AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.1.1.1

Atoms, elements and compounds

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**4**
Available paper years	**2020–2025**

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.

5.1.1.1 Atoms, elements and compounds

Answer 01 · Mark scheme November 2020 | 8464/C/1H | Original Q7

07.1		max **3** marks if reference to incorrect particles / bonding / structure		
	caesium atom loses one electron		1	AO1 5.1.2.5 5.2.1.2
	(and) oxygen atom gains two electrons		1	
	(so) two caesium atoms react with one oxygen atom	allow (to produce) Cs_2O	1	
	any **one** from: • (to form) Cs^+ and O^{2-} • (to form) caesium ion(s) and oxide ion(s) • (to form) ions with full outer shells / levels		1	

5.1.1.1 Atoms, elements and compounds

Answer 01 · Mark scheme

November 2020 | 8464/C/1H | Original Q7

07.2	(caesium has) more energy levels **or** (caesium has) more shells	allow converse for sodium	1	AO2
	(so the) outer electron / shell is further from nucleus **or** outer electron / shell is more shielded		1	AO1
	(so) weaker attraction between nucleus and outer electron / shell		1	AO1
	(so) outer electron is more easily lost	allow (so) less energy needed to remove outer electron	1	AO1 5.1.2.3 5.1.2.5

07.3	early periodic tables were arranged with elements in order of their atomic weights	ignore atomic mass	1	AO1
	iodine has a lower atomic weight than tellurium	allow converse for tellurium	1	AO1
	(so) Mendeleev placed iodine with elements with same / similar properties **or** (so) Mendeleev placed tellurium with elements with same / similar properties	allow F / Cl / Br for elements allow O / S / Se for elements	1	AO2 5.1.2.2

Total			**11**

5.1.1.1 Atoms, elements and compounds

Answer 02 · Mark scheme

June 2022 | 8464/C/1H | Original Q7

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	electrolysis of molten compound (of metal **Y**) **OR** displacement (1) by heating with a more reactive metal **or** by heating with potassium / magnesium (1)	 allow liquid for molten	1 1	AO3 5.4.1.3 5.4.3.2 5.4.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	$4\ Na + TiCl_4 \rightarrow 4\ NaCl + Ti$	allow multiples allow **1** mark for NaCl **and** Ti with incorrect / no balancing	2	AO2 5.1.1.1 5.3.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3	$Na \rightarrow Na^+ + e^-$	ignore state symbols allow multiples allow **1** mark for $Na \rightarrow Na^+ + e^-$ with incorrect balancing	2	AO2 5.4.1.2 5.4.1.4

5.1.1.1 Atoms, elements and compounds

Answer 02 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	**method 1:** (moles of Al = $\frac{108}{27}$ =) 4		1	AO2 5.3.2.2 5.3.2.4
	(moles $CuCl_2$ = $\frac{1210}{134.5}$ =) 8.996	allow 9	1	
	(identifying limiting reactant) 4 moles Al gives 6 moles Cu 8.996 moles $CuCl_2$ gives 8.996 moles Cu	allow correct use of an incorrectly calculated value(s) for moles of Al and / or $CuCl_2$	1	
	therefore aluminium is the limiting reactant	must follow on from MP3	1	
	(mass of Cu = 2 × 3 × 63.5) = 6 × 63.5		1	
	= 381 (g)		1	

07.4 cont.	**method 2:** $2\,Al + 3\,CuCl_2 \rightarrow 3\,Cu + 2\,AlCl_3$ (2×27) (3×134.5) (3×63.5) 54 (g) 403.5 (g) 190.5 (g) (1) (1) (1) (so) 108 g Al (reacts with 807 g $CuCl_2$) to produce 381 g Cu (1) (so) there is excess $CuCl_2$ **or** 807 g $CuCl_2$ is less than 1210 g $CuCl_2$ (1) therefore aluminium is limiting reactant (1) **method 3:** 134.5 g $CuCl_2$ produces 63.5 g Cu (1) (mass conversion 1.21 kg $CuCl_2$ =) 1210 (g) (1) 1210 g $CuCl_2$ produces ($\frac{63.5}{134.5}$ × 1210 =) 571 g Cu (1) 54 g Al produces 190.5 g Cu (1) 108 g Al produces ($\frac{190.5}{54}$ × 108 =) 381 (g) (1) (therefore) aluminium is the limiting reactant (1)	allow correct use of an incorrect calculation of mass for Al / $CuCl_2$ / Cu must follow on from MP4 / MP5 allow correct use of an incorrect / no conversion of mass of $CuCl_2$ must follow on from MP3 and MP5		

