AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.1.2.2

Development of the periodic table

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**12**
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.

4.1.2.2 Development of the periodic table

Answer 01 · Mark scheme

January 2008 | CHY3H | Original Q4 | Legacy

The full source mark scheme begins on page 30. Follow original question 4 in that document.

4.1.2.2 Development of the periodic table

Answer 02 · Mark scheme

Question 4

question	answers	extra information	mark
4(a)(i)	a correct link between any two named elements eg same group / column same properties / number of outer electrons	allow some link between any two elements in the same group (in both Newlands' and **or** the modern periodic table)	1
4(a)(ii)	any **two** from: • elements still being discovered **or** no gaps for undiscovered elements • some boxes have 2 elements in them • metals and non-metals in same column / mixed up • pattern for first 16 or so elements only	ignore statements about lack of evidence / proof accept some elements in same column have different properties. allow any sensible suggestion about misplaced elements eg copper in group 1 elements allow did not work for all elements	2
4(b)(i)	Cl > Br > I **or** I < Br < Cl Cl has 2 reactions, Br has 1 reaction, I doesn't react	accept reactivity / it decreases down the group owtte allow Cl has most / more reactions and I has least / less reactions (must be clear about where Br fits in)	1 1

Question 4 continues on the next page

CHY3H

Question 4 contd

question	answers	extra information	mark
4(b)(ii)	Br_2	allow multiples / fractions if correctly completed and balanced	1
4(b)(iii)	(they) have 7 outer electrons	allow (they) have 7 electrons in highest occupied (energy) level / shells / rings	1
4(c)	down group (atom / elements) bigger **or** outer electrons (level / shell / ring) further from nucleus / centre **or** more shells / level / rings	outer / last / final must be mentioned once in correct context, otherwise max **2** marks comparative required on all three points accept converse ie less reactive up group ignore more electrons do **not** accept more outer shells for this mark	1
	force(s) / attraction(s) are weaker **or** more shielding **or** attracts less	allow electron(s) attracted less easily allow electron(s) less under influence (of nucleus) do **not** accept magnetic / gravitational / intermolecular forces	1
	electron(s) lost more easily	allow electron(s) more likely to be lost allow easier to give away	1
Total			**10**

4.1.2.2 Development of the periodic table

Answer 02 · Mark scheme

January 2011 | CHY3H | Original Q4 | Legacy

CHY3H

4.1.2.2 Development of the periodic table

Answer 03 · Mark scheme

June 2011 | CHY3H | Original Q3 | Legacy

Question 3

question	answers	extra information	mark
3(a)	Group O / 8 **or** noble / rare / inert gases	accept transition elements / metals apply list principle	1
3(b)	(chemically) similar elements (now) in the same group / column	accept iodine has properties of Group 7 / halogens **or** iodine does not have group 6 properties **or** converse for tellurium ignore 'it fits the pattern' or any reference to proton / atomic numbers / atomic structure	1
3(c)	any **three** from: • (some) boxes had <u>two</u> elements • Group 1: copper / silver unreactive (not like the others) • there are non-metals and metals in the same group / box • Mendeleev left spaces / gaps • Medeleev reversed the order (for some elements)	ignore not enough evidence / proof **or** Mendeleev not respected allow <u>two</u> correctly identified elements together (in the same box) allow copper / silver not alkali metals / Group 1 accept named examples accept (some chemists thought) there were no more elements to discover	3

Question 3 continues on the next page

4.1.2.2 Development of the periodic table

Question 3 continued

question	answers	extra information	mark
3(d)	any **two** from: • elements arranged in proton / atomic number order • group: elements in same group / column have same number of outer electrons • elements in same period / row have same number of (electron) shells / energy levels	ignore mass number / atomic weight / neutrons throughout allow number of protons / electrons increases across period allow number of (electron) shells / energy level increase down group allow electron rings allow orbits	2
Total			**7**

