AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.1.1.5

Size and mass of atoms

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**24**
Available paper years	**2008–2025**

Using this booklet

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

Name: _____ **Date:** _____

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

4.1.1.5 Size and mass of atoms

Answer 01 · 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**

4.1.1.5 Size and mass of atoms

Answer 01 · Mark scheme

June 2008 | CHY2H | Original Q7 | Legacy

COMPONENT NUMBER: CHY2H

COMPONENT NAME: Additional Science / Chemistry

STATUS: Final

DATE: June 2008

4.1.1.5 Size and mass of atoms

Answer 02 · 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)		any reference to <u>more</u> protons = **0** marks	
	H-2 atoms have 1 proton and 1 neutron	allow H-2 has more neutrons / particles for **1** mark	1
	H-1 atoms have one proton **or** H-2 atom has one neutron (1) H-1 atom has no neutrons (1)	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	1
		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	
Total			**6**

4.1.1.5 Size and mass of atoms

Answer 02 · Mark scheme January 2010 | CHY2H | Original Q3 | Legacy

CHY2H

Answer 03 · Mark scheme June 2010 | CHY1AP | Original Q4 | Legacy

Four	3	4	3	1

4.1.1.5 Size and mass of atoms

Answer 04 · 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**

4.1.1.5 Size and mass of atoms

Answer 04 · Mark scheme

June 2011 | CHY2H | Original Q4 | Legacy

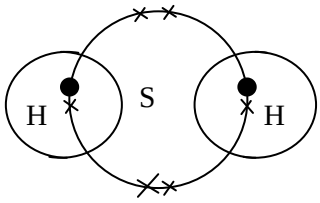
CHY2H

4.1.1.5 Size and mass of atoms

Answer 05 · 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

4.1.1.5 Size and mass of atoms

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**

4.1.1.5 Size and mass of atoms

Answer 05 · Mark scheme

June 2011 | CHY2H | Original Q6 | Legacy

CHY2H

4.1.1.5 Size and mass of atoms

Answer 06 · 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**

4.1.1.5 Size and mass of atoms

Answer 06 · Mark scheme

January 2012 | CH1HP | Original Q1 | Legacy

CH1HP

4.1.1.5 Size and mass of atoms

Answer 07 · Mark scheme

June 2013 | CH2HP | Original Q6 | Legacy

Question 6

question	Answers	extra information	Mark
6(a)	has simple / small molecules	accept molecular covalent	1
	the intermolecular forces / intermolecular bonds (are weak)	do **not** accept weak covalent bonds **or** reference to incorrect bonding	1
	only need a small amount of energy to be overcome	accept only need a small amount of energy to separate the molecules if no other mark awarded, allow it has a low boiling point for **1** mark	1
6(b)(i)	to separate		1
6(b)(ii)	(relative) molecular mass	allow M_r / (R)MM / relative mass / mass of molecule / (R)FM	1
6(c)(i)	any pH value from 0 to 6.9		1
6(c)(ii)	hydrogen	allow H^+ ignore H / H_2 / H^-	1
6(d)	any **three** from:		3
	• same number of protons	accept same atomic number numbers if given must be correct	
	• ^2H has one neutron • ^1H has no neutrons	accept different mass number **or** different number of neutrons for **1** mark ignore relative atomic mass	
	• same number of electrons	numbers if given must be correct	
Total			**10**

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

4.1.1.5 Size and mass of atoms

Answer 08 · 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**	

4.1.1.5 Size and mass of atoms

Answer 08 · Mark scheme

June 2015 | CH1HP | Original Q1 | Legacy



4.1.1.5 Size and mass of atoms

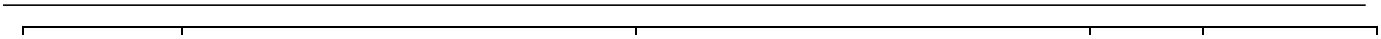
Answer 09 · Mark scheme June 2015 | CH2HP | Original Q4 | Legacy

