AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.2.1.4

Covalent bonding

Past-paper questions

Tier	**Higher**
Question groups	**7**
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.

5.2.1.4 Covalent bonding

Question 01

0 4 This question is about the halogens.

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

[1 mark]

Cl_2 (_____)

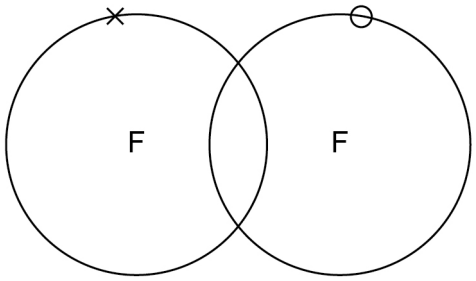
0 4 . 2 **Figure 4** represents one molecule of fluorine.

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 _____

5.2.1.4 Covalent bonding

Question 01 · 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

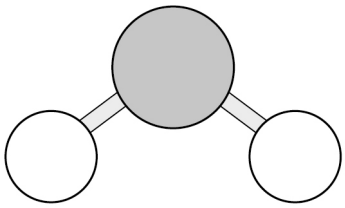
5.2.1.4 Covalent bonding

Question 02

0 2 This question is about substances with covalent bonding.

0 2 . 1 **Figure 2** shows a ball and stick model of a water molecule (H_2O).

Figure 2



Suggest **one** limitation of using a ball and stick model for a water molecule.

[1 mark]

_____

_____

_____

0 2 . 2 Ice has a low melting point.

Water molecules in ice are held together by intermolecular forces.

Complete the sentence.

[1 mark]

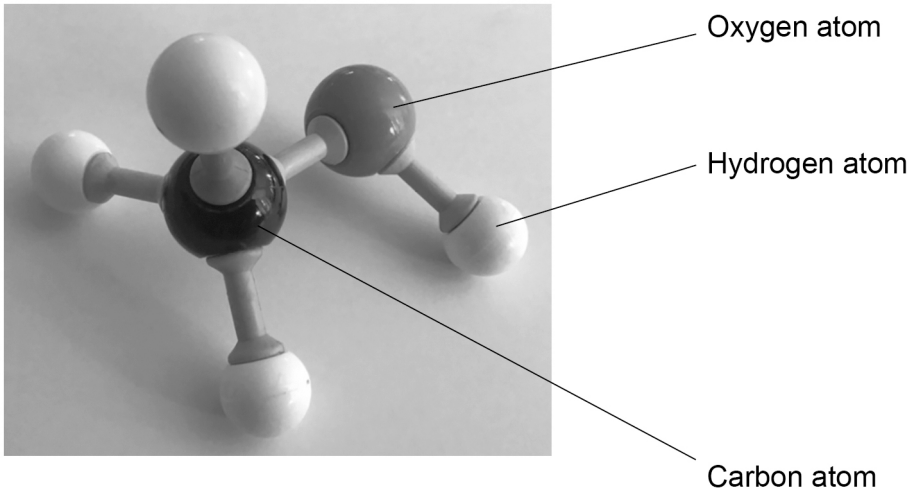
Ice has a low melting point because the

intermolecular forces are _____.

5.2.1.4 Covalent bonding

0 2 . 3 **Figure 3** shows the structure of a molecule.

Figure 3



What is the molecular formula of the molecule in **Figure 3**?

[1 mark]

Question 2 continues on the next page

5.2.1.4 Covalent bonding

Question 02 · continued

Diamond has a giant covalent structure.

0 2 . 4 What is the number of bonds formed by each carbon atom in diamond?

[1 mark]

Tick (✓) **one** box.

2 ☐ 3 ☐ 4 ☐ 8 ☐

0 2 . 5 Give **two** physical properties of diamond.

[2 marks]

1 _____

2 _____

0 2 . 6 Name **two** other substances with giant covalent structures.

[2 marks]

1 _____

2 _____

8

5.2.1.4 Covalent bonding

Question 03

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

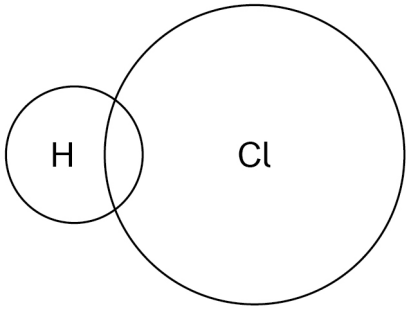
0 6 . 1 Complete the dot and cross diagram to represent the bonding in hydrogen chloride on **Figure 7**.

