AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.1.2.1

The periodic table

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**47**
Available paper years	**2007–2025**

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.

4.1.2.1 The periodic table

Answer 01 · Mark scheme

November 2007 | CHY1A | Original Q6 | Legacy

Six	**3**	**3**	**2**	**3**

Answer 02 · Mark scheme

January 2008 | CHY3H | Original Q4 | Legacy

The full source mark scheme begins on page 84. Follow original question 4 in that document.

Answer 03 · Mark scheme

March 2008 | CHY1BP | Original Q5 | Legacy

Five	**3**	**3**	**3**	**2**

4.1.2.1 The periodic table

Answer 04 · Mark scheme

June 2008 | CHY2H | Original Q7 | Legacy

question	answers	extra information	mark
7(a)	2.8.3 on diagram as Xs / dots **or** e	accept paired **or** unpaired	1
7(b)	any **two** from: • electrons in highest energy level **or** electrons in outer shell • electrons are delocalised **or** sea of electrons • electrons are free **or** electrons move around / flow • electrons carry charge / current	 ignore carry electricity	2
Total			**3**

4.1.2.1 The periodic table

Answer 04 · Mark scheme June 2008 | CHY2H | Original Q7 | Legacy

COMPONENT NUMBER: CHY2H

COMPONENT NAME: Additional Science / Chemistry

STATUS: Final

DATE: June 2008

Answer 05 · Mark scheme November 2008 | CHY1AP | Original Q7 | Legacy

Seven	**4**	**1**	**2**	**3**

Answer 06 · Mark scheme November 2008 | CHY1BP | Original Q1 | Legacy

One	**A**	carbon dioxide	**3**
	B	helium	**1**
	C	nitrogen	**2**
	D	oxygen	**4**

Answer 07 · Mark scheme March 2009 | CHY1AP | Original Q3 | Legacy

Three	**3**	**2**	**1**	**3**

Answer 08 · Mark scheme November 2009 | CHY1AP | Original Q1 | Legacy

Question		Key	
One	**A**	Calcium (Ca)	**2**
	B	Lithium (Li)	**3**
	C	Gold (Au)	**1**
	D	Iron (Fe)	**4**

4.1.2.1 The periodic table

Answer 09 · Mark scheme

Question 3

question	answers	extra information	mark
3(a)	$^{2}_{1}H$	2 and 1 must be on the left 2 must be above half-way on the H and the 1 below half-way accept diagram with 2 <u>different</u> particles in centre and 1 particle on circle	1
3(b)(i)	18	ignore working ignore units	1
3(b)(ii)	forces (of attraction) between molecules **or** bonding between molecules **or** intermolecular forces /intermolecular bonds are weak **or** not much energy needed to break them **or** easily overcome	 must be linked to first mark if no other mark awarded allow <u>small</u> molecules / small M_r for **1** mark allow forces / bonds are weak for **1** mark do **not** allow covalent bonding is weak	1 1

Question 3 continues on next page

CHY2H

Question 3 contd

3(c)	H-2 atoms have 1 proton and 1 neutron H-1 atoms have one proton **or** H-2 atom has one neutron (1) H-1 atom has no neutrons (1)	any reference to <u>more</u> protons = **0** marks allow H-2 has more neutrons / particles for **1** mark allow H-2 has two particles and H-1 has one particle for **1** mark allow H-2 atom has one more neutron for **2** marks **NB** heavy water (molecule) has 2 <u>more</u> neutrons = **2** marks heavy water (molecule) has more neutrons / particles = **1** mark if no other mark awarded then heavy water molecule has M_r of 20 = **1** mark ignore reference to electrons	1 1
Total			**6**

4.1.2.1 The periodic table

Answer 09 · Mark scheme January 2010 | CHY2H | Original Q3 | Legacy

CHY2H

Answer 10 · Mark scheme March 2010 | CHY1AP | Original Q3 | Legacy

Three	**2**	**3**	**2**	**2**

Answer 11 · Mark scheme March 2010 | CHY1AP | Original Q8 | Legacy

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

Answer 12 · Mark scheme November 2010 | CHY1AP | Original Q3 | Legacy

Three	**3**	**4**	**2**	**1**

4.1.2.1 The periodic table

Answer 13 · Mark scheme

January 2011 | CHY2H | Original Q2 | Legacy

Question 2

question	answers	extra information	mark
2(a)(i)	65	correct answer with or without working = **2** marks if answer incorrect evidence of (81 – 16) for **1** mark ignore units	2
2(a)(ii)	zinc	accept error carried forward from (a)(i) allow correct symbol answer given should be element / metal closest to their answer do **not** allow compounds	1
2(b)(i)	• it loses electrons • three electrons	sharing / covalency = max **1** mark	1 1
2(b)(ii)	8 electrons shown in second shell.	accept dots / crosses / mixture of dots and crosses / e electrons do not need to be paired do **not** allow extra electrons in first shell	1
Total			**6**

4.1.2.1 The periodic table

Answer 13 · Mark scheme

January 2011 | CHY2H | Original Q2 | Legacy

CHY2H

4.1.2.1 The periodic table

Answer 14 · 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

4.1.2.1 The periodic table

Answer 14 · Mark scheme

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

4.1.2.1 The periodic table

Answer 14 · Mark scheme

January 2011 | CHY3H | Original Q4 | Legacy

CHY3H

Answer 15 · Mark scheme

March 2011 | CHY1AP | Original Q9 | Legacy

Nine	**3**	**2**	**1**	**4**

4.1.2.1 The periodic table

Answer 16 · Mark scheme

June 2011 | CHY2H | Original Q4 | Legacy

Question 4

question	answers	extra information	mark
4(a)	gives out heat / energy **or** energy / heat transferred to surroundings	allow more energy given out in making bonds than is used in breaking bonds ignore light	1
4(b)	activation	allow phonetic spelling	1
4(c)(i)	2 crosses on inner circle **and** 8 crosses on outer circle	accepts dots / e / — for electrons	1
4(c)(ii)	opposite charges (attract)	allow electrostatic forces (attract) do **not** accept intermolecular attraction / shared electrons	1
Total			**4**