4.1.2.2 Development of the periodic table

Answer 03 · Mark scheme June 2011 | CHY3H | Original Q3 | Legacy

CHY3H

4.1.2.2 Development of the periodic table

Answer 04 · Mark scheme June 2014 | CH3HP | Original Q3 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
3(a)	similar properties	*allow same properties* allow correct example of property ignore answers in terms of atomic structure	1	1 / 3.1.1a	E
3(b)(i)	in order of atomic / *proton* number	*allow increasing number (of protons)*	1	1 / 3.1.2a	E
3(b)(ii)	elements in same group have same number *(of electrons)* in outer shell **or** *highest energy level*	*allow number (of electrons) increases across a period*	1	1 / 3.1.2b	E
3(c)	any **two** from: • stronger / harder • less reactive • higher melting points	*statements must be comparative* *ignore higher densities* *ignore boiling point*	2	2 / 3.1.3c	E
3(d)	*reactivity increases down group* *outer electron is further from nucleus* *less attraction between outer electron and nucleus* *therefore outer electron lost more easily*	*allow converse throughout* *for next three marks, outer electron needs to be mentioned once otherwise max = **2*** *allow more energy levels / shells* *allow larger atoms* *allow more shielding*	1 1 1 1	1 / 3.1.3b/h	E
Total			**9**		

4.1.2.2 Development of the periodic table

Answer 04 · Mark scheme

June 2014 | CH3HP | Original Q3 | Legacy



4.1.2.2 Development of the periodic table

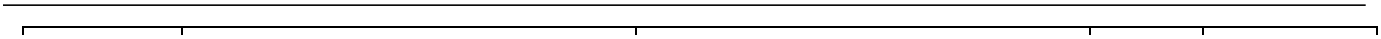
Answer 05 · Mark scheme June 2015 | CH3HP | Original Q2 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
2(a)	(iron) is a metal	accept transition element allow (iron) had different properties (to oxygen and sulfur) ignore electrons	1	**AO2** 3.1.1.a
2(b)	so that elements with similar properties could be placed together	allow to make the pattern fit ignore undiscovered elements	1	**AO1** 3.1.1.b
2(c)	atomic number(s)	allow proton number(s)	1	**AO1** 3.1.2.a
2(d)	all have one electron in the outer shell (highest energy level) (so they) have similar properties **or** react in the same way	allow same number of electrons in the outer shell (highest energy level) allow specific reactions e.g. with water	1 1	**AO1** 3.1.2.b
Total			**5**	

4.1.2.2 Development of the periodic table

Answer 05 · Mark scheme

June 2015 | CH3HP | Original Q2 | Legacy



4.1.2.2 Development of the periodic table

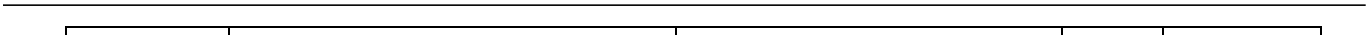
Answer 06 · Mark scheme June 2016 | CH3HP | Original Q3 | Legacy

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**	

4.1.2.2 Development of the periodic table

Answer 06 · Mark scheme

June 2016 | CH3HP | Original Q3 | Legacy



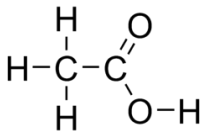
4.1.2.2 Development of the periodic table

Answer 07 · Mark scheme June 2017 | CH3HP | Original Q3 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
3(a)(i)	any **one** from: • for undiscovered elements • so elements with similar properties were in same column / group	ignore so they fit the pattern	1	**AO1** 3.1.1b
3(a)(ii)	any **one** from: • they have different properties from elements above them • they are (transition) metals .	ignore electronic configuration ignore they did not fit the pattern allow transition elements	1	**AO1** 3.1.1a,b
3(b)(i)	7 electrons in outer shell / highest energy level	ignore gain of 1 electron	1	**AO2** 3.1.2b
3(b)(ii)	for bromine: outer shell closer to nucleus stronger force of attraction (to nucleus) electron more easily gained to outer shell	'outer' must be mentioned once for 3 marks. comparatives required. ignore references to bromide / iodide allow converse for iodine allow fewer shells allow smaller atom allow less shielding	1 1 1	**AO1** **AO2** 3.1.3g,h

