AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.4.2.5

Titrations (chemistry only)

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**21**
Available paper years	**2008–2025**

Using this booklet

1. Booklet answer numbers match the question booklet.
2. Use the original question number within marking tables.
3. Examiner comments are included where available.

Name: _____ **Date:** _____

Where a precise marking extract is unavailable, the full source document is included in an appendix. Any missing mark scheme is explicitly identified.

4.4.2.5 Titrations (chemistry 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…

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

4.4.2.5 Titrations (chemistry 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

4.4.2.5 Titrations (chemistry only)

CHY3H

Question 4

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

continued…

4.4.2.5 Titrations (chemistry only)

CHY3H

Question 4 continued…

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

4.4.2.5 Titrations (chemistry 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…

4.4.2.5 Titrations (chemistry 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

4.4.2.5 Titrations (chemistry only)

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

CHY3H

Answer 02 · Mark scheme June 2008 | CHY1H | Original Q5 | Legacy

question	answers	extra information	mark
5(a)(i)	soya high(est) in polyunsaturated fat **and** low(est) in saturated fat	allow bean independent mark	1 1
5(a)(ii)	same / balanced amount of each fat	accept it contains the lowest total amount of these fats **or** it is low in saturated fat allow only 14% for this mark	1
5(b)(i)	turns colourless	accept colour disappears ignore fading	1
5(b)(ii)	any **two** from: • unsaturated fat content / healthiness about the same / similar to maize • less unsaturated / less healthy than soya • more unsaturated / more healthy than olive / palm	 accept about the same number of double carbon bonds as maize accept 'a bit less' for similar accept fewer / less double bonds than soya ignore 'more saturated' accept more double bonds than olive / palm ignore 'less saturated' if no other mark awarded accept sunflower oil has (about) the same result as maize oil for **1** mark ignore comments about saturated fats	2
Total			**6**

4.4.2.5 Titrations (chemistry only)

Answer 02 · Mark scheme

June 2008 | CHY1H | Original Q5 | Legacy

COMPONENT NUMBER: CHY1H

COMPONENT NAME: Science B / Chemistry

STATUS: Final

DATE: June 2008

4.4.2.5 Titrations (chemistry only)

Answer 03 · Mark scheme

Question 7

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

4.4.2.5 Titrations (chemistry only)

Answer 03 · Mark scheme

January 2010 | CHY3H | Original Q7 | Legacy

CHY3H

4.4.2.5 Titrations (chemistry 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

4.4.2.5 Titrations (chemistry 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**

4.4.2.5 Titrations (chemistry only)

Answer 04 · Mark scheme

January 2011 | CHY3H | Original Q6 | Legacy

CHY3H

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**

4.4.2.5 Titrations (chemistry only)

Answer 05 · Mark scheme

June 2011 | CHY3H | Original Q5 | Legacy

CHY3H

4.4.2.5 Titrations (chemistry only)

Answer 06 · Mark scheme

June 2013 | CH3HP | Original Q3 | Legacy

Question 3

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

0 marks	Level 1 (1-2 marks)	Level 2 (3-4 marks)	Level 3 (5-6 marks)
No relevant content.	There is a simple description of using some of the equipment.	There is a description of an experimental method involving a measurement, **or** including addition of alkali to acid (or vice versa).	There is a description of a titration that would allow a successful result to be obtained.

examples of chemistry points made in the response could include:

- acid in (conical) flask
- volume of acid measured using pipette
- indicator in (conical) flask
- sodium hydroxide in burette
- white tile under flask
- slow addition
- swirling
- colour change
- volume of sodium hydroxide added

Extra information

- allow acid in the burette to be added to sodium hydroxide in the (conical) flask
- allow any specified indicator

colour change need not be specified

Total			6

4.4.2.5 Titrations (chemistry only)

Answer 07 · Mark scheme

June 2014 | CH3HP | Original Q4 | Legacy

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

4.4.2.5 Titrations (chemistry only)

Answer 07 · Mark scheme

June 2014 | CH3HP | Original Q4 | Legacy



4.4.2.5 Titrations (chemistry only)

Answer 08 · Mark scheme

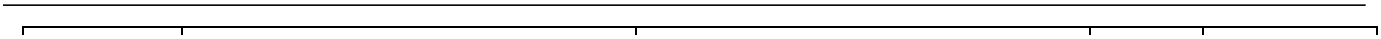
June 2015 | CH3HP | Original Q7 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
7(a)	**X:** Fe^{2+} / iron(II), SO_4^{2-} / sulfate	allow iron(II) sulfate **or** $FeSO_4$	1	**AO1/ AO2** 3.4.1.a/c/e/f
	Y: Na^+ / sodium, I^- / iodide	allow sodium iodide **or** NaI	1	
	Z: Fe^{3+} **/** iron(III), Br^- / bromide	allow iron(III) bromide **or** $FeBr_3$	1	
		correct identification of any two ions = one mark correct identification of any four ions = two marks		
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**	

