AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.1.1.4

Relative electrical charges of subatomic particles

Mark schemes and examiner comments

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

5.1.1.4 Relative electrical charges of subatomic particles

Answer 01 · Mark scheme

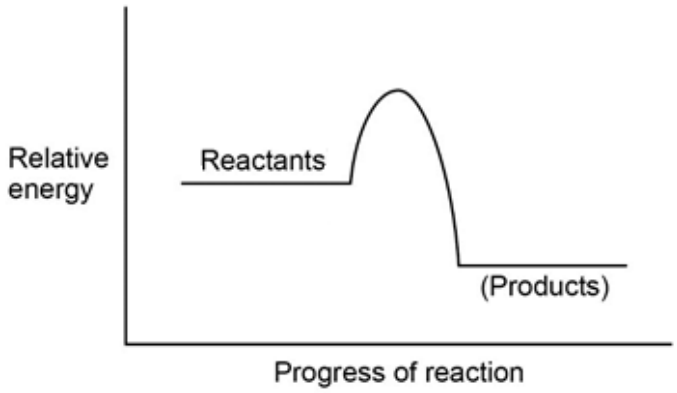
June 2018 | 8464/C/1H | Original Q2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	(difference) sodium has one and chlorine has seven electrons in <u>outer</u> 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	
02.2		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		

5.1.1.4 Relative electrical charges of subatomic particles

Answer 01 · Mark scheme

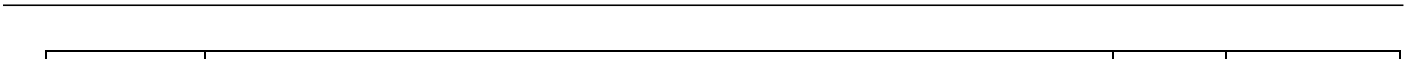
June 2018 | 8464/C/1H | Original Q2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3		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**	

5.1.1.4 Relative electrical charges of subatomic particles

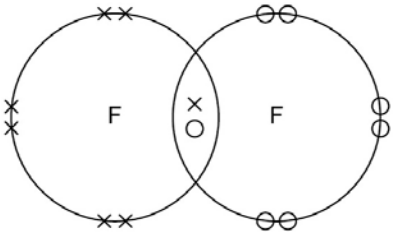
Answer 01 · Mark scheme

June 2018 | 8464/C/1H | Original Q2



5.1.1.4 Relative electrical charges of subatomic particles

Answer 02 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	g	do **not** accept upper case (G) do **not** accept gas	1	AO1 5.1.2.6
04.2		one shared pair anywhere in overlap between two circles **or** on intersection 6 other electrons on each atom allow dots **or** crosses **or** mixture for all marks ignore any inner shell electrons	1 1	AO1 5.1.2.6 5.2.1.4 AO2 5.1.2.6 5.2.1.4
04.3	18		1	AO2 5.1.1.5 5.1.2.6
04.4	$AlBr_3$ **2** Al + **3** Br_2 (→ 2 $AlBr_3$)	ignore state symbols ignore charges ignore brackets as eg $Al(Br)_3$ allow **1** mark for balancing their equation with an incorrect product	 1 1	AO2 5.1.1.1 5.1.2.6

5.1.1.4 Relative electrical charges of subatomic particles

Answer 02 · Mark scheme

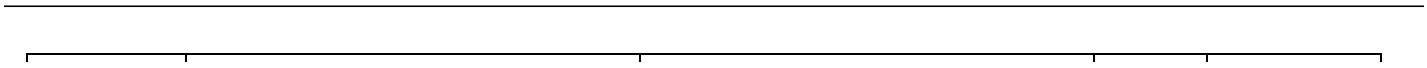
June 2018 | 8464/C/1H | Original Q4

04.5		**max 2** if outer shell / level not mentioned 'it' refers to chlorine allow converse reasons for bromine being less reactive		
	chlorine is a smaller atom **or** has fewer energy levels **or** outer shell closer to nucleus	ignore chlorine has fewer electrons	1	AO1 5.1.2.6
	chlorine has less shielding **or** has the greater attraction between the nucleus and the outer shell **or** incoming electron		1	AO1 5.1.2.6
	therefore chlorine can gain an electron (into the outer shell) more easily		1	AO2 5.1.2.6
		if no other marks awarded allow **1** mark for correct trend in reactivity in Group 7 do **not** accept reference to incorrect particles eg chloride atom		
Total			**9**	

