AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.3.4

Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**25**
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.

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (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…

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (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

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

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

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 01 · Mark scheme

January 2008 | CHY3H | Original Q5 | Legacy

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…

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (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 <u>outer</u> electron shell somewhere in explanation otherwise max of **2** marks	1
total			9

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (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…

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (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

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 01 · Mark scheme

January 2008 | CHY3H | Original Q5 | Legacy

CHY3H

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 02 · Mark scheme

June 2009 | CHY2H | Original Q1 | Legacy

Question 1

question	answers	extra information	mark
1(a)(i)	a continuous straight line missing anomalous point	allow a line which does not start at zero / origin	1
1(a)(ii)	any **two** sensible errors eg • timing errors and / or example • measurement errors and / or example • apparatus errors and / or example • human / experimental / random error and / or example or 'did not do it right' • temperature fluctuation • anomalous point • results not recorded correctly • plotting error • rate calculated incorrectly	ignore systematic / zero error / weighing error **or** error unqualified could be two from **same** category eg two timing errors – watch not started at the same time plus difficulty in deciding when the cross has disappeared. accept outlier / wrong result ignore 'not repeated'	2
1(b)(i)	straight line **or** as concentration increases the rate goes up **or** converse	accept numerical example accept positive correlation accept same gradient ignore 'most points near / on line of best fit'	1

Question 1 continues on the next page…

CHY2H

Question 1 Continued

question	answers	extra information	mark
1(b)(ii)	more collisions	accept greater chance of collisions accept collide more successfully accept alternative versions of collide eg 'bump / hit' ignore references to energy / speed of particles / surface area	1
	more particles (in each volume of solution)(i.e. an attempt at defining concentration)	accept 'particles are closer together' allow ions / atoms / molecules for particles ignore reactants accept greater frequency of collisions **or** greater number of collisions per second for **2** marks	1
Total			**6**

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 02 · Mark scheme

June 2009 | CHY2H | Original Q1 | Legacy

CHY2H

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 03 · Mark scheme January 2010 | CHY3H | Original Q7 | Legacy

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**

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 03 · Mark scheme

January 2010 | CHY3H | Original Q7 | Legacy

CHY3H

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 04 · 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

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (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**

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 04 · Mark scheme

January 2011 | CHY3H | Original Q6 | Legacy

CHY3H

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

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

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**

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 05 · Mark scheme

June 2011 | CHY3H | Original Q5 | Legacy

CHY3H

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 06 · Mark scheme

June 2014 | CH3HP | Original Q4 | Legacy

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

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 06 · Mark scheme

June 2014 | CH3HP | Original Q4 | Legacy



4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 07 · 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

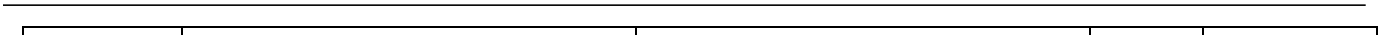
Explanation:
As more copper sulfate reacts, more heat energy is given off
Once copper sulfate is in excess, no further heat energy produced

Total			**9**

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 07 · Mark scheme

June 2015 | CH2HP | Original Q2 | Legacy



4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

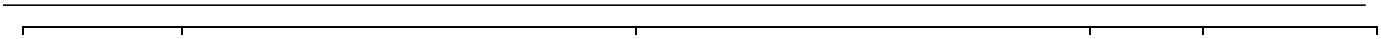
Answer 08 · Mark scheme June 2015 | CH3HP | Original Q7 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
7(a)	**X:** Fe^{2+} / iron(II), SO_4^{2-} / sulfate **Y:** Na^+ / sodium, I^- / iodide **Z:** Fe^{3+} **/** iron(III), Br^- / bromide	allow iron(II) sulfate **or** $FeSO_4$ allow sodium iodide **or** NaI allow iron(III) bromide **or** $FeBr_3$ correct identification of any two ions = one mark correct identification of any four ions = two marks	1 1 1	**AO1/ AO2** 3.4.1.a/c/e /f
7(b)	any **five** from: method 1 • weighing is accurate • not all barium sulfate may be precipitated • precipitate may be lost • precipitate may not be dry • takes longer • requires energy method 2 • accurate • works for low concentrations	allow converse arguments allow not all the barium hydroxide has reacted allow reliable / precise	5	**AO3** 3.4.1.a/c/e /f
Total			**8**	

