AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.1.2.1

# The periodic table

## Mark schemes and examiner comments

| | |
|---|---|
| Tier | **Higher** |
| Question groups | **10** |
| 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.

### 5.1.2.1 The periodic table

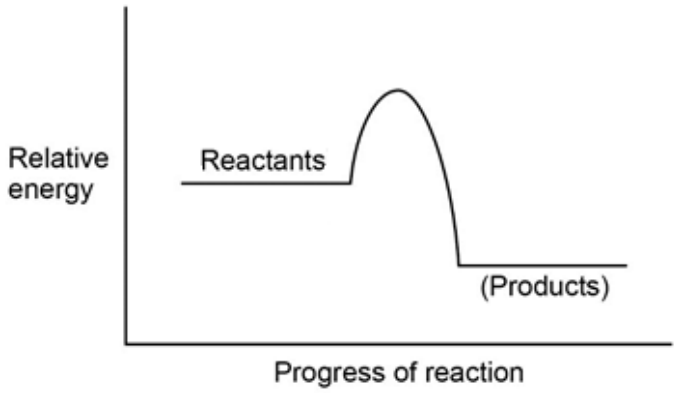
**Answer 01 · Mark scheme** June 2018 | 8464/C/1H | Original Q2

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **02.1** | (difference)<br>sodium has one and chlorine has seven electrons in <u>outer</u> level / shell<br>**or**<br>number of electrons | number of electrons must be correct if quoted | 1 | AO2<br>5.1.1.7<br>5.1.2.1 |
| | (similarity)<br>both have three / same number of levels / shells<br>**or**<br>have electrons in third level / shell<br>**or**<br>both have incomplete (outer) levels / shells | allow both have 2 electrons in inner shell<br>**or**<br>both have 8 electrons in second shell<br>**or**<br>both are one electron away from full outer level / shell | 1 | |
| **02.2** | | allow marks from suitable diagram(s) | | AO1<br>5.2.1.2 |
| | sodium (atom) loses | allow moves / transfers for loses<br>do **not** accept sodium ion loses | 1 | |
| | one (outer shell electron) | | 1 | |
| | chlor<u>i</u>ne (atom) gains | do **not** accept chlor<u>i</u>de | 1 | |
| | one (electron) | | 1 | |
| | | transfer of 1 electron from chlorine to sodium **max 2** marks | | |
| | | reference to sharing **or** covalent bonding **max 3** marks | | |

5.1.2.1 The periodic table

Answer 01 · Mark scheme

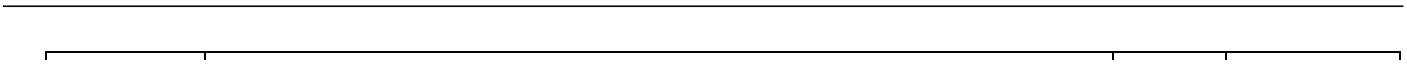
June 2018 | 8464/C/1H | Original Q2

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 02.3 |  | ignore labels<br><br>any curve / line going up and then down<br><br>products line below reactants<br><br>allow curve to start / finish anywhere along reactant / product lines | 1<br><br>1 | AO1<br>5.5.1.2 |
| Total | | | 8 | |

### 5.1.2.1 The periodic table

**Answer 01 · Mark scheme**

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



5.1.2.1 The periodic table

Answer 02 · Mark scheme

June 2019 | 8464/C/1H | Original Q1

| | | | | |
|---|---|---|---|---|
| **01.1** | Ca Mg Zn Cu | | 1 | AO3<br>5.4.1.2 |

| | | | | |
|---|---|---|---|---|
| **01.2** | any **two** from:<br>• mass (of metal / element)<br>• surface area (of metal / element)<br>• concentration (of acid)<br>• volume (of acid)<br>• temperature (of acid) | <br>allow weight<br>ignore size<br>ignore length<br>ignore pH<br>ignore strength<br><br>ignore room temperature | 2 | AO3<br>5.4.1.2 |

| | | | | |
|---|---|---|---|---|
| **01.3** | (type of) metal / element | | 1 | AO2<br>5.4.1.2 |