5.1.1.4 Relative electrical charges of subatomic particles

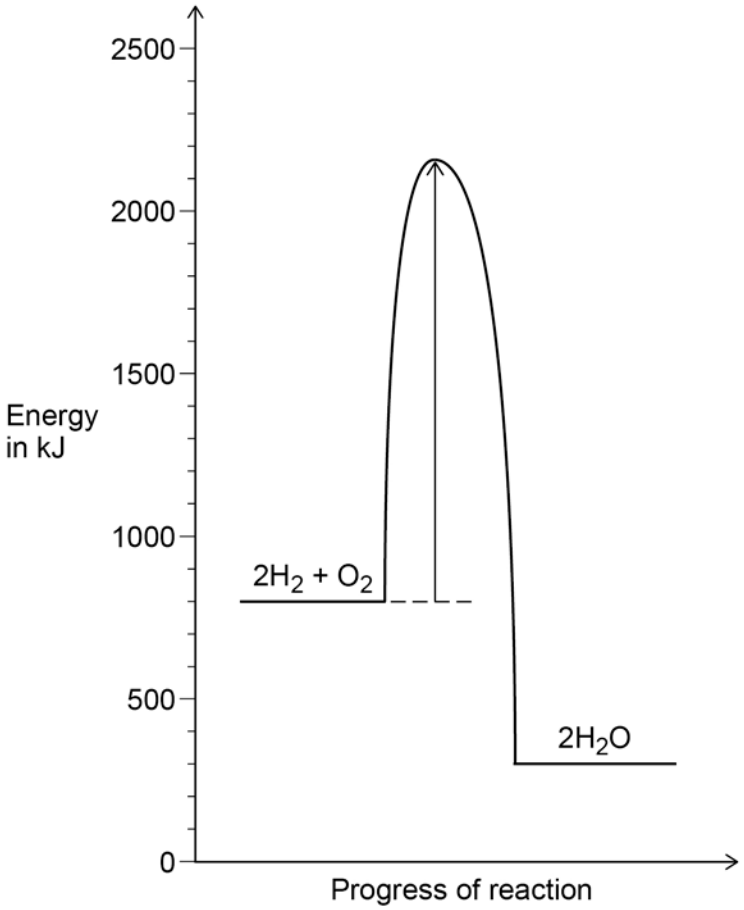
Answer 02 · Mark scheme

June 2018 | 8464/C/1H | Original Q4



5.1.1.4 Relative electrical charges of subatomic particles

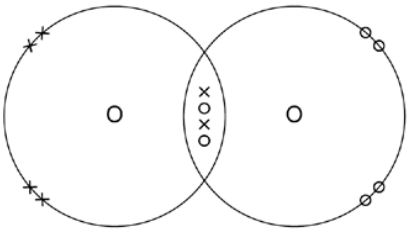
Answer 03 · Mark scheme June 2019 | 8464/C/1H | Original Q3

03.1	line from reactants to top of curve (i.e. from 800 to 2160)  ignore arrowheads	1	AO1 5.5.1.2

03.2		an answer of (–) 500 (kJ) scores **2** marks ignore sign		AO2 AO3 5.5.1.2
	reads levels of reactants (800 kJ) and products (300 kJ)		1	
	(800 – 300) = 500 (kJ)	allow correct subtraction of one incorrect value determined for the energy change	1	

5.1.1.4 Relative electrical charges of subatomic particles

Answer 03 · Mark scheme

03.3	two shared pairs in overlap	allow combination of circles, dots, crosses or $e^{(-)}$	1	AO2 5.2.1.4
	all non-bonding electrons in outer shell (4 electrons on each O atom)	ignore any inner shell electrons  diagram scores 2 marks	1	