4.1.2.1 The periodic table

Answer 16 · Mark scheme

June 2011 | CHY2H | Original Q4 | Legacy

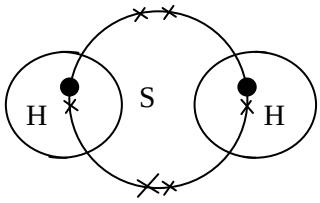
CHY2H

4.1.2.1 The periodic table

Answer 17 · Mark scheme

June 2011 | CHY2H | Original Q6 | Legacy

Question 6

question	answers	extra information	mark
6(a)	$\frac{6.21}{207}$ $\frac{0.64}{16}$	**1** mark for dividing mass by A_r max **2** if A_r divided by mass	1
	= 0.03 = 0.04	**1** mark for correct proportions	1
	3 4	**1** mark for correct whole number ratio (allow multiples) can be awarded from correct formula	1
	Pb_3O_4	**1** mark for correct formula **ecf** allowed from **step 2 to step 3** and **step 3 to step 4** if sensible attempt at **step 1** correct formula with no working gains **2** marks	1
6(b)(i)		allow all dots **or** all crosses **or** e **or** e^- ignore inner shells and any inner electrons allow 4 non-bonded electrons anywhere on shell as long as not in overlap – need not be paired	1

Question 6 continue on the next page

4.1.2.1 The periodic table

Question 6 continued

question	answers	extra information	mark
6(b)(ii)	forces of attraction / bonds <u>between</u> molecules are weak (owtte) **or** <u>intermolecular</u> forces / bonds are weak (owtte) **or** it is made of small molecules with weak forces of attraction	do **not** accept intramolecular forces / covalent bonds are weak do **not** accept reference to ions if **2** marks not awarded made of small molecules / simple molecular gains **1** mark forces of attraction are weak (without specifying between molecules / intermolecular) gains **1** mark (accept easily broken / not much energy needed to break instead of weak) bonds are weak without specifying intermolecular would not gain a mark and would be ignored	2
6(b)(iii)	4		1
Total			**8**

4.1.2.1 The periodic table

Answer 17 · Mark scheme

June 2011 | CHY2H | Original Q6 | Legacy

CHY2H

4.1.2.1 The periodic table

Answer 18 · 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

4.1.2.1 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**

4.1.2.1 The periodic table

Answer 18 · Mark scheme June 2011 | CHY3H | Original Q3 | Legacy

CHY3H

Answer 19 · Mark scheme November 2011 | CHY1BP | Original Q6 | Legacy

Six	**2**	**1**	**4**	**4**

4.1.2.1 The periodic table

Answer 20 · Mark scheme

January 2012 | CH1HP | Original Q1 | Legacy

Question 1

question	answers	extra information	mark
1(a)	2,4	allow electrons in any position on correct shells	1
1(b)	(electron) 79 neutron 118	 allow phonetic spelling 	1 1 1
1(c)(i)	16 **and** 9	in this order	1
1(c)(ii)	any **two** from: • (100% / pure) gold is soft • (alloyed) to make the metal hard(er) • gold is expensive **or** alloy is less expensive	ignore reasons about colour / lustre / corrosion / rarity allow layers can slide in pure gold ignore just 'the ring is an alloy' allow (alloyed) to stop the layers sliding allow (alloyed) to make the metal strong	2
Total			**7**

4.1.2.1 The periodic table

Answer 20 · Mark scheme

January 2012 | CH1HP | Original Q1 | Legacy

CH1HP

4.1.2.1 The periodic table

Answer 21 · Mark scheme

question	answers	extra information	mark
1(a)	hydrogen has one proton whereas helium has two protons	accept numbers for words accept hydrogen only has one proton ignore references to groups	1
	hydrogen has one electron whereas helium has two electrons	accept hydrogen only has one electron allow helium has a full outer shell (of electrons)	1
	hydrogen has no neutrons **or** helium has two neutrons	if no other mark awarded, allow helium has more electrons / protons / neutrons for **1** mark	1
1(b)(i)	2 electrons on first shell **and** 8 electrons on outer shell		1
1(b)(ii)	they have a stable arrangement of electrons	accept they have full outer energy level/shell of electrons do **not** accept they have the same number of electrons in their outer energy level / shell allow they are noble gases ignore they are in group 0	1
Total			**5**

4.1.2.1 The periodic table

Answer 21 · Mark scheme

January 2013 | CH1HP | Original Q1 | Legacy

CH1HP

4.1.2.1 The periodic table

Answer 22 · Mark scheme

June 2013 | CH3HP | Original Q1 | Legacy

Question 1

question	Answers	extra information	Mark
1(a)(i)	hydrogen	accept H_2 allow H	1
1(a)(ii)	hydroxide	accept OH^- allow OH do **not** accept lithium hydroxide	1
1(b)	any **two** from: potassium: • reacts / dissolves faster • bubbles / fizzes faster • moves faster (on the surface) • melts • produces (lilac / purple) flame	'it' = potassium accept converse for lithium allow reacts more vigorously / quickly / violently / explodes ignore reacts more allow fizzes more allow more gas allow moves more allow forms a sphere allow catches fire / ignites do **not** accept other colours	2
Total			**4**

4.1.2.1 The periodic table

Answer 23 · 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		

4.1.2.1 The periodic table

Answer 23 · Mark scheme

June 2014 | CH3HP | Original Q3 | Legacy



4.1.2.1 The periodic table

Answer 24 · Mark scheme

June 2015 | CH1HP | Original Q1 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1(a)(i)	protons	allow “protons or electrons”, but do not allow “protons and electrons”	1	1 / 1.1.1g
1(a)(ii)	protons plus/and neutrons		1	1 / 1.1.1g
1(b)	(because the relative electrical charges are) –(1) for an electron and +(1) for a proton and the number of electrons is equal to the number of protons	allow electrons are negative and protons are positive if no other mark awarded, allow 1 mark for the charges cancel out	1 1	1 / 1.1.1d/e
1(c)	(the electronic structure of) fluorine is 2,7 and chlorine is 2,8,7 (so fluorine and chlorine are in the same group) because they have the same number of or 7 electrons in their highest energy level or outer shell	allow diagrams for the first marking point if no other mark awarded, allow 1 mark for have the same/similar properties	1 1	1+2 / 1.1.1a / 1.1.2a
1(d)	S		1	2 / 1.1.1b
1(e)(i)	ions		1	1 / 1.1.3a
1(e)(ii)	molecules		1	1 / 1.1.3a
Total			9	

4.1.2.1 The periodic table

Answer 24 · Mark scheme

June 2015 | CH1HP | Original Q1 | Legacy



4.1.2.1 The periodic table

Answer 25 · Mark scheme June 2015 | CH1HP | Original Q4 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
4(a)	The ore is not pure or contains impurities or the ore does not contain 100% of the metal compound rock / other compounds need to be removed / separated	allow to concentrate the metal or metal compound	1 1	2+3 / 1.3.1b
4(b)(i)	(cast iron is) brittle	allow not strong ignore weak	1	1 / 1.3.2a
4(b)(ii)	the oxygen reacts with carbon reducing the percentage of carbon in the mixture **or** producing carbon dioxide	allow carbon burns in oxygen or is oxidised	1 1	2 / 1.3.2b
4(c)(i)	aluminium has a low density		1	2 / 1.3.3c
4(c)(ii)	(because copper) is in the central/middle (block of the periodic table) whereas aluminium is in Group 3 (of the periodic table)		1 1	1 / 1.3.3a
4(c)(iii)	iron is more reactive (than copper) so copper is displaced/reduced	ignore cost	1 1	1+2 / 1.3.1h/i
Total			**10**	