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 08 · Mark scheme

June 2015 | CH3HP | Original Q7 | Legacy



4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 09 · 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

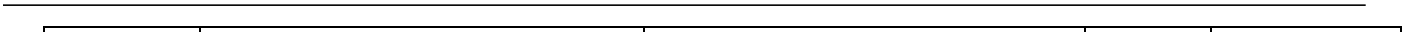
4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

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**	

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 09 · Mark scheme

June 2017 | CH3HP | Original Q4 | Legacy



4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 10 · Mark scheme

June 2018 | 8462/1H | Original Q9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.1	(strong because) completely ionised (in aqueous solution)	ignore pH allow dissociated for ionised do **not** accept hydrogen is ionising do **not** accept H^+ are ionised	1	AO1 4.3.4 4.4.2.6
	(dilute because) small amount of acid per unit volume	ignore low concentration	1	AO1 4.3.4 4.4.2.6
09.2	5.0	allow 5	1	AO2 4.4.2.6

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 10 · Mark scheme

June 2018 | 8462/1H | Original Q9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.3	(titre): chooses titrations 3, 4, 5	an incorrect answer for one step does **not** prevent allocation of marks for subsequent steps	1	AO2 4.3.4 4.4.2.5
	average titre = 22.13 (cm^3)	allow average titre = 22.13(3…) (cm^3) allow a correctly calculated average from an incorrect choice of titrations	1	
	(calculation): (moles NaOH = $\frac{22.13}{1000} \times 0.105 = 0.002324$)	allow use of incorrect average titre from step 2	1	
	(moles H_2SO_4 = ½ × 0.002324 =) 0.001162	allow use of incorrect number of moles from step 3	1	
	(concentration = $\frac{0.001162}{25} \times 1000$) = 0.0465 ($mol/dm^3$)	allow use of incorrect moles from step 4	1	
		alternative approach for step 3, step 4 and step 5 $\frac{2}{1} = \frac{22.13 \times 0.105}{25.0 \times \text{conc. } H_2SO_4}$ (1) (concentration H_2SO_4 =) $\frac{22.13 \times 0.105}{25.0 \times 2}$ = 0.0465 (mol/dm^3) (1)		
		an answer of 0.046473 **or** 0.04648 correctly rounded to at least 2 sig figs scores marking points 3, 4 and 5		
		an answer of 0.092946 **or** 0.09296 **or** 0.185892 **or** 0.18592 correctly rounded to at least 2 sig figs scores marking points 3 and 5		

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 10 · Mark scheme

June 2018 | 8462/1H | Original Q9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.4	pipette measures a fixed volume (accurately) (but) burette measures variable volume	 allow can measure drop by drop	1 1	AO1 4.4.2.5
09.5	 (moles =) $\frac{30}{1000} \times 0.105$ **or** 0.00315 (mol) **or** (mass per dm^3 =) 0.105×40 **or** 4.2 (g) (mass = $\frac{30}{1000} \times 0.105 \times 40$) = 0.126 (g)	an answer of 0.126 (g) scores **2** marks an answer of 126(g) scores **1** mark an incorrect answer for one step does **not** prevent allocation of marks for subsequent steps	 1 1	AO2 4.3.2.5 4.3.4 4.4.2.5
Total			**12**	