5.1.1.4 Relative electrical charges of subatomic particles

03.4	(bonds broken) ((4×463) + (2×138) =) **2128** (bonds made) ((4×463) + (496) =) **2348** (energy change = bonds broken – bonds made) (2128 – 2348 =) (–) **220** (kJ) **alternative approach:** (bonds broken) (2× (O–O) = (2×138) =) **276** (1) (bonds made) (1× (O=O) =) **496** (1) (energy change = bonds broken – bonds made) (276 – 496 =) (–) **220** (kJ) (1)	an answer of (–) 220 (kJ) scores **3** marks an incorrect answer for one step does **not** prevent allocation of marks for subsequent steps ignore energy change sign allow correct calculation using incorrect values from step 1 and/or step 2	1 1 1	AO2 5.1.1.1 5.5.1.1 5.5.1.3

Total			**8**

5.1.1.4 Relative electrical charges of subatomic particles

Answer 03 · Mark scheme

June 2019 | 8464/C/1H | Original Q3

Question	Answers	Extra information	Mark	AO / Spec. Ref.

5.1.1.4 Relative electrical charges of subatomic particles

Answer 04 · Mark scheme June 2019 | 8464/C/1H | Original Q4

04.1	atomic weight	do **not** accept atomic mass or A_r	1	AO1 5.1.2.2

04.2	left gaps / spaces **or** changed the order based on atomic weights	 allow placed them in correct groups according to properties do **not** accept reference to atomic number	1	AO1 5.1.2.2

04.3	weak forces between the molecules **or** weak intermolecular forces	allow weak intermolecular bonds do **not** accept incorrect references to covalent bonds	1	AO1 AO3 5.1.2.6 5.2.2.4
	(so) little energy required to overcome / break the forces between molecules **or** (so) little energy required to overcome / break the intermolecular forces	allow (so) little energy required to separate the molecules allow (so) little energy required to overcome / break the intermolecular bonds ignore less energy	1	

5.1.1.4 Relative electrical charges of subatomic particles

Answer 04 · Mark scheme

04.4	(the) molecules get larger going down the group (so the) forces <u>between the molecules</u> increase **or** (so the) intermolecular forces increase (so the) boiling points increase going down the group **or** (so the) boiling points increase with increasing relative atomic mass	allow converse explanation in terms of boiling point allow (so) more energy is needed to separate the molecules	1 1 1	AO1 AO3 5.1.2.6 5.2.2.4
04.5	2,8 (so) stable arrangement of electrons **or** (so) full outer shell	allow diagram or description	1 1	AO1 5.1.2.4
04.6	$\frac{1}{40} \times 6.02 \times 10^{23}$ **or** $0.025 \times 6.02 \times 10^{23}$ 1.51×10^{22}	an answer of 1.51×10^{22} scores **2** marks allow 1.505×10^{22}	1 1	AO2 5.3.2.1
Total			**11**	

5.1.1.4 Relative electrical charges of subatomic particles

Answer 04 · Mark scheme

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

Question	Answers	Extra information	Mark	AO / Spec. Ref.

5.1.1.4 Relative electrical charges of subatomic particles

Answer 05 · Mark scheme November 2020 | 8464/C/1H | Original Q1

01.1	13 14	this order only	1 1	AO2 5.1.1.4 5.1.1.5

01.2	loss of oxygen	allow (Al^{3+}) gain of electrons allow aluminium oxide loses oxygen	1	AO1 5.4.1.1 5.4.1.3

01.3	 (at high temperature) oxygen reacts with carbon / electrode (so the positive) electrode burns / wears away to produce carbon dioxide	allow anode for (positive) electrode $C + O_2 \rightarrow CO_2$ scores MP1 and MP3	 1 1 1	 AO1 5.4.3.1 5.4.3.2 5.4.3.3

01.4	(delocalised) electron(s) ion(s) (delocalised) electron(s)		1 1 1	AO1 AO2 AO1 5.2.2.3 5.2.2.8 5.2.3.2

Total			**9**

5.1.1.4 Relative electrical charges of subatomic particles

Answer 05 · Mark scheme

November 2020 | 8464/C/1H | Original Q1

Question	Answers	Extra information	Mark	AO / Spec. Ref.