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

4.1.1.5 Size and mass of atoms

Answer 09 · Mark scheme

June 2015 | CH2HP | Original Q4 | Legacy



4.1.1.5 Size and mass of atoms

Answer 10 · Mark scheme

June 2016 | CH2HP | Original Q3 | Legacy

Question	Answers	Extra information	Mark	AO / SpecRef
3(a)(i)	(mass number = 16) because there are 8 protons and 8 neutrons (in the nucleus)	accept mass number is total number of protons and neutrons for **1** mark	2	AO1/AO2 2.3.1a,b,c
3(a)(ii)	same number of protons **or** both have 6 protons	numbers, if given, must be correct accept same atomic number	1	2AO1 / 1AO2 2.3.1d
	^{12}C has 6 neutrons	accept different number of neutrons for **1** mark	1	
	^{14}C has 8 neutrons		1	
		incorrect reference to electrons = **max 2** marks		
3(b)(i)	2 bonding pairs	accept dot, cross or e or – or any combination additional unbonded electrons negates this mark	1	AO1 2.1
	4 unbonded electrons around oxygen		1	
3(b)(ii)	covalent		1	AO1 2.1.1g

Question 3 continues on the next page

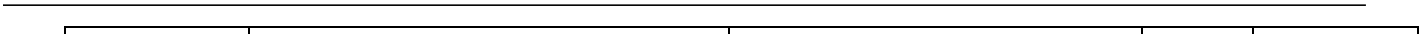
Question 3 continued

3(b)(iii)	any **one** from: • no delocalised / free electrons • no overall electric charge • no ions	do **not** accept any implications of the presence of ions ignore mobile electrons accept no charge (carriers)	1	AO1 2.2.1c
3(c)(i)	larger	accept the size of a few hundred atoms accept atoms are smaller (than nanoparticles) allow up to 1000 atoms	1	AO1 2.2.6a
3(c)(ii)	(nanoparticles have) large(r) surface area		1	AO2 2.2.6a
Total			**11**	

4.1.1.5 Size and mass of atoms

Answer 10 · Mark scheme

June 2016 | CH2HP | Original Q3 | Legacy



4.1.1.5 Size and mass of atoms

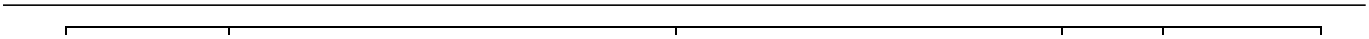
Answer 11 · Mark scheme June 2016 | CH3HP | Original Q3 | Legacy

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**	

4.1.1.5 Size and mass of atoms

Answer 11 · Mark scheme

June 2016 | CH3HP | Original Q3 | Legacy



4.1.1.5 Size and mass of atoms

Answer 12 · Mark scheme

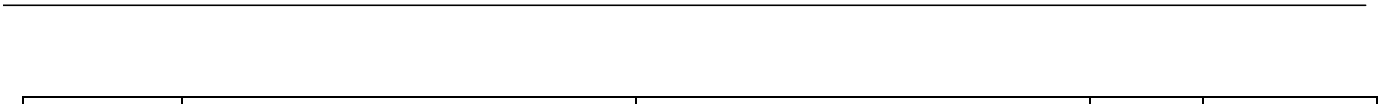
June 2017 | CH1HP | Original Q1 | Legacy

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**	

4.1.1.5 Size and mass of atoms

Answer 12 · Mark scheme

June 2017 | CH1HP | Original Q1 | Legacy



4.1.1.5 Size and mass of atoms

Answer 13 · Mark scheme

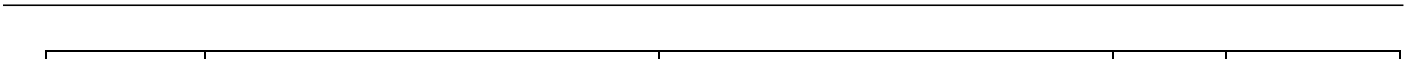
June 2018 | 8462/1H | Original Q4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	B		1	AO1 4.1.1.3
04.2	C		1	AO2 4.1.1.3
04.3	A		1	AO2 4.1.1.3
04.4	sum of protons and neutrons	allow number of protons and neutrons	1	AO1 4.1.1.5
04.5	between 69.5 and 70.0		1	AO2 4.1.1.6
04.6	Chadwick provided the evidence to show the existence of neutrons (this was necessary because) isotopes have the same number of protons **or** (this was necessary because) isotopes are atoms of the same element but with different numbers of neutrons	allow Chadwick discovered neutrons allow (this was necessary because) isotopes have the same atomic number ignore isotopes have the same number of electrons allow but with different mass (numbers)	1 1 1	AO1 4.1.1.3 AO3 4.1.1.5 AO1 4.1.1.5
Total			**8**	

