AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.2.1.2

Ionic bonding

Mark schemes and examiner comments

Tier	**Foundation**
Question groups	**9**
Available paper years	**2018–2025**

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.

5.2.1.2 Ionic bonding

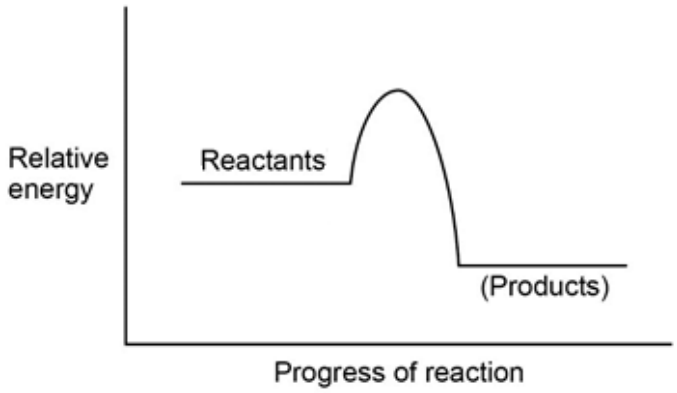
Answer 01 · Mark scheme June 2018 | 8464/C/1F | Original Q6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	(difference) sodium has one and chlorine has seven electrons in outer level / shell **or** number of electrons	number of electrons must be correct if quoted	1	AO2 5.1.1.7 5.1.2.1
	(similarity) both have three / same number of levels / shells **or** have electrons in third level / shell **or** both have incomplete (outer) levels / shells	allow both have 2 electrons in inner shell **or** both have 8 electrons in second shell **or** both are one electron away from full outer level / shell	1	
06.2		allow marks from suitable diagram(s)		AO1 5.2.1.2
	sodium (atom) loses	allow moves / transfers for loses do **not** accept sodium ion loses	1	
	one (outer shell electron)		1	
	chlorine (atom) gains	do **not** accept chloride	1	
	one (electron)		1	
		transfer of 1 electron from chlorine to sodium **max 2** marks		
		reference to sharing **or** covalent bonding **max 3** marks		

5.2.1.2 Ionic bonding

Answer 01 · Mark scheme

June 2018 | 8464/C/1F | Original Q6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3		ignore labels any curve / line going up and then down products line below reactants allow curve to start / finish anywhere along reactant / product lines	1 1	AO1 5.5.1.2
Total			8	

5.2.1.2 Ionic bonding

Answer 01 · Mark scheme June 2018 | 8464/C/1F | Original Q6

Answer 02 · Mark scheme June 2019 | 8464/C/1F | Original Q4

04.1	2 Na + Cl_2 → 2 NaCl	allow multiples	1	AO1 5.1.2.2
04.2	7.1 (g)		1	AO2 5.3.1.1
04.3	 silver green yellow white	this order only allow yellow allow white 	 1 1 1 1	AO1 5.1.2.5
04.4	Na^+ Cl^- 	 if no other mark awarded allow **1** mark for +(1) charge for sodium ion and –(1) charge for chloride ion	1 1	AO1 5.2.1.2
04.5	an electron		1	AO2 5.1.2.5

5.2.1.2 Ionic bonding

Answer 02 · Mark scheme

04.6	potassium (atom) is larger potassium (atom) has more energy levels (of electrons) **or** potassium (atom) has more shells (of electrons)	allow converse for sodium mark independently do **not** accept more outer shells	 1 1	AO2 5.1.2.1 & 5.1.2.5

Total			**11**

5.2.1.2 Ionic bonding

Answer 02 · Mark scheme

June 2019 | 8464/C/1F | Original Q4

Question	Answers	Extra information	Mark	AO / Spec. Ref.