5.1.1.4 Relative electrical charges of subatomic particles

Answer 06 · 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	

5.1.1.4 Relative electrical charges of subatomic particles

Answer 06 · Mark scheme

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

07.2		allow converse for sodium		
	(caesium has) more energy levels **or** (caesium has) more shells		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

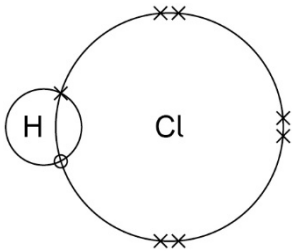
Total			**11**

5.1.1.4 Relative electrical charges of subatomic particles

Answer 07 · Mark scheme

June 2022 | 8464/C/1H | Original Q6

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	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.
06.2	completely ionises in aqueous solution	allow completely dissociates in aqueous solution	1	AO1 5.4.2.5

5.1.1.4 Relative electrical charges of subatomic particles

Answer 07 · Mark scheme

June 2022 | 8464/C/1H | Original Q6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	fizzing / effervescence **or** magnesium disappears		1	AO3 5.4.2.5
	at a greater rate with a strong acid	allow converse with weak acid allow for **2** marks strong acid has a greater temperature increase	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	(pH) decreases	allow pH is lower	1	AO1
	by (a unit of) 2		1	AO2 5.4.2.5

5.1.1.4 Relative electrical charges of subatomic particles

Answer 07 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.5	(bonds broken = (4 × 413) + C=C + 431 =) 2083 + **C=C**		1	AO2 5.5.1.3
	(bonds made = (346 + 339 + (5 × 413) =) 2750		1	
	(energy released = bonds made – bonds broken =) 56 = 2750 – [2083 + C=C]	allow correct use of incorrect value(s) from step 1 and / or step 2	1	
	(C=C) = 611 (kJ/mol)		1	

Total Question 6		**11**

5.1.1.4 Relative electrical charges of subatomic particles

Answer 08 · Mark scheme June 2023 | 8464/C/1H | Original Q3

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	$4\,Na + O_2 \rightarrow 2\,Na_2O$	allow multiples	1	AO2 5.1.1.1 5.1.2.5 5.3.1.1 5.4.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	sodium atom loses one electron		1	AO1 5.1.1.7 5.1.2.3
	(and) oxygen atom gains two electrons		1	5.1.2.5 5.2.1.2
	(so) two sodium atoms to one oxygen atom		1	
	any **one** from: • (to form) Na^+ **and** O^{2-} • (to form) sodium ion(s) **and** oxide ion(s) • (to form) ions with full outer shells / levels.		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	yellow flame	allow orange flame	1	AO1 5.1.2.5
	any **one** from: • sodium melts • white smoke / solid / powder		1	

5.1.1.4 Relative electrical charges of subatomic particles

Answer 08 · Mark scheme

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

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	(potassium) (burns with a) lilac flame	allow (burns with a) different colour flame	1	AO1 5.1.2.5
	burns faster	allow more vigorous reaction	1	

Total Question 3	**9**

5.1.1.4 Relative electrical charges of subatomic particles

Answer 09 · 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

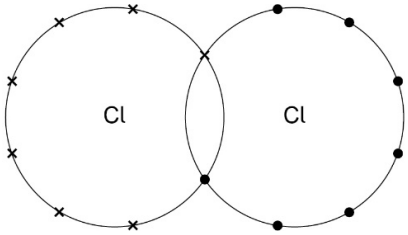
Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	36		1	AO2 5.1.1.4 5.1.1.5

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

5.1.1.4 Relative electrical charges of subatomic particles

Answer 09 · Mark scheme

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

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

Total Question 4	**10**

5.1.1.4 Relative electrical charges of subatomic particles

Answer 10 · Mark scheme

June 2024 | 8464/C/1H | Original Q8

Question 8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	hexagonal (rings of carbon atoms)		1	AO1 5.2.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.2	any **one** from: • nanotechnology • materials	ignore references to electronic use allow suitable use such as: • sporting equipment • body armour allow drug delivery	1	AO1 5.2.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.3	(number of moles =) $\frac{2380}{6.02 \times 10^{23}}$ $= 3.95 \times 10^{-21}$ (mols)	 allow 3.953488×10^{-21} (mols) correctly rounded to at least 2 significant figures	1 1	AO2 5.2.3.3 5.3.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.4	each (carbon) atom forms three covalent bonds (so) one electron from each (carbon) atom is delocalised (so these) delocalised electrons carry (electrical) charge through the structure / nanotube	 ignore throughout for through ignore current / electricity	1 1 1	AO3 5.2.3.3

