AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.1.1.4

Relative electrical charges of subatomic particles

Past-paper questions

Tier	**Higher**
Question groups	**12**
Available paper years	**2018–2025**

Using this booklet

1. Answer the questions in order and show your working.
2. Original question numbers and marks are retained.
3. Print at actual size (100%) for measuring questions.
4. Use the companion answer booklet to check your work.

Name: _____ **Date:** _____

Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

5.1.1.4 Relative electrical charges of subatomic particles

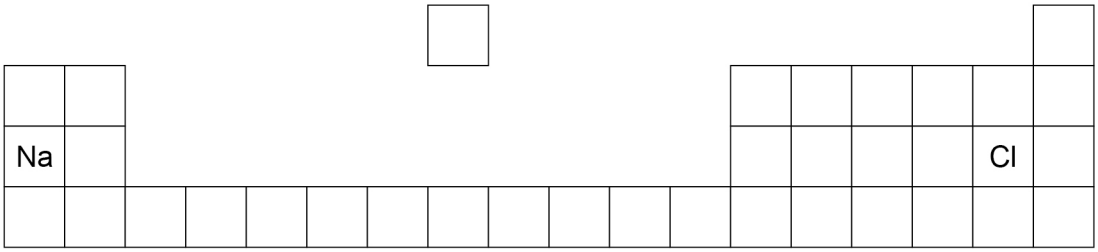
Question 01

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

0 2 This question is about sodium and chlorine.

Figure 2 shows the positions of sodium and chlorine in the periodic table.

Figure 2



0 2 . 1 State **one** difference and **one** similarity in the electronic structure of sodium and of chlorine.

[2 marks]

Difference _____

_____

Similarity _____

_____

0 2 . 2 Sodium atoms react with chlorine atoms to produce sodium chloride (NaCl).

Describe what happens when a sodium atom reacts with a chlorine atom.

Write about electron transfer in your answer.

[4 marks]

_____

_____

_____

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_____

5.1.1.4 Relative electrical charges of subatomic particles

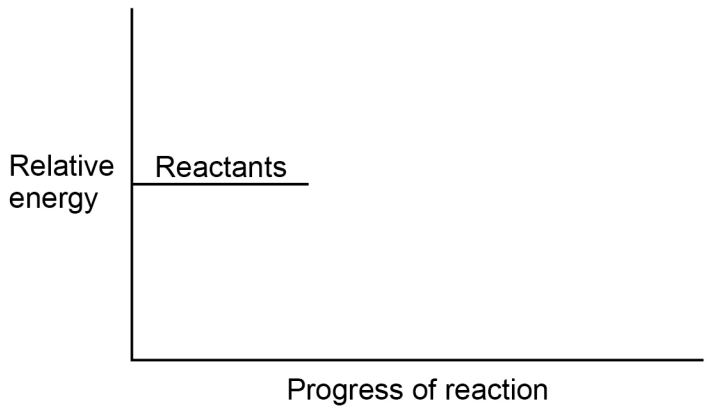
Question 01 · continued

0 2 . 3 The reaction between sodium and chlorine is an exothermic reaction.

Complete the reaction profile for the reaction between sodium and chlorine.

[2 marks]

Figure 3



8

5.1.1.4 Relative electrical charges of subatomic particles

Question 02

0 4 This question is about the halogens.

0 4 . 1 Write the state symbol for chlorine at room temperature.

[1 mark]

Cl_2 (_____)

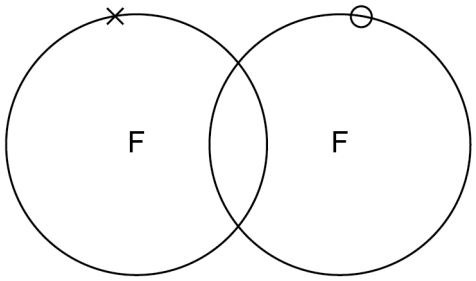
0 4 . 2 **Figure 4** represents one molecule of fluorine.

Complete the dot and cross diagram on **Figure 4**

You should show only the electrons in the outer shells.

[2 marks]

Figure 4



0 4 . 3 A fluorine atom can be represented as $^{19}_{9}F$

What is the total number of electrons in a fluorine molecule (F_2)?