4.4.2.5 Titrations (chemistry only)

Answer 08 · Mark scheme

June 2015 | CH3HP | Original Q7 | Legacy



4.4.2.5 Titrations (chemistry only)

Answer 09 · Mark scheme

June 2015 | CH3HP | Original Q8 | Legacy

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

4.4.2.5 Titrations (chemistry only)

Answer 10 · Mark scheme

June 2016 | CH3HP | Original Q2 | Legacy

The full source mark scheme begins on page 61. Follow original question 2 in that document.

4.4.2.5 Titrations (chemistry only)

Answer 11 · Mark scheme

June 2017 | CH3HP | Original Q4 | Legacy

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

4.4.2.5 Titrations (chemistry only)

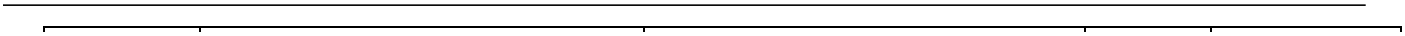
Answer 11 · Mark scheme

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

4.4.2.5 Titrations (chemistry only)

Answer 11 · Mark scheme

June 2017 | CH3HP | Original Q4 | Legacy



4.4.2.5 Titrations (chemistry only)

Answer 12 · 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

4.4.2.5 Titrations (chemistry only)

Answer 12 · Mark scheme

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		

4.4.2.5 Titrations (chemistry only)

Answer 12 · 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**	

4.4.2.5 Titrations (chemistry only)

Answer 13 · 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**

Answer 14 · Mark scheme

November 2020 | 8462/1H | Original Q9

Question 9

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

Answer 14 · 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		

4.4.2.5 Titrations (chemistry only)

Answer 14 · Mark scheme

November 2020 | 8462/1H | Original Q9

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

4.4.2.5 Titrations (chemistry only)

Answer 15 · 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

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

4.4.2.5 Titrations (chemistry 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		

4.4.2.5 Titrations (chemistry only)

Answer 16 · Mark scheme

June 2022 | 8462/1H | Original Q8

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

4.4.2.5 Titrations (chemistry only)

Answer 16 · Mark scheme

June 2022 | 8462/1H | Original Q8

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

4.4.2.5 Titrations (chemistry only)

Answer 16 · Mark scheme

June 2022 | 8462/1H | Original Q8

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

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

Total Question 8		14

4.4.2.5 Titrations (chemistry only)

Answer 17 · Mark scheme

June 2023 | 8462/1H | Original Q5

Question 5

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

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

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

4.4.2.5 Titrations (chemistry only)

Answer 17 · Mark scheme

June 2023 | 8462/1H | Original Q5

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

4.4.2.5 Titrations (chemistry only)

Answer 17 · 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		

4.4.2.5 Titrations (chemistry only)

Answer 17 · Mark scheme

June 2023 | 8462/1H | Original Q5

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

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

Total Question 5	**12**

Answer 18 · Mark scheme

June 2023 | 8462/2H | Original Q3

Question 3

Question	Answers	Mark	AO / Spec. Ref
03.1	**Level 3:** The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.	5–6	AO1 4.8.3.1 4.8.3.4 RPA7
	Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the plan is not fully logically sequenced.	3–4	
	Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2	
	No relevant content	0	
	Indicative content (potassium ions) • **place sample on (clean metal) wire** • **introduce into (blue / non-luminous) flame** • using (Bunsen) burner • **observe lilac flame colour** • which shows presence of potassium (ions) (bromide ions) • **dissolve sample** • in (distilled) water • in test tube • add (dilute) nitric acid • **add silver nitrate (solution)** • using (dropping) pipette • **observe cream precipitate (formed after addition of silver nitrate solution)** • which shows presence of bromide (ions)		

