

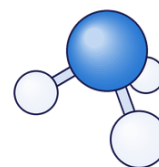
GCSE CHEMISTRY

Covalent Bonding

AQA-style Topic Practice

Based on AQA GCSE Chemistry (8462)

Tier: Mixed demand



Name _____

Date _____

Instructions

- Use black ink or black ball-point pen.
- Answer all questions in the spaces provided.
- Do all rough work in this booklet.
- In all calculations, show clearly how you work out your answer.

Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 49.
- You are expected to use a calculator where appropriate.
- Write clearly, use scientific terms correctly and organise your answers logically.

For marking	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
TOTAL	

These are original practice questions written in the style of AQA GCSE Chemistry (8462). They are not official AQA examination questions and are not endorsed by AQA.

Q1.

This question is about covalent bonding.

- (a) Which **two** substances consist of small molecules?

Tick (✓) **two** boxes.

Ammonia, NH_3

☐

Calcium oxide, CaO

☐

Methane, CH_4

☐

Potassium chloride, KCl

☐

Sodium, Na

☐

(2)

- (b) Hydrazine, N_2H_4 , is a compound of nitrogen and hydrogen.

What type of bonding is in hydrazine?

Tick (✓) **one** box.

Covalent

☐

Ionic

☐

Metallic

☐

(1)

- (c) Covalent bonds are strong.

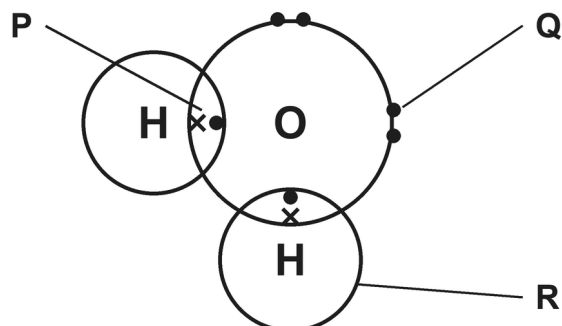
Explain how a covalent bond holds two atoms together.

(2)

Q2.

Figure 1 shows a dot and cross diagram for a molecule of water, H_2O .

Figure 1



- (a) Which label shows a lone pair of electrons?

Tick (✓) **one** box.

P ☐

Q ☐

R ☐

(1)

- (b) What does each cross in Figure 1 represent?

(1)

- (c) Figure 2 shows the atoms in a molecule of water.

Figure 2



Complete Figure 2 to show the displayed formula of water.

Use a line to represent each covalent bond.

(1)

- (d) Give **one** limitation of using a dot and cross diagram to represent a molecule of water.

(1)

Q3.

Nitrogen, N_2 , makes up most of the air.

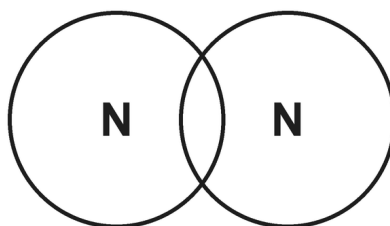
A nitrogen atom has five electrons in its outer shell.

- (a) How many more electrons does a nitrogen atom need to have a full outer shell?

(1)

- (b) Figure 3 shows the outer shells of the two atoms in a nitrogen molecule.

Figure 3



Complete Figure 3 to show the covalent bonding in a nitrogen molecule.

Show the outer shell electrons only.

(2)

- (c) The two atoms in a nitrogen molecule are joined by a triple bond, which is very strong. Nitrogen boils at $-196\text{ }^{\circ}\text{C}$.

Explain why nitrogen has a low boiling point even though the triple bond is very strong.

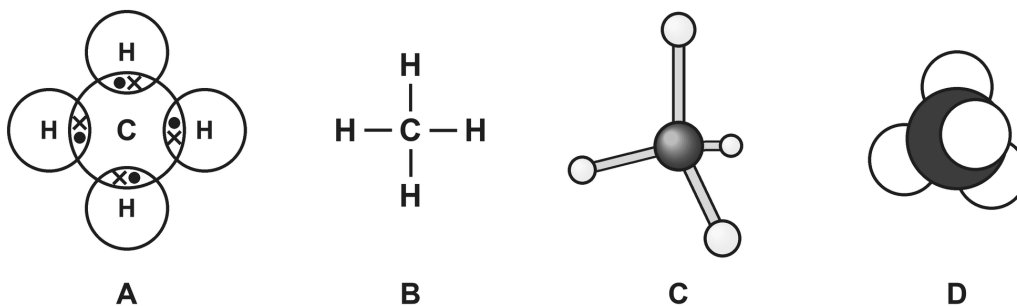
(3)

Q4.

A methane molecule, CH_4 , can be represented in different ways.

Figure 4 shows four representations of a methane molecule, A, B, C and D.