[1 mark]

Tick **one** box.

9 ☐ 14 ☐ 18 ☐ 38 ☐

0 4 . 4 Aluminium reacts with bromine to produce aluminium bromide.

Complete the balanced chemical equation for this reaction.

[2 marks]

_____ Al + _____ Br_2 → 2 _____

5.1.1.4 Relative electrical charges of subatomic particles

Question 02 · continued

0 4 . 5 When chlorine reacts with potassium bromide, chlorine displaces bromine.

$$Cl_2 + 2\,KBr \rightarrow Br_2 + 2\,KCl$$

Explain why chlorine is more reactive than bromine.

[3 marks]

9

5.1.1.4 Relative electrical charges of subatomic particles

Question 03

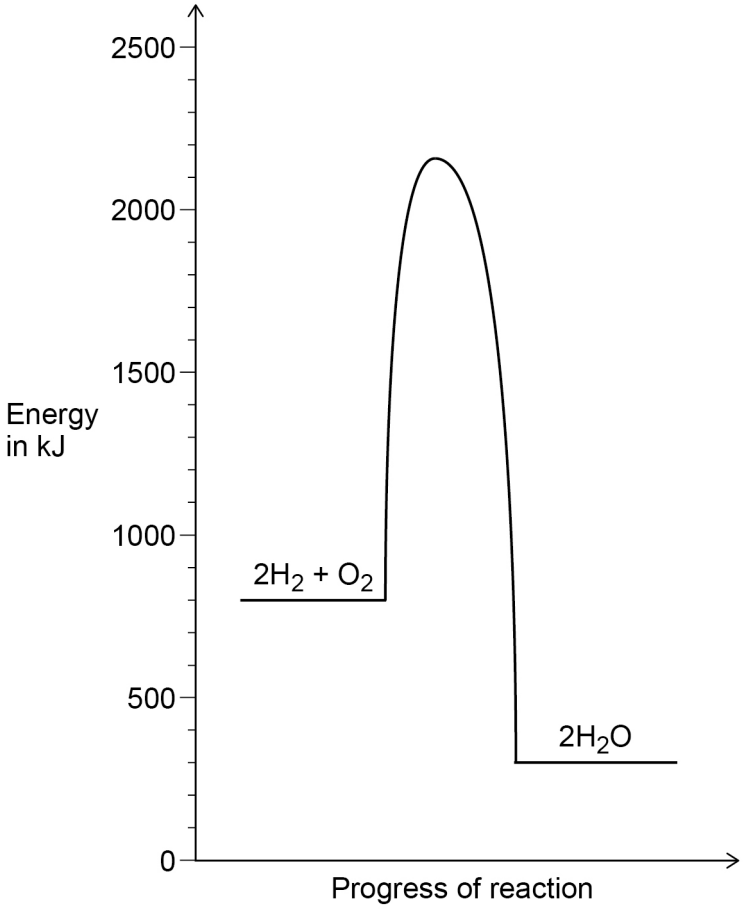
0 3 This question is about oxygen.

0 3 . 1 Hydrogen reacts with oxygen.

$$2\,H_2\,(g) + O_2\,(g) \rightarrow 2\,H_2O\,(g)$$

Figure 2 shows the relative energies of the reactants and products at a certain temperature.

Figure 2



Label the activation energy on **Figure 2**.

[1 mark]

5.1.1.4 Relative electrical charges of subatomic particles

Question 03 · continued

0 3 . 2 Determine the overall energy change for the reaction between hydrogen and oxygen shown in Question **03.1**

Use **Figure 2**.

[2 marks]

Energy change = _____ kJ

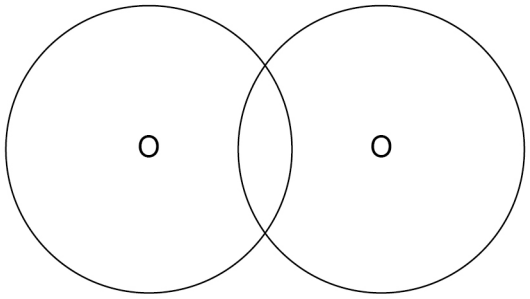
0 3 . 3 Oxygen is in Group 6 of the periodic table.