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

4.4.2.5 Titrations (chemistry only)

Answer 18 · Mark scheme

June 2023 | 8462/2H | Original Q3

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

Total Question 3	8

4.4.2.5 Titrations (chemistry only)

Answer 19 · Mark scheme

June 2024 | 8462/1H | Original Q9

Question 9

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

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

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

4.4.2.5 Titrations (chemistry only)

Answer 19 · Mark scheme

June 2024 | 8462/1H | Original Q9

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

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

Total Question 9	12

4.4.2.5 Titrations (chemistry only)

Answer 20 · Mark scheme

June 2025 | 8462/1H | Original Q8

Question 8

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

4.4.2.5 Titrations (chemistry only)

Answer 20 · 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 20 · Mark scheme

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

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

4.4.2.5 Titrations (chemistry only)

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

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

Total Question 8	**13**

4.4.2.5 Titrations (chemistry only)

Answer 21 · Mark scheme

June 2025 | 8462/2H | Original Q1

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	(a burette is) more accurate (than a measuring cylinder)	allow (a burette has) a higher resolution ignore precise	1	AO3 4.10.1.2 RPA8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	the mass of (dissolved) solids		1	AO1 4.10.1.2 RPA8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	reheat (the evaporating basin and contents) (and reweigh) until constant mass	 allow for **2** marks heat to constant mass	1 1	AO3 4.10.1.2 RPA8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	subtract the mass of the (empty) evaporating basin from the mass of the evaporating basin and contents (at the end of the experiment)	allow subtract initial mass from the final mass	1	AO1 4.10.1.2 RPA8

4.4.2.5 Titrations (chemistry only)

Answer 21 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5	(allow mean mass =) $\frac{0.35 + 0.37 + 0.33 + 0.34}{4}$	(allow mean mass =) $\frac{1.39}{4}$	1	AO2 4.3.2.5 4.10.1.2 RPA8
	= 0.3475 (g)		1	
	(conversion 10 cm^3 =) 0.01 dm^3		1	
	(mean concentration =) $\frac{0.3475}{0.01}$	allow correct use of incorrectly determined mean mass allow correct use of incorrect / no conversion of volume	1	
	= 34.75 (g/dm^3)	allow 34.75 (g/dm^3) correctly rounded to at least 2 significant figures	1	
	alternative approach 1 (conversion 10 cm^3 =) 0.01 dm^3 (1)			
	(concentrations =) $\frac{0.35}{0.01}$ $\frac{0.37}{0.01}$ $\frac{0.33}{0.01}$ $\frac{0.34}{0.01}$ (1)	allow correct use of incorrect / no conversion of volume		
	= 35 37 33 34 (1)			
	(mean concentration =) $\frac{35 + 37 + 33 + 34}{4}$ (1)	(allow mean concentration =) $\frac{139}{4}$ allow correct use of incorrectly determined concentrations		
	= 34.75 (g/dm^3) (1)	allow 34.75 (g/dm^3) correctly rounded to at least 2 significant figures		

	alternative approach 2 using total mass and total volume (total mass = 0.35 + 0.37 + 0.33 + 0.34 =) 1.39 (g) (1) (total volume = 10 + 10 + 10 + 10 =) 40 cm^3 (1) (conversion 40 cm^3 =) 0.04 dm^3 (1) (mean concentration =) $\frac{1.39}{0.04}$ (1) = 34.75 (g/dm^3) (1)	 allow correct use of incorrectly determined total mass allow correct use of incorrect / no conversion of total volume allow 34.75 (g/dm^3) correctly rounded to at least 2 significant figures		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.6	the samples were taken from different places		1	AO3 4.10.1.2

Total Question 1	**11**

4.4.2.5 Titrations (chemistry only)

PMT

AQA

GCSE

Chemistry

CH3HP

Mark scheme

4402

June 2016

Version/Stage: 1.0 Final

4.4.2.5 Titrations (chemistry only)

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

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

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

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Information to Examiners

1. General

The mark scheme for each question shows:

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

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

2. Emboldening and underlining

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

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

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

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

3. Marking points

3.1 Marking of lists

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

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

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

PMT

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

[1 mark]

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

Example 2: Name two planets in the solar system.

[2 marks]

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

3.2 Use of chemical symbols / formulae

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

3.3 Marking procedure for calculations

Full marks can be given for a correct numerical answer, without any working shown.

However, if the answer is incorrect, mark(s) can be gained by correct substitution / working and this is shown in the 'extra information' column or by each stage of a longer calculation.