5.1.2.1 The periodic table

Answer 02 · Mark scheme

June 2019 | 8464/C/1H | Original Q1

| | | | | |
|---|---|---|---|---|
| **01.4** | (beryllium is) less reactive<br><br>any **one** from:<br><br>• greater attraction between nucleus and outer electrons<br>• more energy is needed to remove electrons<br>• loss of electrons is more difficult<br>• outer electrons closer to nucleus<br>• less shielding | allow converse answers for magnesium<br><br>MP2 only if MP1 is correct<br><br>allow higher in group<br>allow reactivity increases down the group<br><br>ignore reactivity series | 1<br><br>1 | AO3<br>5.1.2.3<br>5.1.2.5<br>5.4.1.2 |

5.1.2.1 The periodic table

Answer 02 · Mark scheme



| | | | | |
|---|---|---|---|---|
| **01.5** | $\frac{50}{1000}$ (dm$^3$)<br><br>= 0.05 (dm$^3$)<br><br>($\frac{3.2}{0.05}$) = 64 (g per dm$^3$)<br><br>**alternative approach:**<br><br>$\frac{3.2}{50}$ (1)<br><br>= 0.064 (1)<br><br>(× 1000) = 64 (g per dm$^3$) (1)<br><br>**alternative approach**:<br><br>$\frac{1000}{50}$ (1)<br><br>= 20 (1)<br><br>(× 3.2) = 64 (g per dm$^3$) (1) | an answer of 64 (g per dm$^3$) scores **3** marks<br><br>an incorrect answer for one step does **not** prevent allocation of marks for subsequent steps<br><br>an answer of 0.16 / 0.064 / 0.64 / 6.4 / 6.4 × 10$^{-5}$ (g per dm$^3$) gains **2** marks | 1<br><br>1<br><br>1 | AO2<br>5.3.2.5 |

| | | | |
|---|---|---|---|
| **Total** | | | **9** |

### 5.1.2.1 The periodic table

**Answer 02 · Mark scheme**

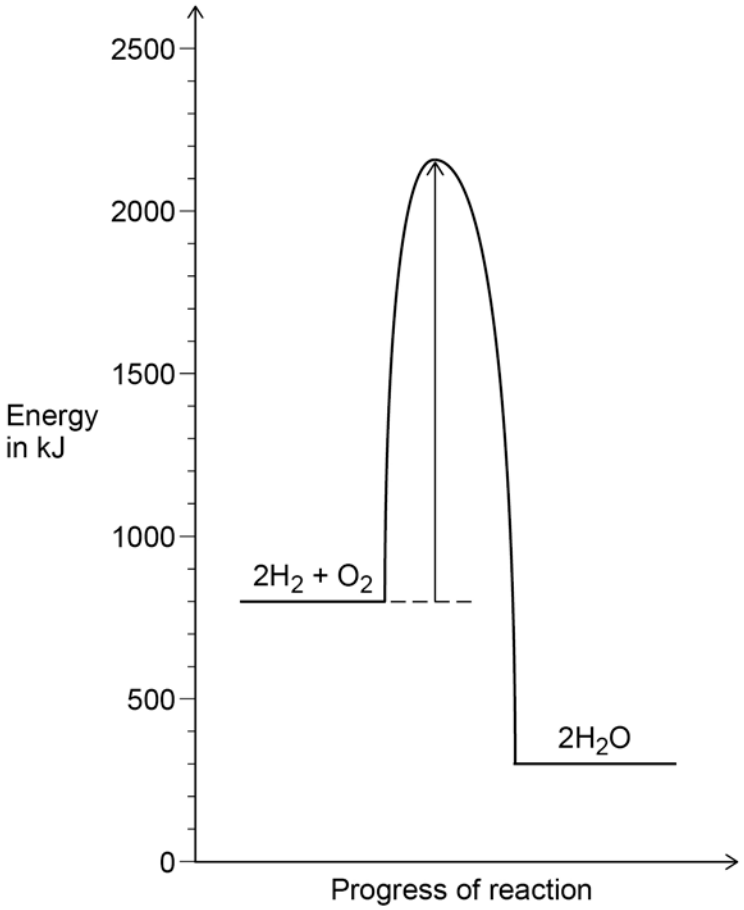
June 2019 | 8464/C/1H | Original Q1

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|

5.1.2.1 The periodic table

Answer 03 · Mark scheme

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

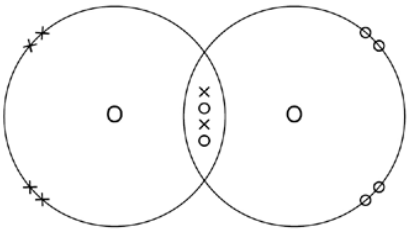
| | | | |
|---|---|---|---|
| **03.1** | line from reactants to top of curve (i.e. from 800 to 2160)<br><br><br>ignore arrowheads | 1 | AO1<br>5.5.1.2 |