Figure 3 shows the outer energy levels in one molecule of oxygen (O_2).

Draw the electrons in the outer energy levels in **Figure 3**.

[2 marks]

Figure 3



Question 3 continues on the next page

5.1.1.4 Relative electrical charges of subatomic particles

Question 03 · continued

0 3 . 4 The equation shows the decomposition of hydrogen peroxide.

$$2\ H{-}O{-}O{-}H \rightarrow 2\ H{-}O{-}H + O{=}O$$

Table 1 shows the bond energies.

Table 1

Bond	**O–O**	**O=O**	**O–H**
Bond dissociation energy in kJ per mole	138	496	463

Calculate the overall energy change for the reaction.

[3 marks]

Energy change = _____ kJ

8

5.1.1.4 Relative electrical charges of subatomic particles

Question 04

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

0 4 This question is about elements in the periodic table.

0 4 . 1 What order did scientists use to arrange elements in early periodic tables?

[1 mark]

0 4 . 2 In the early periodic tables some elements were placed in the wrong groups.

Mendeleev overcame this in his periodic table.

Give **one** way Mendeleev did this.

[1 mark]

Question 4 continues on the next page

5.1.1.4 Relative electrical charges of subatomic particles

Question 04 · continued

Table 2 shows the boiling points of fluorine, chlorine and bromine.

Table 2

Element	Boiling point in °C
Fluorine	–186
Chlorine	–34
Bromine	+59

0 4 . 3 Explain why the boiling points in **Table 2** are low.

[2 marks]

0 4 . 4 Explain the trend in the boiling points in **Table 2**.

[3 marks]

5.1.1.4 Relative electrical charges of subatomic particles

Question 04 · continued

0 4 . 5 Explain why neon is unreactive.

Give the electronic structure of neon in your answer.

[2 marks]

0 4 . 6 How many atoms are there in 1 g of argon?

The Avogadro constant is 6.02×10^{23} per mole.

Relative atomic mass (A_r): Ar = 40

[2 marks]

Number of atoms in 1 g = _____

11

5.1.1.4 Relative electrical charges of subatomic particles

Question 05

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

0 1 This question is about the extraction of aluminium.

0 1 . 1 An aluminium atom is represented as:

$$^{27}_{13}Al$$

Give the number of electrons and neutrons in the aluminium atom.

[2 marks]

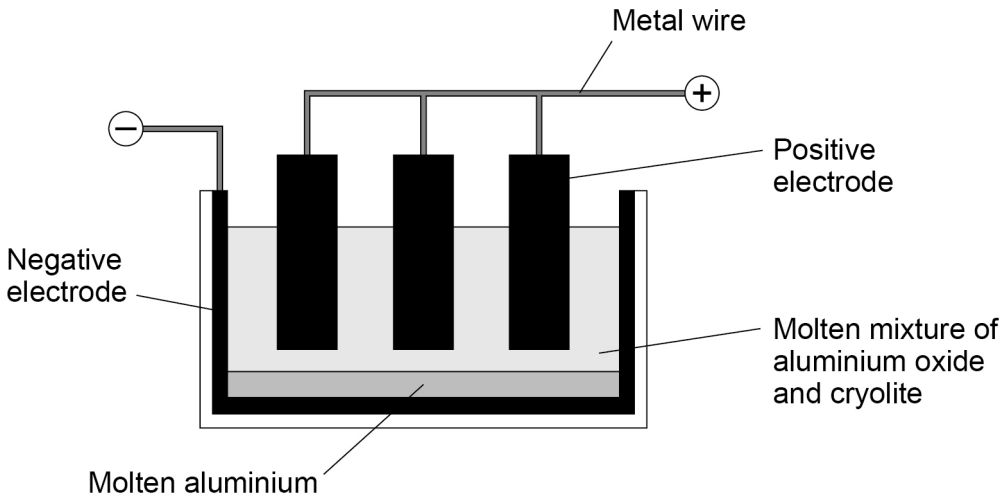
Number of electrons _____

Number of neutrons _____

Aluminium is extracted by the electrolysis of a molten mixture of aluminium oxide and cryolite.

