelling do **not** accept biuret	1
	add NaOH until (indicator) changes from colourless to pink **or** until (indicator) changes colour	do **not** accept incorrect indicator **or** incorrect colour change allow unit indicator changes	1
	note (burette) volume used **or** final volume	allow work out the volume **or** see how much is used	1
	any **one** other point from • repeat • white tile / background • add dropwise / slowly • swirling / mix • read meniscus at eye level • some indication that some apparatus has been washed	ignore stir (with rod)	1

Question 6 continues on the next page

4.3.2.1 Moles (HT only)

CHY3H

Question 6 contd

question	answers	extra information	mark
6(c)	0.06	correct answer with or without working = **2** marks if answer is incorrect (0.1 x 15)/25 **or** 0.0015 x 40 gains **1** mark	2
Total			**10**

4.3.2.1 Moles (HT only)

Answer 03 · Mark scheme

January 2011 | CHY3H | Original Q6 | Legacy

CHY3H

4.3.2.1 Moles (HT only)

Answer 04 · Mark scheme

January 2011 | CHY3H | Original Q7 | Legacy

Question 7

question	answers	extra information	mark
7(a)		correct answer with or without working = **3** marks	
	M1: (bonds broken) = 2148 (kJ)		1
	M2: (bonds made) = 2354 (kJ)		1
	M3: change in energy = (–) 206 (kJ)	ecf ignore sign	1
7(b)	energy released from forming new bonds is greater than energy needed to break existing bonds	allow the energy needed to break bonds is less than the energy released in forming bonds do **not** accept energy needed to form bonds	1
Total			**4**

Question 5

question	answers	extra information	mark
5(a)(i)		incorrect test or no test = **0** mark testing the solution **or** using blue litmus = **0** mark	
	(test ammonia / gas with red) litmus	accept any acid-base indicator with correct result	1
	(goes) blue		1
	OR		
	(conc.) HCl (1)		
	white fumes / smoke / solid (1)	allow white gas / vapour	
	OR		
	(test ammonia / gas with) Universal Indicator (1)		
	blue / purple (1)		
5(a)(ii)		incorrect test or no test = **0** marks	
	add barium chloride / $BaCl_2$ (solution) **or** add barium nitrate / $Ba(NO_3)_2$ (solution)	do **not** accept H_2SO_4 added allow Ba^{2+} solution / aqueous added	1
	white precipitate / solid (formed)	allow white barium sulfate / $BaSO_4$ ignore barium sulfate / $BaSO_4$ alone	1
5(b)(i)	fully / completely ionised / dissociated **or** hydrogen ions fully dissociated	accept has more ions than weaker acid / alkali of same concentration ignore strongly ionised do **not** accept ions are fully ionised ignore concentrated **or** reference to concentrations of ions	1

Question 5 continues on the next page

4.3.2.1 Moles (HT only)

Question 5 continued

question	answers	extra information	mark
5(b)(ii)	methyl orange	accept correct spelling only accept any strong acid-weak base indicator do **not** allow phenolphthalein / litmus / universal indicator	1
5(b)(iii)	32 × 0.05/1000 **or** 0.0016 (mole H_2SO_4) (reacts with) 2 × 0.0016 **or** 0.0032 (mole NH_3 in $25cm^3$) (0.0032 × 1000/25 =) 0.128	accept (0.05 x 32) = (V x 25) **or** 0.05 x 32 / 25 accept dividing rhs by 2 **or** multiplying lhs by 2 allow ecf from previous stage correct answer 0.128 **or** 0.13 with or without working gains all **3** marks	1 1 1
5(b)(iv)	2.176 **or** 2.18 **or** ecf from candidate's answer to (b)(iii) **or** 2.55 if 0.15 moles used	correct answer with or without working if answer incorrect or no answer 0.128 × 17 **or** 0.13 x 17 **or** their (b)(iii) × 17 **or** 0.15 × 17 gains **1** mark	2
Total			**11**

4.3.2.1 Moles (HT only)

Answer 05 · Mark scheme

June 2011 | CHY3H | Original Q5 | Legacy

CHY3H

4.3.2.1 Moles (HT only)

Answer 06 · Mark scheme

June 2011 | CHY3H | Original Q6 | Legacy

Question 6

question	answers	extra information	mark
6(a)(i)	(brown / red / orange / yellow) goes colourless / decolourised	ignore discoloured / goes clear do **not** accept incorrect initial colour	1
6(a)(ii)	(carbon carbon) double bond	accept triple / multiple bonds do **not** allow incorrect double bond	1
6(b)	CO_2: 6.6/44 **or** 0.15(mole) H_2O: 2.7/18 **or** 0.15(mole) CH_2	 ignore multiples	1 1 1
Total			**5**

The AQA UMS Conversion Calculator is available on the Results statistics page of the AQA Website

4.3.2.1 Moles (HT only)

Answer 07 · Mark scheme

January 2013 | CH2HP | Original Q1 | Legacy

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

4.3.2.1 Moles (HT only)

Answer 07 · Mark scheme

January 2013

CH2HP

4.3.2.1 Moles (HT only)

Answer 08 · Mark scheme

Question 7

question	Answers	extra information	Mark
7(a)(i)	ΔT = (64 – 17) = 47 °C		1
	750 x 4.2 x 47	allow ecf using their ΔT	1
	148 050	correct answer gains **3 marks** with **or** without working ignore sign allow 148.05kJ allow 148kJ	1
7(a)(ii)	1085.7	correct answer gains **2** marks with or without working. allow answer in range 1080 – 1089 for **2 marks** allow answer in range 1080000 – 1089000 for **1 mark** if answer is incorrect allow 6/44 = 0.136 mol for **1 mark** allow (44 x their 7(a)(i))/(6 x 1000) correctly calculated for **2 marks** allow (44 x their 7(a)(i))/6 correctly calculated for **1 mark** If they have used the given value of 144 000: Allow any answer in range 1051 - 1059 for **2 marks** with or without working. allow any answer in range 1051000 – 1059000 for **1 mark**	2

Question 7 continues on the next page

Question 7 continued

question	Answers	extra information	Mark
7(a)(iii)	repeat the experiment and then calculate the mean any **one** from: • use a lid • insulate the beaker • stir • prevent draughts	 do **not** allow flammable insulation	1 1
7(a)(iv)	inaccuracies likely to have similar effects	allow systematic errors	1
7(b)(i)	8530	correct answer gains 3 marks with or without working. If answer is incorrect; (6 x 803) = 4818 gains 1 mark (8 x 464) = 3712 gains 1 mark correct addition of their calculated values gains 1 mark (ecf)	3
7(b)(ii)	(6481 – 8530) = (-)2049	ignore sign allow ecf from 7(b)(i)	1
Total			**12**

UMS Conversion Calculator: www.aqa.org.uk/umsconversion

4.3.2.1 Moles (HT only)

Answer 09 · Mark scheme June 2014 | CH3HP | Original Q4 | Legacy

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

4.3.2.1 Moles (HT only)

Answer 09 · Mark scheme

June 2014 | CH3HP | Original Q4 | Legacy



4.3.2.1 Moles (HT only)

Answer 10 · Mark scheme

June 2015 | CH2HP | Original Q2 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
2(a)	any **one** from: • solution becomes colourless or colour fades • zinc becomes bronze / copper coloured • zinc gets smaller • bubbles or fizzing	 allow copper (forms) or a solid (forms) allow zinc dissolves ignore precipitate	1	**AO2** 2.5.1
2(b)	improvement: use a plastic / polystyrene cup or add a lid reason - must be linked reduce / stop heat loss **OR** improvement: use a digital thermometer reason - must be linked more accurate or easy to read or stores data	 accept use lagging/insulation allow use a data logger allow more precise or more sensitive ignore more reliable ignore improvements to method, eg take more readings	1 1	**AO3** 2.5.1a,b

Question 2 continues on the next page

Question 2 continued

2(c) 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.	**AO2/AO3** 2.5.1a,b

0 marks	Level 1 (1–2 marks)	Level 2 (3–4 marks)	Level 3 (5–6 marks)
No relevant content.	There is a statement about the results.	There are statements about the results. These statements may be linked or may include data.	There are statements about the results with at least one link and an attempt at an explanation.