4.1.2.2 Development of the periodic table

Answer 07 · Mark scheme

3(c)(i)	yellow precipitate	allow yellow or dark yellow or light yellow or pale yellow allow dark yellow or light yellow or pale yellow precipitate allow dark yellow or light yellow or pale yellow ppt allow dark yellow or light yellow or pale yellow solid do **not** allow yellow solution	1	**AO1** 3.4.1e
3(c)(ii)	green precipitate	allow green or dark green or light green or pale green or dirty green allow dark green or light green or pale green or dirty green precipitate allow dark green or light green or pale green or dirty green ppt allow dark green or light green or pale green or dirty green solid do **not** allow green solution	1	**AO1** 3.4.1b
3(d)	one colour obscures the other	allow colours mix / blend allow only one colour seen	1	**AO3** 3.4.1a
3(e)(i)		allow -OH in the structure without the -O-H bond shown	1	**AO1** 3.6.2a

4.1.2.2 Development of the periodic table

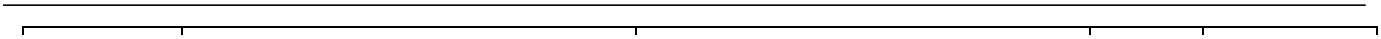
Answer 07 · Mark scheme

3(e)(ii)	weak acid (because) ethanoic acid is not fully ionised / dissociated	allow converse for hydrochloric acid allow (the solution) has a lower concentration of hydrogen ions allow (produces) fewer hydrogen ions. do **not** allow ionising	1 1	**AO3** 3.6.2a,b
Total			**12**	

4.1.2.2 Development of the periodic table

Answer 07 · Mark scheme

June 2017 | CH3HP | Original Q3 | Legacy



4.1.2.2 Development of the periodic table

Answer 08 · Mark scheme

June 2019 | 8462/1H | Original Q1

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	any **one** from: • so elements / iodine / tellurium were in groups with similar properties • iodine has similar properties to Br / Cl / F / Group 7 • iodine has different properties to Se / S / O / Group 6	ignore reference to atomic structure ignore references to Cr, Mn and Mo allow corresponding argument in terms of tellurium	1	AO1 4.1.2.2
01.2	Mendeleev had predicted properties of missing elements elements were discovered (that filled the spaces / gaps) properties (of these elements) matched Mendeleev's predictions	ignore reference to atomic structure allow atomic weights (of these elements) fitted in the spaces / gaps if no other mark awarded, allow **1** mark for in previous versions of the periodic table the pattern of similar properties broke down	1 1 1	AO1 4.1.2.2
01.3	relative atomic mass		1	AO1 4.1.1.6
01.4	(increasing) atomic / proton number	ignore (increasing) electron number do **not** accept relative atomic / proton number	1	AO1 4.1.2.1
01.5	(formula) At_2 (state) solid	ignore incorrect state symbol allow (s) ignore s	1 1	AO1 4.1.2.6

4.1.2.2 Development of the periodic table

Answer 08 · Mark scheme

June 2019 | 8462/1H | Original Q1

01.6	any **two** from: • flame • (white) solid forms • colour of gas / chlorine disappears / fades	allow burns allow (white) smoke forms	2	AO1 4.1.2.5
Total			**10**	

4.1.2.2 Development of the periodic table

Answer 09 · Mark scheme

November 2020 | 8462/1H | Original Q5

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	any **three** from: (nuclear model) • mostly empty space	allow the plum pudding model has no empty space allow the plum pudding model is solid	3	AO1 4.1.1.3
	• the positive charge is (all) in the nucleus	allow in the plum pudding model the atom is a ball of positive charge (with embedded electrons) do **not** accept reference to protons		
	• the mass is concentrated in the nucleus	allow in the plum pudding model the mass is spread out do **not** accept reference to neutrons		
	• the electrons and the nucleus are separate	allow in the plum pudding model the electrons are embedded allow in the nuclear model the electrons are in orbits		
05.2		do **not** accept reference to protons / neutrons		AO1 4.1.1.3
	electrons orbit the nucleus	allow electrons are in energy levels around the nucleus **or** allow electrons are in shells around the nucleus	1	
	electrons are at specific distances from the nucleus		1	
05.3	atomic number is the number of protons		1	AO3 4.1.1.3 4.1.1.4
	(and) protons were not discovered until later	ignore electrons / neutrons were not discovered until later	1	4.1.2.2