Total Question 8	7

5.1.1.4 Relative electrical charges of subatomic particles

Answer 11 · 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

5.1.1.4 Relative electrical charges of subatomic particles

Answer 11 · Mark scheme

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

5.1.1.4 Relative electrical charges of subatomic particles

Answer 11 · Mark scheme

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

5.1.1.4 Relative electrical charges of subatomic particles

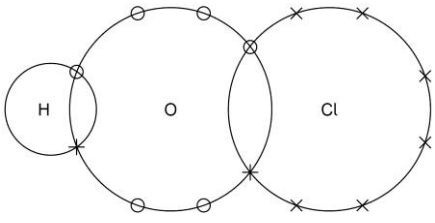
Answer 12 · Mark scheme

June 2025 | 8464/C/1H | Original Q5

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	(hydrogen chloride) g / (g) **and** (water) l / (l) **and** (hydrochloric acid) aq / (aq)		1	AO2 5.2.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	3.16×10^{-4} (mol/dm^3)		1	AO2 5.4.2.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3		allow any combination of x, O, $e^{(-)}$, ● for electrons		AO2 5.2.1.1 5.2.1.4
	1 pair of electrons in both overlaps		1	
	4 non-bonding electrons on oxygen atom **and** 6 non-bonding electrons on chlorine atom	do **not** accept non-bonding electrons on hydrogen	1	
		an answer of  scores **2** marks		

5.1.1.4 Relative electrical charges of subatomic particles

Answer 12 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	a weak acid partially ionises in an aqueous solution (so) produces a lower concentration of hydrogen ions		1 1	AO1 5.4.2.4 5.4.2.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5	(bonds broken = (4 × 413) + 243 =) 1895 (bonds made = (3 × 413) + 346 + 432 =) 2017 (energy change = 1895 − 2017 =) (−) 122 (kJ/mol) **alternative approach** (bonds broken = 413 + 243 =) 656 (1) (bonds made = 346 + 432 =) 778 (1) (energy change = 656 − 778 =) (−) 122 (kJ/mol) (1)	allow correct use of an incorrectly determined value for bonds broken and / or bonds made allow correct use of an incorrectly determined value for bonds broken and / or bonds made	1 1 1	AO2 5.5.1.3

Total Question 5	9

5.1.1.4 Relative electrical charges of subatomic particles

Answer 01 · Examiner comments

June 2018 | 8464/C/1H | Original Q2

Question 2 (standard demand)

02.1 73% of students achieved at least a mark on this question. Many could clearly see the most obvious difference and similarity in the electronic structures of sodium and chlorine. These correct answers were described in a variety ways eg different number of electrons or by stating the correct number of electrons in the outer shell. Examples of similarities related to the number of shells or completed inner energy levels.

Students often used the periodic table shown in the stem of the question to answer the question, but most of these referred to periods and groups and failed to gain marks. Students should note that there is only one 'outer' shell or level.

02.2 This question was well answered with 63% of students achieving all four marks, often with concise statements.

Some students contradicted their description by mentioning covalent, the incorrect type of bonding, or the sharing of electrons, which restricted the number of marks they could attain.

Students need to use scientific terminology accurately. Ionic bonding occurs when a metal transfers its electron(s) to a non-metal (loss and gain of electrons). Whereas covalent bonding involves non-metals sharing electrons, which results in the formation of covalent bonds.

02.3 67% of students achieved both marks, although it was common for students to have incomplete diagrams, by failing to include a horizontal for the products side. Some students confused the two types of energy changes (endothermic and exothermic), while others provided a wide range of incorrect diagrams.

Answer 02 · Examiner comments

June 2018 | 8464/C/1H | Original Q4

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

04.1 Students did not answer this question as well as expected. They were either not aware that chlorine was a gas or were not familiar with state symbols, as answers other than (s), (l) (g) or (aq) were frequently seen. Some wrote the word 'gas' in the space. 36% of students answered correctly.