Figure 4



- (a) Draw **one** line from each representation listed below to what it shows most clearly.

Representation	What it shows most clearly
Dot and cross diagram (A)	The relative sizes of the atoms
Ball and stick model (C)	Which atom each electron came from
Space-filling model (D)	The three-dimensional shape and the angles between the bonds
	The charges on the ions

(2)

- (b) What does each line in representation B represent?

(1)

- (c) Give **one** limitation of representation C.

(1)

Q5.

The halogens are the elements in Group 7. Each halogen consists of small molecules made of two atoms.

Table 1 shows information about four halogens.

Table 1

Halogen	Formula	Relative formula mass	Melting point in °C	Boiling point in °C
Fluorine	F ₂	38	-220	-188
Chlorine	Cl ₂	71	-101	-34
Bromine	Br ₂	160	-7	59
Iodine	I ₂	254	114	184

- (a) Which halogen in Table 1 is a liquid at 20 °C?

(1)

- (b) Describe the pattern in the boiling points shown in Table 1.

(1)

- (c) Explain the pattern in the boiling points.

(2)

- (d) Astatine is below iodine in Group 7. The relative formula mass of At_2 is 420.

Predict the state of astatine at 20 °C.

Give a reason for your answer.

(2)

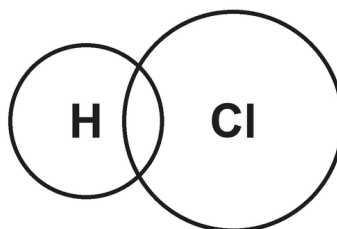
Q6.

Hydrogen chloride, HCl , is a gas at room temperature.

A hydrogen atom has one electron. A chlorine atom has seven electrons in its outer shell.

- (a) Figure 5 shows the outer shells of the atoms in a hydrogen chloride molecule.

Figure 5



Complete Figure 5 to show the covalent bonding in a hydrogen chloride molecule.

Show the outer shell electrons only.

(2)

- (b) Hydrogen chloride has a low boiling point and does not conduct electricity when it is a liquid.

Draw **one** line from each property to the explanation of the property.

Property	Explanation of property
	Electrons are free to move
Low boiling point	There are no charged particles free to move
	Strong covalent bonds
Does not conduct electricity when liquid	Weak forces between molecules
	Ions are free to move

(2)

- (c) A student wrote:

'When hydrogen chloride boils, the covalent bonds between the hydrogen and chlorine atoms break.'

Explain why the student is wrong.

(2)

Q7.

Atoms have a radius of about 0.1 nm.

$$1 \text{ nm} = 1 \times 10^{-9} \text{ m}$$

- (a) Give the radius of an atom in metres.

Give your answer in standard form.

Radius = _____ m

(1)

- (b) A chlorine molecule is about 4×10^{-10} m long.

A full stop printed on this page is about 5×10^{-4} m across.

Calculate how many chlorine molecules, placed end to end, would fit across the full stop.

Number of molecules = _____

(2)

Q8.

A student tested three substances, W, X and Y.

Table 2 shows the results.

Table 2

Substance	Melting point in °C	Boiling point in °C	Conducts electricity when liquid
W	801	1413	yes
X	-95	69	no
Y	1085	2562	yes

- (a) Which substance consists of small molecules?

Tick (✓) **one** box.

W ☐

X ☐

Y ☐

(1)

- (b) Give **two** reasons for your answer.

Use Table 2.

1 _____

2 _____

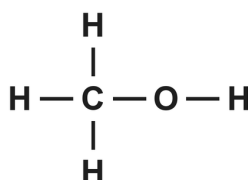
(2)

Q9.

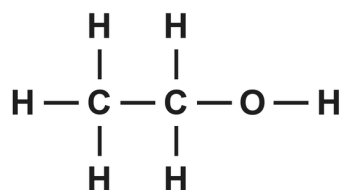
Alcohols are compounds that consist of small molecules.

Figure 6 shows the displayed formulae of two alcohols.

Figure 6



Methanol



Ethanol

- (a) Determine the molecular formula of ethanol.

Use Figure 6.

Molecular formula = _____

(1)

- (b) Table 3 shows the boiling points of three alcohols.

Table 3

Alcohol	Relative formula mass	Boiling point in °C
Methanol	32	65
Ethanol	46	78
Propan-1-ol	60	97

Explain why ethanol has a higher boiling point than methanol.

(2)

- (c) Butan-1-ol is the next alcohol in the series. Its relative formula mass is 74.

Estimate the boiling point of butan-1-ol.

Use Table 3.

Boiling point = _____ °C

(1)

- (d) A student concluded:

'The boiling point increases by the same amount from each alcohol to the next.'

Do the data in Table 3 support this conclusion?

Give a reason for your answer.

(2)

Q10.

Oxygen, O_2 , and ammonia, NH_3 , both consist of small molecules.