4.1.2.2 Development of the periodic table

Answer 09 · Mark scheme

November 2020 | 8462/1H | Original Q5

Question 5 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	so their properties matched the rest of the group	allow converse	1	AO1 4.1.2.2
Total			**8**	

4.1.2.2 Development of the periodic table

Answer 10 · Mark scheme

November 2021 | 8462/1H | Original Q2

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	(atoms with the) same number of protons	allow atoms with the same atomic number allow atoms of the same element	1	AO1 4.1.1.4 4.1.1.5
	(but with) different numbers of neutrons	ignore the same number of electrons ignore (but with) different mass numbers do **not** accept (but with) different relative atomic mass	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	$(A_r =) \frac{(69 \times 60) + (71 \times 40)}{100}$		1	AO2 4.1.1.6
	= 69.8		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	(number of electrons) = 31		1	AO2 4.1.1.4
	(number of neutrons) = 38		1	4.1.1.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	Ga^{3+}		1	AO3 4.2.1.2

4.1.2.2 Development of the periodic table

Question 2 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.5	(gallium) fitted in a gap (Mendeleev had left)		1	AO2 4.1.2.2
	(gallium's) properties were predicted correctly (by Mendeleev)	allow (gallium's) properties matched the rest of the group	1	

Total			**9**

4.1.2.2 Development of the periodic table

Answer 11 · Mark scheme

June 2023 | 8462/1H | Original Q1

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	a ball of positive charge with (negative) electrons embedded	do **not** accept references to protons, nuclei, neutrons	1 1	AO1 4.1.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	(earliest) electrons protons (latest) neutrons		1	AO1 4.1.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	(number of outer shell electrons) 7 (reason) (tennessine is in) Group 7	 allow the number of outer electrons is the same as the group number allow tennessine is a halogen MP2 is dependent on MP1 being awarded	1 1	AO2 4.1.2.1 4.1.2.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	(time needed for) peer review	allow the idea that other scientists had to check the results	1	AO3 4.1.2.2

4.1.2.2 Development of the periodic table

Answer 11 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5	(A_r =) $\frac{(6 \times 7.6) + (7 \times 92.4)}{100}$ = 6.924 = 6.9	 allow $\frac{45.6 + 646.8}{100}$ allow (6 × 0.076) + (7 × 0.924) allow 0.456 + 6.468 allow an answer correctly rounded to 1 decimal place from an incorrect calculation which uses all the data in the table	 1 1 1	AO2 4.1.1.6

Total Question 1	9

4.1.2.2 Development of the periodic table

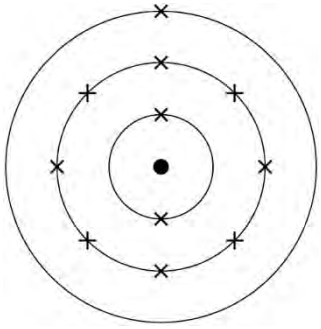
Answer 12 · Mark scheme

June 2025 | 8462/1H | Original Q1

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	towards the right **and** the top	allow a description of the position in the periodic table allow in Groups (3) 4 to 0	1	AO1 4.1.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	a melting point below 100 °C		1	AO3 4.1.2.3 4.2.2.7 4.2.2.8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3		allow any combination of ×, ●, o, $e^{(-)}$ for electrons	1	AO1 4.1.1.7

4.1.2.2 Development of the periodic table

Answer 12 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4		ignore reference to atomic structure		
	any **one** from: • so elements / tellurium / iodine were in groups with similar properties • iodine has similar properties to Group 7 elements • iodine has different properties to Group 6 elements	allow named element(s) for Group 6 / 7 elements allow converse arguments in terms of tellurium	1	AO1 4.1.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5		allow energy level for shell		AO1 4.1.2.4
	argon has a full outer shell (of electrons)	allow argon has eight outer shell electrons ignore argon has no outer shell electrons	1	
	(so argon) has a stable arrangement of electrons **or** (so argon) has a stable electronic structure	allow (so argon) does not gain / lose / share electrons	1	