4.1.2.1 The periodic table

Answer 25 · Mark scheme

June 2015 | CH1HP | Original Q4 | Legacy



4.1.2.1 The periodic table

Answer 26 · Mark scheme

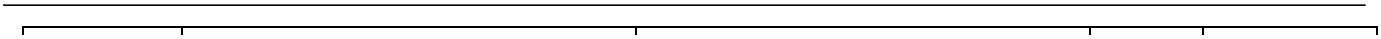
June 2015 | CH3HP | Original Q1 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1(a)	Li **and** K	either order allow lithium **and** potassium	1	**AO1** 3.1.3.a
1(b)	Fe	allow iron	1	**AO1** 3.5.1.b
1(c)	N **and** As	either order allow nitrogen **and** arsenic	1	**AO2** 3.1.2.b
1(d)	Cu	allow copper	1	**AO1** 3.1.3.d
Total			**4**	

4.1.2.1 The periodic table

Answer 26 · Mark scheme

June 2015 | CH3HP | Original Q1 | Legacy



4.1.2.1 The periodic table

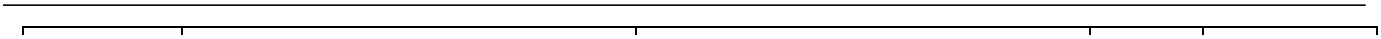
Answer 27 · Mark scheme June 2015 | CH3HP | Original Q2 | Legacy

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**	

4.1.2.1 The periodic table

Answer 27 · Mark scheme

June 2015 | CH3HP | Original Q2 | Legacy



4.1.2.1 The periodic table

Answer 28 · Mark scheme

June 2016 | CH1HP | Original Q1 | Legacy

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1(a)(i)	electronic structure 2,3 drawn	allow any representation of electrons, such as, dots, crosses, or numbers (2,3)	1	AO2 1.1.1h
1(a)(ii)	nucleus		1	AO1 1.1.1c
1(a)(iii)	protons and neutrons (relative charge of proton) +1 (relative charge of neutron) 0	do **not** allow electrons in nucleus allow positive allow no charge/neutral ignore number of particles	1 1 1	AO1 1.1.1c/d/f
1(b)	too many electrons in the first energy level or inner shell too few electrons in the second energy level or outer shell neon does not have 9 electrons **or** neon has 10 electrons	allow inner shell can only have a maximum of 2 electrons allow neon has 8 electrons in its outer shell **or** neon does not have 1 electron in its outer shell allow neon has a stable arrangement of electrons or a full outer shell allow one electron missing allow fluorine has 9 electrons ignore second shell can hold (maximum) 8 electrons or 2,8,8 rule or is a noble gas or in Group 0 max 2 marks if the wrong particle, such as atoms instead of electrons if no other mark awarded allow 1 mark for the electronic structure of neon is 2,8	1 1 1	AO2+AO3 1.1.1h; 1.1.2b
Total			8	

4.1.2.1 The periodic table

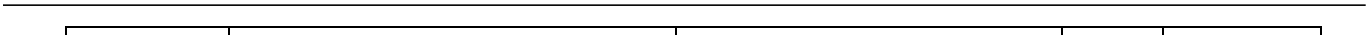
Answer 29 · Mark scheme June 2016 | CH3HP | Original Q3 | Legacy

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**	

4.1.2.1 The periodic table

Answer 29 · Mark scheme

June 2016 | CH3HP | Original Q3 | Legacy



4.1.2.1 The periodic table

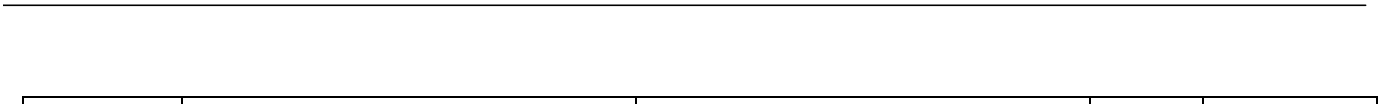
Answer 30 · Mark scheme June 2017 | CH1HP | Original Q1 | Legacy

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

4.1.2.1 The periodic table

Answer 30 · Mark scheme

June 2017 | CH1HP | Original Q1 | Legacy



4.1.2.1 The periodic table

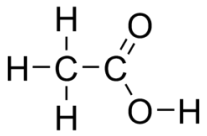
Answer 31 · Mark scheme

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

4.1.2.1 The periodic table

Answer 31 · 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

4.1.2.1 The periodic table

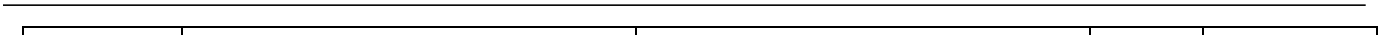
Answer 31 · Mark scheme

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**	

4.1.2.1 The periodic table

Answer 31 · Mark scheme

June 2017 | CH3HP | Original Q3 | Legacy



4.1.2.1 The periodic table

Answer 32 · 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

4.1.2.1 The periodic table

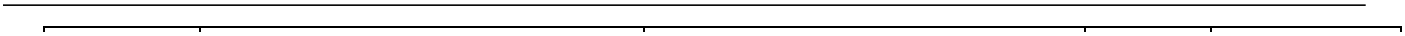
Answer 32 · Mark scheme

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**	

4.1.2.1 The periodic table

Answer 32 · Mark scheme

June 2017 | CH3HP | Original Q4 | Legacy



4.1.2.1 The periodic table

Answer 33 · Mark scheme

June 2018 | 8462/2H | Original Q7

Question	Answers	Extra information	Mark	AO/Spec. Ref.
07.1	incomplete combustion (because) insufficient / limited oxygen supply		1 1	AO1 4.9.3.1
07.2	any **two** from: • carbon monoxide toxic / poisonous • greater public concern / awareness about pollution • more cars so otherwise there would be more carbon monoxide entering atmosphere • improved engine technology • catalytic converters have been introduced	allow description of how carbon monoxide is toxic / poisonous ignore carbon monoxide is harmful / dangerous / deadly ignore comments about the effects of other pollutants ignore unspecified comments about carbon monoxide pollution	2	AO1 AO3 4.9.3.2
07.3	any **one** from: • (to reduce) health problems • (to reduce) global dimming	allow (to reduce) specified health problems eg breathing difficulties, asthma, lung cancer allow (to reduce) the effects of global dimming eg reduced light levels allow (to reduce) smog allow (to reduce) the formation of particulates ignore global warming do **not** accept to reduce soot	1	AO1 4.9.3.1 4.9.3.2