Examples of chemistry points made in the response:

Description:

Statements
Concentration of copper sulfate increases
Temperature change increases
There is an anomalous result
The temperature change levels off
Reaction is exothermic

Linked Statements
Temperature change increases as concentration of copper sulfate increases
The temperature change increases, and then remains constant
After experiment 7 the temperature change remains constant

Statements including data
The trend changes at experiment 7
Experiment 3 is anomalous

Attempted Explanation:
Temperature change increases because rate increases
Temperature change levels off because the reaction is complete

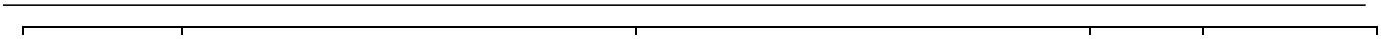
Explanation:
As more copper sulfate reacts, more heat energy is given off
Once copper sulfate is in excess, no further heat energy produced

Total			**9**

4.3.2.1 Moles (HT only)

Answer 10 · Mark scheme

June 2015 | CH2HP | Original Q2 | Legacy



4.3.2.1 Moles (HT only)

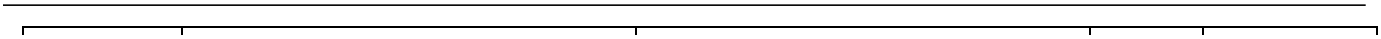
Answer 11 · Mark scheme June 2015 | CH2HP | Original Q4 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
4(a)	because this lithium atom has 3 protons and 4 neutrons mass number is total of neutrons and protons	 accept protons and neutrons have a mass of 1 accept number of neutrons = 7 - 3(protons) ignore mass of electron is negligible	 1 1 1	**AO1/ AO2** 2.3.1abc
4(b)	grams ^{12}C	accept g allow carbon-12 **or** C-12 ignore hydrogen **or** H	1 1	**AO1** 2.3.1eg
4(c)	 any **three** from: • both have 8 protons • ^{18}O has 10 neutrons • ^{16}O has 8 neutrons • both have 8 electrons	max **2** if no numbers given numbers if given must be correct accept same number of protons accept different number of neutrons or ^{18}O has two more neutrons for **1** mark accept same number of electrons	3	**AO1/ AO2** 2.3.1d
Total			**8**	

4.3.2.1 Moles (HT only)

Answer 11 · Mark scheme

June 2015 | CH2HP | Original Q4 | Legacy



4.3.2.1 Moles (HT only)

Answer 12 · Mark scheme

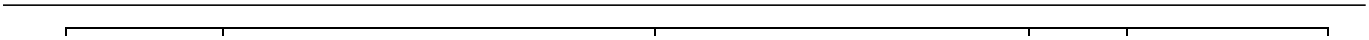
June 2016 | CH3HP | Original Q5 | Legacy

Question	Answers	Extra information	Mark	AO / SpecRef
5(a)	CH_4 + $2O_2$ → CO_2 + $2H_2O$	allow multiples	1	AO2 3.3.1a
5(b)	3444 J	if answer incorrect: one mark for temperature increase = 16.4 °C one mark for mass of water = 50 g ecf for one incorrect value gains two marks for correct calculation no ecf for two incorrect values	3	AO2 3.3.1a
5(c)(i)	1276 (kJ per mole)	ignore + or - if answer incorrect: [(5 x 413) + 347 + 358 +467] + [(3 x 495)] = 4722 (1 mark) [(4 x 799) + (6 x 467)] = 5998 (1 mark) correct subtraction of calculated energy values (1 mark)	3	AO2 3.3.1f
5(c)(ii)	because energy released when bonds form is greater than energy used when bonds broken	allow converse if no mark awarded allow one mark for energy is used to break bonds or one mark for energy is released when bonds form	2	AO1 3.3.1e,f
5(c)(iii)	products line lower than reactants activation energy labelled overall energy change labelled		1 1 1	2AO2 / 1AO3 3.3.1d
Total			12	

4.3.2.1 Moles (HT only)

Answer 12 · Mark scheme

June 2016 | CH3HP | Original Q5 | Legacy



4.3.2.1 Moles (HT only)

Answer 13 · Mark scheme June 2017 | CH3HP | Original Q4 | Legacy

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

4.3.2.1 Moles (HT only)

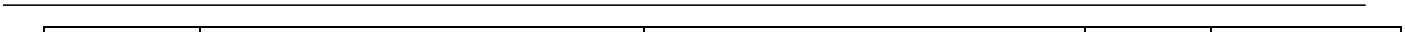
Answer 13 · Mark scheme

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

4.3.2.1 Moles (HT only)

Answer 13 · Mark scheme

June 2017 | CH3HP | Original Q4 | Legacy



4.3.2.1 Moles (HT only)

Answer 14 · Mark scheme June 2018 | 8462/1H | Original Q6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	solid (zinc chloride) does not conduct (electricity) **or** zinc chloride needs to be in solution **or** molten	allow liquid / aqueous	1	AO1 4.4.3.1
	(because) ions cannot move in the solid **or** (as) ions can (only) move in liquid / solution	do **not** accept references to movement of electrons in zinc chloride	1	
06.2		allow free electrons for delocalised electrons		AO1 4.2.3.2
	each carbon / atom forms 3 (covalent) bonds		1	
	one electron per carbon / atom is delocalised		1	
	(so) these electrons carry charge through the graphite **or** (so) these electrons move through the structure	ignore carry current / electricity	1	
		if no other mark scored, allow **1** mark for delocalised / free electrons		
06.3	use measuring cylinders (instead of test tubes)	allow use burettes allow use (gas) syringes allow Hoffmann voltameter	1	AO3 4.4.3.4
	(because) test tubes cannot measure volume **or** (because) test tubes have no graduations / scale	allow (so that) volume can be measured	1	

4.3.2.1 Moles (HT only)

Answer 14 · Mark scheme

June 2018 | 8462/1H | Original Q6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	any **three** from: • the volume of hydrogen collected is directly proportional to the time • the rate of collection of hydrogen is 0.45 (cm^3/min) • up to 8 minutes chlorine is collected at an increasing rate • after 8 minutes the rate of collection of chlorine is the same as that of hydrogen **or** after 8 minutes the rate of collection of chlorine is 0.45 (cm^3/min)	allow the (volume of) hydrogen is collected at a constant / steady rate allow any value from 6 to 8 minutes allow initially chlorine is collected at an increasing rate allow any value from 6 to 8 minutes allow after 8 minutes the (volume of) chlorine is collected at a constant / steady rate if neither bullet point 3 nor bullet point 4 is awarded allow **1** mark for chlorine is collected slowly up to 8 minutes and then more quickly allow any value from 6 to 8 minutes	3	AO2 4.4.3.4
06.5	chlorine reacts with water **or** chlorine dissolves (in the solution)		1	AO3 4.3.5 4.4.3.4

4.3.2.1 Moles (HT only)

Answer 14 · Mark scheme

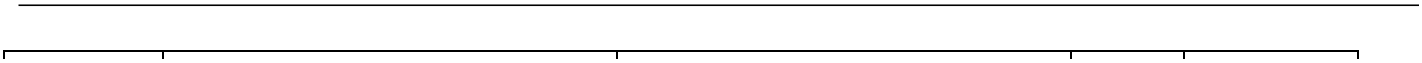
June 2018 | 8462/1H | Original Q6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.6		an answer of 2.75×10^{-4} (mol) or 2.8×10^{-4} (mol) scores **3** marks an answer of 0.000275 / 0.00028 / 2.75×10^{-1} / 2.8×10^{-1} (mol) / scores **2** marks an incorrect answer for one step does **not** prevent allocation of marks for subsequent steps		AO2 4.3.5
	(volume=) $\frac{6.6}{1000}$ (dm^3) **or** 0.0066 (dm^3)	allow 6.5 (cm^3) for 6.6 (cm^3)	1	
	(moles=) $\frac{0.0066}{24}$	allow use of incorrect volume from step 1	1	
	= 2.75×10^{-4} (mol)	allow 2.8×10^{-4} (mol) allow answer from incorrect calculation given in standard form alternative approach for marking points 1 and 2 24 dm^3 = 24 000 cm^3 (1) (moles =) $\frac{6.6}{24\,000}$ (1)	1	
Total			**14**	

4.3.2.1 Moles (HT only)

Answer 14 · Mark scheme

June 2018 | 8462/1H | Original Q6



4.3.2.1 Moles (HT only)

Answer 15 · Mark scheme June 2018 | 8462/2H | Original Q9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.1	enzyme		1	AO2 4.6.1.4
09.2	2.0×10^3 moles		1	AO2 4.3.2.1
09.3	smaller yield (because) favours endothermic reaction	allow less methanol is produced allow (because) favours reverse reaction allow equilibrium / reaction shifts to the left allow equilibrium / reaction shifts to reduce the temperature ignore reference to forward reaction is exothermic ignore references to rate	1 1	AO2 4.6.2.4 4.6.2.6

4.3.2.1 Moles (HT only)

Answer 15 · Mark scheme

June 2018 | 8462/2H | Original Q9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.4	(yield) equilibrium position moves to the product side	allow converse arguments allow equilibrium / reaction moves to the right allow equilibrium / reaction shifts to reduce the pressure	1	AO2 4.6.1.3 4.6.2.4 4.6.2.7
	(because) fewer molecules / moles / particles on product side	allow (because) fewer molecules / moles / particles on the right allow (because) smaller volume on product side	1	
	(rate) more collisions per unit time	allow increases collision frequency / rate ignore more collisions alone ignore faster collisions do **not** accept any indication of more energetic / forceful collisions	1	
	(because) more molecules / particles per unit volume	allow (gas) molecules / particles closer together ignore more molecules / particles alone	1	
09.5	provides different reaction pathway	allow provides a different mechanism / route	1	AO1 4.6.1.4
	(which has a) lower activation energy	 ignore references to collisions	1	