Figure 1 shows the cell used for the electrolysis.

Figure 1



0 1 . 2 Aluminium is produced by the reduction of aluminium oxide (Al_2O_3).

What is meant by the term reduction?

[1 mark]

_____

_____

5.1.1.4 Relative electrical charges of subatomic particles

Question 05 · continued

0 1 . 3 Oxygen is formed at the positive carbon electrodes.

Explain why the positive carbon electrodes must be continually replaced.

[3 marks]

0 1 . 4 A substance conducts electricity because of free moving, charged particles.

What are the free moving, charged particles in a:

- carbon electrode (made from graphite)
- molten mixture of aluminium oxide and cryolite
- metal wire?

[3 marks]

Carbon electrode (made from graphite) _____

Molten mixture of aluminium oxide and cryolite _____

Metal wire _____

9

5.1.1.4 Relative electrical charges of subatomic particles

Question 06

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

0 7 This question is about elements.

Caesium is in Group 1 of the periodic table.

0 7 . 1 Explain what happens to caesium atoms and to oxygen atoms when caesium reacts with oxygen to produce caesium oxide.

You should answer in terms of electrons.

[4 marks]

0 7 . 2 Explain why caesium is more reactive than sodium.

You should answer in terms of electrons.

[4 marks]

5.1.1.4 Relative electrical charges of subatomic particles

Question 06 · continued

0 7 . 3 **Figure 6** shows part of Mendeleev's periodic table.

Figure 6

16 **O**	19 **F**
32 **S**	35.5 **Cl**
79 **Se**	80 **Br**
128 **Te**	127 **I**

Explain why the early periodic tables placed iodine (I) before tellurium (Te), but then Mendeleev placed tellurium before iodine.

[3 marks]

11

5.1.1.4 Relative electrical charges of subatomic particles

Question 07

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

0 6 This question is about hydrogen chloride and hydrochloric acid.

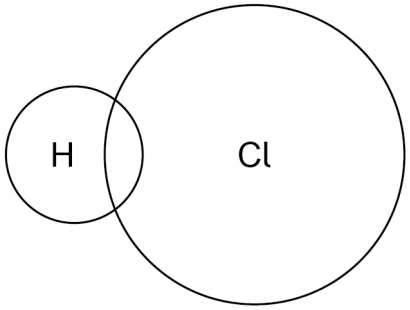
0 6 . 1 Complete the dot and cross diagram to represent the bonding in hydrogen chloride on **Figure 7**.

Use dots (o) and crosses (x) to represent electrons.

You should show only the electrons in the outer shells.

[2 marks]

Figure 7



0 6 . 2 Hydrogen chloride dissolves in water to produce hydrochloric acid.

Hydrochloric acid is a strong acid.

What is meant by the term strong acid?

[1 mark]

0 6 . 3 Describe how magnesium can be used to distinguish between a strong acid and a weak acid of the same concentration.

[2 marks]

5.1.1.4 Relative electrical charges of subatomic particles

Question 07 · continued

0 6 . 4 The concentration of hydrochloric acid is increased by a factor of 100

What is the change in pH?

[2 marks]

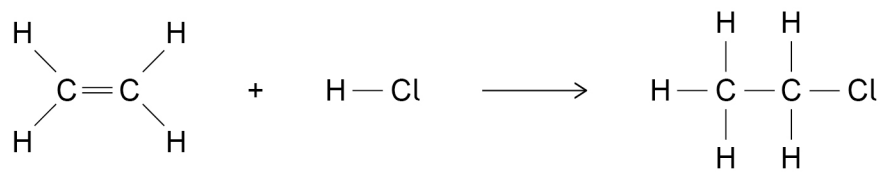
Question 6 continues on the next page

5.1.1.4 Relative electrical charges of subatomic particles

Question 07 · continued

0 6 . 5 Ethene and hydrogen chloride react to produce chloroethane.

The displayed formulae equation for the reaction is:



The reaction is exothermic.

In the reaction the energy released forming new bonds is 56 kJ/mol greater than the energy needed to break existing bonds.

Table 1 shows some bond energies.