5.1.1.1 Atoms, elements and compounds

Answer 02 · Mark scheme

June 2022 | 8464/C/1H | Original Q7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.5	delocalised electrons carry (electrical) charge through the metal / sodium	allow free electrons ignore throughout for through ignore current / electricity MP2 is dependent upon MP1	1 1	AO1 5.2.2.8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.6	(conducts electricity) when liquid / molten **or** (conducts electricity) in (aqueous) solution (because) <u>ions</u> (ions) are free to move **or** (ions) allow charge to flow	allow (conducts electricity) when dissolved in water	1 1 1	AO1 5.2.2.3

Total Question 7		17

5.1.1.1 Atoms, elements and compounds

Answer 03 · Mark scheme

June 2023 | 8464/C/1H | Original Q4

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	electron → proton → neutron		1	AO1 5.1.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	(times heavier =) $\frac{1.673 \times 10^{-27}}{9.109 \times 10^{-31}}$ = 1837	 allow 1836.645076 correctly rounded to at least 3 significant figures	1 1	AO2 5.1.1.5

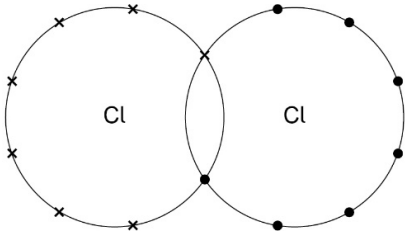
Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	46		1	AO2 5.1.1.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	36		1	AO2 5.1.1.4 5.1.1.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	(A_r =) $\frac{(35 \times 75.77) + (37 \times 24.23)}{100}$ = 35.4846 = 35.48	 allow an answer correctly calculated to 2 decimal places from an incorrect calculation which uses the values in the question	1 1 1	AO2 5.1.1.6

5.1.1.1 Atoms, elements and compounds

Answer 03 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.6		allow any combination of circles, dots, crosses, $e^{(-)}$ for electrons		AO1 5.1.2.6 5.2.1.1
	one shared pair in overlap		1	5.2.1.4
	each chlorine atom with 6 non-bonded electrons (on outer shell)	ignore any inner shell electrons	1	
		the diagram below scores 2 marks  		

Total Question 4	10

5.1.1.1 Atoms, elements and compounds

Answer 04 · Mark scheme

June 2025 | 8464/C/1H | Original Q3

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	atoms have a charged nucleus the mass of an atom is concentrated in the nucleus		1 1	AO1 5.1.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	(particle **X**) has more electrons than protons	allow (particle **X**) has a different number of protons and electrons allow because atoms have the same number of protons and electrons do **not** accept (particle **X**) has a different number of neutrons	1	AO3 5.1.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	$^{79}_{35}Br^-$		1	AO2 5.1.1.5

5.1.1.1 Atoms, elements and compounds

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	(going down the group) molecules increase in size	allow (going down the group) atoms increase in size	1	AO1 5.1.2.6 5.2.2.4
	(so the) forces between the molecules increase **or** (so the) intermolecular forces increase		1	
	(so) more energy is needed to break the intermolecular forces	allow (so) more energy is needed to separate the molecules	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	covalent	ignore intermolecular forces	1	AO1 5.1.2.6 5.2.1.1

Question	Answers	Mark	AO / Spec. Ref.
03.6	chlorine + sodium bromide → bromine + sodium chloride allow Br_2 for bromine allow NaCl for sodium chloride	1	AO2 5.1.2.6