4.3.2.1 Moles (HT only)

Answer 15 · Mark scheme

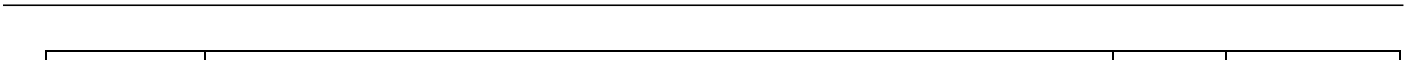
June 2018 | 8462/2H | Original Q9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.6	less energy is needed	allow reduces the temperature required allow reduces costs ignore references to pressure ignore references to rate or time	1	AO2 4.6.1.4
09.7	no effect / change		1	AO3 4.6.1.4 4.6.2.3
Total			**12**	

4.3.2.1 Moles (HT only)

Answer 15 · Mark scheme

June 2018 | 8462/2H | Original Q9



4.3.2.1 Moles (HT only)

Answer 16 · Mark scheme

June 2019 | 8462/1H | Original Q7

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	mixture has a lower melting point (than aluminium oxide) (so) less energy needed	allow cryolite lowers melting point (of aluminium oxide) ignore boiling point do **not** accept cryolite is a catalyst ignore cost	1 1	AO1 4.4.3.3
07.2	aluminium ions gain electrons		1	AO1 4.4.1.4 4.4.3.3
07.3	$2O^{2-} \rightarrow O_2 + 4e^-$	allow multiples allow **1** mark for an unbalanced equation containing correct species	2	AO2 4.1.1.1 4.4.3.1 4.4.3.3
07.4	the electrode reacts with oxygen the electrode is carbon / graphite (so) carbon dioxide is produced	 allow (so) the electrode / carbon / graphite is used up allow (so) the electrode / carbon / graphite is burned away ignore (so) the electrode / carbon / graphite is worn away ignore (so) the electrode / carbon / graphite is corroded	1 1 1	AO1 4.4.3.3

Question 7 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.5	(M_r of Al_2O_3 =) 102	an answer of 941 (kg) scores **4** marks	1	AO2 4.3.2.2
	$\left(\frac{2\,000\,000}{102} =\right)$ 19 608 (mol Al_2O_3)	allow correct calculation using incorrectly calculated value of M_r of Al_2O_3	1	
	$\left(19\,608 \times \frac{3}{2} =\right)$ 29 412 (mol O_2)	allow correct calculation using incorrectly calculated value of moles of Al_2O_3	1	
	$\left(\frac{29\,412 \times 32}{1000} =\right)$ 941 (kg)	allow 941.1764706 (kg) correctly rounded to at least 2 significant figures allow correct answer using incorrectly calculated value of moles of O_2	1	
	alternative approach: (2 M_r of Al_2O_3 =) 204 (1) 204 (kg of Al_2O_3) gives 96 (kg of O_2) (1) (2000 kg of Al_2O_3 gives) $\frac{2000}{204}$ × 96 (kg of O_2) **or** $\frac{2000000}{204}$ × 96 (g of O_2) (1) = 941 (kg) (1)			

07.6	hydrogen (gas) would be produced (instead of sodium) (because) sodium is more reactive than hydrogen		1 1	AO3 4.4.1.2 4.4.3.3 4.4.3.4
07.7	$\left(\frac{150\,000}{71} =\right)$ 2113 (mol of Cl_2) **or** (volume of 1 g of $Cl_2 = \frac{24}{71} =$) 0.34 (dm^3) ($\frac{150\,000}{71}$ x 24) = 50700 (dm^3)	an answer of 50700 (dm^3) scores **2** marks an answer of 50.7 (dm^3) scores **1** mark allow 50704.22535 (dm^3) correctly rounded to at least 2 significant figures allow correct calculation using their calculated number of moles and/or calculated volume of 1 g	1 1	AO2 4.3.5
Total			**16**	

4.3.2.1 Moles (HT only)

Answer 17 · Mark scheme

November 2020 | 8462/1H | Original Q7

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	the activation energy should be from the reactants (line to the peak) the products (line) should be below the reactants (line) **or** the products should have less energy than the reactants	ignore description of where the activation energy is on the diagram allow the product (line) is above the reactants (line) allow the products have more energy than the reactants allow the profile shows an endothermic reaction ignore the arrow for the overall energy change should point downwards	1 1	AO3 4.5.1.2
07.2	any **two** from: (hydrogen fuel cells) • no toxic chemicals to dispose of at the end of the cell's life • take less time to refuel (than to recharge rechargeable cells) • travel further before refuelling (than before recharging rechargeable cells) • no loss of efficiency (over time)	allow converse arguments for a rechargeable cell allow has a greater range allow does not lose capacity / range in cold weather	2	AO1 4.5.2.2

Question 7 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3	any **one** from: • $H_2 \rightarrow 2H^+ + 2e^-$ • $O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$ • $H_2 + 2OH^- \rightarrow 2H_2O + 2e^-$ • $O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$	allow multiples allow $H_2 - 2e^- \rightarrow 2H^+$ allow $H_2 + 2OH^- - 2e^- \rightarrow 2H_2O$	1	AO1 4.5.2.2
07.4	any **two** from: • hydrogen is not shown as H_2 / molecules • particles are shown as spheres • particles are shown as solid • does not show the (weak) forces (between particles) • does not show the movement / speed (of particles) • is only two-dimensional		2	AO1 4.2.2.1
07.5	any **one** from: • under (higher) pressure • cool • absorb / adsorb in a solid	allow increase concentration allow condense allow store as a liquid / solid allow develop more efficient engines	1	AO3 4.2.2.1 4.5.2.2

Question 7 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.6	(58 MJ =) 58 000 kJ **or** (290 kJ =) 0.290 MJ	allow (58 MJ =) 58 000 000 J **and** (290 kJ =) 290 000 J	1	AO2 4.3.2.1 4.3.5 4.5.2.2
	(moles = $\frac{58000}{290}$ **or** $\frac{58}{0.290}$ =) 200	allow correct use of an incorrectly converted or unconverted value of energy	1	
	(volume =) 200 × 24	allow correct use of an incorrectly calculated number of moles of hydrogen	1	
	= 4800 (dm^3)		1	
	alternative approach: (58 MJ =) 58 000 kJ (1) (energy released per dm^3 = $\frac{290}{24}$ =) 12.08333 (kJ/dm^3) (1) (volume =) $\frac{58000}{12.08333}$ (1) = 4800 (dm^3) (1)	allow correct use of an incorrectly converted or unconverted value of energy allow correct use of an incorrectly calculated energy released per dm^3		

Total			12

4.3.2.1 Moles (HT only)

Answer 18 · Mark scheme

November 2020 | 8462/1H | Original Q8

Question 8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	liquid gas		1	AO2 4.2.2.1
08.2	(boiling point) increases (down the table / group) (because) the relative formula / molecular mass increases **or** (because) the size of the molecule increases (so) the intermolecular forces increase (in strength) (so) more energy is needed to overcome the intermolecular forces	 allow (so) the forces between molecules increase (in strength) allow (so) more energy is needed to separate the molecules do **not** accept a reference to breaking bonds unless specifically between molecules	1 1 1 1	AO1 4.1.2.6 4.2.2.1 4.2.2.4
08.3	boiling point is a bulk property	allow boiling point is related to intermolecular forces (so more than one molecule is involved)	1	AO1 4.2.2.1
08.4	the gas / halogen is toxic	allow the gas / halogen is poisonous / harmful allow to prevent inhalation of the gas / halogen ignore deadly / lethal	1	AO3 4.1.2.6

4.3.2.1 Moles (HT only)

Answer 18 · Mark scheme

November 2020 | 8462/1H | Original Q8

Question 8 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.5		allow energy level for shell throughout		AO1 4.1.2.6
	(going down the group) the outer electrons / shell become further from the nucleus	allow the atoms become larger allow the number of shells increases ignore the number of outer shells increases	1	
	(so) the nucleus has less attraction for the outer electrons / shell	allow (so) the nucleus has less attraction for the incoming electron allow (so) increased shielding between the nucleus and the outer electrons / shell allow (so) increased shielding between the nucleus and the incoming electron	1	
	(so) an electron is gained less easily		1	

4.3.2.1 Moles (HT only)

Answer 18 · Mark scheme

November 2020 | 8462/1H | Original Q8

Question 8 continued

08.6	4.48 (g iron) **and** 8.52 (g chlorine)		1	AO2 4.1.1.1 4.1.2.6 4.3.2.3
	(moles Fe = $\frac{4.48}{56}$ =) 0.08	allow correct calculation using incorrectly calculated mass of iron	1	
	(moles Cl = $\frac{8.52}{35.5}$ =) 0.24	allow correct calculation using incorrectly calculated mass of chlorine allow (moles Cl_2 = $\frac{8.52}{71}$ =) 0.12	1	
	(Fe : Cl = 0.08 : 0.24 =) 1 : 3	allow correct calculation using incorrectly calculated moles of iron and / or chlorine	1	
	$2\ Fe + 3\ Cl_2 \rightarrow 2\ FeCl_3$	allow multiples / fractions allow a correctly balanced equation including Fe and Cl_2 from an incorrect ratio of Fe : Cl allow **1** mark for Fe **and** Cl_2 (reactants) **and** $FeCl_3$ (product) **or** allow **1** mark for Fe **and** Cl_2 (reactants) **and** a formula for iron chloride correctly derived from an incorrect ratio of Fe : Cl (product)	2	