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]

5.2.1.4 Covalent bonding

Question 03 · continued

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

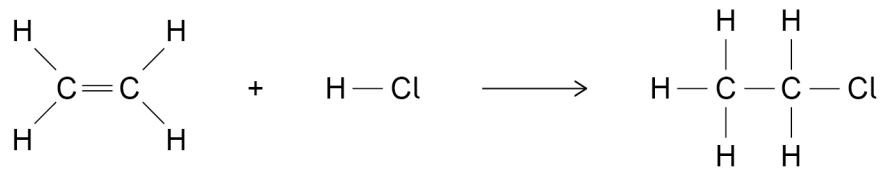
What is the change in pH?

[2 marks]

Question 6 continues on the next page

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

5.2.1.4 Covalent bonding

Question 04

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 = _____

5.2.1.4 Covalent bonding

Question 04 · 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) = _____

5.2.1.4 Covalent bonding

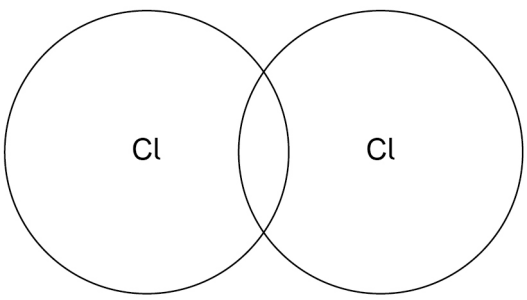
Question 04 · continued

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



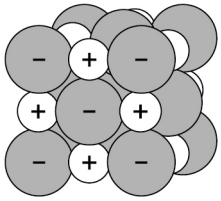
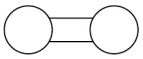
10

5.2.1.4 Covalent bonding

Question 05

0 3 **Table 2** shows diagrams which represent the structures of two substances.

Table 2

Substance	Structure
Sodium chloride NaCl	
Oxygen O_2	

Compare the structure and bonding of sodium chloride and oxygen.

[6 marks]

6

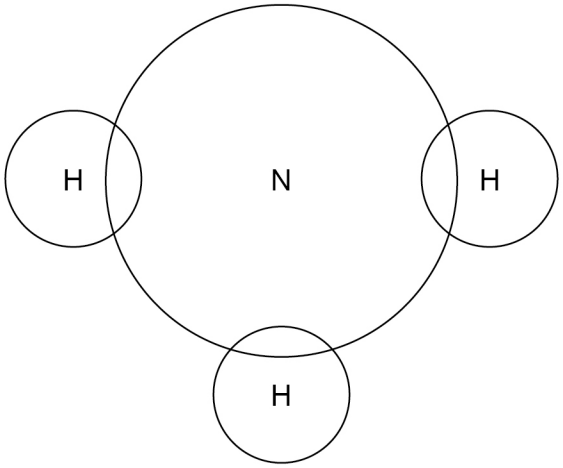
5.2.1.4 Covalent bonding

Question 06

0 5 Nitrogen reacts with hydrogen to produce ammonia (NH_3).

0 5 . 1 Complete the dot and cross diagram for an ammonia molecule.

[2 marks]



5.2.1.4 Covalent bonding

Question 06 · continued

0 5 . 2 The equation for the reaction between nitrogen and hydrogen to produce ammonia is:

$$N_2 + 3H_2 \rightarrow 2NH_3$$

Calculate the mass of hydrogen that is needed to produce 25 g of ammonia.

Relative atomic masses (A_r): H = 1 N = 14

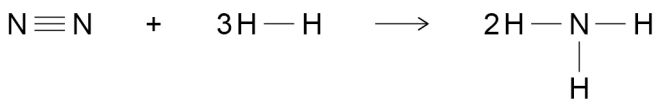
[4 marks]

Mass of hydrogen = _____ g

Question 5 continues on the next page

Figure 7 shows the displayed formulae equation for the reaction of nitrogen with hydrogen.