| | | | | |
|---|---|---|---|---|
| **03.2** | | an answer of (–) 500 (kJ) scores **2** marks<br>ignore sign | | AO2<br>AO3<br>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 | |

5.1.2.1 The periodic table

Answer 03 · Mark scheme



| | | | | |
|---|---|---|---|---|
| **03.3** | | allow combination of circles, dots, crosses or e(–) | | AO2<br>5.2.1.4 |
| | two shared pairs in overlap | | 1 | |
| | all non-bonding electrons in outer shell (4 electrons on each O atom) | ignore any inner shell electrons | 1 | |
| | | <br>diagram scores 2 marks | | |

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

| | | | |
|---|---|---|---|
| **Total** | | | **8** |

### 5.1.2.1 The periodic table

**Answer 03 · Mark scheme**

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

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|

5.1.2.1 The periodic table

**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<br>5.1.2.2 |
| **04.2** | left gaps / spaces<br><br>**or**<br><br>changed the order based on atomic weights | <br><br><br><br>allow placed them in correct groups according to properties<br><br>do **not** accept reference to atomic number | 1 | AO1<br>5.1.2.2 |
| **04.3** | weak forces between the molecules<br>**or**<br>weak intermolecular forces<br><br>(so) little energy required to overcome / break the forces between molecules<br>**or**<br>(so) little energy required to overcome / break the intermolecular forces | allow weak intermolecular bonds<br>do **not** accept incorrect references to covalent bonds<br><br>allow (so) little energy required to separate the molecules<br><br>allow (so) little energy required to overcome / break the intermolecular bonds<br><br>ignore less energy | 1<br><br>1 | AO1<br>AO3<br>5.1.2.6<br>5.2.2.4 |

| | | | | |
|---|---|---|---|---|
| **04.4** | (the) molecules get larger going down the group<br><br>(so the) forces between the molecules increase<br>**or**<br>(so the) intermolecular forces increase<br><br>(so the) boiling points increase going down the group<br>**or**<br>(so the) boiling points increase with increasing relative atomic mass | allow converse explanation in terms of boiling point<br><br><br><br>allow (so) more energy is needed to separate the molecules | 1<br><br>1<br><br><br><br>1 | AO1<br>AO3<br>5.1.2.6<br>5.2.2.4 |

| | | | | |
|---|---|---|---|---|
| **04.5** | 2,8<br><br>(so) stable arrangement of electrons<br>**or**<br>(so) full outer shell | allow diagram or description | 1<br><br>1 | AO1<br>5.1.2.4 |

| | | | | |
|---|---|---|---|---|
| **04.6** | $\frac{1}{40} \times 6.02 \times 10^{23}$<br>**or**<br>$0.025 \times 6.02 \times 10^{23}$<br><br>$1.51 \times 10^{22}$ | an answer of $1.51 \times 10^{22}$ scores **2** marks<br><br><br><br>allow $1.505 \times 10^{22}$ | <br><br>1<br><br><br><br>1 | AO2<br>5.3.2.1 |

| | | | |
|---|---|---|---|
| **Total** | | | **11** |

### 5.1.2.1 The periodic table

**Answer 04 · Mark scheme**

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

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|

5.1.2.1 The periodic table

Answer 05 · Mark scheme

November 2020 | 8464/C/1H | Original Q6

| | | | | |
|---|---|---|---|---|
| **06.1** | atoms have a positively charged nucleus.<br><br>mass is concentrated in the nucleus in the centre of atoms. | | 1<br><br>1 | AO1<br>5.1.1.3 |