Total			**16**

4.3.2.1 Moles (HT only)

Answer 19 · Mark scheme

November 2020 | 8462/2H | Original Q8

Question 8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	all seven points plotted correctly	allow a tolerance of ±½ small square allow **1** mark for five or six points plotted correctly	2	AO2 4.6.1.1
	line of best fit		1	
08.2	0.0038 **and** 0.0014		1	AO2 4.6.1.1
	$\frac{0.0038 - 0.0014}{105 - 20}$	allow correct use of incorrectly determined mole value(s)	1	
	= 0.000028 **or** = 2.8×10^{-5}		1	
	mol/s	allow moles per second	1	
08.3	(for large lumps) a smaller number of moles of gas is collected in the same time **or** (for large lumps) more time is needed to collect the same number of moles of gas **or** the line (of best fit for large lumps) is less steep	allow converse statement for small lumps allow the line (of best fit for large lumps) takes more time to become horizontal	1	AO2 4.6.1.1

4.3.2.1 Moles (HT only)

Question 8 (continued)

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.4	(surface area = 6 x 0.5 x 0.5) = 1.5 (cm^2) (volume = 0.5 x 0.5 x 0.5) = 0.125 (cm^3) (surface area : volume =) 12 : 1	 allow correctly calculated ratio using incorrectly calculated values for surface area and/or volume	1 1 1	AO2 4.6.1.3
08.5	decreases by a factor of 10	allow 10 times smaller allow one tenth allow 1/10 allow 1 : 10 (large cube to small cube)	1	AO2 4.2.4.1 4.6.1.3
Total			**12**	

4.3.2.1 Moles (HT only)

Answer 20 · Mark scheme

November 2021 | 8462/1H | Original Q5

Question 5

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

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

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

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

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

4.3.2.1 Moles (HT only)

Question 5 continued

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

Total			**10**

4.3.2.1 Moles (HT only)

Answer 21 · Mark scheme

November 2021 | 8462/1H | Original Q7

Question 7

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

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

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

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

Question 7 continued

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

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

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

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

Question 7 continued

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

Total			17

4.3.2.1 Moles (HT only)

Answer 22 · Mark scheme

November 2021 | 8462/2H | Original Q10

Question 10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.1	(steam / catalytic) cracking	allow thermal decomposition	1	AO1 4.7.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.2	high temperature steam / catalyst	allow a temperature in the range 300 – 900 °C	1 1	AO1 4.7.1.4

Question 10 continued

Question	Answers	Mark	AO/ Spec. Ref
10.3	**Level 3:** Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account.	5–6	AO2 4.6.1.3 4.6.2.4 4.6.2.6 4.6.2.7 4.7.2.2
	Level 2: Relevant points (reasons/causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.	3–4	
	Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1–2	
	No relevant content	0	
	Indicative content **Rate** • higher temperature gives higher rate • because more frequent collisions • higher pressure gives higher rate • because more frequent collisions • a catalyst can be used to give a higher rate • because the activation energy is reduced **Yield** • higher temperature gives lower yield • because the reaction is exothermic • higher pressure gives higher yield • because there are more molecules on left hand side **Other factors** • higher temperatures use more energy so costs increase • higher pressures use more energy so costs increase • higher pressures require stronger reaction vessels so costs increase **Compromise** • chosen temperature is a compromise between rate and yield • chosen temperature is a compromise between rate and cost (of energy used) • chosen pressure is a compromise between rate and cost (of energy used) • chosen pressure is a compromise between yield and cost (of energy used)		

Question 10 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.4	fermentation	allow ferment(ing)	1	AO1 4.7.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.5	warm anaerobic (conditions)	allow a value in the range 25 °C to 45 °C allow without oxygen / air	1 1	AO2 4.7.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.6	(conversion) 200 km = 200,000 m (moles =) $\frac{200000 \times 1.95 \text{ (mol)}}{1300}$ = 300 (mol)	 allow correct use of incorrect / no conversion for distance	1 1 1	AO2 4.7.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.7	$C_4H_9OH + 6\,O_2 \rightarrow 4\,CO_2 + 5\,H_2O$	allow $C_4H_{10}O$ for C_4H_9OH allow multiples allow **1** mark for $C_4H_9OH + O_2 \rightarrow CO_2 + H_2O$ with incorrect / no multipliers ignore state symbols	2	AO2 4.1.1.1 4.3.1.1 4.7.2.3

Total			17

4.3.2.1 Moles (HT only)

Answer 23 · Mark scheme

June 2022 | 8462/1H | Original Q3

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	giant structure	allow macromolecular allow (giant) lattice	1	AO1 4.2.3.1
	covalent (bonds)		1	
	four bonds per carbon / atom		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	(covalent) bonds are strong		1	AO1 4.2.2.1
	(and many covalent) bonds must be broken		1	4.2.2.6 4.2.3.1
	(so) a lot of energy is required		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	fullerene		1	AO1 4.2.3.3

4.3.2.1 Moles (HT only)

Answer 23 · Mark scheme

June 2022 | 8462/1H | Original Q3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	any **one** from: • (C_{70} is) hollow • (C_{70} is) unreactive • (C_{70} is) not toxic • (C_{70} has) a large surface area to volume ratio	ignore references to ease of movement around the body allow (C_{70}) acts as a cage allow (C_{70}) traps the drug	1	AO3 4.2.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	$\left(\text{moles of } C_{70} \text{ molecules} = \frac{1}{70} = \right) 0.0\dot{1}42857\dot{}$ (molecules =) $0.0\dot{1}42857\dot{} \times 6.02 \times 10^{23}$ $= 8.6 \times 10^{21}$	 allow correct use of an incorrect attempt at the calculation of the number of moles of C_{70} molecules	1 1 1	AO2 4.3.2.1

Total Question 3		11

4.3.2.1 Moles (HT only)

Answer 24 · Mark scheme

June 2022 | 8462/2H | Original Q8

Question 8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	(sulfur is a) precipitate / solid **or** (sulfur is an) insoluble substance		1	AO2 4.6.1.2 RPA5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.2 View with Figure 7	correctly drawn tangent at 30 s		1	AO2 4.6.1.1 RPA5
	correct values for *x* step **and** *y* step from tangent	allow correct use of an incorrectly drawn tangent allow a tolerance of ± ½ a small square for each coordinate	1	
	(ratio =) $\frac{\text{value for y step}}{\text{value for x step}}$	allow correct use of incorrectly determined values from tangent for *x* step and/or *y* step	1	
	correct calculation of ratio		1	
	(conversion rate = ratio × 7.1 × 10^{-5}) correct evaluation of rate (mol/s)	allow correct use of an incorrectly calculated ratio	1	

4.3.2.1 Moles (HT only)

Answer 24 · Mark scheme

June 2022 | 8462/2H | Original Q8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.3	rate decreases (because) concentration of reactants decreases **alternative approach:** greatest rate at start (1) (because) greatest concentration of reactants at start (1)	allow the collision frequency decreases allow the collision frequency is highest at the start	1 1	AO2 4.6.1.1 4.6.1.2 RPA5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.4	(hydrochloric) acid is used up	allow (hydrochloric) acid is the limiting reactant ignore reactants used up	1	AO3 4.3.2.4 4.6.1.2 RPA5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.5 View with Figure 8	decreasing curve starting at (0,95) **and** steeper initially than curve for 0.10 mol/dm^3 sodium thiosulfate solution levelling at 24%		1 1	AO2 4.6.1.2 RPA5

4.3.2.1 Moles (HT only)

Answer 24 · Mark scheme

June 2022 | 8462/2H | Original Q8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.6	stop light from other sources reaching the light sensor		1	AO3 4.6.1.2 RPA5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.7	repeatable		1	AO3 4.6.1.2 RPA5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.8	$V \propto m$		1	AO2 4.6.1.2

4.3.2.1 Moles (HT only)

Answer 24 · Mark scheme

June 2022 | 8462/2H | Original Q8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.9 View with Figure 9	volume of sodium thiosulfate solution **and** volume of hydrochloric acid at any fixed mass	allow a tolerance of ± ½ a small square for volume readings	1	AO2 4.6.1.2
	$\left(\frac{\text{volume of } Na_2S_2O_3 \text{ solution}}{\text{volume of hydrochloric acid}} =\right)$ 0.25	allow $\left(\frac{\text{volume of hydrochloric acid}}{\text{volume of } Na_2S_2O_3 \text{ solution}} =\right)$ 4 allow correct use of incorrectly determined volumes	1	
	1 : 4		1	