5.2.1.2 Ionic bonding

Answer 03 · Mark scheme November 2020 | 8464/C/1F | Original Q4

04.1	$\frac{8}{10} \times 100$ **or** 0.8×100 $= 80$ (%)	 if no other mark awarded allow **1** mark for 20 (%)	1 1	AO2 5.1.2.3
04.2	any **two** from: • conducts electricity • conducts thermal energy • ductile • high melting point • malleable • shiny • strong	 allow conducts heat allow high boiling point allow can be bent / shaped allow dense allow sonorous ignore chemical properties	2	AO1 5.1.2.3
04.3	$2\ Na + Cl_2 \rightarrow 2\ NaCl$	allow multiples	1	AO2 5.1.2.5 5.1.2.6 5.3.1.1
04.4	electrostatic attractions		1	AO3 5.2.1.3 5.2.2.3
04.5	(heat sodium chloride until) molten / liquid dissolve in water	 allow form aqueous solution allow add water	1 1	AO1 5.2.2.3
Total			**8**	

5.2.1.2 Ionic bonding

Answer 03 · Mark scheme

November 2020 | 8464/C/1F | Original Q4

Question	Answers	Extra information	Mark	AO / Spec. Ref.

5.2.1.2 Ionic bonding

Answer 04 · Mark scheme November 2020 | 8464/C/1F | Original Q5

05.1	atomic weight		1	AO1 5.1.2.2
05.2	(because) properties were similar **or** (because) iodine has similar / same properties as bromine / chlorine / fluorine	allow symbols	1	AO3 5.1.2.2
05.3	solid		1	AO3 5.1.2.5 5.2.2.1
05.4	scale on the y-axis up to 180 bar for sodium at 98 (°C) bar for potassium at 63 (°C)	ignore scale beyond 180 allow a tolerance of ± half a small square allow a tolerance of ± half a small square	1 1 1	AO2 5.1.2.4 5.2.2.1
05.5	 lithium (atom) loses one electron chlorine (atom) gains one electron any **one** from: • ions are formed • lithium forms positive ion • chlorine forms negative ion • form a full outer shell(s) / level(s)	max **2** marks if reference to incorrect particle / bonding allow ionic bonding allow noble gas structure is formed	 1 1 1	 AO2 AO2 AO1 5.1.2.3 5.2.1.2

5.2.1.2 Ionic bonding

Answer 04 · Mark scheme

November 2020 | 8464/C/1F | Original Q5

05.6	any **two** from: • reactivity of elements increases going down the group • potassium has more shells • potassium can lose an (outer) electron more easily • potassium has an outer shell / electron further away from the nucleus • potassium has more shielding (of the outer shell / electron) • potassium has a weaker attraction between nucleus and outer shell / electron	allow energy levels for shells allow converse for lithium	2	AO1 AO2 5.1.2.3 5.1.2.5

Total			**11**

5.2.1.2 Ionic bonding

Answer 04 · Mark scheme

November 2020 | 8464/C/1F | Original Q5

Question	Answers	Extra information	Mark	AO / Spec. Ref.

5.2.1.2 Ionic bonding

Answer 05 · Mark scheme

June 2022 | 8464/C/1F | Original Q1

Question 1

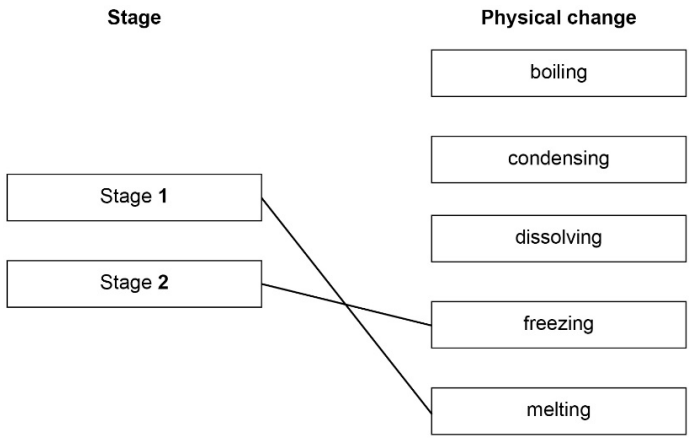
Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	alkali metals		1	AO1 5.1.2.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	3 / three 4 / four	must be in this order	1 1	AO2 5.1.1.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	+1		1	AO2 5.1.1.4