4.1.2.2 Development of the periodic table

Answer 12 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.6	atoms with the same number of protons (but with) different numbers of neutrons	allow atoms of the same element allow atoms with the same atomic number ignore atoms with the same number of electrons	1 1	AO1 4.1.1.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.7	~115		1	AO2 4.1.1.6

Total Question 1	9

4.1.2.2 Development of the periodic table

Version 1.0: 0108

ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Secondary Education

Chemistry 4421

CHY3H Unit 3 Chemistry

Mark Scheme

2008 examination – January series

4.1.2.2 Development of the periodic table

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

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

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

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Dr Michael Cresswell Director General

4.1.2.2 Development of the periodic table

MARK SCHEME

Information to Examiners

1. General

The mark scheme for each question shows:

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

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

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

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

2. Emboldening

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

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

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

3. Marking points

3.1 Marking of lists

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

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

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

4.1.2.2 Development of the periodic table

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

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

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

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

3.2 Use of chemical symbols / formulae

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

3.3 Marking procedure for calculations

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

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

3.4 Interpretation of 'it'

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

3.5 Errors carried forward

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

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

3.6 Phonetic spelling

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

3.7 Brackets

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

3.8 Unexpected Correct Answers not in the Mark Scheme

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

4.1.2.2 Development of the periodic table

CHY3H

Question 1

question	answers	extra information	mark
(a)	either: calculations: all correct (ethanol = 6, methanol = 3, peanut oil = 10, vegetable oil = 15) **or** implication of correct calculation (vegetable oil) gives largest temperature / heat increase <u>per gram</u> (owtte)	ignore repetition of data from table unqualified allow 'produced most heat in proportion to the fuel used' owtte for **1** mark	2
(b)	any **one** from: • smoke • soot • carbon • carbon monoxide • carbon dioxide • global warming / climate change / greenhouse gases • (air) pollution • harmful / poisonous scrub / wash the gases owtte	owtte ignore references to crops/food filter / remove (gases / fumes / appropriate named substance) owtte (add extra oxygen) can burn more efficiently owtte use a cleaner fuel owtte plant more trees or similar linked to CO_2 any sensible answer 'don't burn so much fuel' insufficient alone ignore extractor fans / air conditioning	1 1

continued…

4.1.2.2 Development of the periodic table

CHY3H

Question 1 continued…

question	answers	extra information	mark
(c)(i)	A		1
(c)(ii)	B		1
total			6

4.1.2.2 Development of the periodic table

CHY3H

Question 2

question	answers	extra information	mark
(a)(i)	smooth curve through all points over full range finishing between 6.4 and 5.4 at 50°C		1
(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…

4.1.2.2 Development of the periodic table

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)	any sensible answer	1
	(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	1
total			9

4.1.2.2 Development of the periodic table

CHY3H

Question 3

question	answers	extra information	mark
(a)	scale – (solid) formed when <u>heat</u> decomposes dissolved calcium / magnesium compounds owtte	allow: scale is formed when <u>hard</u> 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 <u>hard</u> 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

4.1.2.2 Development of the periodic table

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…

4.1.2.2 Development of the periodic table

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

4.1.2.2 Development of the periodic table

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…

4.1.2.2 Development of the periodic table

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

4.1.2.2 Development of the periodic table

CHY3H

Question 6

question	answers	extra information	mark
(a)(i)		each correct test and one result = **1** mark	
		one other result for any test = **1 mark** this mark can only be awarded <u>once</u>	1
	Na_2CO_3: HCl → (odourless) gas (1) CO_2 / carbon dioxide (1)		1
	NaCl: $AgNO_3$ → white ppt (1) silver chloride (1)		1
	$NaNO_3$: Al + NaOH → pungent /sharp smell / choking gas (1) NH_3 / ammonia (1)		1
	Na_2SO_4: $BaCl_2$ → white ppt (1) barium sulfate (1)		1
(a)(ii)	all would give a <u>yellow</u> / <u>yellow-orange</u> (flame) / <u>same</u> coloured (flame) / <u>same</u> results **or** they all contain <u>sodium</u> owtte	allow <u>orange</u> (flame)	1
(b)	any **two** from: • fast / quick or comment about speed • small amounts • sensitive / accurate • ease of automation • sample not used up • reliable / efficient • can be left to run / continuous analysis	ignore cost ignore human error accept any valid answer accept operators do not need <u>chemical</u> skills ignore results can be saved	2
total			8