4.1.2.1 The periodic table

Answer 33 · Mark scheme

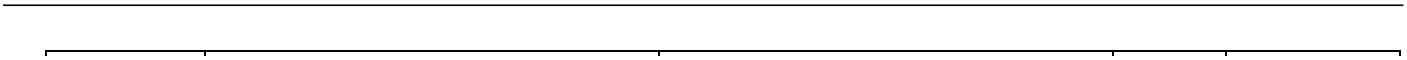
June 2018 | 8462/2H | Original Q7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	nitrogen (from atmosphere) reacts with oxygen (from atmosphere) at high temperature (in engine) **or** with a spark (from spark plug)	 ignore heat / hot	1 1	AO1 4.9.3.1
07.5	**2** $NO_2 \rightarrow N_2$ + **2** O_2	allow multiples if incorrect, allow N_2 for **1** mark	2	AO2 4.1.1.1 4.3.1.1
07.6	any **two** from: • acid rain • respiratory problems • carbon monoxide • global dimming **or** smog	**max 1** mark if global warming mentioned allow specific effects of acid rain allow specific respiratory problems eg breathing difficulties, asthma	2	AO1 4.9.3.2
07.7	transition metals		1	AO2 4.1.3.2
Total			**12**	

4.1.2.1 The periodic table

Answer 33 · Mark scheme

June 2018 | 8462/2H | Original Q7



4.1.2.1 The periodic table

Answer 34 · 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

4.1.2.1 The periodic table

Answer 34 · 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**	

4.1.2.1 The periodic table

Answer 35 · 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

4.1.2.1 The periodic table

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**	

4.1.2.1 The periodic table

Answer 36 · 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 ignore the same number of electrons	1	AO1 4.1.1.4 4.1.1.5
	(but with) different numbers of neutrons	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

4.1.2.1 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**

4.1.2.1 The periodic table

Answer 37 · Mark scheme

November 2021 | 8462/1H | Original Q3

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	(3 × M_r H_2O = 3 × (2 + 16) =) 54 (A_r **R** = 150 – 54 =) 96 **alternative approach**: (M_r **R**O_3 = 150 – 6 =) 144 (1) (A_r **R** = 144 – (3 × 16) =) 96 (1)	 ignore units ignore units	1 1	AO2 4.3.1.1 4.3.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	**(R** =) molybdenum / Mo	allow ecf from question **03.1**	1	AO3 4.1.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	(total M_r of reactants) = 163 (% atom economy =) $\frac{119}{163}$ (×100) = 73 (%)	 allow correct use of an incorrectly calculated value of total M_r allow 73.00613 (%) correctly rounded to at least 2 significant figures	1 1 1	AO2 4.3.1.2 4.3.3.2

Question 3 continued

Question	Answers	Mark	AO/ Spec. Ref
03.4	**Level 2:** Some logically linked reasons are given. There may also be a simple judgement.	3-4	AO3 4.4.1.3
	Level 1: Relevant points are made. They are not logically linked.	1–2	
	No relevant content	0	
	Indicative content • carbon and iron are the cheapest reactants • hydrogen is the most expensive reactant • separating solid products is expensive • separating solid products is time consuming • in method 1, tungsten needs to be separated from tungsten carbide • in method 1, some tungsten is lost as tungsten carbide • in method 1, the carbon dioxide produced will escape • in method 2, the water vapour produced will escape • in method 2, no separation of solids is needed • in method 3, tungsten needs to be separated from iron oxide		

Total			**10**

4.1.2.1 The periodic table

Answer 38 · Mark scheme

June 2022 | 8462/1H | Original Q1

Question 1

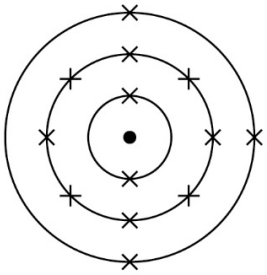
Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	D		1	AO3 4.1.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	B		1	AO3 4.1.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	any **two** from: (Group 1 elements) • have lower melting / boiling points • have lower densities • are less strong • are softer	allow converse statements for transition elements allow (Group 1 elements are) more malleable / ductile allow (Group 1 elements) are not useful as catalysts ignore transition elements form coloured compounds ignore transition elements form ions with different charges ignore references to chemical properties	2	AO1 4.1.3.1 4.1.3.2

4.1.2.1 The periodic table

Answer 38 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4		allow any combination of x, •, o, $e^{(-)}$ for electrons	1	AO2 4.1.1.7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5	delocalised electrons	allow free electrons	1	AO1 4.2.1.5 4.2.2.8
	(the electrons) carry (electrical) charge	ignore current / electricity for charge	1	
	(the electrons move) through the metal / aluminium / structure	ignore throughout for through	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.6	ionic		1	AO1 4.2.1.1

4.1.2.1 The periodic table

Answer 38 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.7	magnesium (atom) loses electrons		1	AO2 4.2.1.1 4.2.1.2
	oxygen (atom) gains electrons		1	
	two electrons (are transferred)		1	
	magnesium ions **and** oxide ions are formed	allow Mg^{2+} (ions) **and** O^{2-} (ions) are formed allow magnesium forms positive ions and oxygen forms negative ions allow (both) form a complete outer shell	1	

Total Question 1		13

4.1.2.1 The periodic table

Answer 39 · Mark scheme

June 2022 | 8462/1H | Original Q5

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	any **one** from: • more vigorous bubbling (for rubidium) • bigger / brighter flame (for rubidium)	allow converse statements for potassium allow (rubidium) catches fire more quickly allow (rubidium) moves around more quickly allow (rubidium) explodes allow (rubidium) disappears more quickly allow (rubidium) melts more quickly	1	AO3 4.1.2.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2		allow energy level for shell throughout allow converse argument in terms of potassium		AO1 4.1.2.5 4.4.1.2
	(rubidium's) outer shell / electron is further from the nucleus	allow the (rubidium) atom is larger allow (rubidium) has more shells	1	
	(so) there is less (electrostatic) attraction between the nucleus and the outer electron (in rubidium)	allow (so) there is more shielding between the outer electron and the nucleus (in rubidium)	1	
	(so) the (outer) electron (in rubidium) is more easily lost	allow (so) less energy is needed to remove the (outer) electron (in rubidium)	1	