5.1.1.1 Atoms, elements and compounds

Answer 04 · Mark scheme

June 2025 | 8464/C/1H | Original Q3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.7	(going down the group the) the outer shell / electrons become further from the nucleus	allow energy level for shell allow the atoms become larger allow the atoms have more shells	1	AO1 5.1.2.6
	(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	

Total Question 3	12

5.1.1.1 Atoms, elements and compounds

Answer 02 · Examiner comments

June 2022 | 8464/C/1H | Original Q7

Question 7 (Standard/high and high demand)

07.1 Students had to recognise the relative position of a metal in a reactivity series and to deduce the method and conditions used to extract the metal from a compound of the metal. Over 50% of students gained 1 mark. Electrolysis was the most common answer. However, many students then went on to talk about electrolysis of a solution rather than the molten compound. The displacement route was less common and those who chose this method often only scored 1 mark as they failed to mention 'heating' when talking about potassium or magnesium.

07.2 Students had to complete an equation for the displacement reaction between sodium and titanium chloride. Some students were not able to identify the products. Titanium was usually identified, but sodium chloride was often written as $NaCl_4$. Without the correct formulae balancing was not possible. Generally, element symbols were written well with upper and lower case letters in the appropriate place. Nearly 20% of students gained both marks.

5.1.1.1 Atoms, elements and compounds

Answer 02 · Examiner comments June 2022 | 8464/C/1H | Original Q7

07.3 Students were asked to write the half equation to show the oxidation of sodium. This proved very challenging. Approximately 5% gained two marks with about a fifth of students not attempting the question. One mark was infrequently scored, since identifying the equation and not the balancing proved to be the problem.

07.4 This reacting mass calculation where students had to identify the limiting reagent proved very challenging. Only a small percentage of students were able to show that aluminium was the limiting factor. Although there were several methods available to students, many attempted to use more than one method to get to the answer. Many students could work out the number of moles of aluminium and copper chloride or the ratio of masses that reacted together, but then were unable to use these numbers further. 30% of students scored 3 marks in this calculation but few scored any further marks..

07.5 Students had to describe how sodium metal conducts electricity. More than 50% of students gained 1 mark for stating that delocalised electrons or free electrons were responsible for electrical conduction in metals. The idea that these delocalised electrons carry the charge through the metal was infrequently given (the second marking point). Many students suggested throughout or around, which did not give direction to their answer.

07.6 Students had to explain how sodium chloride conducts electricity. Many students gave the impression that sodium chloride is a liquid or (to a lesser extent) aqueous solution, rather than conveying that conductivity is restricted to when sodium choride is in these states. Many incorrectly described the electrons as the particles that were able to move. 10% of students gained all 3 marks for stating that sodium chloride needed to be either molten or in aqueous solution in order to conduct electricity and went on to mention ions that are free to move.

5.1.1.1 Atoms, elements and compounds

Answer 02 · Examiner comments

June 2022 | 8464/C/1H | Original Q7

Use of statistics

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

Mark Ranges and Award of Grades

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

Answer 03 · Examiner comments — June 2023 | 8464/C/1H | Original Q4

Question 4 (standard and standard/high demand)

04.1 Nearly half of the students correctly selected the order of discovery of the electron, proton and neutron. A third of students thought that the proton was discovered before the electron and chose the fourth option.

04.2 Just over a third of students calculated the number of times a proton is heavier than an electron. Most students were able to correctly round their answers to 3 significant figures although those who gained 1 mark invariably evaluated the ratio correctly but then incorrectly rounded the answer (1836.645076) usually by 'truncating' this to 1836. The most common error here was to invert the mathematical expression.

04.3 More than three-quarters of students deduced the number of neutrons in the bromine $^{81}_{35}Br$ atom.

04.4 Only 20% of students deduced the number of electrons in the bromide $^{81}_{35}Br^-$ ion. The majority gain the number of electrons in a bromine atom.

04.5 This question was a good discriminator. Just under a third of students gained all 3 marks with a few students gaining 2 of the 3 marks for not giving their answer to 2 decimal places.