5.2.1.2 Ionic bonding

Answer 05 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	 do **not** accept more than one line from a box on the left		1 1	AO1 5.2.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5	28 (°C)		1	AO2 5.1.2.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.6	bar plotted at 63 °C	allow a tolerance of ± ½ a small square	1	AO3 5.1.2.5

5.2.1.2 Ionic bonding

Answer 05 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.7	(melting point) decreases as go down Group 1	allow converse in terms of increasing melting point ignore boiling points allow **1** mark for (melting point) decreases	2	AO1
	(and the) differences get smaller **or** initial drop is largest		1	AO3 5.1.2.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.8	liquid		1	AO3 5.1.2.5 5.2.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.9	loses an electron		1	AO1 5.1.1.7 5.1.2.1 5.1.2.5

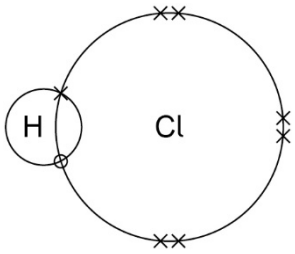
Total Question 1		13

5.2.1.2 Ionic bonding

Answer 06 · Mark scheme

June 2022 | 8464/C/1F | Original Q2

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	one shared pair in overlap	allow any combination of circles, dots, crosses or $e^{(-)}$	1	AO1 5.1.2.6 5.2.1.4
	6 non-bonding electrons in outer shell of chlorine	do **not** accept extra electron(s) on outer shell of hydrogen ignore any inner shell electrons	1	
		an answer of  scores **2** marks		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	sodium chloride	allow NaCl	1	AO2 5.4.2.2

5.2.1.2 Ionic bonding

Answer 06 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	5.85 (g)		1	AO2 5.3.1.1 5.4.2.2 5.5.1.1 RPA10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	17.6 (°C)		1	AO2 5.4.2.2 5.5.1.1 RPA10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.5	exothermic (reaction)	allow neutralisation (reaction)	1	AO2 5.5.1.1 RPA10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.6	Na^+ OH^-		1 1	AO1 AO2 5.4.2.2 5.4.2.4 5.5.1.1

Total Question 2		**8**

5.2.1.2 Ionic bonding

Answer 07 · Mark scheme

June 2022 | 8464/C/1F | Original Q4

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	**2** Mg + O_2 → 2 MgO	allow multiples	1	AO2 5.1.2.5 5.4.1.1

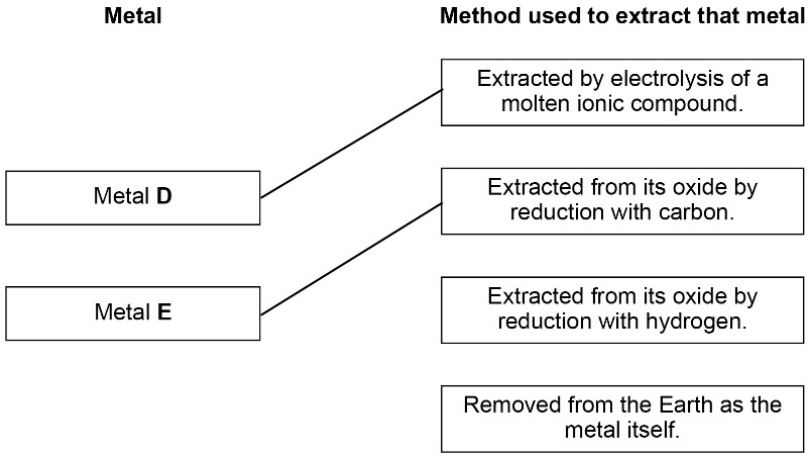
Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	any **one** from: • wear safety glasses / goggles • do not look directly at burning magnesium • wear heat proof glove	allow look through blue glass allow use tongs allow tie hair back	1	AO3 5.4.1.1 5.4.1.2 5.5.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	(M_r =) 24 + (2 × 19) = 62		1 1	AO2 5.1.2.5 5.3.1.2