Figure 7



In the reaction the energy released forming new bonds is 93 kJ/mol greater than the energy needed to break existing bonds.

Table 3 shows bond energies.

Table 3

Bond	N≡N	H—H	N—H
Bond energy in kJ/mol	945	**X**	391

0 5 . 3 Calculate the bond energy **X** for the H—H bond.

Use **Figure 7** and **Table 3**.

[5 marks]

X = _____ kJ/mol

5.2.1.4 Covalent bonding

Question 06 · continued

0 5 . 4 Energy is released from the reaction to produce ammonia.

Figure 8 shows part of the reaction profile for the reaction between nitrogen and hydrogen to produce ammonia.

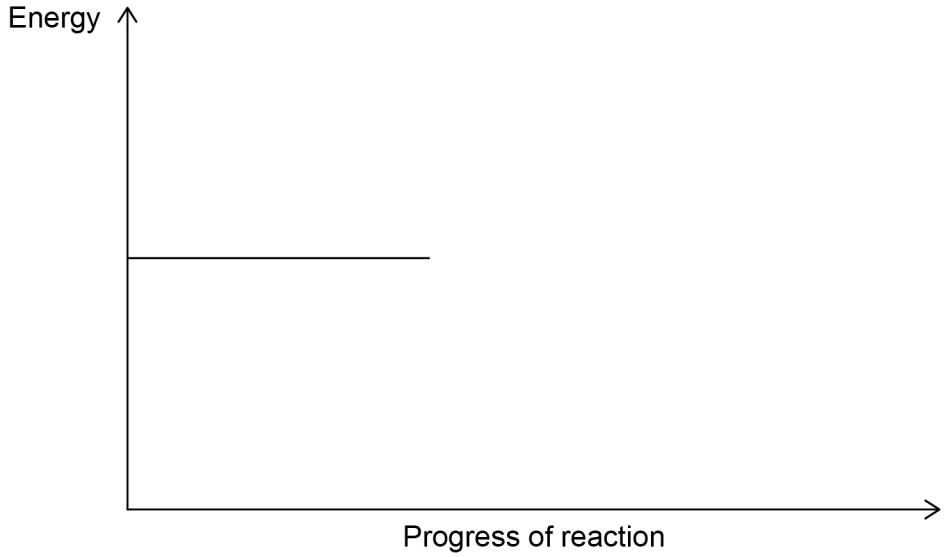
Complete **Figure 8**.

You should:

- complete the profile line
- label the energy level of the reactants and the product
- label the **overall** energy change.

[3 marks]

Figure 8



14

5.2.1.4 Covalent bonding

Question 07

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

5.2.1.4 Covalent bonding

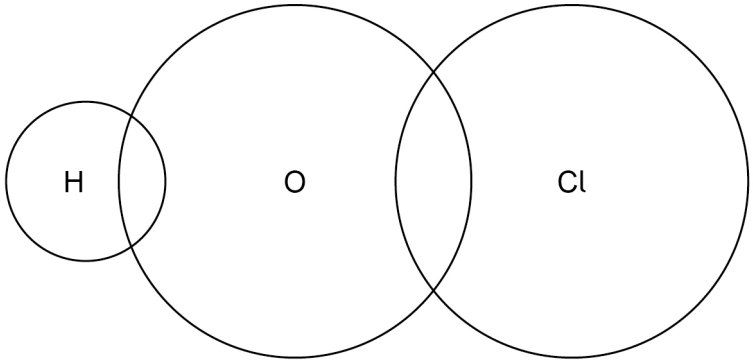
Question 07 · continued

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

5.2.1.4 Covalent bonding

Question 07 · 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

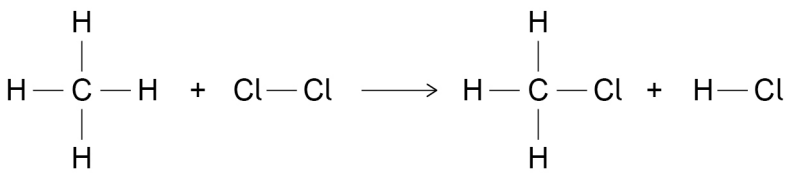


Table 4 shows the bond energies.

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