04.2 This question was very well answered with 64% of students achieving full marks. Students showed a good understanding of the number of electrons involved in this example of covalent bonding, by ensuring that they had two electrons in the overlap area and six other electrons in the energy level of each fluorine.

A common mistake was to include two electrons in the overlap, but still included the seven electrons each fluorine originally contained in the level outside the overlap.

04.3 48% of students selected the correct answer to this question. The question followed the diagram of a fluorine (F_2) molecule in question **04.2** and focussed on this species.

A significant number of students incorrectly selected '9' as their response, which is the number of electrons in one fluorine atom.

04.4 Students are expected to represent the electronic structures of the first 20 elements of the periodic table and to predict and explain reactions of elements from their position in the periodic table.

A small number of students were able to state the correct formula, $AlBr_3$, with AlBr and $AlBr_2$ being the most common incorrect formulae. But, students did show a good understanding of balancing equations, in this case based upon their wrong formula for aluminium bromide. 68% of students achieved a single mark.

04.5 This question was not answered well, with 8% of students achieving three marks for the explanation that included:

- comparative size of atoms
- comparative difference in attraction
- the ease of which an electron was gained.

This last point was the one that was seen the least and the word 'outer' (shell or level) was omitted in a lot of answers.

Often students would repeat the question stem in terms of chlorine and bromine's reactivity without relating it to the whole of Group 7 and in many instances referring to the reactivity series (of metals).

5.1.1.4 Relative electrical charges of subatomic particles

Answer 03 · Examiner comments June 2019 | 8464/C/1H | Original Q3

Question 3

This was the first question not common with the Foundation tier. There was a ramping of demand through the question from standard demand (03.1) to standard/high demand (03.2) then to high demand (03.3 and 03.4).

03.1 A good proportion of students correctly identified the activation energy. Common errors included arrows pointing to the maximum of the energy diagram or to a section of the line leading to the peak.

03.2 Students were very good at determining the overall energy change; nearly three-quarters of all students gained full marks. Those students who selected one value of either the reactants or products from the graph gained credit for a correct subtraction of their values.

03.3 Students provided a wide range of responses for the dot-and-cross diagram of oxygen. Half of all students appreciated the number of electrons involved in bonding and non-bonding. A number of students did not appreciate that oxygen always has two sharing pairs of electrons; in this case a double bond results between the two atoms. Others who added 4 electrons for a double bond often still added 3 other non-bonding pairs on each O atom.

03.4 This question discriminated very well where two-fifths of students gained all three marks for an answer of (–) 220 kJ.

Many students presented their working clearly. This allowed examiners to identify where any errors had been made which allowed access to the final marking point (MP3); a subtraction of bonds made (their MP2) from bonds broken (their MP1).

Answer 03 · Examiner comments June 2019 | 8464/C/1H | Original Q3

Common mistakes centred on using an O-O value when an O=O bond strength should have been used and not taking into account the stoichiometry of the equation.

5.1.1.4 Relative electrical charges of subatomic particles

Answer 04 · Examiner comments

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

Question 4

Most of this question was at standard/high demand.

04.1 Scientists' use of atomic weight to arrange elements in early periodic tables was not well known. Far too many students did not fully appreciate the historical nature of the question and provided concepts that were not known at the time, such as atomic number and electrons.

04.2 Over half the entry gave a correct reason. Large numbers of students appreciated that Mendeleev left gaps or grouped elements with similar properties. Changing the order based upon atomic weights was correct but less common.

04.3 Only the higher-attaining students were able to explain that halogens have low boiling points because of weak intermolecular forces. It is these forces that are overcome when a 'little energy' is applied; less energy did not gain this mark, as less does not necessarily equate to little. Many students answered this question incorrectly in terms of the covalent bonds within the halogens. A lot of students linked the listed values to reactivity within group 7.

5.1.1.4 Relative electrical charges of subatomic particles

Answer 04 · Examiner comments June 2019 | 8464/C/1H | Original Q4

04.4 The concept of intermolecular forces and the fact that the intermolecular forces increase because the molecules got larger was rarely seen in explanations. Many students gained a mark for stating that the boiling points increased down the group; down the table or periodic table did not gain this mark. Students commonly tried to explain a trend in reactivity down the group and attempted to link that to boiling points. Some struggled with negative temperatures.