4.1.2.2 Development of the periodic table

Answer 08 · Examiner comments

June 2019 | 8462/1H | Original Q1

Question 1 (standard demand)

01.1 Approximately 40% of students scored this mark which required an appropriate reference to the properties of tellurium and/or iodine.

Most correct answers referred to iodine having similar properties to other Group 7 elements.

References to atomic structure were quite common, for example, iodine has 7 electrons in the outer shell so fits in Group 7. This was not creditworthy since this detail of atomic structure would not have been known by Mendeleev.

01.2 Students found this question difficult with almost half scoring 0 marks.

The most commonly awarded mark was for the idea that the missing elements were eventually discovered.

The ideas that Mendeleev predicted the properties of the missing elements and that when discovered the actual properties matched his predictions were not often stated.

01.3 Approximately three-quarters of students correctly identified relative atomic mass as the modern name for atomic weight.

4.1.2.2 Development of the periodic table

Answer 08 · Examiner comments

June 2019 | 8462/1H | Original Q1

01.4 Approximately 70% of students scored this mark with the most common response being 'atomic number'.

The most common responses seen that were not credited:

- reactivity
- relative atomic mass
- mass
- number of electrons in the outer shell.

01.5 Almost 70% of students scored at least 1 mark.

To gain the mark for the formula, At_2, the correct casing for the letters needed to be used; also, a subscript for the number. This mark was scored more often than the mark for the state.

01.6 Students found this question difficult and were often unable to give the observations associated with the reaction between sodium and chlorine.

The few students that gained credit mostly did so for the formation of a solid or for a flame.

Many students gave observations that would be expected from adding sodium to water, for example, a vigorous reaction or fizzing.

Other common non-scoring responses referred to:

- a precipitate being formed
- salt or sodium chloride being produced
- transfer of electrons.

4.1.2.2 Development of the periodic table

Answer 09 · Examiner comments

November 2020 | 8462/1H | Original Q5

Question 5 (standard / high and high demand)

05.1 Students had difficulty in expressing their ideas clearly; electrons in the plum pudding model were variously described as ‘floating’ or ‘covering’ the atom rather than embedded in the atom. A popular misconception was that the plum pudding model had an overall positive charge. A large number of students lost credit by referring to protons and neutrons in the nuclear model, despite the timeline which showed they had not been discovered at the time of the development of the model. Some answers did not make it clear which model was being written about.

Answer 09 · Examiner comments

November 2020 | 8462/1H | Original Q5

05.2 Many students stated that the Bohr model had electrons that orbit the nucleus, but fewer said that the orbits were at specific distances from the nucleus. Again, it was not uncommon to see mention of protons and neutrons despite the timeline provided.

05.3 Many students were able to deduce that the issue was that protons had not yet been discovered, but few also stated the relevance of the fact that the atomic number is the number of protons.

05.4 Few students could express coherently that the reason was to place elements with similar properties in the same group. There was a lot of imprecise language which did not earn credit; ‘reactivity’ is not the same as properties and placing elements ‘with’ those with similar properties does not necessarily mean in the same group or column.

4.1.2.2 Development of the periodic table

Answer 10 · Examiner comments November 2021 | 8462/1H | Original Q2

Question 2 (standard demand)

02.1 The usual definition (atoms with the same number of protons but a different number of neutrons), was not well known. Some students contradicted themselves by referring to elements in plural, rather than atoms of the same element. This was largely caused by the incorrect use of the word 'element' instead of 'atom'. Others said that the relative atomic mass (rather than the mass number) is different. One misconception is that an isotope is a single atom whose numbers of protons and electrons are the same, but whose number of neutrons differs from the number of protons. Electrons are not part of the definition of an isotope; their inclusion can lead to this type of confusion and ambiguous answers.