04.6 More than three-quarters of students correctly drew a dot and cross diagram for chlorine. When only one mark was gained this was usually for the two shared electrons in the overlap between the atoms. Some failed to show that there are six unshared electrons on each chlorine atom.

Answer 04 · Examiner comments — June 2025 | 8464/C/1H | Original Q3

Question 3 (Standard and Standard/High demand)

03.1 Just under half of students gave the two correct conclusions of the alpha particle scattering experiment as atoms have a charged nucleus and the mass of an atom is concentrated in the nucleus. The most popular incorrect distractor was electrons orbit the nucleus at specific distances.

03.2 Overall this question was well attempted with very few failing to offer an answer. The two most common incorrect responses were 'number of protons not equal to the number of electrons so X is an isotope' and 'protons should be the same as neutrons'.

03.3 Just than half of students used the number of subatomic particles to correctly deduce that particle X was $^{79}_{35}Br^-$. The most popular incorrect distractor was $^{79}_{35}Se^-$

© 2024 AQA and its licensors. All rights reserved.

5.1.1.1 Atoms, elements and compounds

Answer 04 · Examiner comments June 2025 | 8464/C/1H | Original Q3

03.4 Students found this question difficult with very few achieving 3 marks, and many failing to score. The most commonly awarded mark was MP1 which was related to the size of the atom. A large number of students answered in terms of reactivity rather than the physical property of boiling point, so references relating to the distance from the nucleus to the outer shell or outer electrons were common which were incorrect in this context. Linking boiling point to the ease of gaining electrons was another common response, together with incorrect references to electrostatic forces of attraction between the nucleus and electrons, again confusing reactivity and boiling points. There was also a significant number of students who used 'forces' and 'bonds' inconsistently and therefore could not be awarded marks as it was not clear what they meant.

0 3 . 4 **Table 2** shows the boiling points of some Group 7 elements.

Table 2

Element	Boiling point in °C
Fluorine	−188
Chlorine	−35
Bromine	59
Iodine	184

Explain the increase in the boiling points of the Group 7 elements going down the group.

[3 marks]

As you go down group 7 the boiling point increases
this is because ~~of the~~ the Molecules get larger and
the intermolecular forces get stronger which requires more
energy to break.

This response gained 3 marks. Size, force and energy are all correctly described.

03.5 More than three quarters of students deduced that the bonding in the compound ClF_3 was covalent as two non-metals had combined. Ionic and metallic were common incorrect responses.

03.6 The majority of students added sodium chloride and bromine to complete the word equation. The most common error was the mixing up of bromine with bromide and chlorine with chloride.

03.7 Students found this question difficult with very few achieving 3 marks, and many failing to score. Common errors for MP1 were students stating that the 'elements' have more shells or 'more outer shells'. A common error for MP2 was not mentioning the 'outer shell electrons' or referenced attraction between the nucleus and the 'outer shell' which was insufficient for the mark. The most commonly awarded mark was MP3 which related to the difficulty of gaining of an electron. References to attracting electrons were common but this was not creditworthy as it does not necessarily suggest electrons being gained. There were many students who were very close to 3 marks but scored 0 due to these incorrect or incomplete statements.

© 2024 AQA and its licensors. All rights reserved.

5.1.1.1 Atoms, elements and compounds

Answer 04 · Examiner comments

June 2025 | 8464/C/1H | Original Q3

0 3 . 7 Explain why Group 7 elements become less reactive going down the group.

[3 marks]

Group 7 elements become less reactive because as you go down a group, the number of shells increases so ~~they~~ the strength of the attraction between the positive nucleus and negative electrons is weaker as the distance is greater, this means the nucleus is less likely to be able to attract another electron for its outer ~~ten~~ layer.

This response gained 0 marks. MP1 was not awarded as 'atoms' (have more shells) is missing. MP2 was not awarded as 'outer' (electrons) is omitted. MP3 is not gained as attracting electrons does not necessarily suggest an electron is gained. This is an example of answers that were very close to each of the 3 marks but scored 0 due to incomplete statements for each one.

© 2024 AQA and its licensors. All rights reserved.