Total Question 8		17

4.3.2.1 Moles (HT only)

Answer 25 · Mark scheme

June 2023 | 8462/1H | Original Q5

Question 5

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

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

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

4.3.2.1 Moles (HT only)

Answer 25 · Mark scheme

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

4.3.2.1 Moles (HT only)

Answer 25 · Mark scheme

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

4.3.2.1 Moles (HT only)

Answer 25 · Mark scheme

June 2023 | 8462/1H | Original Q5

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

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

Total Question 5	**12**

4.3.2.1 Moles (HT only)

Answer 26 · Mark scheme

June 2023 | 8462/1H | Original Q9

Question 9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.1	(substance reduced) Fe_2O_3 (reason) (Fe_2O_3) loses oxygen	allow iron oxide MP2 is dependent upon MP1 being awarded ignore Fe^{3+} gains electrons	1 1	AO2 4.4.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.2	$\frac{3}{2}$ × 12g		1	AO2 4.3.1.1 4.3.2.1 4.3.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.3	**A** loses electrons and $\mathbf{B}^+$ gains electrons		1	AO2 4.4.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.4	**D**		1	AO3 4.4.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.5	(metal) **C** (explanation) aluminium forms ions with a charge 3+ (so) 3 nitrate ions are needed for 1 aluminium ion	 allow aluminium forms Al^{3+} (ions) allow (so) 3 nitrate ions are needed to balance the 3+ charge on 1 aluminium (ion)	1 1 1	AO3 4.4.1.2 4.4.3.3

4.3.2.1 Moles (HT only)

Answer 26 · Mark scheme

June 2023 | 8462/1H | Original Q9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.6	(percentage atom economy =) $\frac{A_rX}{A_rX + 54} \times 100 = 77.3$		1	AO2 4.3.3.2
	100 A_r**X** = 77.3 (A_r**X** + 54)	allow A_r**X** = 0.773 (A_r**X** + 54) allow correct use of an incorrectly determined value of the M_r of the non-useful reactant atoms	1	
	22.7 A_r**X** = 4174.2	allow 0.227 A_r**X** = 41.742	1	
	A_r**X** = 184	allow 183.8854626 correctly rounded to at least three significant figures	1	
	alternative approach 1: ($3M_r$ H_2O = (3 × 16) + (6 × 1) =) 54 **and** (percentage = 100 – 77.3 =) 22.7% (1)			
	(total M_r of reactants =) $\frac{100}{22.7} \times 54$ (1)	allow correct use of an incorrectly determined value for $3M_r$ H_2O and/or percentage of unwanted products		
	= 238 (1)			
	(A_r**X** = 238 – 54) **or** $\left(A_r\mathbf{X} = 238 \times \frac{77.3}{100}\right)$ = 184 (1)	allow correct use of an incorrectly determined value of total M_r of reactants and/or value for $3M_r$ H_2O allow 183.8854626 correctly rounded to at least three significant figures		

4.3.2.1 Moles (HT only)

Answer 26 · Mark scheme

	alternative approach 2: ($3M_r$ H_2O = (3 × 16) + (6 × 1) =) 54 **and** (percentage = 100 – 77.3 =) 22.7% (1) $\left(\frac{1}{22.7} \times 54 =\right)$ 2.3788546 (1) 2.3788546 × 77.3 (1) = 184 (1)	allow correct use of an incorrectly determined value for $3M_r$ H_2O and/or percentage of unwanted products allow correct use of an incorrectly determined value for 1% of the total M_r of reactants allow 183.8854626 correctly rounded to at least three significant figures		

Total Question 9	**12**

4.3.2.1 Moles (HT only)

Answer 27 · Mark scheme

June 2023 | 8462/1H | Original Q10

Question 10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.1	(nanoparticles) any **two** from: • have a higher surface area to volume ratio • less (material) needed (for the same effect) • more light gets through	allow converse arguments for fine particles allow a thinner coating is needed	2	AO3 4.2.4.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.2	(M_r TiO_2 =) 80		1	AO2 4.3.1.2 4.3.2.1 4.3.2.2 4.3.5
	(conversion 100 kg =) 100 000 (g)		1	
	$\left(\text{moles } TiO_2 = \frac{100\,000}{80} =\right)$ 1250	allow correct use of an incorrectly determined M_r allow correct use of an incorrect / no conversion of mass	1	
	(moles Cl_2 = 1250 × 2 =) 2500	allow correct use of an incorrectly determined number of moles of TiO_2	1	
	(volume Cl_2 =) 2500 x 24	allow correct use of an incorrectly determined number of moles of Cl_2	1	
	= 60 000 (dm^3)		1	

Total Question 10	8

4.3.2.1 Moles (HT only)

Answer 28 · Mark scheme

June 2024 | 8462/1H | Original Q7

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	(thermal) energy is transferred by delocalised electrons	allow heat is transferred	1 1	AO1 4.2.1.5 4.2.2.8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2		allow (positive / metal) ions for atoms throughout		AO1 4.2.2.7
	(the alloy / mixture has) different sized atoms		1	
	(so the) layers are distorted		1	
	(so the) layers cannot easily slide	allow (so the) atoms cannot slide over each other	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3	$2\,Fe + 3\,Cl_2 \rightarrow 2\,FeCl_3$		1	AO2 4.3.1.1 4.3.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	$1\ Fe^{2+} : 2\ Fe^{3+} : 4\ O^{2-}$		1	AO2 4.4.2.2

Answer 28 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.5	(M_r Fe_3O_4 =) 232		1	AO2 4.3.1.2
	(% Fe =) $\frac{3 \times 56}{232} \times 100$	allow $\frac{168}{232} \times 100$ allow correct use of an incorrectly determined M_r using the values of A_r given in the question	1	
	= 72.4 (%)	allow 72.41379 correctly rounded to at least 2 significant figures	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.6		a maximum of **4** marks can be awarded for a method which determines and uses the volume of iron oxide as a gas		AO2 4.3.2.1 4.3.2.2
	(40.0 kg =) 40 000 (g)		1	
	(moles Fe_2O_3 = $\frac{40\,000}{160}$ =) 250	allow correct use of an incorrectly converted or unconverted mass	1	
	(moles CO_2 = 250 × $\frac{3}{2}$ =) 375	allow correct use of an incorrectly determined number of moles of Fe_2O_3	1	
	(volume of CO_2 =) 375 × 24	allow correct use of an incorrectly determined number of moles of CO_2	1	
	= 9000 (dm^3)		1	

Total Question 7	15

4.3.2.1 Moles (HT only)

Answer 29 · 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		1	AO1 4.4.2.5 RPA2
	any **two** from: • into a conical flask • add an indicator (to the alkali) • take the initial burette reading • use a white tile (under a conical flask)	ignore beaker allow named indicator do **not** accept add universal indicator	2	

4.3.2.1 Moles (HT only)

Answer 29 · Mark scheme

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

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

Total Question 9	12

4.3.2.1 Moles (HT only)

Answer 30 · 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)		1	AO3 4.6.1.2 RPA5
	(because the reaction starts) before the stopper is put in	allow (because) stopper cannot be inserted instantly	1	
		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		

4.3.2.1 Moles (HT only)

Answer 30 · 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)		

4.3.2.1 Moles (HT only)

Answer 30 · 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)		

4.3.2.1 Moles (HT only)

Answer 30 · 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	

4.3.2.1 Moles (HT only)

Answer 30 · 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

4.3.2.1 Moles (HT only)

Answer 31 · Mark scheme

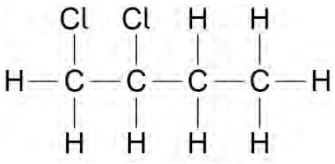
June 2025 | 8462/2H | Original Q5

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	– 6 (°C)	allow a value in the range (+)4 to –16 (°C)	1	AO2 4.7.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	ethanol	allow C_2H_5OH	1	AO2 4.7.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	(test) damp litmus paper (result) litmus paper is bleached **or** litmus paper turns white	 ignore litmus paper turns red ignore litmus paper turns red	1 1	AO1 4.8.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4			1	AO2 4.7.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5	propene		1	AO1 4.7.2.1

4.3.2.1 Moles (HT only)

Answer 31 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.6	(because of) incomplete combustion	ignore insufficient oxygen	1	AO1 4.7.2.2

4.3.2.1 Moles (HT only)

Answer 31 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.7	(conversion 24 dm^3 =) 24 000 cm^3	allow conversion of volume anywhere in method	1	AO2 4.3.1.2 4.3.2.1 4.3.5 4.7.2.1
	(M_r = (3 × 12) + (6 × 1) =) 42		1	
	(moles = $\frac{2.1}{42}$ =) 0.05	allow correct use of an incorrectly determined M_r	1	
	(volume =) 24 000 × 0.05	allow correct use of an incorrectly determined number of moles allow correct use of an incorrect / no conversion of volume	1	
	= 1200 (cm^3)		1	
	alternative approach			
	(conversion 24 dm^3 =) 24 000 cm^3 (1)	allow conversion of volume anywhere in method		
	(M_r = (3 × 12) + (6 × 1) =) 42 (1)			
	(ratio of mass = $\frac{42}{2.1}$ =) 20 (1)	allow correct use of an incorrectly determined M_r		
	(volume =) $\frac{24\,000}{20}$ (1)	allow correct use of an incorrect / no conversion of volume		
	= 1200 (cm^3) (1)			

Total Question 5	12

4.3.2.1 Moles (HT only)

Answer 14 · Examiner comments

June 2018 | 8462/1H | Original Q6

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

06.1 Students found it difficult to score both marks on this question, although 77% of students scored one or more marks. Lower-attaining students simply stated that the electrolyte was a solid, without further explanation. Others incorrectly referred to the movement of delocalised electrons, rather than ions. Some refereed to zinc instead of zinc chloride.