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 11 · Mark scheme

June 2019 | 8462/1H | Original Q2

Question 2

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

Question 2 continued

Question	Answers	Mark	AO/ Spec. Ref
02.5	**Level 3**: The design/plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	5–6	AO3 AO1
	Level 2: The design/plan would not necessarily lead to a valid outcome. Most steps are identified, but the plan is not fully logically sequenced.	3–4	AO1 x 2
	Level 1: The design/plan would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2	AO1 x 2
	No relevant content	0	
	Indicative content allow converse using acid added to alkali Key steps • measure the volume of acid • add indicator to the acid • add sodium hydroxide solution • until the colour changes • record volume of sodium hydroxide solution added • repeat procedure with the other acid Use of results • compare the two volumes of sodium hydroxide solution to find which sample **P** or **Q** is more concentrated Other points • pipette to measure volume of acid • use a few drops of indicator • swirl • use a white tile • rough titration to find approximate end point • add dropwise near the endpoint • read volume from bottom of meniscus • repeat and take a mean		4.4.2.5

Total		**11**	

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 12 · Mark scheme

June 2019 | 8462/1H | Original Q9

Question 9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.1	polystyrene is a better (thermal) insulator (so) reduces energy exchange (with the surroundings)	allow polystyrene is a poorer (thermal) conductor allow (so) reduces energy / heat loss (to the surroundings)	1 1	AO3 4.5.1.1
09.2	all six points plotted correctly line of best fit through points plotted from Table 6 both lines of best fit extrapolated correctly until they cross	allow a tolerance of ± ½ a small square allow **1** mark for at least 3 points plotted correctly	2 1 1	AO2 4.5.1.1
09.3	11 (cm^3)	allow ecf from question **09.2** allow answers in the range 10.75 to 11.25 (cm^3) allow a tolerance of ± ½ a small square	1	AO2 4.5.1.1
09.4	(27.5 – 18.9) = 8.6 (°C)	allow ecf from question **09.2** allow answers in the range 8.5 to 8.7 (°C) allow a tolerance of ± ½ a small square	1	AO2 4.5.1.1

Question 9 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.5		an answer of 0.62 (mol/dm^3) for concentration in mol/dm^3 scores **4** marks an answer of 0.31 (mol/dm^3) for concentration in mol/dm^3 scores **3** marks		AO2/2 4.3.1.2 4.3.2.5 4.3.4 4.4.2.5
	(moles H_2SO_4 = 0.500 × $\frac{15.5}{1000}$) = 0.00775		1	
	(moles KOH = 2 x moles H_2SO_4 = 2 x 0.00775) = 0.0155	allow correct calculation using incorrectly calculated value of moles of H_2SO_4	1	
	(conc KOH = moles KOH x $\frac{1000}{25.0}$) = 0.0155 x $\frac{1000}{25.0}$	allow correct calculation using incorrectly calculated value of moles of KOH	1	
	= 0.62 (mol/dm^3)	allow correct answer using incorrectly calculated value of moles of KOH	1	
	(M_r KOH =) 56		1	
	(conc = M_r x conc in mol/dm^3 = 56 x 0.62) = 34.7 (g/dm^3)	allow 35 or 34.72 (g/dm^3) allow correct answer using incorrectly calculated value of concentration in mol/dm^3 and/or incorrect M_r	1	
	alternative approach for step 1 to step 4 $\frac{2}{1} = \frac{25 \times \text{conc KOH}}{15.5 \times 0.500}$ (2) (conc KOH) = $\frac{2 \times 15.5 \times 0.500}{25.0}$ (1) = 0.62 (mol/dm^3) (1)	allow **1** mark if mole ratio is incorrect		

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 12 · Mark scheme

June 2019 | 8462/1H | Original Q9

Total			**14**

Question 9

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

Answer 13 · Mark scheme

Question 9 continued

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

Question 9 continued

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

Question 9 continued

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

Total			18

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 14 · Mark scheme

November 2021 | 8462/1H | Original Q9

Question 9

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

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

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

Answer 14 · Mark scheme

Question 9 continued

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

Question 9 continued

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

Total			9

Question 9

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

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

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

Question 9 continued

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

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

Total			10

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 16 · Mark scheme

June 2022 | 8462/1H | Original Q8

Question 8

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

Answer 16 · Mark scheme

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

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 16 · Mark scheme

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

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

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

Total Question 8		14

Answer 17 · Mark scheme

June 2022 | 8462/2H | Original Q5

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1		allow a description of each process		AO1 4.10.1.3
	screening **or** grit removal	allow filtering to remove (large) solids	1	
	sedimentation (to produce sewage sludge and effluent)		1	
	anaerobic digestion of (solid sewage) sludge		1	
	aerobic biological treatment of (liquid) effluent	allow aerobic digestion of effluent	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	Na^+ : 0.003 mol/dm^3 Cl^- : 0.003 mol/dm^3		1	AO3 4.10.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	the ions pass through the filter	allow the ions are not trapped / removed by the filter	1	AO3 4.1.1.2 4.10.1.2
	(because) the ions are in solution	allow (because) the ions are smaller than the filter pores	1	