3.4 Interpretation of 'it'

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

3.5 Errors carried forward

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

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

3.6 Phonetic spelling

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

3.7 Brackets

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

3.8 Accept / allow

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

3.9 Ignore / Insufficient / Do not allow

Ignore or insufficient is used when the information given is irrelevant to the question or not enough to gain a marking point. Any further correct amplification could gain the marking point.

Do **not** allow means that this is a wrong answer which, even if the correct answer is given, will still mean that the mark is not awarded.

4. Quality of Written Communication and levels marking

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

Students will be required to:

- use good English
- organise information clearly
- use specialist vocabulary where appropriate.

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

Level 1: Basic

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

Level 2: Clear

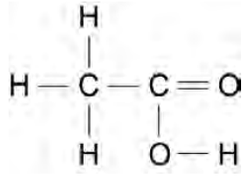
- Knowledge of accurate information
- Clear understanding
- The answer has some structure and organisation, use of specialist terms has been attempted but not always accurately, some detail is given
- There is reasonable accuracy in spelling, punctuation and grammar, although there may still be some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

Level 3: Detailed

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

4.4.2.5 Titrations (chemistry only)

MARK SCHEME – GCSE CHEMISTRY – CH3HP – JUNE 2016

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

<table>
<tr><th>Question</th><th>Answers</th><th>Extra information</th><th>Mark</th><th>AO / SpecRef</th></tr>
<tr><td>2</td><td></td><td></td><td>6</td><td rowspan="4">2AO1 / 3AO2 / 1AO3
3.4.1g</td></tr>
<tr><td colspan="4">Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5 and apply a ‘best-fit’ approach to the marking.</td></tr>
<tr><td colspan="4"><table>
<tr><th>0 marks</th><th>Level 1 (1–2 marks)</th><th>Level 2 (3–4 marks)</th><th>Level 3 (5–6 marks)</th></tr>
<tr><td>No relevant content.</td><td>There is a simple description of using some of the apparatus.</td><td>There is a description of an experimental method including addition of acid to alkali which may include an indicator or colour change and may include a measurement of volume.</td><td>There is a description of titrations that would allow a comparison to be made between the two solutions of hydrochloric acid.</td></tr>
</table></td></tr>
<tr><td colspan="4">examples of chemistry points made in the response could include:
• acid in burette or flask
• alkali/sodium hydroxide or acid in burette or flask
• volume of acid or alkali measured using the pipette
• indicator in flask
• white tile under the flask
• slow addition
• swirling/mixing
• colour change of indicator
• burette volume measured</td></tr>
</table>

Total		6

4.4.2.5 Titrations (chemistry only)

MARK SCHEME – GCSE CHEMISTRY – CH3HP – JUNE 2016

Question	Answers	Extra information	Mark	AO / SpecRef
3(a)(i)	atomic weights	allow atomic masses	1	AO1 3.1.1a
3(a)(ii)	proton	allow proton number	1	AO1 3.1.2a
3(b)(i)	F/fluorine	allow F_2	1	AO3 3.1.3a,b,f
3(b)(ii)	any **one** from: • copper has a higher density • copper is stronger • copper is harder • copper is less reactive	allow converse for potassium allow named property ignore colour, conductivity, melting point and boiling point	1	AO1 3.1.3c
3(b)(iii)	relative distance from nucleus relative attraction to nucleus relative ease of gain or loss of electron opposite explanation of ease of gain or loss of electron for other group	max 3 marks if 'outer' not mentioned allow more / fewer energy levels / shells or larger / smaller atom allow more / less shielding	1 1 1 1	2AO1 / 1AO2 / 1AO3 3.1.3b,f,h
Total			8	

Question	Answers	Extra information	Mark	AO / SpecRef
4(a)	development / maintenance of teeth / bones	allow lowers risk of heart disease	1	AO1 3.2.1f
	because contains calcium ions / compounds	allow contains calcium	1	
4(b)	scum or calcium stearate		1	AO1 3.2.1a
4(c)	temporary hard water contains calcium hydrogencarbonate or hydrogencarbonate ions	allow hydrogencarbonate	1	1AO1 / 2AO2 / 1AO3 3.2.1c,d,e
	when heated / boiled these decompose	allow decompose (in the kettle)	1	
	to produce a precipitate / scale or to produce calcium carbonate		1	
	coats the heating element or coats the kettle	allow prevents heat / energy transfer to the water	1	
4(d)		ions must be mentioned once to gain both of the first two marking points		2AO1 / 1AO2 3.2.1g, 3.2.2b
	ion exchange resins contain sodium / hydrogen ions		1	
	which replace / remove the calcium / magnesium ions	allow displace, but do not allow references to reactivity series	1	
	so removing the hardness or producing soft water		1	
Total			10	