Table 1

Bond	H–C	C=C	H–Cl	C–C	C–Cl
Bond energy in kJ/mol	413	**X**	431	346	339

Calculate the bond energy **X**.

[4 marks]

X = _____ kJ/mol

11

5.1.1.4 Relative electrical charges of subatomic particles

Question 08

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

0 3 Sodium is in Group 1 of the periodic table.

Sodium reacts with oxygen to produce sodium oxide.

0 3 . 1 Balance the equation for the reaction.

[1 mark]

$$___\ Na + O_2 \rightarrow ___\ Na_2O$$

0 3 . 2 Explain what happens to sodium atoms and to oxygen atoms when sodium reacts with oxygen to produce sodium oxide (Na_2O).

Answer in terms of electrons.

[4 marks]

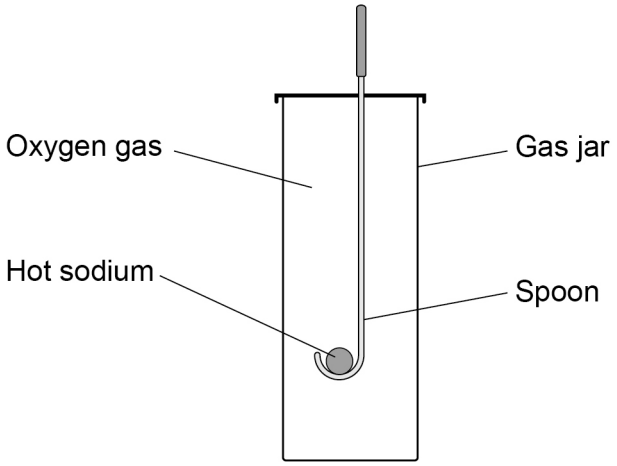
5.1.1.4 Relative electrical charges of subatomic particles

Question 08 · continued

0 3 . 3 Sodium burns in a gas jar of oxygen.

Figure 3 shows the apparatus.

Figure 3



Give **two** observations seen during the reaction.

[2 marks]

1 _____

_____

2 _____

_____

0 3 . 4 Describe **two** differences in the observations if potassium is used instead of sodium.

[2 marks]

1 _____

_____

2 _____

_____

9

5.1.1.4 Relative electrical charges of subatomic particles

Question 09

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

0 4 Group 7 elements are known as the halogens.

All atoms of Group 7 elements contain protons, neutrons and electrons.

0 4 . 1 What is the order of discovery of the proton, neutron and electron?

[1 mark]

Tick (✓) **one** box.

electron → neutron → proton ☐

electron → proton → neutron ☐

neutron → proton → electron ☐

proton → electron → neutron ☐

0 4 . 2 **Table 1** shows the mass of a proton and of an electron.

Table 1

Name of particle	Mass in kg
Proton	1.673×10^{-27}
Electron	9.109×10^{-31}

Calculate how many times heavier a proton is than an electron.

[2 marks]

Times heavier a proton is than an electron = _____

5.1.1.4 Relative electrical charges of subatomic particles

Question 09 · continued

A bromine atom can be represented as $^{81}_{35}Br$.

0 4 . 3 What is the number of neutrons in this bromine atom?

[1 mark]

0 4 . 4 What is the number of electrons in a bromide **ion**?

[1 mark]

0 4 . 5 Chlorine has two isotopes.

Table 2 shows the percentage abundance of the two isotopes of chlorine.

Table 2

Isotope	Percentage (%) abundance
$^{35}_{17}Cl$	75.77
$^{37}_{17}Cl$	24.23

Calculate the relative atomic mass (A_r) of chlorine.

Give your answer to 2 decimal places.

[3 marks]

Relative atomic mass (2 decimal places) = _____

5.1.1.4 Relative electrical charges of subatomic particles

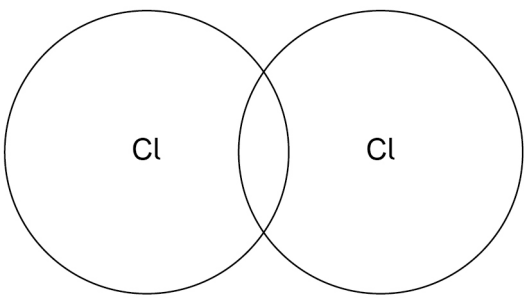
Question 09 · continued

0 4 . 6 **Figure 4** shows the outer shells in one molecule of chlorine (Cl_2).