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 17 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	(the ground water) contains microbes which are harmful (to health) (so) the water is sterilised **or** (so) the microbes are destroyed		1 1	AO3 AO1 4.10.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5	(the water is) unadulterated **or** (the water is) in its natural state	allow nothing is added (to the water) allow (the water) contains no microbes	1	AO2 4.8.1.1 4.10.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.6	(use) damp litmus paper (the paper) is bleached **or** (the paper) turns white	MP2 is dependent upon MP1 ignore paper turns red	1 1	AO1 4.8.2.4

Total Question 5		12

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	

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 18 · 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

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 18 · 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

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 18 · 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

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

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 19 · Mark scheme

June 2023 | 8462/1H | Original Q5

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

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 19 · Mark scheme

June 2023 | 8462/1H | Original Q5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5	(moles Na_2CO_3 = $\frac{25.0}{1000}$ × 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		

Answer 19 · Mark scheme

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

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

Total Question 5	**12**

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	(a catalyst) provides a different pathway for the reaction (which has a) lower activation energy		1 1	AO1 4.6.1.3 4.6.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	(oxygen is) a gas (which) escaped from the flask		1 1	AO2 4.3.1.3 4.6.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3	correct value for *x* step **and** *y* step from tangent (rate =) $\frac{\text{value for } y \text{ step}}{\text{value for } x \text{ step}}$ correct calculation of rate answer to 2 significant figures	 allow correct use of incorrectly determined *x* and/or *y* step allow an answer correctly rounded to 2 significant figures from an incorrect calculation which uses values determined from the graph.	1 1 1 1	AO2 4.6.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	line starting at 0,0 which is less steep than existing line which becomes level at 0.80 g	 allow a tolerance of ± ½ a small square	1 1	AO2 4.3.4 4.6.1.2

Total Question 7	10

Question 9

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

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

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.3	use a (volumetric) pipette to add the alkali 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	1 2	AO1 4.4.2.5 RPA2

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 21 · Mark scheme

June 2024 | 8462/1H | Original Q9

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

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

Total Question 9	12

Answer 22 · Mark scheme

Question 1

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

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

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

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 22 · Mark scheme

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

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 22 · Mark scheme

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

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

Total Question 1	**10**

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 23 · 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		

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 23 · 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)		

	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)		

Answer 23 · Mark scheme

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	

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 23 · 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

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 24 · Mark scheme

June 2025 | 8462/1H | Original Q8

Question 8

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

Answer 24 · Mark scheme

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

Answer 24 · Mark scheme

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

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

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 24 · Mark scheme

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

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

Total Question 8	**13**

Question 6

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

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

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

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

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

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

Total Question 6	11

Answer 10 · Examiner comments

June 2018 | 8462/1H | Original Q9

Question 9 (standard / high and high demand)

09.1 46% of students could explain the idea of a strong acid correctly, but few could articulate the idea of a dilute acid using correct scientific ideas. Most referred either to a low concentration (which merely expresses the opposite of the word dilute) or adding water, explaining the word diluted rather than dilute. To gain the mark, the idea of few particles per unit volume was required. Some students tried to explain the ideas in terms of pH, failing to realise that pH is itself affected by both the strength of an acid and by its concentration.

09.2 This question, on a new area of the specification, was answered well, with 68% of students giving the correct answer.

09.3 This question discriminated very well. The highest-attaining students gave excellent answers, with clearly set out working which was easy to follow. 20% of students achieved full marks, and 41% were able to achieve at least two marks, usually for calculating the correct average titre from concordant results.