4.1.2.1 The periodic table

Answer 39 · Mark scheme

June 2022 | 8462/1H | Original Q5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	$2\ Rb + 2\ H_2O \rightarrow 2\ RbOH + H_2$	ignore state symbols allow multiples allow **1** mark for H_2 allow **1** mark for RbOH	3	AO2 4.1.1.1 4.1.2.5 4.3.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	the noble gases have boiling points that increase going down the group		1	AO1 4.1.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5	(relative atomic mass =) $\frac{(90.48 \times 20)+(0.27 \times 21)+(9.25 \times 22)}{100}$ = 20.1877 = 20.2	allow (relative atomic mass =) $\frac{1809.6 + 5.67 + 203.5}{100}$ allow (relative atomic mass =) 18.096 + 0.0567 + 2.035 allow an answer correctly rounded to 3 significant figures from an incorrect calculation which uses all of the values in **Table 1** ignore units	1 1 1	AO2 4.1.1.6

Total Question 5		11

4.1.2.1 The periodic table

Answer 40 · 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

4.1.2.1 The periodic table

Answer 40 · 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

4.1.2.1 The periodic table

Answer 41 · 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

4.1.2.1 The periodic table

Answer 41 · 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

4.1.2.1 The periodic table

Answer 41 · Mark scheme

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

4.1.2.1 The periodic table

Answer 41 · Mark scheme

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

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

Total Question 5	**12**

4.1.2.1 The periodic table

Answer 42 · Mark scheme

June 2023 | 8462/1H | Original Q8

Question 8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	(atoms of) argon have a stable arrangement of electrons (so) argon (atoms) do not share / transfer electrons	allow (atoms of) argon have a full outer shell (of electrons)	1 1	AO1 4.1.2.3 4.1.2.4 4.2.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.2	PH_3	allow H_3P	1	AO2 4.1.2.1 4.2.1.4

4.1.2.1 The periodic table

Answer 42 · Mark scheme

June 2023 | 8462/1H | Original Q8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.3		MP2 is dependent upon MP1 being awarded		AO3 4.1.2.3
	yes, because tellurium is towards the right of the periodic table	allow yes, because tellurium is in Group 6	1	
	(so) tellurium is a non-metal	allow (so) tellurium will gain electrons (from a metal)	1	
	OR			
	yes, because tellurium is in the same group as oxygen / sulfur (1)			
	(and) oxygen / sulfur will react with metals (1)	allow (so) tellurium is a non-metal allow (so) tellurium will gain electrons (from a metal)		
	OR			
	no, because tellurium is towards the bottom of the periodic table (1)			
	(so) tellurium is a metal (1)	allow (so) difficult for tellurium to gain electrons (from a metal) (1)		
	OR			
	cannot predict as tellurium is towards the bottom and to the right of the periodic table (1)			
	(so) don't know whether tellurium is a metal or non-metal (1)	allow (so) don't know whether tellurium will gain electrons		

4.1.2.1 The periodic table

Answer 42 · Mark scheme

June 2023 | 8462/1H | Original Q8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.4	any **two** from: • effervescence / fizzing / bubbles • barium disappears • forms a colourless solution • temperature increases	ignore references to floating / flames ignore produces a gas allow barium gets smaller allow barium moves around	2	AO3 4.1.2.1 4.4.1.2 4.4.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.5	$Ba + 2\ HCl \rightarrow BaCl_2 + H_2$	allow multiples allow **1** mark for $BaCl_2$ allow **1** mark for H_2 ignore state symbols	3	AO2 4.1.1.1 4.4.1.2 4.4.2.1

Total Question 8	10

4.1.2.1 The periodic table

Answer 43 · Mark scheme

June 2024 | 8462/1H | Original Q2

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	(similarity) both have one outer (shell) electron	allow energy level for shell allow same number of outer (shell) electrons	1	AO1 4.1.2.1
	(difference) sodium has 3 shells but potassium has 4 shells	allow potassium has more shells allow (different) number of shells	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	any **two** from: • effervescence / bubbles / fizzing • (potassium) floats • (potassium) moves around • (potassium) becomes smaller • (potassium) melts • flame • explosion	ignore gas produced allow (potassium) forms a ball ignore colour of flame	2	AO1 4.1.2.5 4.4.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	blue / violet / purple		1	AO2
	(the solution is) alkaline	allow (the solution) contains OH^- (ions) allow (the solution) contains hydroxide ions allow the solution is basic	1	AO1 4.1.2.5 4.4.2.4

4.1.2.1 The periodic table

Answer 43 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	all five points correctly plotted	allow a tolerance of ± ½ a small square allow **1** mark for three or four points correctly plotted	2	AO2 4.1.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.5	3.4 (mg/cm^3)	allow a value in the range 3.0 to 3.8 (mg/cm^3)	1	AO3 4.1.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.6	chlorine and potassium bromide		1	AO2 4.1.2.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.7	relative molecular mass increases and boiling point increases		1	AO1 4.1.2.6

Total Question 2	**11**

4.1.2.1 The periodic table

Answer 44 · Mark scheme

June 2024 | 8462/2H | Original Q7

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1		ignore (hydrochloric / nitric / sulfuric) acid		AO1 4.8.3.5
	(test) add barium chloride (solution)	allow add barium nitrate (solution)	1	
	(result) white precipitate		1	
		MP2 is dependent upon MP1 being awarded		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	the yield is smaller at higher temperatures because the reaction is exothermic		1	AO2 4.6.2.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3		allow converse		AO2 4.6.2.7
	there are more moles / molecules (of gas) on the left	ignore particles	1	
	(so the position of) equilibrium shifts to the right		1	

4.1.2.1 The periodic table

Answer 44 · Mark scheme

June 2024 | 8462/2H | Original Q7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	any **two** from: • the yield is already high • more energy required • risk of explosion is increased • higher income from increased yield is outweighed by the extra expenditure • increased cost of safety precautions	allow requires stronger vessels allow requires thicker walls	2	AO3 4.6.2.7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.5	vanadium (V)		1	AO3 4.1.3.2

Total Question 7	**8**

4.1.2.1 The periodic table

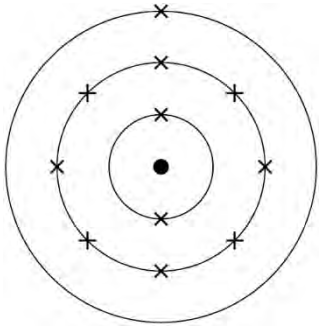
Answer 45 · Mark scheme

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

4.1.2.1 The periodic table

Answer 45 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	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	ignore reference to atomic structure 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	argon has a full outer shell (of electrons)	allow energy level for shell allow argon has eight outer shell electrons ignore argon has no outer shell electrons	1	AO1 4.1.2.4
	(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	