4.1.1.5 Size and mass of atoms

Answer 13 · Mark scheme

June 2018 | 8462/1H | Original Q4



4.1.1.5 Size and mass of atoms

Answer 14 · Mark scheme

June 2019 | 8462/1H | Original Q4

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	(neutron) 1 0 proton 1 (+1)	both needed allow (neutron) 1 neutral both needed	1 1	AO1 4.1.1.4 4.1.1.5
04.2	number of protons plus neutrons	allow number of protons and neutrons ignore protons and neutrons unqualified do **not** accept references to mass or relative mass of protons and / or neutrons	1	AO1 4.1.1.5
04.3	(the isotopes contain) different numbers of neutrons		1	AO2 4.1.1.5
04.4	most (alpha) particles passed (straight) through (the gold foil) (so) the mass of the atom is concentrated in the nucleus / centre **or** (so) most of the atom is empty space some (alpha) particles were deflected **/** reflected (so) the atom has a (positively) charged nucleus / centre	 if not awarded for MP2, allow (so) the mass of the atom is concentrated in the nucleus / centre.	1 1 1 1	AO1 4.1.1.3
Total			**8**	

4.1.1.5 Size and mass of atoms

Answer 15 · Mark scheme

November 2020 | 8462/1H | Original Q2

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	they form ions with different charges they have high melting points		1 1	AO1 4.1.3.1 4.1.3.2
02.2	the (grey) crystals are silver the copper ions (produced) are blue (because) copper displaces silver	 allow the copper nitrate / compound (produced) is blue 	1 1 1	AO3 4.4.1.2

Question 2 continued

Question	Answers	Mark	AO/ Spec. Ref
02.3	**Level 2:** The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.	3–4	AO1 AO3 4.4.1.2 4.5.1.1 RPA 4
	Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2	
	No relevant content	0	
	Indicative content **Key steps** • add the metals to (dilute) hydrochloric acid • measure temperature change **or** compare rate of bubbling **or** compare colour of resulting solution for copper: • no reaction • shown by no temperature change **or** shown by no bubbles for magnesium and iron: • magnesium increases in temperature more than iron **or** magnesium bubbles faster than iron **or** magnesium forms a colourless solution and iron forms a coloured solution **Control variables** • same concentration / volume of hydrochloric acid • same mass / moles of metal • same particle size of metal • same temperature (of acid if comparing rate of bubbling)		

4.1.1.5 Size and mass of atoms

Question 2 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	$\frac{(203 \times 30) + (205 \times 70)}{100}$ **or** $\frac{6090 + 14\,350}{100}$ = 204.4	 ignore units	1 1	AO2 4.1.1.6
Total			**11**	

4.1.1.5 Size and mass of atoms

Answer 16 · 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

4.1.1.5 Size and mass of atoms

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**	

4.1.1.5 Size and mass of atoms

Answer 17 · 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

4.1.1.5 Size and mass of atoms

Question 2 continued

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

Total			**9**

4.1.1.5 Size and mass of atoms

Answer 18 · 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	

Answer 18 · 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

4.1.1.5 Size and mass of atoms

Answer 19 · 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

4.1.1.5 Size and mass of atoms

Answer 19 · Mark scheme

June 2023 | 8462/1H | Original Q1

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

4.1.1.5 Size and mass of atoms

Answer 20 · 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

4.1.1.5 Size and mass of atoms

Answer 20 · 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		

4.1.1.5 Size and mass of atoms

Answer 20 · 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

4.1.1.5 Size and mass of atoms

Answer 21 · 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

4.1.1.5 Size and mass of atoms

Answer 21 · 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**

4.1.1.5 Size and mass of atoms

Answer 22 · Mark scheme

June 2024 | 8462/1H | Original Q3

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	(model **A**) plum pudding (model **B**) Bohr	allow Thomson (model) allow nuclear (model) allow planetary (model) allow Rutherford-Bohr (model)	1 1	AO1 4.1.1.3