5.2.1.2 Ionic bonding

Answer 07 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	any **one** from: • argon has a full outer shell • argon has 8 electrons in the outer shell • argon has a stable arrangement of electrons.	allow energy level for shell allow does not need to lose and / or gain electrons	1	AO2
	(so) argon is unreactive	ignore argon is a noble gas	1	AO1 5.1.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	 do **not** accept more than one line from a box on the left		1 1	AO3 5.4.1.2 5.4.1.3 5.4.3.1 5.4.3.2 5.4.3.3

5.2.1.2 Ionic bonding

Answer 07 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.6	(because) ions (which are) free to move when molten (but are) fixed in solid	 allow reference to charged particles for MP2 and MP3	1 1 1	AO1 5.2.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.7	(sodium contains) delocalised electrons (which) carry (electrical) charge (through the metal / sodium)	allow free electrons ignore throughout for through ignore current / electricity	1 1	AO1 5.2.2.8

Total Question 4		13

5.2.1.2 Ionic bonding

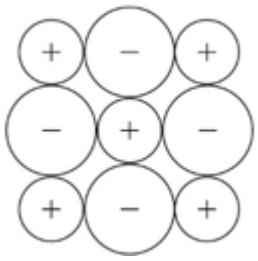
Answer 08 · Mark scheme

June 2023 | 8464/C/1F | Original Q3

Question 3

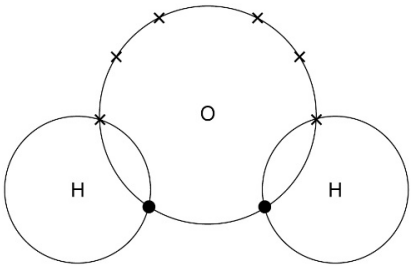
Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	noble gases		1	AO1 5.2.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	potassium (atoms) lose electrons		1	AO2
	chlorine (atoms) gain electrons		1	AO2
	reference to one electron		1	AO2
	any **one** from: • to form ions • to form full outer shell(s) • to form full energy level(s)	allow to form a noble gas structure	1	AO1 5.2.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3			1	AO2 5.2.1.3

5.2.1.2 Ionic bonding

Answer 08 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	one shared pair in each overlap	allow any combination of circles, dots, crosses, $e^{(-)}$ for electrons	1	AO1 5.2.1.1 5.2.1.4
	four non-bonding electrons in outer shell of oxygen	do **not** accept extra electron(s) on outer shell of hydrogen ignore any inner shell electrons the diagram below scores 2 marks 	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	1 Si : 2 O	allow 6 Si : 12 O	1	AO3 5.2.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.6	weak intermolecular forces		1	AO1 5.2.2.5

5.2.1.2 Ionic bonding

Answer 08 · Mark scheme

June 2023 | 8464/C/1F | Original Q3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.7		ignore references to boiling point		AO3 5.2.2.4 5.2.2.5
	the melting point increases as the length of the polymer molecule increases	allow **1** mark for melting point increases	2	
	(then the) melting point levels off (as the polymer molecule length increases)	allow (then the) melting point becomes constant (as the polymer molecule length increases)	1	