| | | | | |
|---|---|---|---|---|
| **06.2** | $\frac{4 \times 10^{-7}}{2400}$<br><br>$= 1.66666 \times 10^{-10}$<br><br>$= 1.67 \times 10^{-10}$ (m) | <br><br><br><br>allow 0.000 000 000 167 (m)<br><br>allow an answer correctly rounded to 3 significant figures from an incorrect calculation which uses the values in the question | 1<br><br>1<br><br>1 | AO2<br>5.1.1.5 |

| | | | | |
|---|---|---|---|---|
| **06.3** | (moles Au = $\frac{0.175}{197}$ =) 0.000888<br><br>(moles $Cl_2$ = 0.000888 × $\frac{3}{2}$ =) 0.00133<br><br>(mass $Cl_2$ =) 0.00133 × 71<br><br>= 0.0946 (g)<br><br>= 94.6 (mg) | <br><br>allow a correct calculation using an incorrectly calculated value of moles of gold<br><br>allow a correct calculation using an incorrectly calculated value of moles of chlorine<br><br><br>allow a correct conversion using an incorrectly calculated mass of chlorine | 1<br><br>1<br><br>1<br><br>1<br><br>1 | AO2<br>5.3.1.1<br>5.3.2.2 |

| | | | | |
|---|---|---|---|---|
| | **alternative approach:**<br><br>(from equation 2 moles of Au reacts with 3 moles of $Cl_2$)<br>(so) 394 g Au reacts with 213 g $Cl_2$ (1)<br><br>1 g Au reacts with ($\frac{213}{394}$ =)<br>0.54 g $Cl_2$ (1)<br><br>0.175 g Au reacts with<br>0.54 × 0.175 g $Cl_2$ (1)<br><br>= 0.0946 (g) (1)<br><br>= 94.6 (mg) (1) | <br><br><br><br>allow a correct calculation using an incorrectly calculated value of mass of gold and / or chlorine<br><br>allow a correct calculation using an incorrectly calculated value of mass of gold and / or chlorine<br><br><br><br>allow a correct conversion using an incorrectly calculated mass of chlorine | | |

| | | | |
|---|---|---|---|
| **Total** | | | **10** |

### 5.1.2.1 The periodic table

**Answer 05 · Mark scheme**

November 2020 | 8464/C/1H | Original Q6

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|

5.1.2.1 The periodic table

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<br>5.1.2.5<br>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:<br>• (to form) $Cs^+$ and $O^{2-}$<br>• (to form) caesium ion(s) and oxide ion(s)<br>• (to form) ions with full outer shells / levels | | 1 | |

5.1.2.1 The periodic table



| | | | | |
|---|---|---|---|---|
| **07.2** | | allow converse for sodium | | |
| | (caesium has) more energy levels<br>**or**<br>(caesium has) more shells | | 1 | AO2 |
| | (so the) outer electron / shell is further from nucleus<br>**or**<br>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<br>5.1.2.3<br>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<br>**or**<br>(so) Mendeleev placed tellurium with elements with same / similar properties | allow F / Cl / Br for elements<br><br>allow O / S / Se for elements | 1 | AO2<br>5.1.2.2 |

| | | | |
|---|---|---|---|
| **Total** | | | **11** |

5.1.2.1 The periodic table

Answer 07 · Mark scheme

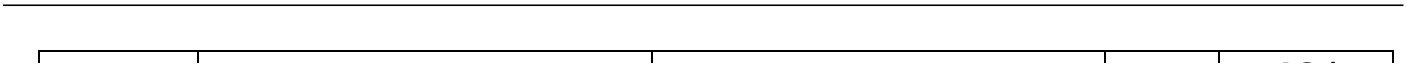
November 2021 | 8464/C/1H | Original Q1

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **01.1** | (Group) 0<br>**or**<br>noble gases | | 1 | AO2<br>5.1.2.2 |
| **01.2** | B | | 1 | AO2<br>5.1.1.3 |
| **01.3** | A | | 1 | AO3<br>5.1.1.3 |
| **01.4** | (atoms with the) same number of protons | allow atoms with the same atomic number<br><br>allow atoms of the same element<br><br>ignore the same number of electrons | 1 | AO1<br>5.1.1.5 |
| | (but with) different numbers of neutrons | ignore (but with) different mass numbers<br><br>do **not** accept (but with) different relative atomic mass | 1 | |
| **01.5** | $\frac{(39 \times 93.1) + (41 \times 6.9)}{100}$<br><br>= 39.138<br><br>= 39.1 | <br><br><br><br>allow correctly rounded answer to **1** decimal place from an incorrect calculation using all the values given in the question | 1<br><br>1<br><br>1 | AO2<br>5.1.1.6 |
| **Total** | | | **8** | |