4.1.2.1 The periodic table

Answer 45 · 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

4.1.2.1 The periodic table

Answer 46 · Mark scheme

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	CaS		1	AO2 4.2.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	calcium (atom) loses electrons		1	AO2 4.2.1.1 4.2.1.2
	sulfur (atom) gains electrons		1	
	reference to transfer of two electrons		1	
	calcium forms positive ions **and** sulfur forms negative ions	allow Ca^{2+} (ions) **and** S^{2-} (ions) are formed allow calcium ions **and** sulfide ions are formed	1	

4.1.2.1 The periodic table

Answer 46 · Mark scheme

Question	Answers	Mark	AO / Spec. Ref.
02.3	**Level 2:** Scientifically relevant facts, events or processes are identified and given in detail to form an accurate account.	3–4	AO1 4.2.1.1 4.2.1.4 4.2.2.6 4.2.3.2
	Level 1: Facts, events or processes are identified and simply stated but their relevance is not clear.	1–2	
	No relevant content	0	
	Indicative content • giant structure • layers • of hexagonal rings • each (carbon) atom forms three bonds • has no covalent bonds between layers • with delocalised electrons • one delocalised electron from each carbon atom • the bonds are covalent • with shared (pairs of) electrons • the (covalent) bonds are strong		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	the molecules do not have an (overall electric) charge	allow there are no ions allow there are no delocalised electrons	1	AO1 4.2.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.5	poly(ethene) has stronger intermolecular forces to overcome than methane		1	AO1 4.2.2.4 4.2.2.5

Total Question 2	11

4.1.2.1 The periodic table

Answer 47 · Mark scheme

June 2025 | 8462/1H | Original Q4

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	–34 °C	allow a value in the range –70 to –20 °C	1	AO3 4.1.2.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	solid	allow (s)	1	AO3 4.1.2.6 4.2.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	7		1	AO1 4.1.2.1 4.1.2.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	HAt		1	AO2 4.1.2.1 4.1.2.6

4.1.2.1 The periodic table

Answer 47 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5		allow energy level for shell		
	reactivity decreases (going down the group)		1	AO1 4.1.2.6
	(because) the outer shell / electrons become further from the nucleus	allow (because) the atoms become larger allow (because) the atoms have more shells	1	
	(so) there is less (electrostatic) attraction between the nucleus and the outer electron(s)	allow (so) there is more shielding between the outer electron(s) and the nucleus	1	
	(so) gaining an electron is more difficult		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.6	$Br_2 + 2KI \longrightarrow I_2 + 2KBr$	allow multiples allow **1** mark for Br_2 **and** I_2 allow **1** mark for KI **and** KBr ignore state symbols	3	AO2 4.1.1.1 4.1.2.6

Total Question 4	11

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

4.1.2.1 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.

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4.1.2.1 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.

4.1.2.1 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.

4.1.2.1 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…

4.1.2.1 The periodic table

CHY3H

Question 1 continued…

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

4.1.2.1 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…

4.1.2.1 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) (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

4.1.2.1 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

4.1.2.1 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…

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

4.1.2.1 The periodic table

CHY3H

Question 5

question	answers	extra information	mark
(a)		**must** be description of a titration no titration = no marks	
	NaOH in <u>burette</u>	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…

4.1.2.1 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

4.1.2.1 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

Answer 33 · Examiner comments

June 2018 | 8462/2H | Original Q7

Question 7 (standard & standard / high demand)

07.1 This was generally well answered with 72% of students achieving one or two marks. The mark most commonly not achieved was for an insufficient or limited oxygen supply. This was usually because the students either did not mention oxygen or failed to say the supply was limited. However a number of students did not achieve the mark by stating that **no** oxygen was present. Global warming was a frequent response but was not creditworthy.

07.2 This was less well answered with 5% of students achieving both marks. Many students realised that CO is toxic in some way, but were too vague using words like 'harmful' or 'dangerous'. However this was the mark which was most frequently awarded.

Many students struggled to find a second reason. Again specific responses were required. Responses such as 'improved technology', 'more efficient cars' were not, on their own, sufficient to gain the 'improved engine technology' mark.

Although the question specifically mentioned new cars, responses comparing old cars to new cars did not normally contain creditworthy material.

07.3 This was not well answered with 11% of students achieving the mark. Most students did not appear to have realised that the question was asking about unburned hydrocarbons. Many who did were side-tracked into talking about wasting petrol / resources, or the flammability of unburned hydrocarbons. Again, global warming was a frequent response which did not gain credit.

07.4 There were a few good responses, but many that were not. 11% of students achieved both marks.

Students did not have to state where the oxygen and nitrogen came from, but when they did this needed to be correct. Nitrogen coming from the petrol or from combustion was not an acceptable response. The second mark was frequently not given because of the use of vague terms such as 'hot', rather than naming the conditions required ('high temperature')

07.5 This was generally well answered, although ‘2N’ was a common incorrect response. Students need to remember that gases such as nitrogen, hydrogen and oxygen normally exist as diatomic molecules. 61% of students achieved both the marks.

07.6 Again global warming and other associated responses were frequently seen, and in this case lost credit. Vague responses were also frequently seen. However most responses referred correctly to acid rain and one mark was often awarded. Some good responses included details about the pollutants that contribute to these effects. 56% of students were able to gain at least one mark.

07.7 61% of students knew that the transition metal block was the most likely source of catalysts.

4.1.2.1 The periodic table

Answer 34 · Examiner comments

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.

4.1.2.1 The periodic table

Answer 34 · 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.

4.1.2.1 The periodic table

Answer 35 · 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 35 · 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.

4.1.2.1 The periodic table

Answer 36 · 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 37 · Examiner comments

November 2021 | 8462/1H | Original Q3

Question 3 (standard demand)

03.1 This was well answered by many students. A common error was to not multiply the relative formula mass of hydrogen by three, leading to an answer of 100.

03.2 This was well answered. Credit was given to those who applied an incorrect response to question **03.1** correctly. Some students gave an answer which corresponded to their answer to question **03.1** used as atomic number rather than relative atomic mass.

03.3 This was well answered, although a common error was to omit the carbon in calculating the total M_r of the reactants.