Oxygen is in Group 6. Nitrogen is in Group 5. A hydrogen atom has one electron.

Both substances are gases at room temperature and do not conduct electricity.

Describe the covalent bonding in a molecule of oxygen and in a molecule of ammonia.

Explain why both substances are gases at room temperature and do not conduct electricity.

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(6)

END OF QUESTIONS

Mark scheme

Credit any answer that is scientifically correct and has the same meaning as the answer given, unless the extra information says otherwise. Words in brackets are not needed to gain the mark.

Qu.	Answers	Extra information	Mark	AO / Spec. ref.
1(a)	Ammonia, NH ₃ Methane, CH ₄	1 mark for each correct box ticked if more than two boxes are ticked, deduct 1 mark for each extra box, to a minimum of 0	2	AO1 (1) AO2 (1) 4.2.1.4
1(b)	Covalent	if more than one box is ticked, award no mark	1	AO2 (1) 4.2.1.1
1(c)	the atoms share a pair of electrons (electrostatic) attraction between the shared pair (of electrons) and the nuclei (of both atoms)	allow electrons are shared for the first marking point do not accept attraction between ions or between oppositely charged atoms	2	AO1 (2) 4.2.1.1
Total			5	

Qu.	Answers	Extra information	Mark	AO / Spec. ref.
2(a)	Q	if more than one box is ticked, award no mark	1	AO2 (1) 4.2.1.4
2(b)	an electron from a hydrogen atom	allow (outer shell) electron of hydrogen do not accept electron alone	1	AO2 (1) 4.2.1.4
2(c)	H–O–H, with one line between the oxygen atom and each hydrogen atom	ignore lone pairs if drawn do not accept a line between the two hydrogen atoms	1	AO1 (1) 4.2.1.4
2(d)	any one from: • does not show the (three-dimensional) shape of the molecule • does not show the angle between the bonds • does not show the relative sizes of the atoms • electrons are not really fixed in position / electrons are all the same	ignore it is not the real colour	1	AO1 (1) 4.2.1.4
Total			4	

Qu.	Answers	Extra information	Mark	AO / Spec. ref.
3(a)	3	allow three	1	AO2 (1) 4.2.1.4
3(b)	three pairs of electrons in the overlap (each pair one dot and one cross) one lone pair on each nitrogen atom	allow any symbols for electrons if the two atoms' electrons are distinguished do not award the second marking point if either atom has more or fewer than 8 electrons in its outer shell ignore inner electrons if drawn	2	AO1 (2) 4.2.1.4
3(c)	(nitrogen consists of) small molecules with weak intermolecular forces between them little energy is needed to overcome the intermolecular forces the (triple / covalent) bond is not broken when nitrogen boils	allow weak forces between molecules for intermolecular forces if the answer states that covalent bonds break on boiling, award a maximum of 1 mark	3	AO1 (1) AO2 (2) 4.2.2.4
Total			6	

Qu.	Answers	Extra information	Mark	AO / Spec. ref.
4(a)	Dot and cross diagram → Which atom each electron came from Ball and stick model → The three-dimensional shape and the angles between the bonds Space-filling model → The relative sizes of the atoms	all three lines correct = 2 marks one or two lines correct = 1 mark more than one line from a representation cancels the mark for that representation	2	AO1 (2) 4.2.1.4
4(b)	a (single) covalent bond	allow a shared pair of electrons do not accept a bond alone	1	AO1 (1) 4.2.1.4
4(c)	any one from: • does not show the electrons / which electrons are shared • the bonds are not really sticks • the atoms are much closer together than shown • the sizes of the atoms are not to scale	ignore it is not the real colour	1	AO1 (1) 4.2.1.4
Total			4	

Qu.	Answers	Extra information	Mark	AO / Spec. ref.
5(a)	bromine	allow Br ₂	1	AO2 (1) 4.2.2.1
5(b)	the boiling point increases as the relative formula mass increases	allow boiling point increases down the table / group allow the bigger the molecule, the higher the boiling point	1	AO3 (1) 4.2.2.4
5(c)	the intermolecular forces increase as the size of the molecules increases so more energy is needed to overcome them	allow the forces between molecules are stronger in larger molecules if the answer states that covalent bonds break, award a maximum of 1 mark	2	AO1 (2) 4.2.2.4
5(d)	solid (1) the trend suggests that astatine would have a higher melting point than iodine / its melting point would be above 20 °C (1)	allow equivalent reasoning: At ₂ molecules are larger than I ₂ molecules, so the intermolecular forces would be stronger, more energy would be needed to overcome them, and the melting point would be expected to be higher than iodine's the reason must support the prediction that astatine is a solid at 20 °C; do not award the second marking point without the first students do not need to know an actual melting point for astatine	2	AO2 (1) AO3 (1) 4.2.2.1 · 4.2.2.4
Total			6	