### 5.1.2.1 The periodic table

**Answer 07 · Mark scheme**

November 2021 | 8464/C/1H | Original Q1



5.1.2.1 The periodic table

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<br>5.1.1.1<br>5.1.2.5<br>5.3.1.1<br>5.4.1.1 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **03.2** | sodium atom loses one electron | | 1 | AO1<br>5.1.1.7<br>5.1.2.3 |
| | (and) oxygen atom gains two electrons | | 1 | 5.1.2.5<br>5.2.1.2 |
| | (so) two sodium atoms to one oxygen atom | | 1 | |
| | any **one** from:<br>• (to form) $Na^+$ **and** $O^{2-}$<br>• (to form) sodium ion(s) **and** oxide ion(s)<br>• (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<br>5.1.2.5 |
| | any **one** from:<br>• sodium melts<br>• white smoke / solid / powder | | 1 | |

5.1.2.1 The periodic table

Answer 08 · Mark scheme

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

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

| Total Question 3 | 9 |
|---|---|

5.1.2.1 The periodic table

Answer 09 · Mark scheme

June 2024 | 8464/C/1H | Original Q7

## Question 7

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 07.1 | each calcium atom loses two electrons | allow **1** mark for calcium atoms lose electrons **and** chlorine atoms gain electrons | 1 | AO2<br>5.1.2.6<br>5.2.1.1 |
| | (and) each chlorine atom gains one electron | | 1 | |
| | (so) one calcium atom reacts with two chlorine atoms | | 1 | |
| | (to form) $Ca^{2+}$ ions **and** $Cl^-$ ions<br>**or**<br>(to form) calcium ion(s) **and** chloride ion(s) | allow (to form) ions with full outer shells<br><br>allow energy level for shell | 1 | |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 07.2 | | allow converse for bromine<br><br>allow energy level for shell | | AO1<br>5.1.2.3<br>5.1.2.6 |
| | chlorine has fewer shells | allow chlorine is a smaller atom | 1 | |
| | (so the) outer shell is closer to the nucleus | allow (so the) outer electrons are closer to the nucleus<br>allow (so there) is less shielding | 1 | |
| | (so) stronger attraction between nucleus and electron gained<br>**or**<br>(so) stronger attraction between nucleus and outer shell | | 1 | |
| | (so) gains the electron more easily | | 1 | |

5.1.2.1 The periodic table

Answer 09 · Mark scheme

June 2024 | 8464/C/1H | Original Q7

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 07.3 | as the relative formula mass increases the boiling points (of the hydrogen halides) increase | | 1 | AO3 5.1.2.6 |
| | (but) HF has the highest boiling point<br>**or**<br>(but) HF does not follow the trend | allow (but) HF is anomalous | 1 | |

| Total Question 7 | 10 |
|---|---|

5.1.2.1 The periodic table

Answer 10 · Mark scheme



## Question 3

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **03.1** | atoms have a charged nucleus<br><br>the mass of an atom is concentrated in the nucleus | | 1<br><br>1 | AO1<br>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<br><br>allow because atoms have the same number of protons and electrons<br><br>do **not** accept (particle **X**) has a different number of neutrons | 1 | AO3<br>5.1.1.4 |

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

5.1.2.1 The periodic table

Answer 10 · 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<br><br>allow $Br_2$ for bromine<br>allow NaCl for sodium chloride | 1 | AO2 5.1.2.6 |

Answer 10 · 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<br>allow the atoms become larger<br>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 |
|---|---|

5.1.2.1 The periodic table

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.

5.1.2.1 The periodic table

Answer 02 · Examiner comments

June 2019 | 8464/C/1H | Original Q1

## Question 1

This question was common with the Foundation paper and each item was at standard demand.

**01.1** The decreasing reactivity of the metals was deduced from the amount of effervescence in each reaction. Most students selected the correct order.