06.2 Students struggled to put sufficient detail into their answers, although no more was required than what is directly stated in the specification. 9% of students achieved all three marks.

A lot of weakly expressed ideas were seen. Instead of stating that each atom forms three covalent bonds, many students stated that graphite has three covalent bonds, or that three out of four carbon atoms are bonded, both of which are untrue.

Very few said that each carbon atom has one delocalised electron: a statement directly from the specification. Those who did score the marks for the structure often didn't say that delocalised electrons move or carry charge **through** the structure. They often implied the delocalised electrons just moved around at random. Many students misunderstood the process of electrical conductivity completely, thinking that it is something to do with layers sliding over each other.

Some students referred to other properties such as softness, instead of confining their answer to the question posed.

06.3 58% of students did not achieve a mark for this question. The investigation was stated to be about the relationship between volume and time, but the diagram showed no means of measuring volume. The expected answer was to use inverted measuring cylinders so that volume (not 'amount') could be measured.

Although it would pose practical difficulties, the idea of using gas syringes was also accepted (on the grounds that it could be made to work if they were attached to funnels placed over the electrodes). Many suggested changing the electrodes as graphite is not inert, suggesting a lack of understanding of the required practical. Some students suggested that the apparatus is upside down.

Answer 14 · Examiner comments

06.4 Although 75% of students achieved one mark, usually for the trend in the hydrogen graph, just 7% achieved three marks.

In order to score the mark for proportionality of the hydrogen graph, both variables had to be stated, not just 'it is proportional'. Alternatively, a steady rate of collection would gain the mark. It had not been anticipated that students would calculate the rate of collection, but those who did were awarded credit. Some referred to proportionality correctly, but did not state which gas they were referring to.

The chlorine line posed more difficulty. Many described the chlorine line after 8 minutes as proportional. It is not as it shows a linear relationship, where the volume of chlorine increases at a steady rate.

Students are very unsure of how to describe trends in curved graphs; the idea of the chlorine being collected at an increasing rate (which could be expressed as faster and faster) being very rarely seen.

As in other questions, the language used by students created a barrier to attaining marks. 'It remains constant' could mean the gas volume no longer changes, rather than the rate of collection.

06.5 2% of students were able to answer this question. Many students either had not read or understood the statement that the number of moles of each gas produced is the same.

There were attempts to justify the difference in terms of reactivity, formula mass, size of molecules, pressure difference or the concentration of H^+ and Cl^- in solution. Some students referred to the length of time taken for the chlorine to react, rather than to be formed. Others suggested the molar volume was different for different gases, ignoring what they know from the part of the specification on gas volumes.

The formation of chlorine and hydrogen is part of the electrolysis required practical, so students should not be completely unfamiliar with the bubbles of chlorine taking longer to form. They should also be familiar with 'chlorine water' from their work on Group 7.

06.6 Students found this calculation on a new area of the specification quite difficult, with 26% of students providing a fully correct answer.

It was necessary to read off the correct volume from the graph and change the units from cm^3 to dm^3, or to change those of the gas molar volume to cm^3/mol, but many students didn't do this. Many students also struggled to express their answer in standard form.

Answer 15 · Examiner comments

June 2018 | 8462/2H | Original Q9

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

09.1 88% of students could identify an enzyme as a (biological) catalyst.

09.2 64% of students could use the equation to work out that 2.0×10^3 moles of carbon monoxide would react.

09.3 The endothermic nature of the backwards reaction was often identified as the reason the equilibrium position moved to the left; however many made no comment about the yield of methanol. Many students thought there would be a higher yield. 39% of students achieved both marks.

09.4 While many students did well, there were many others who demonstrated partial knowledge or who did not express themselves clearly. Many thought that an increase in pressure caused an increased yield of methanol because it was an exothermic reaction, rather than because the equilibrium moved to the position of fewer moles / molecules / particles.

The increased rate of reaction was better understood; students usually gave some indication that the particles are closer or there are **more particles** in a **fixed** volume or there are the **same number of particles** in a **smaller** volume. Simply saying there were more particles was insufficient.

In addition, students needed to link collisions **and** time to gain credit, usually by saying that the particles collide more often or there are more frequent collisions. Simply saying **more collisions** alone was insufficient. The idea that an increase in pressure supplied energy (and therefore increased the speed of the particles) was discounted.

73% of students were able to achieve some credit, with 12% of students achieving full marks.

09.5 Higher-attaining students achieved both marks for stating that catalysts reduce the activation energy by providing an alternative route or pathway, though the second point was less well known than the first. Sometimes one or other of these points was omitted. A popular incorrect idea was that catalysts supply energy.

09.6 47% of students knew that catalysts reduce costs, save energy or allow lower temperatures to be used. Others just mentioned that catalysts can be reused or that they speed up the reaction.

09.7 The effect of a catalyst on the equilibrium yield of methanol was not well understood. It was widely thought that a catalyst increased the yield of methanol because the reaction was faster and would, therefore, produce more of the product. 24% of students answered correctly.

4.3.2.1 Moles (HT only)

Answer 16 · Examiner comments

June 2019 | 8462/1H | Original Q7

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

07.1 The explanation for the use of cryolite in the extraction of aluminium does not appear to be well known. Almost two-thirds of students scored 0 marks.

A common misconception was that cryolite acts as a catalyst.

Common responses seen that were not credited included:

- to melt the aluminium oxide so that it conducts electricity
- so that the ions can move freely
- to reduce costs.

07.2 Almost 60% of students correctly identified that aluminium ions gain electrons as the process occurring at the negative electrode.

07.3 Students found the completion of the half-equation difficult. Almost 70% scored 0 marks.

Common errors included:

- including Al / Al_2O_3
- representing the oxide ion as O^- or O_2^-
- 2 electrons rather than 4 electrons being produced.

07.4 However, only approximately a quarter of students were able to state why the positive electrode needs to be replaced and hence score all 3 marks.

4.3.2.1 Moles (HT only)

Answer 16 · Examiner comments June 2019 | 8462/1H | Original Q7

07.5 Most students scored at least 1 mark. Approximately 40% scored all 4 marks.

The most frequently scored mark was for M_r (Al_2O_3) = 102 (or '204' from the alternative approach in the mark scheme).

A common error was M_r (Al_2O_3) = 156 but students were still able to score marks for using this incorrect value in subsequent steps.

A valid variation on the reacting mass method was to calculate the percentage by mass of oxygen in Al_2O_3 and then use this to calculate the mass of oxygen in 2000 kg of Al_2O_3

It was not always clear which approach was being used. A common incorrect final answer was 1412 (kg) where students had applied the 2 : 3 mole ratio (from the main approach) as well as the 96 / 204 mass ratio (from the alternative approach).

07.6 Students found this question difficult. Almost two-thirds of students scored 0 marks.

Even when students realised that reactivity was the key idea, they sometimes compared the reactivity of the wrong species, for example, sodium and chlorine or Na^+ ions and H^+ ions

A common misconception was that sodium chloride solution does not conduct electricity.

07.7 Approximately two-thirds of students scored at least 1 mark for this calculation.

However, the most common final answer was 50.7 dm^3. The error here was the omission of the unit conversion, kg to g.

Answer 17 · Examiner comments November 2020 | 8462/1H | Original Q7

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

07.1 Many students spotted that the curve was for an endothermic reaction rather than exothermic. Many also realised the activation energy was incorrect but could not always express correctly that activation energy should start at the energy of the reactants rather than the products.

07.2 Most students did not score well on this question. There were many vague references to 'better for the environment' without any justification for that statement. Many students referenced the fact that water is the only product, failing to realise that rechargeable cells produce no waste products at all. Others failed to realise that the infrastructure for recharging cells is actually better than that for refuelling with hydrogen. Some students

4.3.2.1 Moles (HT only)

Answer 17 · Examiner comments

were effectively giving advantages of hydrogen fuel cells over petrol engines, instead of answering the question. Others failed to express themselves clearly; saying that hydrogen fuels cells take less time to charge which did not gain credit, as the cells are refuelled, not recharged.

07.3 Many students did not realise that either hydrogen or oxygen had to be a reactant. Many impossible species such as e^{2-} or O_2^+ were seen.

07.4 Many students were able to score at least one mark but only one in six scored both. Many noted that the movement of the particles was not shown; many also noted that the particles are not shown as diatomic, or that the forces between them are not shown.

07.5 This was quite well answered, with most students favouring compressing the gas rather than cooling to condense the gas. A number of students incorrectly stated that hydrogen can be taken in from the atmosphere.

07.6 A third of students were able to score full marks. It was not possible to give partial credit for working when the students did not explain what they were doing; too often there was a jumble of numbers with various operators between them, with no words or units. No credit was given for multiplying a value by 24 unless that value was identified as a number of moles.