04.5 Most students were able to state that neon's outer shell was full. Many did not gain the second mark by not giving the electronic structure of neon.

04.6 A third of students calculated the correct answer for 2 marks. Many were confused by standard form, with only a few students making slight calculation errors.
Most wrong answers came from either dividing the Avogadro number by 0.025 (the number of moles) or from multiplying by 40; they did not appreciate that 1g of argon is less than 1 mole of argon so the answer to this question must be less than 6×10^{23}

Answer 07 · Examiner comments June 2022 | 8464/C/1H | Original Q6

Question 6 (Standard, standard/high and high demand)

06.1 Two third of students correctly drew a dot and cross diagram for hydrogen chloride. The most common mark was for the two shared electrons in the overlap between the atoms. Many did not show that there are six unshared electrons.

06.2 Less than 10% were able to state what is meant by the term strong acid. Many omitted 'in aqueous solution'.

06.3 40% of students gained 1 mark usually for referring to an observation when magnesium reacts with a strong acid and a weak acid. The second mark was for a comparison of the rates of reaction between magnesium and the two acids, with few students being able to develop their response to give this.

06.4 Nearly 40% of students gained 1 mark usually for stating that the pH decreases when the concentration was increased. However very few recognised that pH was related to the power of 10, so when the concentration of hydrochloric acid is increased by a factor of 100 then the pH will decrease by 2.

06.5 Many students were good at calculating the energy changes for bonds broken and bonds made, however then went on to simply subtract these two numbers without taking into account the C=C bond energy. Many students kept their working to a minimum which often did not help them score. This question discriminated well with better responses showing clear working where the energy released was equated to the difference between the bonds made and the bonds broken.

5.1.1.4 Relative electrical charges of subatomic particles

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

Question 3 (standard, standard/high demand and high demand)

03.1 Nearly three-quarters of the students correctly balanced the equation for the reaction of sodium with oxygen to produce sodium oxide.

03.2 This question was a good discriminator. Most students understood the processes involved in this question, but poor use of chemical language meant they often did not achieve the marks. Students often referred to sodium and oxygen, rather than sodium atoms and oxygen atoms and many incorrect terms such as ‘atoms sharing electrons to form ionic bonds’, ‘metal ions losing electrons’ and ‘non-metal ions gaining electrons’ were seen. Formation of O^- was a common misconception, rather than recognising that two sodium atoms each lose one electron, and both electrons are gained by one oxygen atom to form an oxide ion (O^{2-}). A common error was for students to write oxygen ion instead of oxide ion.

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

03.3 Students found this question very challenging and instead of giving observations tried to explain what was happening in the reaction. Ver few students gave two observations for burning sodium in oxygen. A yellow flame was a common answer for those who gained one of the marks although ‘flame’ was insufficient. If students wrote ‘smoke’ they often did not state the colour and so did not achieve the mark. Many referred to the reaction of sodium with water so bubbles was a common incorrect response.

03.4 Again very few students gave two differences comparing burning potassium with sodium in oxygen. Most students did not know that potassium burns with a lilac flame. Students did not tend to write ‘burns faster’ for MP2 but they did achieve this mark by making a comparison of the two reactions, for example, by writing the reaction was more vigorous.

5.1.1.4 Relative electrical charges of subatomic particles

Answer 09 · 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 10 · Examiner comments

June 2024 | 8464/C/1H | Original Q8

Question 8 (standard & high demand)

08.1 A third of students scored one mark. A diagram was included to help students describe the structure of fullerenes as based on hexagonal rings of carbon atoms.

08.2 A third of students gave an appropriate use of nanotubes.

08.3 In this question students were asked to calculate the number of moles of carbon in a nanotube that contains 2380 carbon atoms. Students needed to divide the number of carbon atoms by the Avogadro constant. Just under 20% of students gained 1 mark with about half of these being able to continue and evaluate the expression correctly.

08.4 Students found it challenging to explain why carbon nanotubes can conduct electricity. Responses were frequently too vague to access a marking point. Those who looked at the diagram of the nanotube would have seen that each atom forms three covalent bonds. Students might have linked the hexagonal structure as also being present in the more familiar structures of graphene and graphite where one electron from each atom is delocalised and that these delocalised electrons carry electrical charge through the structure.