Complete the dot and cross diagram to show the electrons in the outer shells.

[2 marks]

Figure 4



10

5.1.1.4 Relative electrical charges of subatomic particles

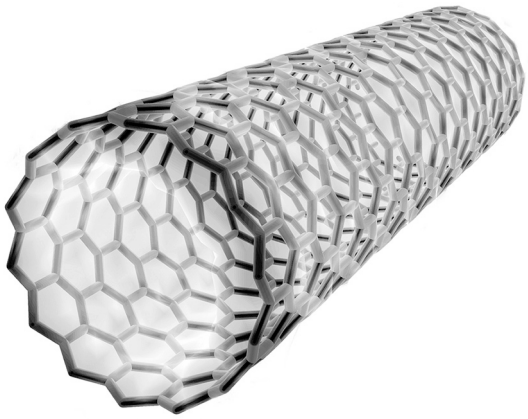
Question 10

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

0 8 Carbon nanotubes are cylindrical fullerenes.

Figure 11 represents the structure of a carbon nanotube.

Figure 11



0 8 . 1 Describe the arrangement of carbon atoms in the nanotube shown in **Figure 11**.

[1 mark]

0 8 . 2 Nanotubes are used in electronics.

Give **one** other use of nanotubes.

[1 mark]

5.1.1.4 Relative electrical charges of subatomic particles

Question 10 · continued

0 8 . 3 A nanotube contains 2380 carbon atoms.

Calculate the number of moles of carbon in this nanotube.

The Avogadro constant is 6.02×10^{23} per mole.

[2 marks]

Number of moles of carbon = _____ mols

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

Refer to bonding between carbon atoms in your answer.

[3 marks]

7

5.1.1.4 Relative electrical charges of subatomic particles

Question 11

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

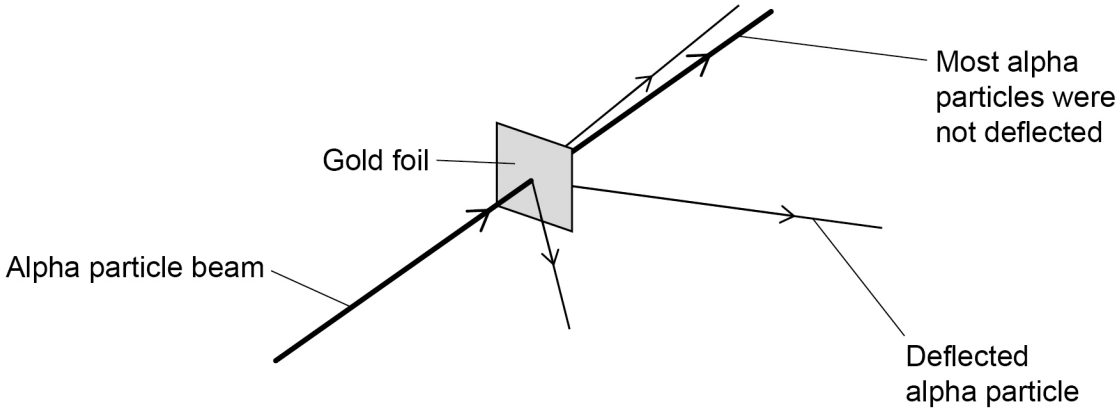
0 3 This question is about atoms, ions and elements.

0 3 . 1 **Figure 3** shows the results of the alpha particle scattering experiment.

In the experiment, alpha particles were fired at gold foil.

Alpha particles are positively charged.

Figure 3



What **two** conclusions were made from the results?

[2 marks]

Tick (✓) **two** boxes.

- Atoms are very small. ☐
- Atoms have a charged nucleus. ☐
- Electrons orbit the nucleus at specific distances. ☐
- Isotopes of an element have a different number of neutrons. ☐
- The mass of an atom is concentrated in the nucleus. ☐

5.1.1.4 Relative electrical charges of subatomic particles

Question 11 · continued

Particle **X** consists of:

- 35 protons
- 44 neutrons
- 36 electrons.