Total Question 3	13

5.2.1.2 Ionic bonding

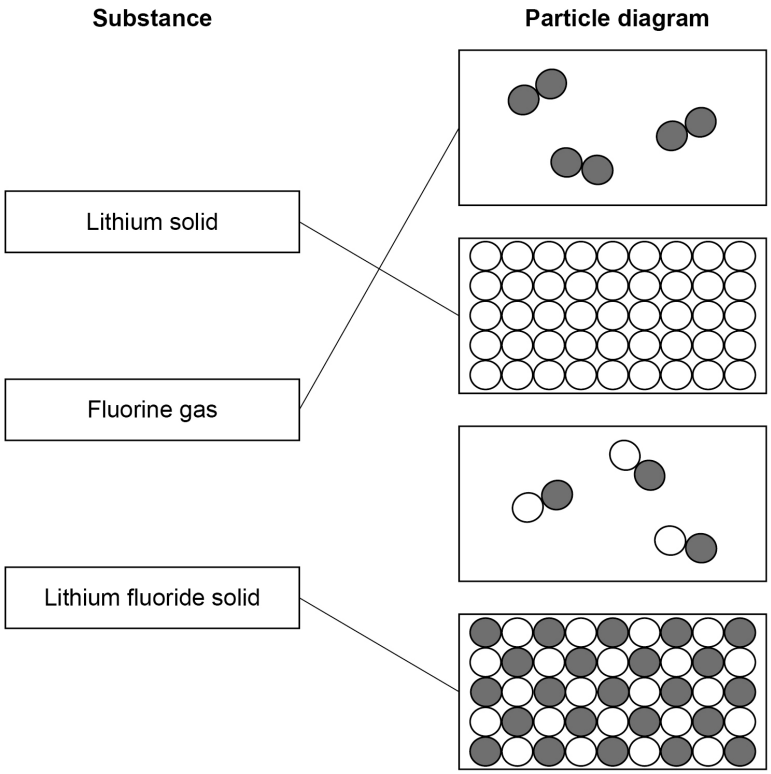
Answer 09 · Mark scheme

June 2025 | 8464/C/1F | Original Q2

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	Li		1	AO1 5.1.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	delocalised electrons from the outer shell		1	AO1 5.2.1.5

Question	Answers	Mark	AO / Spec. Ref.
02.3	 do **not** accept more than one line from a box on the left	1 1 1	AO3 5.1.1.1 5.2.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	**D**		1	AO3 5.2.2.3

5.2.1.2 Ionic bonding

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.5	diamond		1	AO1 5.2.3.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.6	(relative formula mass =) 12 + (19 × 4) = 88		1 1	AO2 5.3.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.7	6	allow 3 pairs	1	AO2 5.2.1.1 5.2.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.8	nitride		1	AO2 5.1.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.9	neon has a stable arrangement of electrons		1	AO1 5.1.2.4

Total Question 2	**12**

Answer 01 · Examiner comments

June 2018 | 8464/C/1F | Original Q6

Question 6 (standard demand)

06.1 This question discriminated well with 27% of students achieving some degree of credit. Many students did not consider the most obvious difference and similarity in the electronic structures of sodium and chlorine. Students often used the periodic table shown in the stem of the question to answer this question, but most of these students referred to periods or rows and groups or columns and so failed to gain any marks.

06.2 This question discriminated well. 23% of students achieved all four marks, often with concise statements about the transfer of the outer electron of sodium to chlorine.

Some students contradicted their description by mentioning covalent bonding, or the sharing of electrons, which restricted the number of marks they could attain. Poor expression and the use of incorrect terms were the main problem for most students. It was common to see the term ‘atom’ used instead of ‘electron’. 19% of students did not attempt to answer this question.

06.3 This question discriminated well. 26% of students achieved both marks; whereas 185 of students achieved a single mark. It was common for students to have incomplete reaction profile diagrams, by failing to include a horizontal line for the products.

Some students confused the two types of energy changes (endothermic and exothermic), while others provided a wide range of incorrect diagrams. Labels were ignored because they were not required to answer the question. 20% of students did not attempt to answer this question.

5.2.1.2 Ionic bonding

Answer 05 · Examiner comments June 2022 | 8464/C/1F | Original Q1

Question 1 (Low demand)

01.1 Almost three-quarters of the students could correctly identify Group 1 metals as the alkali metals.

01.2 Just over 60% of students correctly deduced the number of electrons and the number of neutrons from the structure of a lithium atom.