0 8 . 4 Explain why carbon nanotubes can conduct electricity.

Refer to bonding between carbon atoms in your answer.

[3 marks]

- Strong covalent bonds between carbon atoms
- Sea of delocalised electrons that are free to move.
- They carry current- meaning they conduct electricity.

Each of the three statements in this response is close to one of the marking points but is not sufficient to gain credit:

- strong covalent bonds also exist in diamond where each carbon atom forms 4 covalent bonds
- the origin of the delocalised electrons has not been stated
- the word ‘they’ could refer to the carbon atoms or the delocalised electrons, but there is no reference to ‘carry charge through the structure’ so the mark is not awarded.

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5.1.1.4 Relative electrical charges of subatomic particles

Contact us

Our friendly team will be happy to support you between 8am and 5pm, Monday to Friday.

Tel: 01483 477756
Email: gcsescience@aqa.org.uk

aqa.org.uk

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5.1.1.4 Relative electrical charges of subatomic particles

Answer 11 · 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 $^{79}_{35}Se^-$

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5.1.1.4 Relative electrical charges of subatomic particles

Answer 11 · 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.

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5.1.1.4 Relative electrical charges of subatomic particles

Answer 11 · 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.

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5.1.1.4 Relative electrical charges of subatomic particles

Answer 12 · Examiner comments

Question 5 (Standard/High and High demand)

05.1 The state symbols for hydrogen chloride gas and water were well known but aqueous for hydrochloric acid was not. Some students mixed up l and aq. Most students correctly use lower case letters.

05.2 Few students gained this high demand mark. Those students who gained the mark often wrote down a few words next to the values given in the question, e.g. 'add 1, divide by 10' or 'concentration increases by factor of 10, pH decreases by 1'. Numerous students multiplied by 10 rather than dividing and many struggled to evaluate data in standard form.

05.3 More than half of students gained two marks for completing the dot and cross diagram. When 1 mark was gained it was usually for 1 pair of electrons in both overlaps with extra non-bonding electrons on hydrogen or incorrect numbers of non-bonding electrons on the oxygen atom and/or the chlorine atom.

05.4 Very few gained both marks. Students had to explain why a weak acid has a higher pH than a strong acid of the same concentration. Most answers were in terms of a pH comparison. Lots of students did not achieve MP1 by not using the full definition including in aqueous solution. For MP2 many students said there were less H^+ ions omitting reference to concentration or number per unit volume.

05.5 Many students were able to calculate the energy changes for bonds broken and for bonds made and then subtracted the latter value from the former. The value of bonds broken was less than bonds made so the overall energy change was a negative number. Those students who miscounted the bonds broken or made, could not gain MP1 and/or MP2 but were still able to access MP3 by evaluating their own figures correctly.

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5.1.1.4 Relative electrical charges of subatomic particles

Answer 12 · Examiner comments June 2025 | 8464/C/1H | Original Q5

0 5 . 5 Hydrogen chloride is produced in the reaction between methane and chlorine.

Figure 6 represents the equation for the reaction.

Figure 6

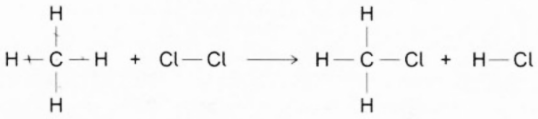


Table 4 shows the bond energies.

Table 4

Bond	C — H	Cl — Cl	C — Cl	H — Cl
Bond energy in kJ/mol	413	243	346	432

Calculate the overall energy change for the reaction.

[3 marks]

reactants	Products
413 x 4 = 1652	1 x 346 = 346
243 x 2 = 486	413 x 3 = 1239
total = 1652 + 486 =	432 x 1 = 432
2138 − 2017 = 121	total = 2346 + 1239 + 432
	= 2017

Overall energy change = 121 kJ/mol

This student has broken 2× Cl—Cl bonds (not 1×) for the reactants so is not awarded MP1. They then correctly subtract the correct value for bond making (2017) so MP2 and MP3 are credited.

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