**01.2** Although most students had a good understanding of the control variables in this situation, the way they described the variable sometimes lacked the correct terminology. 'Amount of acid' was often used instead of 'volume of acid'.

**01.3** This question to identify the independent variable was well answered, although it was common to see other incorrect variables mentioned, such as reactivity of the metals or number of bubbles.

**01.4** This question comparing the reactivity of beryllium to magnesium was reasonably well answered. A number of students gained no credit as they stated that beryllium was more reactive. Some students stated that magnesium has more 'outer shells'; all elements only have one outer shell. Trends in reactivity had to refer to the group (as the question stated to use the periodic table) and not the periodic table or reactivity series. The word 'outer' was frequently omitted, so responses such as the electrons in magnesium are further from the nucleus were insufficient.

**01.5** A quarter of students used a variety of methods to correctly calculate the concentration. Just under a half of the students scored 2 of the 3 marks, usually failing to correctly convert $cm^3$ to $dm^3$

5.1.2.1 The periodic table

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.

5.1.2.1 The periodic table

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.

### 5.1.2.1 The periodic table

**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 $6 \times 10^{23}$

**Answer 07 · Examiner comments** November 2021 | 8464/C/1H | Original Q1

**Question 1 (standard demand)**

**01.1** More than two thirds of students knew that Group 0, the noble gases, had not been discovered when Mendeleev's version of the periodic table was published.

**01.2** The plum pudding model was identified by more than four fifths of students.

**01.3** Chadwick discovered the neutron. Just under half of students were able to make the link between this discovery and the figure which represented an atom containing neutrons.

**01.4** The question required students to answer in terms of 'subatomic particles'; the answer was that isotopes are atoms with the same number of protons but different numbers of neutrons. Just over one third of students gained two marks.

**01.5** Many students gained the first mark by showing that the weighted average had to be divided by 100. The evaluation of this gained the second mark which then needed to be correctly rounded to one decimal place. Approximately one third of students gained all three marks.

### 5.1.2.1 The periodic table

**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.

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

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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.

Answer 09 · Examiner comments

June 2024 | 8464/C/1H | Original Q7

# Question 7 (standard/high & high demand)

**07.1** This question was a good differentiator between students. Electron transfer from a metal to a non-metal to form an ionic compound is frequently asked.

Most students understood the processes involved in this question, but their weak use of chemical language meant they often did not achieve the marks. Students often referred to calcium and chlorine, rather than calcium atoms and chlorine atoms. There were many incorrect terms such as 'atoms sharing electrons to form ionic bonds', 'metal ions losing electrons' and 'non-metal ions gaining electrons'. Formation of $Ca^{+}$ was a common misconception, rather than recognising that two electrons are lost by one calcium atom and two chlorine atoms each gain one electron. To achieve the final mark students had to use the word 'ion', and this was often missing. A common error was for students to write chlorine ion instead of chloride ion.

0 7 . 1 Calcium reacts with chlorine to produce calcium chloride.

Explain what happens to calcium atoms and to chlorine atoms when calcium reacts with chlorine to produce calcium chloride.

**[4 marks]**

When calcium reacts with chlorine to produce calcium chloride, the atoms share electrons. Calcium is in group 2 meaning it has 2 electrons on it outer shell and chlorine is in group 7 meaning it has 7 electrons on its outer shell. Two chlorine atoms will be present shared with one calcium atom so that each chlorine atom gets 1 electron to complete its ourer shell.

A number of students did not appreciate that ionic bonding occurs when a metal reacts with a non-metal. The sharing of electrons described here contradicts the transfer of electrons from the metal to the non-metal for the first two marking points. This response gains 1 mark for the correct ratio between calcium atoms and chlorine atoms but does not say that ions are formed.

**07.2** This question was also a good differentiator between students. Nearly half of students were able to gain some credit but few gained all 4 marks. Those students who gained 1 or 2 marks invariably described chlorine as having fewer shells, that the outer shell is closer to the nucleus or that chlorine atoms gain an electron more easily (or the converse for bromine). A stronger attraction between the nucleus and the electron gained was rarely seen.