01.3 The relative charge on a lithium atom was given by more than 55% of the students.

01.4 The physical changes occurring when a solid changes into a liquid and when the liquid changes back into a solid were known by 60% of the students.

01.5 More than 80% of the students were able to read the melting point of caesium from a bar chart.

01.6 More than 80% of the students were able to draw a bar at 63 °C for the melting point of potassium on a bar chart. The most common mistake was for students to misinterpret the scale on the graph. Others did not use a ruler so did not draw a straight horizontal line.

01.7 Almost half of the students gained two marks, for describing the trend as the melting point decreases going down Group 1. Many students recognised that the melting points decrease but had difficulty in articulating that this is as you go down or descend the group. Very few accessed the third marking point which was that the differences got smaller going down the group or that the initial drop was greatest.

01.8 Just under half of the students deduced that sodium is a liquid at 150 °C. Solid proved to be a popular distractor.

01.9 More than a third of students knew that potassium is more reactive than sodium because potassium more easily loses an electron.

Answer 06 · Examiner comments June 2022 | 8464/C/1F | Original Q2

Question 2 (Low demand)

02.1 More than a third of students correctly drew a dot and cross diagram for hydrogen chloride. The most commonly awarded mark was for the two shared electrons in the overlap between the atoms. Many failed to show that there are six unshared electrons.

02.2 Only 20% of students gained this mark for correctly identifying sodium chloride as one of the products of the reaction between hydrochloric acid and sodium hydroxide. The most common error was identifying the product as sodium chlorine. Some students also attempted to add other products to the equation.

02.3 Only 20% of students gained the mark for calculating the correct mass. Many students added the three masses together rather than recognising that in a reaction the mass of reactants equals the mass of products.

02.4 More than three-quarters of the students correctly read the temperature reading on the thermometer scale.

5.2.1.2 Ionic bonding

Answer 06 · Examiner comments June 2022 | 8464/C/1F | Original Q2

02.5 Just under a quarter of students knew that when the temperature of a reaction increases an exothermic reaction is taking place. The most common error described the reaction as endothermic.

02.6 30% of students correctly identified that Na^+ and OH^- ions are present in sodium hydroxide.

Answer 07 · Examiner comments June 2022 | 8464/C/1F | Original Q4

Question 4 (Low and standard demand)

04.1 More than 70% of students correctly balanced the equation. Some students changed the formula, usually from MgO to MgO_2

04.2 Almost three-quarters of students stated a safety precaution that should be taken when heating magnesium and oxygen. The most common correct responses were to wear eye protection and to use tongs.

04.3 Almost one-quarter of students gave the correct answer for the relative formula mass of magnesium fluoride. These students recognised that the subscript 2 means the relative atomic mass of fluorine needed to be doubled before being added to the relative atomic

5.2.1.2 Ionic bonding

Answer 07 · Examiner comments June 2022 | 8464/C/1F | Original Q4

mass of magnesium. Many showed clear steps in their calculation. The most common errors were to either add or multiply 24 and 19.

04.4 Magnesium does not react when heated with argon - argon is unreactive because argon atoms have eight electrons in the outer shell. Common responses referred to magnesium (and argon) both being unreactive, that metals (or solids) do not react with gases or that both elements had full outer shells. This question discriminated well.

04.5 Almost 60% of students gained at least one of the two marks for correctly deducing the method used to extract a metal. The students were given a reactivity series showing the position of these two metals compared to other known metals, carbon and hydrogen.

04.6 Students found difficulty in explaning why sodium chloride conducts electricity when molten but not when a solid. Many indicated that this was due to something being able to move but failed to link this to ions or charged particles. Most referred to moving particles, atoms or electrons.

04.7 Students also found difficulty in explaning why sodium conducts electricity when solid. Delocalised electrons were rarely seen as was the concept of these delocalised electrons carrying charge through the sodium.