4.1.1.5 Size and mass of atoms

Answer 22 · Mark scheme

June 2024 | 8462/1H | Original Q3

Question	Answers	Mark	AO / Spec. Ref.
03.2	**Level 2:** Scientifically relevant features are identified; the way(s) in which they are similar / different is made clear and (where appropriate) the magnitude of the similarity / difference is noted.	3–4	AO1 4.1.1.3
	Level 1: Relevant features are identified and differences noted.	1–2	
	No relevant content	0	
	Indicative content **Similarities** • both contain electrons • both are neutral overall **Differences** • model **A** has no nucleus **or** the model used today has a nucleus • model **A** has no protons **or** the model used today has protons • model **A** has no neutrons **or** the model used today has neutrons • model **A** has positive charge spread throughout the atom **or** model **A** is a ball of positive charge • the model used today has the positive charge in the centre • model **A** the electrons are distributed randomly • the model used today has electrons in shells / energy levels • the mass was spread throughout model **A** • the mass is concentrated at the centre of the model used today • model **A** does not have empty space • model used today is mostly empty space		

4.1.1.5 Size and mass of atoms

Answer 22 · Mark scheme

June 2024 | 8462/1H | Original Q3

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

Total Question 3	8

4.1.1.5 Size and mass of atoms

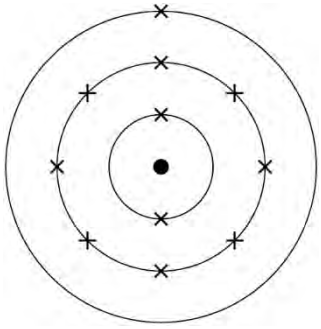
Answer 23 · Mark scheme

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

4.1.1.5 Size and mass of atoms

Answer 23 · Mark scheme

June 2025 | 8462/1H | Original Q1

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	

4.1.1.5 Size and mass of atoms

Answer 23 · 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

4.1.1.5 Size and mass of atoms

Answer 24 · Mark scheme

June 2025 | 8462/1H | Original Q5

Question 5

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

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	any **two** from: • the mass of the atom is concentrated at the centre / nucleus • the nucleus is positive / charged • most of the atom is empty space • electrons orbit the nucleus	do **not** accept references to shells	2	AO1 4.1.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	electrons orbit the nucleus at specific distances	allow electrons orbit the nucleus in energy levels allow electrons orbit the nucleus in shells	1	AO1 4.1.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	~100 000 times larger		1	AO2 4.1.1.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5	(surface area = 6×1.2^2 =) 8.64 (nm^2)		1	AO2 4.2.4.1
	(volume = 1.2^3 =) 1.728 (nm^3)		1	
	(ratio = 8.64 : 1.728 =) $\frac{8.64}{1.728}$ (: 1)	allow (ratio = 1.728 : 8.64 =) (1 :) $\frac{1.728}{8.64}$ allow correct use of incorrectly determined values of surface area and / or volume	1	
	= 5 : 1	allow = 1 : 0.2	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.6		allow converse arguments in terms of fine particles		AO3 4.2.4.2
	(nanoparticles) have a higher surface area to volume ratio		1	
	(so) less coating is used	(so) a thinner layer can be used	1	
	OR			
	(with nanoparticles) a thinner layer can be used (1)	allow less coating is used		
	(so) more light gets through the lenses (1)	allow (so) visibility is not reduced (as much)		

Total Question 5	12

Answer 13 · Examiner comments

June 2018 | 8462/1H | Original Q4

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

04.1 87% of students could identify the plum pudding model from the diagrams. E was the most popular distractor, where the charges were reversed.

04.2 68% of students could identify the model resulting from the alpha particle scattering experiment. The Bohr model was the most popular distractor.