Some working was very hard to follow, making it difficult to give partial marks. This was particularly the case when students wrote numbers around a pair of triangles rather than giving a step by step process. It is as important to communicate how the answer is obtained as it is to get an answer. It is also hard to follow working when partial answers are left as fractions bearing no relation to the actual data; a calculator display should always be converted to decimal form for intermediate steps as well as the final answer.

Some students had a correct answer but then took their final answer down to one significant figure. Having done a required practical, students should know that titration is a very accurate technique so that an answer to one significant figure would never be appropriate.

09.4 There was little understanding of the reasons for using different apparatus to measure the two volumes. Answers often did not mention volume at all but referred vaguely to ‘amount’ or ‘how much’. Both a pipette and a burette measure accurately and precisely – the difference is that a pipette can only measure one single volume, but a burette measures variable volumes.

09.5 32% of students achieved both marks. The most common errors were to forget to divide by 1000 when calculating the number of moles, or to calculate the mass per dm^3 but not then scale to 30 cm^3.

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 10 · Examiner comments

June 2018 | 8462/1H | Original Q9

Use of statistics

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

Mark Ranges and Award of Grades

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

Answer 11 · Examiner comments

June 2019 | 8462/1H | Original Q2

Question 2 (standard demand)

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

The most common incorrect response was OH^-

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

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

A common incorrect response for the product was hydrogen.

Answer 11 · Examiner comments

June 2019 | 8462/1H | Original Q2

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

Other common incorrect responses included:

- pipette
- syringe
- measuring cylinder.

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

The most common incorrect answer was 28.4 cm^3.

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

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

The most common key steps to be omitted were:

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

Answer 12 · Examiner comments

June 2019 | 8462/1H | Original Q9

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

09.1 Almost a half of students scored 0 marks.

The mark scheme required the use of comparatives.

Common correct responses were:

- Better insulator
- Less heat loss

Common responses seen that were not credited included:

- good insulator
- no heat loss.

09.2 This graph question was well answered with approximately half of students scoring full marks.

Some students attempted to draw a straight line of best fit. In most cases, this was inappropriate.

Some students did not draw their line so that the two lines of best fit crossed. Instead, they drew a curved peak.

Answer 12 · Examiner comments

09.3 Approximately 60% of students were able to determine the neutralisation point from their graph.

In some cases, students misunderstood the scale of the x-axis, for example, reading 11 cm^3 as 10.1 cm^3.

09.4 Only approximately a third of students correctly determined the overall temperature change for the reaction from their graph.

A common incorrect answer was 8.2 °C (from subtraction of the highest and lowest temperature values in the table).

09.5 Students found this titration calculation difficult and approximately a third of students scored 0 marks.

The marks for calculating the number of moles of sulfuric acid and for calculating the relative formula mass of potassium hydroxide were the most scored. Even when these values were incorrect, this did not prevent students from gaining marks in subsequent steps.

The correct answer for the concentration in mol/dm^3 was achieved more often than the subsequent conversion to g/dm^3. A common error was to use a conversion factor of 112 (2 × M_r(KOH)) rather than 56.

Answer 12 · Examiner comments

Use of statistics

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

Mark Ranges and Award of Grades

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Answer 13 · Examiner comments

November 2020 | 8462/1H | Original Q9

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

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

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

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

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

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

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

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

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

Mark Ranges and Award of Grades

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

Answer 14 · Examiner comments

November 2021 | 8462/1H | Original Q9

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

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

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

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

Concluding Remarks

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

Answer 14 · 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.

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 15 · Examiner comments

November 2021 | 8462/2H | Original Q9

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

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

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

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

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

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

Answer 16 · Examiner comments

June 2022 | 8462/1H | Original Q8

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

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

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

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

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 16 · Examiner comments June 2022 | 8462/1H | Original Q8

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

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

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.

Answer 17 · Examiner comments

June 2022 | 8462/2H | Original Q5

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

05.1 About a fifth of the students gained all the available marks. Many students answered the question in terms of treating water to make it potable, rather than treating sewage. Those who did answer in terms of treating sewage initially answered well though many answers broke down after mention of screening and sedimentation.