03.4 The best answers gave the pros and cons of each method and then gave a judgement. One misconception was that the iron oxide in method 3 could be sold. Many concentrated only on cost, and the number of by-products, rather than what those products were and how difficult or costly further separation would be. Few students used the information provided, that solid products have to be separated. A few very good students commented on the low atom economy that method 1 would give because of some tungsten being lost as tungsten carbide.

4.1.2.1 The periodic table

Answer 38 · Examiner comments — June 2022 | 8462/1H | Original Q1

Question 1 (Standard demand)

01.1 Students found this question challenging. It was expected that the lack of electrical conductivity and the low melting point would have suggested a non-metal and therefore section **D**. However, fewer than half of students gave this response, with distractors **A** and **C** both proving very attractive to students.

01.2 Nearly two thirds of students recognised element **R** as a transition metal and therefore in area **B**.

01.3 Fewer than 20% of students scored two marks, although more than half scored at least one mark. Students were asked to compare physical properties of Group 1 elements with transition elements. Many students gave chemical properties such as reactivity instead of physical properties. Others referred to atomic structure. Some students described a property of either a Group 1 element or a transition element without reference to the other.

01.4 Nearly all students could draw the electronic structure correctly.

01.5 The great majority of students referred to delocalised electrons in their answer. Many also referred to the electrons carrying charge. However, few articulated the idea that the electrons themselves move through the metal in a particular direction. Many implied that the movement was random by the use of words such as ‘throughout’ rather than ‘through’. Some students incorrectly referred to electrons bumping into other atoms or electrons.

01.6 The great majority of students correctly identified the type of bonding.

Answer 38 · Examiner comments — June 2022 | 8462/1H | Original Q1

01.7 The majority of students gave excellent descriptions of the transfer of two electrons from a magnesium atom to an oxygen atom to produce magnesium ions and oxide ions,with more than 80% scoring at least three marks. A few students showed a lack of understanding by subsequently referring to electrons being shared.

4.1.2.1 The periodic table

Answer 39 · Examiner comments — June 2022 | 8462/1H | Original Q5

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

05.1 Nearly half of students described how a specific observation would differ. Vague comments about a more violent reaction, with no specific visual observation, did not gain credit.

05.2 Most students scored at least two marks. They knew that rubidium would lose an electron more easily, and that it was the larger size of the atom that was responsible (often expressed as the rubidium atom having more shells). The description of the weaker attraction of the rubidium nucleus for the outer electron was less well expressed; some students omitted to say that the attraction was for the outer electron or that the attraction was between the outer electron and the nucleus. Some gave an inappropriate description of the attraction, such as intermolecular or magnetic. Some contradicted their attraction argument by saying that the outer electron in rubidium is less shielded from the nucleus, rather than more shielded.

05.3 Only about a sixth of students scored full marks. Many knew that one of the products was hydrogen, and could write its formula correctly. However, far fewer knew that RbOH was the other product. Of those who did, most managed to balance the equation correctly.

05.4 Fewer than half of students gave the correct answer. Nearly as many, though, stated that the noble gases all have eight outer shell electrons, appearing to forget about helium.

05.5 More than half of students completed the calculation successfully and rounded to the appropriate 3 significant figures. Common errors were to divide by 63 (sum of the mass numbers) or 3 (number of isotopes) rather than by 100.

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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

4.1.2.1 The periodic table

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

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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

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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.

4.1.2.1 The periodic table

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

08.1 This question was well answered, with nearly all students referencing the stability of the outer electron shell. 'Full outer shell' was accepted even though it is not strictly true for a Period 3 element. About a half of students also referred to the lack of ability to share or transfer electrons, but some simply repeated that argon does not form compounds or does not form bonds. This was insufficient as the question required students to answer in terms of electrons.

08.2 About three fifths of students were able to give a correct formula by analogy with ammonia. PH_2 was a common incorrect response.

08.3 More than two fifths of students scored both marks, with nearly two thirds scoring at least one. Those who failed to score usually did not answer in terms of the position in the periodic table, as required. Students could reference the position on the right, and/or towards the bottom, or in Group 6 (the most common answer) to deduce whether or not a reaction would occur. However, many just stated that tellurium has six electrons in its outer shell, without mentioning the position.

08.4 About two thirds of students scored one mark, but far fewer were able to give a second valid observation. The most common observation was effervescence / bubbling / fizzing, but sometimes students used two of these words as if they were separate observations. Students sometimes gave deductions (gas produced, heat produced) instead of the actual observation (bubbling, temperature increase). Other common errors were to give observations which might be seen in any chemical change (eg formation of a precipitate, or a colour change) rather than this specific one.

08.5 Over a third of students scored at least two marks on this high demand question, with most of these students scoring all three marks. Nearly three quarters scored one mark, usually for the formula H_2. Those students who managed to work out the correct formula for barium chloride often scored all three marks. Some students were unable to work out that barium chloride and hydrogen would be the products. It was not uncommon to see the wrong symbol for barium, despite its being given at the top of the page.

4.1.2.1 The periodic table

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Question 2 (standard demand)

02.1 This was very well answered by the majority of students, with nearly two thirds scoring both marks. Most stated that both atoms have one outer shell electron and that potassium has one more shell than sodium. Sometimes the wrong number of shells was given for the two elements; usually 2 shells for sodium and 3 for potassium. Some stated that potassium has more outer shells than sodium. This is not correct as the phrase 'outer shell' is always taken to mean the single outermost shell. Some students gave consequences of the electronic structure rather than referring to the electronic structure itself; this was not given credit. Simply stating that the number of electrons is different did not answer the question; the number of electrons is not the electronic configuration.

02.2 More than two thirds of students gave two correct observations, with bubbling and a flame being the most popular. 'Gas produced' did not gain credit as it is not an observation but a deduction from the observation of bubbling. 'Fizzing' is taken to mean effervescence, so fizzing and bubbling are the same thing rather than two different observations. Credit was not given for any observation requiring extra equipment such as a thermometer or an indicator.

02.3 Well over half of students gave a correct colour and a correct reason, either in terms of the solution being alkaline or containing hydroxide ions. Nearly three quarters of students gained one mark. Some students had evidently seen, and remembered, the experiment done with phenolphthalein in the water, and therefore stated the indicator colour to be pink even though they knew the solution to be alkaline. Some answers were not clearly expressed; 'potassium is an alkali' did not gain credit as it is the potassium hydroxide solution that is alkaline. There were

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also, however, some excellent answers in terms of the hydroxide ion produced causing the solution to be alkaline.

02.4 More than four fifths of students plotted all of their points accurately. Many also drew a line of best fit although this was not required. A few drew their points as small dots instead of crosses, making it very difficult for the examiners to see them on a scanned image. Points do need to be visible, albeit sharp.