04.3 72% of students could identify the Bohr model correctly. The most popular distractor being the model from the alpha particle scattering experiment.

04.4 69% of students could define mass number correctly. Some lost the mark by writing 'protons and neutrons' with no further information. Others mistakenly gave a description of relative atomic mass, or referred to the total mass of the protons and neutrons instead of the total number.

04.5 This question was well answered, with 75% of students able to estimate (or calculate) the relative atomic mass.

04.6 19% of students achieved all three marks. Two marks could be obtained just for defining isotopes. The other mark was for linking this to Chadwick's discovery of the neutron. No knowledge of how he made this discovery was required.

Many students were able to recall that Chadwick discovered the neutron, and that isotopes have different number of neutrons. Many students didn't mention that isotopes have the same number of protons, or are atoms of the same element. Clarity of expression was important here; the statement that isotopes are different forms of the same element gained no credit as it could refer to allotropes. Similarly, 'mass of an element' does not mean 'mass of an atom'.

Some students appear to think that isotopes are not 'normal' atoms of an element, and some think that isotopes are always unstable. There was some confusion of Chadwick with Rutherford, and even with Mendeleev.

4.1.1.5 Size and mass of atoms

Answer 14 · Examiner comments June 2019 | 8462/1H | Original Q4

Question 4 (standard and standard/high demand)

04.1 Approximately 80% of students scored both marks for the names / properties of the proton and the neutron.

04.2 Approximately 70% of students gave the correct definition of mass number.

However, there were some incorrect references to mass, for example, ‘mass number is the total mass of the protons and neutrons’.

04.3 Approximately 80% of students correctly answered that isotopes of the same element have different numbers of neutrons.

04.4 Most students made a good attempt at this question about the alpha particle scattering experiment.

The marks for the ideas that some particles were deflected and/or reflected and that there is a charged nucleus were the most frequently awarded.

The mark for the idea that most of the particles passed straight through the gold foil was the least frequently awarded.

Those students gained fewer marks tended to focus on expected outcomes but didn’t know exactly what happened in the experiment.

Answer 15 · Examiner comments November 2020 | 8462/1H | Original Q2

Question 2 (standard demand)

02.1 Nearly all students scored at least one mark. The most commonly seen incorrect response was ‘they form colourless compounds’.

02.2 Whilst many students realised that copper was displacing silver, most were unable to deduce that the grey crystals were silver and the blue solution was copper nitrate or a copper compound. There were many poorly worded answers which did not gain credit, such as ‘it displaced silver’, or ‘copper is blue in solution’. It was not uncommon for the grey crystals to be described as copper nitrate crystallising from the solution.

02.3 Whilst many students included a control variable in their plan, few actually said how they would identify each metal as magnesium, iron or copper, so were unable to access the higher levels.

02.4 This calculation was very well done by most students.

4.1.1.5 Size and mass of atoms

Answer 16 · 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 16 · 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.

4.1.1.5 Size and mass of atoms

Answer 17 · 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.

4.1.1.5 Size and mass of atoms

Answer 18 · 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.

Answer 19 · Examiner comments June 2023 | 8462/1H | Original Q1

Question 1 (standard demand)

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

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

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

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

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

4.1.1.5 Size and mass of atoms

Answer 19 · Examiner comments June 2023 | 8462/1H | Original Q1

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

Answer 20 · Examiner comments June 2023 | 8462/1H | Original Q8

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.

4.1.1.5 Size and mass of atoms

Answer 21 · Examiner comments — June 2024 | 8462/1H | Original Q2

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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Answer 21 · Examiner comments — June 2024 | 8462/1H | Original Q2

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.

4.1.1.5 Size and mass of atoms

Answer 22 · Examiner comments

June 2024 | 8462/1H | Original Q3

Question 3 (standard demand)

03.1 Nearly all students could name the plum pudding model, but most described model B as the nuclear model rather than the Bohr model (the nuclear model would not have the electrons in fixed orbits). This was, however, accepted, as the Bohr model is an adaptation of the nuclear model. Some students described model B as the atomic model, which simply rewords 'model of the atom.' Some described model B as the modern model, which contradicts the information that both were early models of the atom.