02.2 This was well answered by over half of the students, although a few ignored the instruction to give their answer to one decimal place. Some students did not appear to recognise that providing an answer that was not in between the mass numbers of the two isotopes was mathematically incorrect.

02.3 This was very well answered.

02.5 Many students had difficulty in articulating their answers. Many gave generic answers about Mendeleev having left gaps, rather than pointing out specifically that gallium fitted one of those gaps. There were also vague statements about gallium's properties fitting the adjacent elements, rather than matching the rest of the group. Some mentioned Mendeleev having predicted properties, without saying that those predictions were correct.

Answer 11 · Examiner comments June 2023 | 8462/1H | Original Q1

Question 1 (standard demand)

01.1 Only two fifths of students scored both marks, although three quarters scored at least one mark. The plum pudding model is described in the specification. However, some students referred to a ball of positive energy rather than positive charge, and some did not name the electrons, or implied that they were outside the positive ball rather than embedded in it.

01.2 Nearly three fifths of students could give the correct order of discovery.

01.3 More than three quarters of students scored both marks by locating tennessine in Group 7 and therefore deducing that it has 7 outer shell electrons. Some ignored the instruction to use the periodic table and tried unsuccessfully to work out the electron configuration.

01.4 Only one fifth of students were familiar with the idea of peer review or could apply it to this situation. A common incorrect reason was the scarcity of the element; this was the same for the original group of scientists so does not explain the delay.

01.5 Two thirds of students gave fully correct answers, and the question discriminated well. The great majority scored at least one mark, for giving an attempt at the calculation to one decimal place. Some divided by the sum of the mass numbers instead of the sum of the percentages (ie 100). There were very few rounding errors. Some students did not realise

4.1.2.2 Development of the periodic table

Answer 11 · Examiner comments June 2023 | 8462/1H | Original Q1

that their answer must lie somewhere between 6 and 7, the two mass numbers of the isotopes.

Question 1 (standard demand)

01.1 Only a quarter of students scored the mark, despite the clear statement in the specification. Many referred to the right of the table, but fewer referred to the top. Those who referred to specific groups were often correct but some omitted Group 0. Some referred to a 'staircase' but did not specify what it means; it should be noted that the periodic table provided does not show a staircase.

01.2 More than three quarters of students correctly chose the low melting point as the atypical property. The last distractor, 'forms positive ions' was the least popular, but the other distractors were about equal.

01.3 Nearly all students drew the electronic structure correctly. A few tried to use either 12 or 23 electrons.

01.4 Only two fifths of students were able to make sensible comments about the properties of the elements and either the groups that they would have been in or the groups that they were moved to. However, many comments were not clear, either not mentioning similar properties to the rest of the group or referring to vague regions of the periodic table rather than groups. Some stated that the elements were placed in order of atomic number, but atomic number was not known at Mendeleev's time, so these answers were disregarded. Some referred to leaving spaces for elements that had not been discovered, which does not answer this particular question.

01.5 Students scored well on this question, with more than two thirds scoring both marks and nearly all scoring at least one. Most referred to argon having a full outer shell of electrons, although some stated that there were no electrons in the outer shell, which is meaningless as the shell is not present without electrons. Fewer scored the second mark, for explaining that argon does not gain, lose or share electrons. Very few mentioned that the electron arrangement is stable; some said that argon is stable, which is just a rewording of the question.

01.6 The vast majority of students knew that isotopes have the same number of protons but a different number of neutrons. However, just over a half did not state that isotopes are atoms with the same number of protons, or atoms of the same element, so were restricted to one mark. Some implied that an isotope is a single atom where the number of neutrons is different to the number of protons, as in carbon-13.

01.7 The vast majority of students estimated the A_r correctly as ~115. The most popular distractor was ~114. Some students did not realise that an actual calculation was not required: only an estimation from the huge proportion of the isotope with mass number 115.