0 3 . 2 Why is particle **X not** an atom?

Answer in terms of subatomic particles.

[1 mark]

0 3 . 3 Which is the correct representation of particle **X**?

Use the periodic table.

[1 mark]

Tick (✓) **one** box.

$^{79}_{35}Br^{+}$ ☐

$^{79}_{35}Br^{-}$ ☐

$^{79}_{35}Se^{+}$ ☐

$^{79}_{35}Se^{-}$ ☐

5.1.1.4 Relative electrical charges of subatomic particles

Question 11 · continued

Group 7 elements are known as the halogens.

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]

Question 3 continues on the next page

5.1.1.4 Relative electrical charges of subatomic particles

Question 11 · continued

0 3 . 5 Chlorine reacts with fluorine to form a compound with the formula ClF_3

What is the type of bonding in the compound ClF_3?

[1 mark]

0 3 . 6 Chlorine reacts with a solution of sodium bromide.

Complete the word equation for the reaction.

[1 mark]

chlorine + sodium bromide ⟶ _____ + _____

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

[3 marks]

12

5.1.1.4 Relative electrical charges of subatomic particles

Question 12

0 5 This question is about hydrogen chloride (HCl) and hydrogen chlorate (HOCl).

Hydrogen chloride and hydrogen chlorate both form acids when dissolved in water.

0 5 . 1 Hydrogen chloride gas dissolves in water to form hydrochloric acid.

Give the state symbols for:

- hydrogen chloride
- water
- hydrochloric acid.

[1 mark]

Hydrogen chloride _____

Water _____

Hydrochloric acid _____

0 5 . 2 A solution of hydrochloric acid has:

- a pH of 2.5
- a concentration of H^+ ions of 3.16×10^{-3} mol/dm^3.

What is the concentration of H^+ ions in a solution of hydrochloric acid that has a pH of 3.5?

[1 mark]

_____

Concentration = _____ mol/dm^3

5.1.1.4 Relative electrical charges of subatomic particles

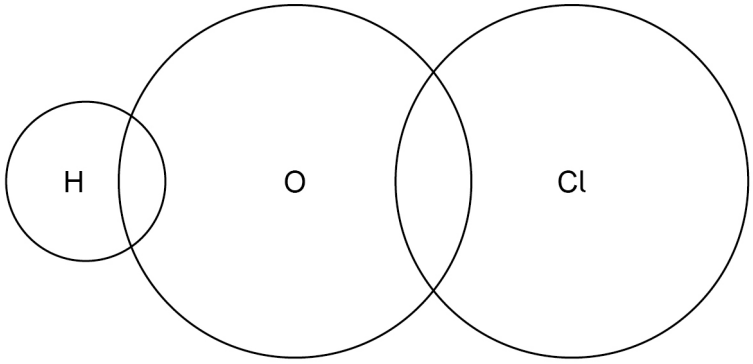
Question 12 · continued

0 5 . 3 **Figure 5** shows the outer shells in one molecule of hydrogen chlorate (HOCl).

Complete the dot and cross diagram to show the electrons in the outer shells.

[2 marks]

Figure 5



0 5 . 4 Hydrogen chlorate dissolves in water to form a weak acid.

Explain why a weak acid has a higher pH than a strong acid of the same concentration.

[2 marks]

Question 5 continues on the next page

5.1.1.4 Relative electrical charges of subatomic particles

Question 12 · continued

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

Figure 6 represents the equation for the reaction.

Figure 6

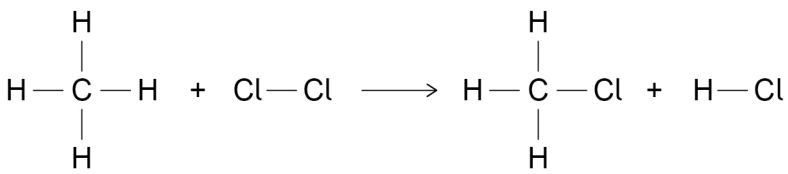


Table 4 shows the bond energies.

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]

Overall energy change = _____ kJ/mol

9