Answer 08 · Examiner comments June 2023 | 8464/C/1F | Original Q3

Question 3 (low/standard demand)

03.1 More than half the students identified the noble gases as the group of elements that do not form ions.

03.2 This question was a good discriminator. Many gained the first three marks although MP4 was less common. Many incorrect terms such as ‘atoms sharing electrons to form ionic bonds’, ‘metal ions losing electrons’ and ‘non-metal ions gaining electrons’ were seen.

03.3 More than two thirds of students identified the structure that represents the arrangement of ions in solid potassium chloride. The first option was the best distractor.

03.4 More than a quarter of students correctly drew a dot and cross diagram for water. When only one mark was gained this was usually for the shared electrons in the overlap between oxygen and one of the hydrogen atoms. Some failed to show that there are four unshared electrons on the oxygen atom and others added more electrons into the circle around one or both of the hydrogen atoms.

03.5 More than three-quarters of students deduced the ratio of silicon atoms to oxygen atoms from the structure of silica.

5.2.1.2 Ionic bonding

Answer 08 · Examiner comments June 2023 | 8464/C/1F | Original Q3

03.6 Only 20% of students knew that weak intermolecular forces hold polymer molecules together in a polymer. Covalent bonds and electrostatic attraction between ions were perhaps terms more familiar to the students and both proved more popular options than the correct answer.

03.7 Students found difficulty in recognising the link between the two variables from the *x*-axis and the *y*-axis. Many stated that as the melting point increases the length of the polymer molecule increases. Students should appreciate that the independent variable is on the *x*-axis and that as this is changed, the effect on the dependent variable (*y*-axis) can be observed ie as the length of the polymer molecule increases (independent, *x*-axis) then the melting point increases (dependent, *y*-axis).