4.4.2.5 Titrations (chemistry only)

MARK SCHEME – GCSE CHEMISTRY – CH3HP – JUNE 2016

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

Question	Answers	Extra information	Mark	AO / SpecRef
6(a)(i)	natural gas	allow fossil fuels / biogas generator	1	AO1 3.5.1a
6(a)(ii)	air contains oxygen this would react with / oxidise the hydrogen	 allow this would react with / oxidise the iron ignore nitrogen	1 1	AO3 3.5.1b
6(a)(iii)	cooled ammonia condenses / liquefies (so can be separated) nitrogen and hydrogen (remain as gases and) are returned to the reactor	 allow recycled	1 1 1	AO1 3.5.1b
6(b)(i)	200 °C **and** 1000 atmospheres		1	AO3 3.5.1b
6(b)(ii)	the reaction is reversible forward reaction is exothermic so increased temperature lowers the yield of ammonia a lower temperature would decrease rate of reaction a higher pressure would increase the yield of ammonia because the forward reaction produces the least number of (gaseous) molecules / moles higher pressures would involve high cost / energy	allow stated as equilibrium or forward / backward reaction anywhere in answer allow converse allow converse allow converse ignore risk / explosion	1 1 1 1 1	3AO1 / 2AO3 3.5.1d,e,f,g,h
Total			12	

Answer 12 · 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.

4.4.2.5 Titrations (chemistry only)

Answer 12 · 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.

4.4.2.5 Titrations (chemistry only)

Answer 13 · 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 13 · 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 14 · 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

Answer 14 · Examiner comments November 2020 | 8462/1H | Original Q9

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

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

4.4.2.5 Titrations (chemistry only)

Answer 14 · Examiner comments

November 2020 | 8462/1H | Original Q9

Mark Ranges and Award of Grades

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

Answer 15 · 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.

Mark Ranges and Award of Grades

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

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.

4.4.2.5 Titrations (chemistry 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.

4.4.2.5 Titrations (chemistry only)

Answer 16 · Examiner comments

June 2022 | 8462/1H | Original Q8

Use of statistics

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Mark Ranges and Award of Grades

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4.4.2.5 Titrations (chemistry only)

Answer 17 · 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 17 · Examiner comments

June 2023 | 8462/1H | Original Q5

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

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

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

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

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

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

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

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

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

4.4.2.5 Titrations (chemistry only)

Answer 18 · Examiner comments June 2023 | 8462/2H | Original Q3

Question 3 (standard demand)

Answer 18 · Examiner comments

June 2023 | 8462/2H | Original Q3

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

A simplistic approach to the level descriptors might be:

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

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

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

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

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

The halide test was slightly less well known.

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

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

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

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

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

4.4.2.5 Titrations (chemistry only)

Answer 19 · Examiner comments

June 2024 | 8462/1H | Original Q9

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

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

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4.4.2.5 Titrations (chemistry only)

Answer 19 · Examiner comments

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

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

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

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

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

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4.4.2.5 Titrations (chemistry only)

Mark Ranges and Award of Grades

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4.4.2.5 Titrations (chemistry only)

Answer 20 · 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 20 · Examiner comments

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

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

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

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

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

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

4.4.2.5 Titrations (chemistry only)

Answer 21 · Examiner comments June 2025 | 8462/2H | Original Q1

Question 1

01.1 Two thirds of students gained this marking point. Common incorrect responses included accurate (no comparative), more precise, easier to use and less likely to spill.

01.2 This mark was gained by three quarters of students. the most common errors were the volume of sea water and not mentioning mass.

01.3 The idea of heating to constant mass was known by a quarter of students, who gained two marks. Nearly 3 in 5 students gained no marks, often suggesting heating for longer, looking at the basin to see if there was any water left, heating above 100°C or patting dry.

01.4 Three fifths of students expressed the correct method of calculating the mass of dissolved solids. Those that did not gain this mark often missed the use of a mass or just suggested using a weighing scale.

01.5 Over half of students scored all five marks on this calculation. Where all five marks were not achieved, the most common error was an incorrect or no conversion from cm^3 to dm^3.

01.6 Half of students were able to suggest that the samples had come from different areas of the sea. Those that did not gain the mark tended to just reword the question.