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5.1.2.1 The periodic table

**Answer 09 · Examiner comments** June 2024 | 8464/C/1H | Original Q7

**07.3** Students were given the boiling points of four hydrogen halides and were asked to describe how the boiling points change as the relative formula mass changes. Many students found it challenging to interpret the negative numbers and deduced an incorrect trend whilst others referred to the halogens and not the hydrogen halides. Few gained 2 marks by correctly stating that the boiling points increase as the formula mass increases and that HF was anomalous and does not follow the trend.

**Answer 10 · 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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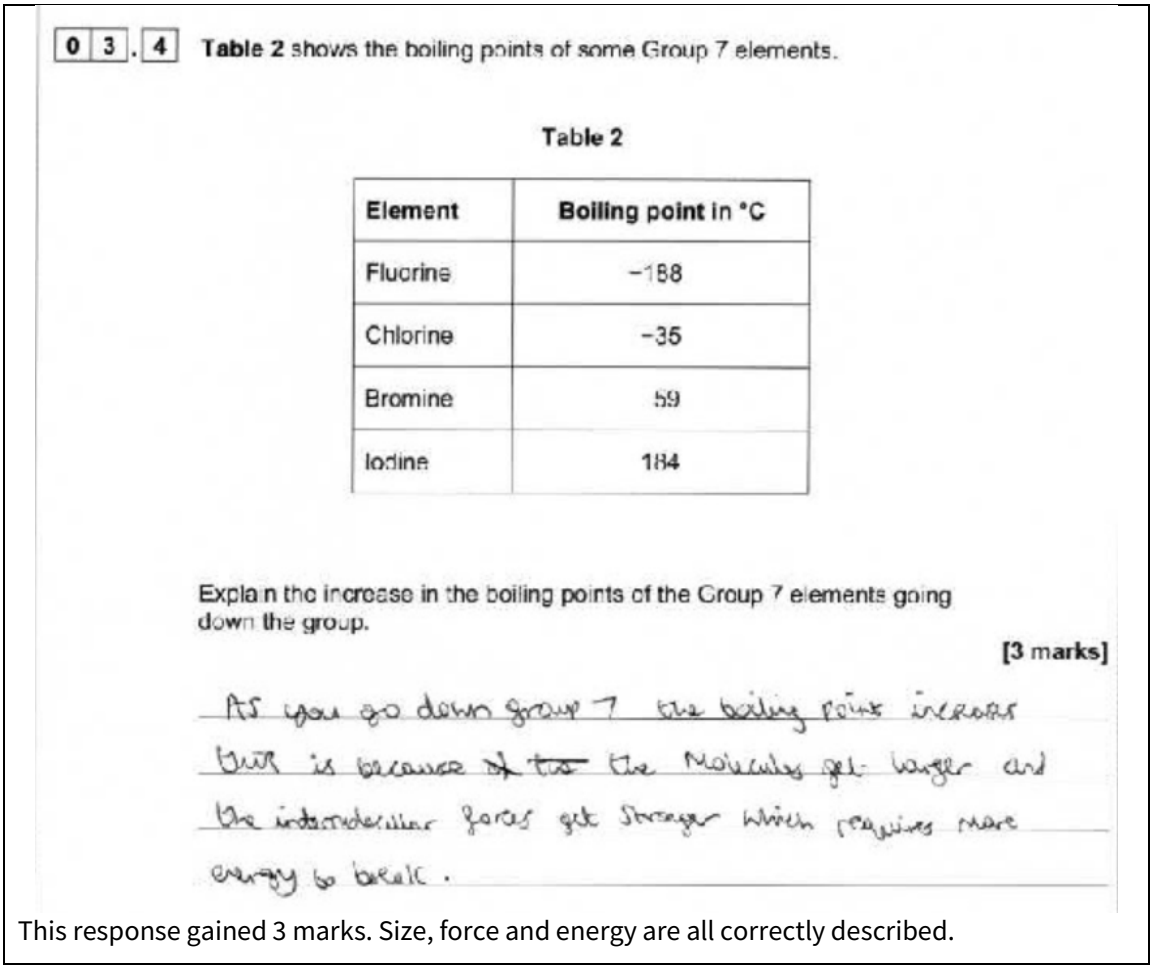
### 5.1.2.1 The periodic table

**Answer 10 · 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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### 5.1.2.1 The periodic table

**Answer 10 · 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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