02.5 Students could nearly always estimate the density of krypton to within the tolerance allowed. Many used a line of best fit to do so although this was not necessary. In some cases inappropriate methods were used, such as finding the mean of all the other values; this did not gain credit even if it gave a value withing the range allowed.

02.6 Three quarters of students identified the correct pair of solutions, with the spread of incorrect responses being approximately equal.

02.7 Over two thirds of students identified the correct pair of trends. Most of the incorrect responses thought that boiling point decreases down the group.

4.1.2.1 The periodic table

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

07.1 Around 40% of students scored two marks for this question. However, many students were not able to name the correct reagent for the test. White precipitate was often given as the result of the test, but this answer was not creditworthy unless the correct reagent had been named. Sodium hydroxide and silver nitrate were the most common incorrect reagents. A significant number of students left the answer space blank.

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07.2 This multiple-choice question was well answered with two-thirds of students gaining the mark.

07.3 Around 30% of students scored both the marks on this question. Clear descriptions about the numbers of moles / molecules on each side of the equation and the resulting shift in the position of equilibrium at higher pressure were seen. A number of students failed to score the first marking point because they did not give a comparison of the number of moles or molecules of gas on each side of the equation. Answers that focused on changes in the rate of reaction or particle collisions were not creditworthy, nor were those which stated that the equilibrium shifted to the side with lower pressure.

07.4 This question was not well answered and only around 2% of students were awarded both marks. The most common creditworthy responses were based on the idea that a higher pressure is not used because the yield is already high or because more energy would be required to achieve a higher pressure. Many answers could not be given credit because they were not comparative. Higher risk of explosion or higher cost of safety precautions were creditworthy responses that focused on the consequences of using higher pressure compared to using a lower pressure.

07.5 This multiple-choice question was answered correctly by around a quarter of students who used their periodic table to locate and identify vanadium as a transition metal.

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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.

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Question 2 (standard demand)

02.1 Fewer than half of students could count the ions and realise that the ratio was 1:1 so the formula is CaS. Some tried to do it from the formulae of the ions but often wrote $CaSO_4$. Ca_9S_9 was a common incorrect answer, as was 9CaS. A formula was required, not an equation; equations did not gain credit.

02.2 More than three fifths of students gave fully correct answers, and nearly all scored at least 3 marks. The main omission was not saying what ions were formed. Students sometimes contradicted themselves by describing the atoms sharing electrons as well as those electrons being transferred. Any mention of sharing electrons negated the first three marking points. The correct formula of the sulfide ion was sometimes contradicted by an incorrect name such as 'sulfur ion' or 'sulfate ion'.

02.3 This was well answered by the majority of students, with two thirds reaching level 2. The question discriminated well. Many referred to the giant structure, the layers, the covalent bonds and the delocalised electrons. Fewer referred to the hexagonal rings of carbon atoms, with some incorrectly referring to the layers themselves as hexagonal. Many tried to refer to each carbon atom having three bonds, but some could not express themselves clearly, for example by leaving out the word atom or by implying that the whole structure contained only 3 bonds or 3 atoms. Fewer referred to the strength of the covalent bonds, with some incorrectly saying that covalent bonds are weak. Many also referred to the lack of covalent bonds between layers or the presence of weak intermolecular forces between the layers, but some referred to intermolecular forces without specifying their location. Very few referred to covalent bonds being shared pairs of electrons or to the fact that there is one delocalised electron per carbon atom. Many students introduced properties of graphite, which were not asked for and did not gain credit.

02.4 Very few gave the expected answer, which is the syllabus statement that small molecules do not have an overall electric charge. Some did try to refer to this but were not clear enough; 'they do not have an overall charge' does not necessarily refer to the small molecules since the subject of the sentence was 'substances. More than half did score the mark, but this was usually due to a reference to the lack of delocalised electrons. Some stated that there was no space for delocalised electrons, which is not the same thing and did not gain credit. Some stated that there are no mobile ions, which is ambiguous as it could mean that there are ions, but they are not mobile; this would not be correct.

02.5 Just over a half of students gave the correct reason, with 'poly(ethene) has more covalent bonds to break than methane' being the most popular distractor. Some ticked 2 boxes – usually the first and last; this automatically scores zero when the instruction is to tick **one** box.

4.1.2.1 The periodic table

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Question 4 (standard, standard/high and high demand)

04.1 More than two thirds of students were able to estimate the boiling point from the bar chart. A generous range was allowed, from -70 °C to -20 °C. A surprising number of students gave 0 °C or a positive value.

04.2 Three quarters of students were able to use the bar chart to deduce that -250 °C is below fluorine's melting point, so fluorine must be a solid at that temperature. Many stated fluorine to be a gas at that temperature, preferring to rely on what they 'knew' about fluorine than to analyse the data.

4.1.2.1 The periodic table

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04.3 Nearly all students gave the correct answer. Some produced an answer of 3, perhaps by trying to work out the detailed electronic configuration instead of simply looking at the group number.

04.4 Fewer than three fifths gave a correct answer. Students were expected to give the formula HAt by analogy with HCl. AtH was also accepted. However, there were many instances of H_2At, HAt_2, H_2At_2 or 2HAt. Some students tried to write an equation, which is never an appropriate response when asked for a formula and did not gain credit.

04.5 This question discriminated well, with nearly all students gaining at least one mark but only one in seven scoring all four. Precise use of language was required. Most students were able to state that reactivity decreases going down Group 7. Many were also able to state that gaining an electron became more difficult going down the group, although some referred incorrectly to likelihood rather than difficulty. Far fewer students were awarded the other two marks. Many said 'they' or 'the elements' become larger or 'they' or 'the elements' have more shells rather than specifically referring to the atom. Others stated that electrons, rather than outer shell electrons, become further from the nucleus. Some stated incorrectly that atoms have more outer shells. All atoms have one outer shell. Many students referred to the attraction between the nucleus and the outer shell, rather than between the nucleus and the electrons in the outer shell. Some incorrectly described this attraction as intermolecular or gravitational. Those who tried to refer to shielding usually found difficulty in expressing the idea correctly. Some brought in trends in melting and boiling points, which were not relevant.

04.6 This question also discriminated well, with nearly two thirds of students gaining at least one mark and one third gaining all three. Most students who could write the correct formulae could also balance the equation. However, there were many incorrect formulae, with errors such as Br instead of Br_2, KI_2 instead of KI, and even interhalogen compounds as products such as BrI. Compensation marks were available for those who could write the correct formulae for the two halogens and / or the correct formulae for the two potassium halides. There was no credit for balancing incorrect formulae.