03.2 The features of each model were very well known and students scored highly on this question, with over half scoring full marks and more than nine tenths reaching level 2. The structure of many answers, however, sometimes made it difficult to see whether a comparison had been made. Many students described one model and then the other, rather than writing a true comparison of the features of each, with one feature compared at a time. Some of the best answers were written in the form of a table, with comparisons such as 'no nucleus'… 'has a nucleus.' To score full marks it was necessary to note a similarity as well as differences, with the most common similarity being 'both models have electrons.' One fairly common misconception is that the plum pudding model had an overall positive charge, rather than the positive charge being countered by the charges on the electrons, giving a neutral atom overall.

03.3 Many students knew that isotopes had different numbers of neutrons but did not say that isotopes were atoms with the same number of protons or of the same element. Thus, only a third of students scored both marks, although five sixths scored one. Some referred to 'elements' with the same number of protons, which did not gain the first marking point. Some students appear to believe that an isotope is a single atom where the number of neutrons is different to the number of protons, for example 'an atom with more neutrons than protons.' Some students' answers made it clear that they think there is only one 'true' atom of an element, with isotopes being improper deviants.

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Answer 23 · Examiner comments

June 2025 | 8462/1H | Original Q1

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.

4.1.1.5 Size and mass of atoms

Answer 24 · Examiner comments

June 2025 | 8462/1H | Original Q5

Question 5 (standard/high and high demand)

05.1 Over half of students scored both marks by giving the description in the specification. For the first marking point, the idea of both the shape and the charge were needed. Common errors were to refer to a positive 'cloud' or a ball of positive 'energy'. Other errors were to refer to protons, which had not been discovered, or to imply that there was an overall positive charge on the atom as a whole; atoms were known to be neutral in terms of charge. For the second marking point the electrons needed to be referred to as such, not just negative charge. Common errors were to imply that electrons were on the surface rather than embedded, or that they were moving.

05.2 This was well answered, with four fifths of students scoring at least one mark. Many referred to the mass being concentrated at the centre and also the positive charge but

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failed to refer to the centre as the nucleus. Many referred to most of the atom being empty space, but some simply said that there is empty space in the atom which is not quite the same. Fewer referred to electrons orbiting the nucleus, and many of those who did referred incorrectly to shells.

05.3 Whilst many students knew that Bohr's contribution to the model of the atom was electron shells, many did not mention that the electrons were orbiting the nucleus in these shells. Even fewer referred to specific distances from the nucleus. Many confused Bohr with Chadwick and stated that Bohr discovered neutrons. Only one third of students gave a fully correct answer.

05.4 More than four fifths of students gave the correct response, with 10 000 times larger being the most popular distractor.

05.5 Two thirds of students gave fully correct answers. Most students could calculate the volume correctly, although some incorrectly gave the units as nm instead of nm^3. They had more difficulty with the surface area, with some forgetting to multiply the area of one face by 6 and others miscounting the number of faces. The marks for calculating the ratio could be obtained from incorrect values for the surface area and / or volume. The simplest ratio was required, so this needed to be either a whole number ratio or with one of the values reduced to 1. Dividing one value by the other was by far the simplest way of finding the ratio. A few students unnecessarily decided to change the units from nm to m, mm or even μm. As this ratio is not dimensionless, this approach gave different values depending on the units chosen. Full marks could be obtained if the conversions were correct, but many were not. If students are not instructed to give an answer in particular units, they should stick with the ones provided.

05.6 Students found this question more difficult than expected, with fewer than half scoring one mark and about one in ten scoring both. Many students gave the general answer; that nanoparticles have a greater surface area to volume ratio. However, fewer were able to express clearly the idea that a thinner coating could be used, with many using ambiguous phrases such as 'less nanoparticles needed' rather than less of the coating or another description of less material in bulk. Fewer concentrated on the specific use in glasses. Although many said that visibility would not be reduced as much if nanoparticles were used, many thoughts this would be because the particles themselves could be seen if fine particles were used, which is not the case. Some students did not give answers in comparative terms, for example referring to a high (rather than higher) surface area to volume ratio.