1 Hydrogen chloride is formed in the reaction between hydrogen and chlorine.
The equation for the reaction is

$$H_2 + Cl_2 \rightarrow 2HCl$$

(a) Each molecule in this equation contains the same type of bonding.

Name this type of bonding.

(1)

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(b) The bonding in a hydrogen molecule is strong.

Explain why the boiling point of hydrogen is low.

(2)

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(c) Explain how the two atoms in a chlorine molecule are held together.

(2)

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(d) Draw a dot and cross diagram to show the bonding in a hydrogen chloride molecule.

Show only the outer electrons in each atom.

(2)

(e) Hydrogen chloride gas dissolves in water to form solution A.

Hydrogen chloride gas dissolves in methylbenzene to form solution B.

A teacher adds a piece of magnesium ribbon to each solution.

Explain why she observes effervescence with solution A but not with solution B.

(3)

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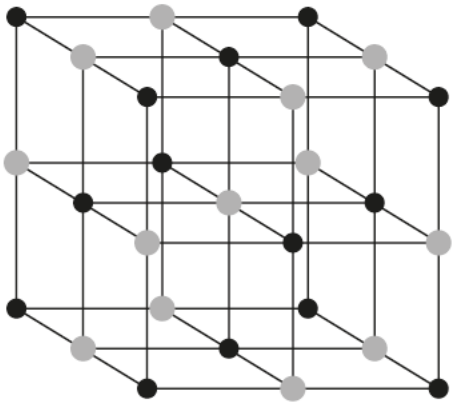
(Total for Question 1 = 10 marks)

2 Sodium chloride (NaCl) and silicon dioxide (SiO_2) both have giant lattice structures.

Sodium chloride is an ionic compound.

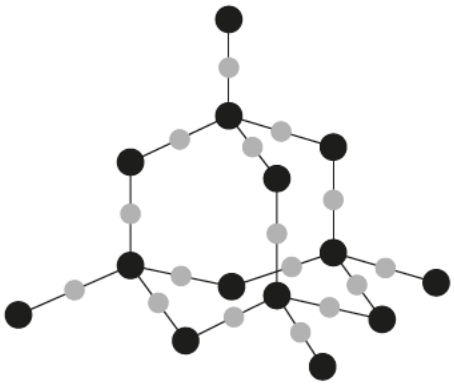
Silicon dioxide is a covalent compound.

Structure of sodium chloride



● Na^+ ● Cl^-

Structure of silicon dioxide



● Si ● O

The table shows some properties of each compound.

Sodium chloride	Silicon dioxide
melting point = 801 °C	melting point = 1610 °C
soluble in water	insoluble in water
conducts electricity when molten	does not conduct electricity when molten

(a) (i) Explain why silicon dioxide has a high melting point.

(2)

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(ii) Suggest why the melting point of silicon dioxide is higher than the melting point of sodium chloride.

(1)

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(b) State why sodium chloride conducts electricity when molten.

(1)

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(c) Carbon dioxide is described as a simple molecular substance.

State why carbon dioxide (CO_2) is a gas at room temperature.

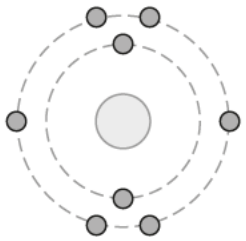
(1)

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(Total for Question 2 = 5 marks)

3 The diagram shows how the electrons are arranged in an atom of oxygen.



Oxygen atoms form both covalent and ionic bonds.

(a) Water is formed when two atoms of hydrogen combine with one atom of oxygen.

(i) Draw a dot and cross diagram of a molecule of water. You need only show the electrons in the outer shells.

(2)

(ii) Explain how the covalent bonds in the water molecule hold the hydrogen and oxygen atoms together.

(2)

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(b) The electronic configuration of a sodium atom is 2.8.1
Sodium oxide, Na_2O, is an ionic compound formed when sodium reacts with oxygen.

(i) Describe, in terms of electrons, what happens when sodium oxide is formed in this reaction.

(3)

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(ii) The reaction of sodium to form sodium oxide can be described as oxidation because it involves the addition of oxygen.

State one other reason why this reaction can be described as oxidation.

(1)

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(c) Explain why water has a much lower melting point than sodium oxide.

(2)

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(d) A teacher added sodium oxide to water in a beaker.
The equation shows the reaction that occurred.

$$Na_2O(.....) + H_2O(.....) \rightarrow 2NaOH(.....)$$

(i) Insert the appropriate state symbols in this equation.

(2)

(ii) Some universal indicator was then added to the beaker. A colour change occurred. State the final colour of the universal indicator and identify the ion responsible for the colour change.

(2)

Final colour .....

Ion responsible for colour change .....

(Total for Question 3 14 marks)

4 Ammonium chloride contains oppositely charged ions.

(a) State the formula of each ion.

(2)

Positive ion .....

Negative ion .....

(b) (i) Describe a chemical test to show that a substance contains ammonium ions.

(3)

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(ii) Describe a chemical test to show that a substance contains chloride ions.

(3)

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(c) Ammonium chloride decomposes when heated:

$$NH_4Cl(s) \rightleftharpoons NH_3(g) + HCl(g)$$

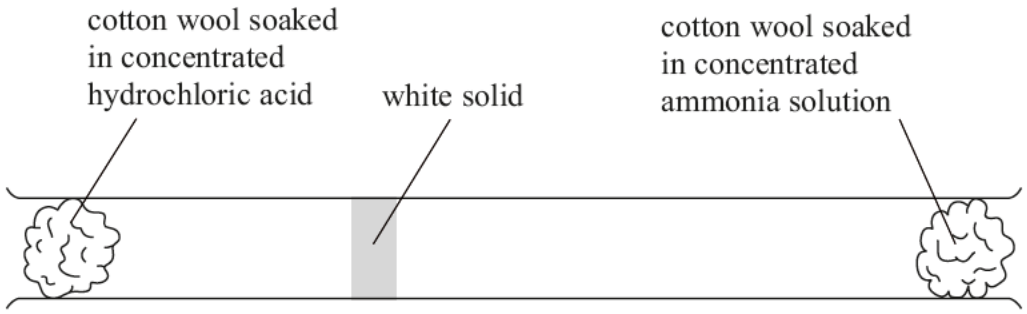
What does the $\rightleftharpoons$ symbol indicate about the reaction?

(1)

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(d) The reaction between ammonia and hydrogen chloride can be used to illustrate diffusion with the following apparatus.



After a few minutes, a white solid appears inside the tube.

(i) Identify the white solid.

(1)

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(ii) What does the diagram show about the speed of the ammonia molecules compared to the speed of the hydrogen chloride molecules?

(1)

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(e) State the main hazard when using concentrated hydrochloric acid in the experiment in (d).

Suggest **one** precaution you could use to minimise this hazard.

(2)

Hazard .....

Precaution .....

.....

(Total for Question 4 13 marks)