4.3.2.1 Moles (HT only)

Answer 18 · Examiner comments — November 2020 | 8462/1H | Original Q8

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

08.1 The majority scored the mark, but many thought bromine is a solid at 0 ºC.

08.2 This question was not well answered. Most students stated that the boiling point increased going down the group, although some were evidently confused by the negative values in the table and stated the opposite trend. However, many students then confused boiling point with reactivity and tried to explain the trend using forces within the atom rather than forces between molecules. Students should refer to intermolecular forces rather than intermolecular bonds, to avoid any confusion about which 'bonds' they are referring to in terms of breaking them to make the substance change state.

08.3 This was very poorly answered. The idea of a bulk property was very rarely seen. There was considerable confusion between the terms atom and molecule, with many stating that bromine was diatomic so there are always two molecules. The best answers referred to the fact that boiling point relates to intermolecular forces, which cannot exist if there is only one molecule.

08.4 Many students realised that the fume cupboard would prevent inhalation of the gas, which is toxic. However, some students regard a fume cupboard as insulation to prevent the escape of heat energy, or thought it was to trap and retain the gas.

08.5 Most students knew and were able to express, that the atoms get larger going down the group. Some, however, referred incorrectly to the number of outer shells increasing. Fewer were able to express that there was a reducing attraction between the nucleus and the outer electrons or the incoming electron, with many vague references to shielding without mentioning the nucleus or the relevant electrons. Even fewer were able to express the increase in difficulty of gaining (rather than merely attracting) an electron.

Answer 18 · Examiner comments — November 2020 | 8462/1H | Original Q8

08.6 Very few students scored full marks. Most students were able to calculate the mass of iron, but some calculated the mass of iron chloride instead of chlorine. They sometimes then assumed a formula of iron chloride and tried to work backwards. Of those who did calculate the masses of both iron and chlorine, most were then able to calculate the number of moles of each, but many then failed to find the simplest ratio as 1:3, instead leaving it as 0.08:0.24. Some calculated the number of moles of chlorine molecules instead of atoms; these students almost always failed to multiply by 2 to obtain the number of moles of atoms, giving a ratio of 2:3 instead of 1:3. Very few were then able to give a balanced equation; most did not use their ratio to give the formula of iron chloride as $FeCl_3$. It was rare to see the formula of chlorine written correctly as Cl_2, and iron was sometimes seen as Fe_2.

4.3.2.1 Moles (HT only)

Answer 19 · Examiner comments November 2020 | 8462/2H | Original Q8

Question 8 (standard and standard / high demand)

08.1 The point that was most frequently plotted incorrectly was the final one (180, 0.0040). A number of students failed to plot (0,0). There were some examples of rulers being used to to complete lines of best fit, with a number of straight lines seen. Some students produced excessively thick or 'feathered' lines. However, the majority of students were able to score at least two marks.

08.2 If either of the mole values were incorrectly determined from the graph, it was still possible to gain credit for using these values correctly. Some attempted to determine the instantaneous rate at a particular time by drawing a tangent to the curve. Units were sometimes written imprecisely e.g. moles per s, and some wrote 'm/s'. Many students were able to score at least two marks.

08.3 This part was quite well answered by many. Most students preferred to answer in terms of line steepness rather than time and moles collected.

08.4 This item was quite well answered by many students. The most common error was to fail to multiply the area of one face by six.

08.5 Only a very few students scored here, with many just responding 'smaller' rather than stating by what factor it was smaller. A few assumed that because the cube was larger, so too was the surface area : volume ratio. Only a tiny number of students gained a mark here.

Answer 20 · Examiner comments November 2021 | 8462/1H | Original Q5

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

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

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

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

4.3.2.1 Moles (HT only)

Answer 20 · Examiner comments November 2021 | 8462/1H | Original Q5

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

Answer 21 · Examiner comments November 2021 | 8462/1H | Original Q7

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

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

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

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

4.3.2.1 Moles (HT only)

Answer 21 · Examiner comments November 2021 | 8462/1H | Original Q7

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

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

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

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

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

Answer 22 · Examiner comments November 2021 | 8462/2H | Original Q10

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

10.2 More than two thirds of students knew one condition (high temperature) and more than one third knew two.

10.3 There was a very wide range of marks but many did not score above Level 1. The main failure to reach Level 2 was that the question focuses on economics so that an answer which fails to mention energy, cost or a compromise in reaction conditions does not meet the level descriptor for Level 2. Similarly, the requirements for Level 3 were not usually met if the references did not mention the impact of reaction conditions on both rate and yield. Only a handful of students gave a Level 3 answer.

10.4 Fermentation was well known.

10.5 Around half of students scored one mark by extending their knowledge of fermentation to this unfamiliar context, 'warm' was seen much more often than 'anaerobic'.

10.6 This was completely correct in the responses of nearly half of students. Where a mark was not obtained, this was usually caused by a failure to convert kilometres to metres.

10.7 A challenging concluding equation with no scaffolding which students found difficult.

Concluding Remarks

There is still some evidence that command words are misunderstood or ignored. This limits the marks awarded, especially in extended response questions. This is particularly true where a command word demands a reasoned judgement.

Students seemed well prepared for questions based on Organic Chemistry and Chemistry of the Atmosphere. In this series they seemed less equipped to deal with Chemical Analysis, Rate of Reaction and some aspects of Using Resources.

There were a number of instances of key reagents, techniques and colour changes still not being well known.

4.3.2.1 Moles (HT only)

Answer 22 · Examiner comments

Mark Ranges and Award of Grades

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

4.3.2.1 Moles (HT only)

Answer 23 · Examiner comments — June 2022 | 8462/1H | Original Q3

Question 3 (Standard, standard/high and high demand)

03.1 This was generally well answered. Some students omitted to mention that diamond is a giant structure, and a few stated that each atom is bonded to three others instead of four, despite the diagram provided. Although the majority of students mentioned covalent bonding, many contradicted themselves by referring to intermolecular forces; these are not present in diamond and negated the mark for covalent bonding.

03.2 There were many excellent answers. However, a large number of students contradicted themselves by referring to 'strong intermolecular forces' as well as strong bonds. There are no intermolecular forces in diamond, let alone strong ones. Students sometimes referred to 'more energy' required to break the bonds. This did not gain credit as there was no idea of what the energy was being compared with.

03.3 Most students correctly identified the molecule as a fullerene.

03.4 Many students answered correctly in terms of the hollow shape of the molecule. Only a few referred to its non-toxic or unreactive nature. Some students concentrated on the ease of movement of the molecule around the body. This did not gain credit, as this does not explain why the molecule is useful for drug delivery.

03.5 More than a third of students scored all three marks. Partial credit could be obtained by those who attempted to calculate the number of moles of molecules made by 1 mole of carbon atoms, and then multiplying their answer by the Avogadro constant. There were many attempts to calculate various masses or relative molecular masses which were not relevant to the question set.

Answer 24 · Examiner comments — June 2022 | 8462/2H | Original Q8

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

08.1 The majority of the students recognised that the solution became cloudy due to one of the products being a precipitate / solid.

08.2 The large majority of the students were able to draw a tangent at 30 seconds.
The construction lines used to determine the values of Δy and Δx were less well done.
Some students appeared to have difficulty reading the scales on each of the axes.

Students should be aware that using very small portions of the graph for this type of calculation (and also in the ratio calculation in **08.9**) potentially limits the accuracy of their final answer.

Most students who determined the values of Δy and Δx went on to determine the correct ratio. The better responses then continued to use the ratio to determine the rate in mol/s. One-fifth of the students gained all five marks, whilst over half scored four, most often as a result of not using the factor 7.1×10^{-5} correctly.

4.3.2.1 Moles (HT only)

Answer 24 · Examiner comments

08.3 Most students recognised that the rate of reaction decreased as the reaction proceeded but a significant proportion of these students did not gain the second mark because they referred to the concentration of unspecified substances rather than stating that the concentration of the reactants decreases. Nearly one-third of students gained both of these marks.

08.4 Some students made an insufficient general statement about reactants being used up. However a larger number mentioned the acid being used up. Few used the term limiting reactant. Over a third of students gained this mark.

08.5 Just over a third of students scored two marks on this question, understanding the meaning of a sketch graph. Others realised the gradient needed to be steeper for the sketch but did not level the line at 24%.

A sizeable minority had the sketch with a shallower gradient. Such a sketch seldom levelled out at 24%.

08.6 More than 80% of the students were able to identify the required improvement.

08.7 Just under half of the students gained the mark for this multiple choice question. Reproducible was a very common incorrect response.

08.8 Around 70% of the students were able to identify the expression representing the relationship between volume and mass.

08.9 Around half of the students gained all three marks. Students were usually able to find the smallest whole number ratio once they had determined the volumes. Students often did not indicate on the graph where the volumes were from, but this was not an actual requirement, just an aid to answering the question. Many chose the limits of the lines, i.e. 120 and 480 cm^3 respectively.

Students should be aware that using very small portions of the graph for this type of calculation (and also in the rate calculation in **08.2**) potentially reduces the accuracy of their final answer. Many answers of 6:25 were seen and awarded credit because the error in reading the graph values was within half a small square.