Qu.	Answers	Extra information	Mark	AO / Spec. ref.
6(a)	one dot and one cross in the overlap three lone pairs on the chlorine atom	allow any symbols for electrons if the two atoms' electrons are distinguished the chlorine atom must have 8 electrons in its outer shell and the hydrogen atom 2	2	AO1 (2) 4.2.1.4
6(b)	Low boiling point → Weak forces between molecules Does not conduct electricity when liquid → There are no charged particles free to move	1 mark for each correct line more than one line from a property cancels the mark for that property	2	AO1 (2) 4.2.2.4
6(c)	the covalent bonds do not break / only the intermolecular forces are overcome because the intermolecular forces are weak, but the covalent bonds are strong	allow the molecules move apart but stay whole for the first marking point allow forces between molecules for intermolecular forces	2	AO2 (1) AO3 (1) 4.2.2.4
Total			6	

Qu.	Answers	Extra information	Mark	AO / Spec. ref.
7(a)	1×10^{-10} (m)	allow 1.0×10^{-10} do not accept 0.1×10^{-9} , which is not in standard form	1	AO2 (1) 4.1.1.5 · WS 4.4
7(b)	$(5 \times 10^{-4}) \div (4 \times 10^{-10})$ $= 1.25 \times 10^6$	award 2 marks for the correct answer with no working shown allow 1 250 000 or 1.3×10^6 award 1 mark for 1.25×10^n with an incorrect power of ten	2	AO2 (2) 4.1.1.5 · WS 4.4
Total			3	

Qu.	Answers	Extra information	Mark	AO / Spec. ref.
8(a)	X	if more than one box is ticked, award no mark	1	AO3 (1) 4.2.2.4
8(b)	low melting point / boiling point does not conduct electricity (when liquid)	allow it is a liquid at room temperature allow use of data, e.g. melting point -95°C ignore references to W and Y unless incorrect	2	AO3 (2) 4.2.2.4
Total			3	

Qu.	Answers	Extra information	Mark	AO / Spec. ref.
9(a)	C_2H_6O	allow C_2H_5OH allow the symbols in any order	1	AO2 (1) 4.2.1.4
9(b)	ethanol molecules are larger (than methanol molecules) / have a higher relative formula mass so the intermolecular forces are stronger and more energy is needed to overcome them	if the answer states that covalent bonds break, award a maximum of 1 mark	2	AO2 (2) 4.2.2.4
9(c)	any value from 110 to 125 ($^{\circ}C$)	the actual boiling point is 118 $^{\circ}C$	1	AO3 (1) 4.2.2.4 · WS 3.5
9(d)	no the increase from methanol to ethanol is 13 $^{\circ}C$, but from ethanol to propan-1-ol it is 19 $^{\circ}C$	the second marking point needs both differences, or a clear comparison using data from Table 3 do not award the first marking point without a reason	2	AO3 (2) WS 3.5
Total			6	

Question 10 is marked by levels of response. Decide which level best describes the answer, then award a mark within the level.

Level	Marks	Description
Level 3	5–6	A detailed and coherent answer. The bonding in both molecules is described in terms of shared pairs of electrons, including the double bond in oxygen. Both properties are explained in terms of weak intermolecular forces and the lack of charged particles.
Level 2	3–4	The bonding in at least one molecule is described in terms of shared electrons, and at least one property is explained. Some points may be missing or not linked.
Level 1	1–2	Simple statements about covalent bonds, molecules or the properties, with little or no explanation.
	0	No relevant content.

Qu.	Answers	Extra information	Mark	AO / Spec. ref.
10	Indicative content: • a covalent bond is a shared pair of electrons • each oxygen atom has 6 outer electrons and needs 2 more • the two oxygen atoms share two pairs of electrons: a double bond • each oxygen atom has two lone pairs • nitrogen has 5 outer electrons and needs 3 more; each hydrogen needs 1 more • nitrogen shares one pair of electrons with each of three hydrogen atoms: three single bonds • nitrogen has one lone pair • covalent bonds are strong • the intermolecular forces between the molecules are weak • little energy is needed to overcome them, so the boiling points are low / below room temperature • the covalent bonds are not broken when the substances boil • the molecules have no overall (electric) charge • so there are no charged particles free to move and carry a current	the indicative content is not a checklist; credit other relevant, correct points to reach Level 3, both molecules' bonding and both properties must be addressed if the answer states that covalent bonds break on boiling, it cannot reach Level 3	6	AO1 (3) AO2 (3) 4.2.1.4 · 4.2.2.4
Total			6	

Assessment objectives in this paper

Assessment objective	Marks
AO1 knowledge and understanding	21 (43%)
AO2 applying knowledge and understanding	19 (39%)
AO3 analysing, interpreting and evaluating	9 (18%)
Total	49