05.2 Half of the students were able to give the correct pair of concentrations in this multiple choice question.

05.3 The common error in this question was to concentrate on what Process 1 (filtering) did do, rather than the lack of effect on the ions. Of those who did correctly answer the question, more were awarded the first mark on the mark scheme. Around a quarter of the students gained both of the marks.

05.4 Students needed to state that the microbes were harmful and because of this some did not gain the first mark, although many were awarded the second. About 40% of the students scored both marks.

05.5 Less than a third of students answered this successfully with many responses stating the company meant the water was chemically pure, in spite of this being explicitly negated in the question.

05.6 Most students knew the test for chlorine gas; however a significant number did not refer to the need for the litmus paper to be damp and therefore did not gain the first mark. Over one-third of the students gained both marks.

Answer 18 · 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 Δ*y* and Δ*x* 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 Δ*y* and Δ*x* 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.

Answer 18 · 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.

Use of statistics

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Mark Ranges and Award of Grades

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

4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 19 · 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 19 · 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.

Answer 20 · Examiner comments

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

07.1 The effect of a catalyst on the rate of a reaction was generally well known. Most correct answers referred to the lowering of the activation energy. Many students also referred to the catalyst providing a different pathway for the reaction. References to changes in the number of collisions were insufficient as they did not answer the question. Over one-third of responses gained two marks, and around two-thirds of responses gained one mark.

07.2 Many responses correctly referred to a gas being produced in the reaction. However, as oxygen was given as a product in the stem of the question, if another gas, such as hydrogen or carbon dioxide, was referred to, then the first mark was not awarded. 'The gas was released' was not sufficient for the second marking point but 'being released into the air' or 'released into the surroundings' gained credit. The idea that a gas evaporates from the flask negated the idea of escape in marking point two. Nearly half of the students gained both marks.

07.3 Many students correctly used the tangent to the line drawn in the question to calculate the rate of reaction at 75 seconds.

If the tangent was not used then only MP4 was available for a correct rounding of data obtained correctly from the graph to 2 significant figures. This commonly involved the use of the student reading the y-axis value from a vertical line at 75 seconds.

For the first mark there had to be clear evidence from the graph or data put into the equation, that values for *x* and *y* were chosen from the graph. Some students counted the squares in the *y* and *x* axes and did not score MP1 but the remaining marks were still accessible.

Answer 20 · Examiner comments

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A small number of students added extra calculation steps after evaluating values in an equation. This often meant the second and third marking points were contradicted and therefore those marks could not be awarded.

If *x* and *y* values were awarded but the equation was inverted, only MP1 and MP4 were available.

Over half the students scored all four marks.

07.4 The award of both marks for this question was not often seen. The idea of a line that was less steep than the line given was often credited. However, the second marking point was not awarded on many occasions as the line sketched by the student did not level off at 0.80 g. The link between the only difference between the experiments being a halving of the concentration of hydrogen peroxide solution as the only reactant using a manganese dioxide catalyst was not recognised, resulting in a variety of incorrect responses. The most common answer was for the sketch line to finish at 1.60 g. Around 25% of students scored both marks.

Answer 21 · Examiner comments

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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Answer 21 · 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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Mark Ranges and Award of Grades

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4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 22 · Examiner comments June 2024 | 8462/2H | Original Q1

Question 1 (standard demand)

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

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

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

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

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Answer 22 · Examiner comments June 2024 | 8462/2H | Original Q1

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

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

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

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

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

Answer 23 · Examiner comments

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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4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 23 · Examiner comments

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

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Answer 23 · Examiner comments

Mark Ranges and Award of Grades

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4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only)

Answer 24 · Examiner comments

June 2025 | 8462/1H | Original Q8

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

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

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

Answer 24 · Examiner comments June 2025 | 8462/1H | Original Q8

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

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

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

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

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

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

Answer 25 · Examiner comments

June 2025 | 8462/2H | Original Q6

Question 6

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

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

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

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

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

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