Some students used two masses of sulfur rather than the volumes of each reactant and therefore did not gain any marks.

4.3.2.1 Moles (HT only)

Use of statistics

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

Mark Ranges and Award of Grades

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

4.3.2.1 Moles (HT only)

Answer 25 · Examiner comments

June 2023 | 8462/1H | Original Q5

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

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

Answer 25 · Examiner comments

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

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

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

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

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

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

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

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

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

4.3.2.1 Moles (HT only)

Answer 26 · Examiner comments

June 2023 | 8462/1H | Original Q9

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

09.1 Students found this question difficult, with only a tenth of students scoring both marks and not many more scoring one. Most students gave incorrect responses for the substance reduced: usually iron, but sometimes carbon. Those who gave the correct substance were usually able to give the correct reason in terms of loss of oxygen. It seems that students are so well versed in the definitions of redox in terms of electrons (as in question 09.3) that they have forgotten the simpler definitions in terms of gain or loss of oxygen.

09.2 Fewer than a third of students gave the correct answer, with all three distractors being very popular. This suggests a large degree of guessing rather than using the equation to work out the mole ratio of C:Fe as 3/2 and then multiply by 12 grams.

09.3 Over three-quarters of students could correctly apply their knowledge of redox in terms of electrons. By far the most common incorrect response was **A** gains electrons and $\mathbf{B}^{+}$ loses electrons.

09.4 Fewer than one in seven students answered this high demand question correctly, with the great majority giving metal **A** as the answer. It was necessary to realise that the greatest tendency to form positive ions means the most reactive metal. It was then necessary to work out from the three reactions in the table that **A** is more reactive than **B**, **C** is more reactive than **A**, and **C** is less reactive than **D**, making **D** the most reactive.

09.5 This question discriminated well. Over half of students scored at least one mark, with just over one in ten scoring all three.

Many students tried to answer in terms of the reactivity series. This was not possible, as insufficient detail was provided to identify any of the four metals. The formula of the nitrate ion was provided but was not referenced by the majority of students. The key to answering the question was in the formulae of the nitrates; aluminium forms an ion of charge 3+, so each ion requires three nitrate ions to balance the charge. Even when students got the basic idea, they often did not express themselves clearly enough, using phrases such as ‘aluminium has a 3+ charge’ rather than referring to an aluminium ion.

09.6 Those who understood the concept of atom economy were able to complete this difficult calculation successfully; over a fifth of students scored all four marks and two fifths scored at least one.

There were two main approaches. One was to substitute values into the atom economy expression, followed by successive rearrangements of the expression to give the value of A_r of **X**. A neater solution, used by students who had a good understanding of atom economy, was to realise that the remaining 22.7% was the total M_r of the waste atoms, ie 54, and then scale either to 100% and subtract the 54, or scale straight to 77.3%. Many students misunderstood the M_r of XO_3, thinking it meant the A_r of **X** times 48. Some also misunderstood $3H_2$ or $3H_2O$, giving various values for what should have been a total of 54 for the M_r of the waste atoms. Nevertheless, correct manipulation after these errors allowed access to 3 marks.

4.3.2.1 Moles (HT only)

Answer 27 · Examiner comments

June 2023 | 8462/1H | Original Q10

Question 10 (standard/high and high demand)

10.1 About a third of students scored one mark, but far fewer scored a second mark. Many students did not give comparative answers. Many referred to nanoparticles having a larger surface area, but failed to realise that this depends on the amount used. A higher surface area to volume ratio, or a higher surface area for the same mass of material was creditworthy and was the most common correct answer. This leads on to other creditworthy answers, such as a thinner coating being needed, and hence, more light getting through the window, but these answers were rarely seen. References to cost were ignored.

10.2 This question discriminated well. The great majority of students scored at least one mark, with nearly a half scoring five or six marks. The most common error was not converting 100 kilograms to grams in order to calculate the moles, or converting incorrectly. Another common error was to calculate a spurious volume of TiO_2. Some converted the number of moles of chlorine to a mass first, before converting to a volume; whilst unnecessary, this did give the correct answer and gained full credit. Students who gained one or two marks usually calculated the relative formula mass of TiO_2 and/or converted 100 kilograms to grams. A few seemed to be concerned by the large value of the answer and introduced a division by 1000 into what would have been a correct answer.

Students sometimes tried more than one method and did not cross out the one they did not want to be marked. This led to confusion and contradictions, sometimes meaning that marks could not be awarded. Students should always cross out discarded methods; examiners will not make the choice for the student.

4.3.2.1 Moles (HT only)

Answer 27 · Examiner comments

Mark Ranges and Award of Grades

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

4.3.2.1 Moles (HT only)

Answer 28 · Examiner comments — June 2024 | 8462/1H | Original Q7

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

07.1 Only a quarter of students gained both marks, and a third did not score. Many students described how solids in general conduct thermal energy, rather than answering the question which is specifically about conduction in a metal. Many students realised that the process has something to do with delocalised electrons. However, many described how electricity is conducted, rather than thermal energy. The idea of the delocalised electrons transferring thermal energy through the metal was not at all well known. As the question asked how thermal energy is conducted, repetition of the word 'conduct' did not help to explain the meaning of that word.

07.2 This question discriminated well, with over a half of students scoring 2 or 3 marks. There were many well-expressed, complete answers. Common errors often involved an attempt to describe some sort of stronger bonding (sometimes covalent or ionic) in the alloy. Some lost credit because of poor use of language; it is not 'metals' which are different sizes, but their atoms (or positive ions). A common error was to refer to different shapes of atoms. 'Particles' is also insufficient as it could refer to other types of particle than atoms. 'Intermolecular forces' were often referred to, although they are not present in either a pure metal or an alloy.

07.3 Just over a half of students identified the correct equation, spotting that the mole ratio of Fe:Cl_2 was 2:3. The most popular distractor was Fe + Cl_2 → $FeCl_2$, where the student had ignored the information provided about the reacting number of moles.

07.4 Only two fifths of students identified the correct response by working out the total charge of the various combinations and choosing the one with a net zero charge. $3Fe^{2+}$:$4O^{2-}$ was a very popular distractor, with $3Fe^{3+}$:$4O^{2-}$ not far behind.

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Answer 28 · Examiner comments — June 2024 | 8462/1H | Original Q7

07.5 Over three quarters of students obtained full marks on this question. For those who did not, it was sometimes difficult to award any credit because the M_r had not been evaluated. Common errors were 56/M_r x 100 or 64/M_r x 100. Some students attempted to bring in the 0.12 and 0.18 from question **07.3**, which was about a different compound.

07.6 Those students who understand moles had little difficulty with this question; almost a half scored at least 4 marks. The most common error was a failure to convert the mass of Fe_2O_3 to grams. Some students attempted to calculate a volume of Fe_2O_3, not appreciating that it is a solid as shown by the state symbols in the equation. Some students unnecessarily calculated the mass of carbon dioxide before converting this to a volume. The mole ratio was sometimes applied incorrectly to the mass of Fe_2O_3. Despite being given the M_r of Fe_2O_3 as 160, many students used 320 instead. Whilst this sometimes led mathematically to the 'correct' answer, it is incorrect chemistry and full credit was therefore not awarded.

4.3.2.1 Moles (HT only)

Answer 29 · 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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4.3.2.1 Moles (HT only)

Answer 29 · Examiner comments

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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4.3.2.1 Moles (HT only)

Answer 29 · Examiner comments

Mark Ranges and Award of Grades

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4.3.2.1 Moles (HT only)

Answer 30 · 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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4.3.2.1 Moles (HT only)

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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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4.3.2.1 Moles (HT only)

Mark Ranges and Award of Grades

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4.3.2.1 Moles (HT only)

Answer 31 · Examiner comments — June 2025 | 8462/2H | Original Q5

Question 5

05.1 Over four fifths of students correctly estimated the boiling point. Those that did not gain the mark were often giving values that were just outside of the range given in the mark scheme.

05.2 Fewer than half of the students correctly identified ethanol as the product of the reaction between ethene and steam. Many of those who did not gain this mark gave the product as alcohol, which was insufficient.

05.3 Over half of students gained both marks on this item. Where students gained one mark, about 20%, it was because 'damp' was omitted from the test and only litmus paper was given.

05.4 The product of the chlorination of butene was well known by over 90% of students.

05.5 Around three quarters of students correctly identified propene. The most common incorrect response was butene. Very few students did not identify an alkene.

05.6 Around two fifths of students knew that alkenes burn with a smoky flame due to incomplete combustion. Many of the incorrect answers seen referred to there being a double bond present, or that there was insufficient oxygen.

05.7 This multi-step calculation was well answered by over 40% of students who gained all five marks. The most common error was the omission of the volume conversion from dm^3 to cm^3. Some students divided by the volume, rather than multiplying. Equally, a number multiplied by the M_r to calculate the number of moles. In both instances, marks were awarded where clear working was shown for correct

Answer 31 · Examiner comments — June 2025 | 8462/2H | Original Q5

additional steps. when one mark alone was awarded, it was for the correct determination of the M_r.