Answer 09 · Examiner comments

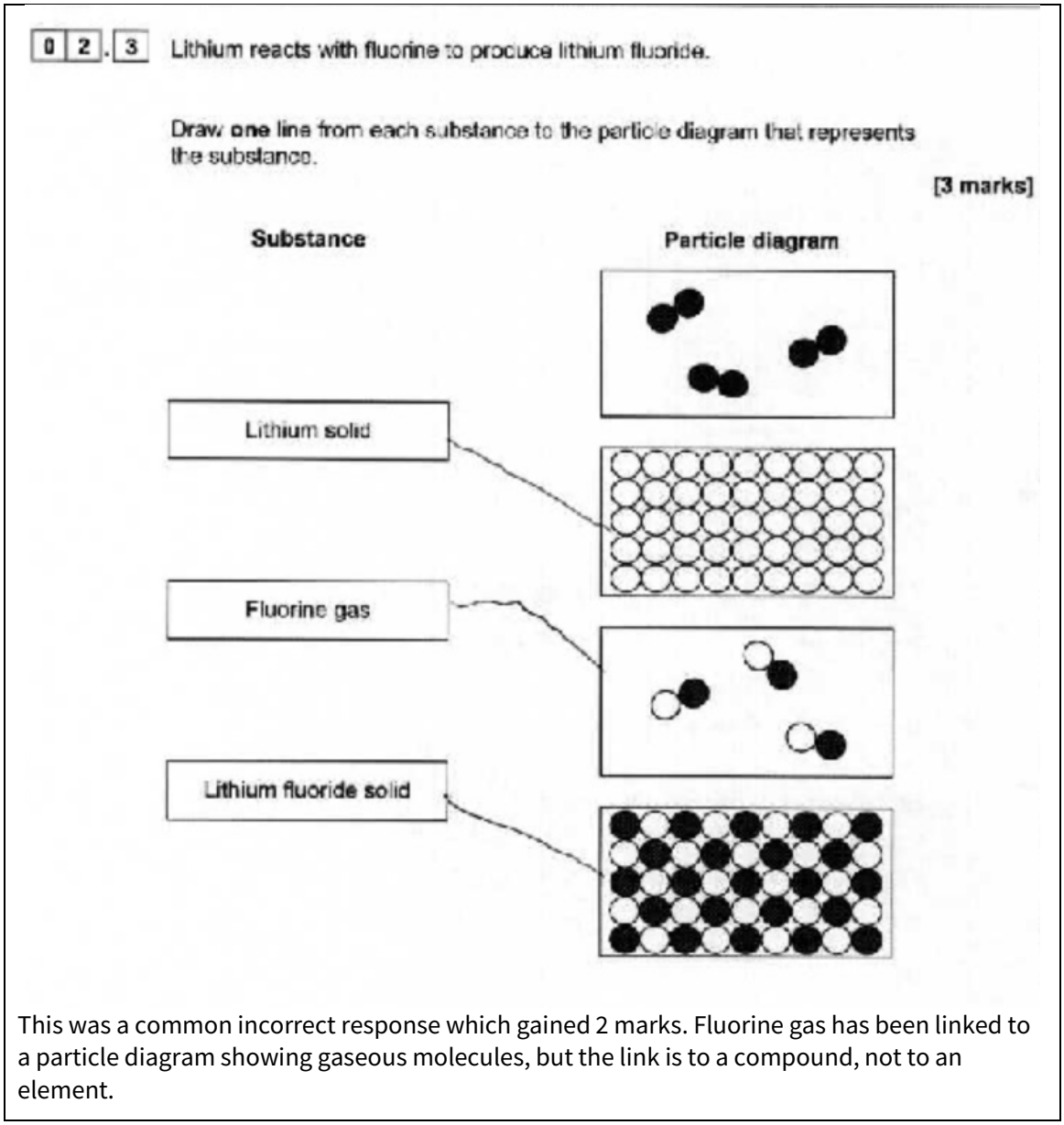
June 2025 | 8464/C/1F | Original Q2

Question 2 (Low demand)

02.1 Many students correctly wrote the chemical symbol of lithium with a capital L followed by a lower case i. When writing symbols lowercase letters must be discernibly smaller than capitals.

02.2 More than half of students knew that delocalised electrons from the outer shell are involved in metallic bonding. Fixed electrons in the outer shell was the most popular incorrect distractor.

02.3 Students should recognise particle diagrams for solid and gaseous states and for elements and compounds. Different colour circles are used to represent different atoms or ions so students should deduce that both the (diatomic) fluorine gaseous molecule and lithium solid particle diagram would only have one colour circle whereas the ionic compound lithium fluoride solid particle diagram would have two different colour circles. The majority of students correctly linked the substance to the particle diagram that represents the substance.



This was a common incorrect response which gained 2 marks. Fluorine gas has been linked to a particle diagram showing gaseous molecules, but the link is to a compound, not to an element.

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5.2.1.2 Ionic bonding

Answer 09 · Examiner comments June 2025 | 8464/C/1F | Original Q2

02.4 Just over half the students were able to use the electrical conductivity of a substance when solid and liquid to identify the ionic compound lithium fluoride.

02.5 Just over half the students recognised the structure of diamond. Graphite was the most common incorrect response.

02.6 A third of students gained both marks for 88 with or without working. Some gained 1 mark for the correct mathematical expression or writing 12 + 76. Many students did not multiply the number of atoms by the relative atomic mass of the atom so gave either 31 or 288 by adding or multiplying the A_r values of carbon and fluorine or used the 4 (atoms of fluorine) as a power giving a M_r of several thousand.

02.7 Just over half the students identified that six shared electrons were shown in the overlap of energy levels in the diagram representing a molecule of nitrogen. Three pairs would have been an acceptable answer although 3 was a common incorrect answer.

02.8 Only 5% of students were able to select the word from the box to complete the name of the compound with the formula Li_3N. The most common answer was nitrogen. Credit was awarded if the student identified the correct answer in the box, provided this was not contradicted by what was written in the answer space.

02.9 Just under half of students knew that neon does not react with other elements because neon has a stable arrangement of electrons. The most popular incorrect distractor was neon is a non-metallic element.