



The properties of hydrogen chloride

Learning objectives

- 1 Investigate the properties of hydrogen chloride gas.
- 2 Investigate the properties of dilute hydrochloric acid.
- 3 Compare the structure and bonding of HCl(g) and HCl(aq) .
- 4 Explain how the differences in structure and bonding in HCl(g) and HCl(aq) lead to different properties.

Introduction

Hydrogen chloride, HCl(g) , exists as a colourless, odourless gas at room temperature and pressure. When it dissolves in water, hydrochloric acid, HCl(aq) , is formed.

Teacher demonstration

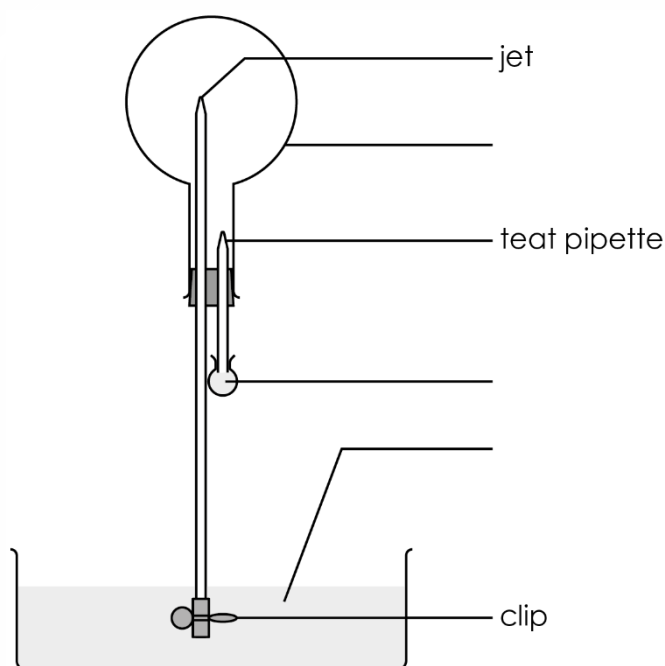
In this demonstration, you will observe the formation of hydrochloric acid from hydrogen chloride gas as it dissolves in water.

1. Use the words to label the diagram:

water

hydrogen chloride gas

water containing universal indicator





2. State the formula of hydrogen chloride. _____

3. Tick ✓ the box that best describes the colour of the universal indicator.

at the start

☐

red

☐

yellow

☐

green

☐

blue

at the end

☐

red

☐

yellow

☐

green

☐

blue

4. Name the solution formed at the end of the demonstration.

5. Complete the word equation to represent the changes that have taken place.

hydrogen chloride + _____ → _____



Class practical: investigating the properties of dilute hydrochloric acid

- Before you start, put on your eye protection.
- Dilute hydrochloric acid is an irritant, so take care not to get it on your skin.
- Carry out the following experiments. Note down your observations in a table.

Testing for pH

1. One-third fill a test tube with the hydrochloric acid.
2. Add a couple of drops of universal indicator solution.
3. Using a pipette, slowly add sodium hydroxide solution. Shake to mix after each addition. Continue adding the alkali until no more changes are observed.

Testing with magnesium

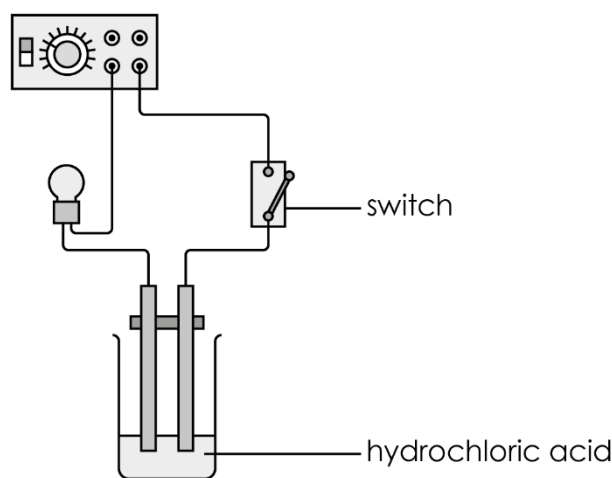
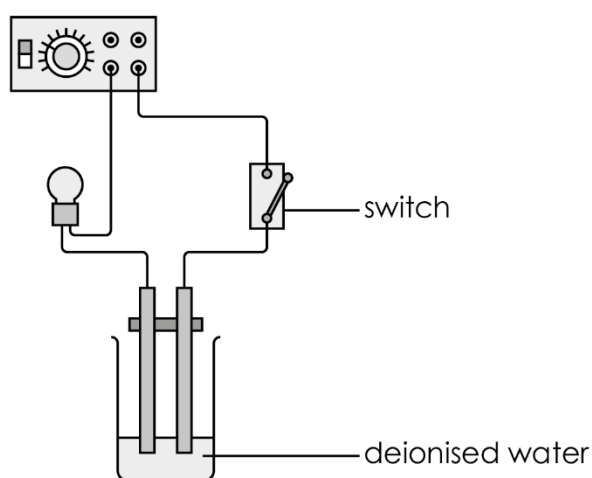
1. One-third fill a test tube with the hydrochloric acid.
2. Add a strip of magnesium.
3. Hold an inverted test tube over the reaction test tube for several seconds, to collect the gas.
4. Place a burning splint at the mouth of the inverted test tube.

Testing with marble chips (calcium carbonate)

1. One-third fill a test tube with the hydrochloric acid.
2. Add a few marble chips.
3. Add a few drops of limewater to a clean test tube.
4. Using a dropper, transfer some of the evolving gases into the limewater.

Testing for conductivity

1. Set up the circuits as shown:



2. Press down the switch to complete the electric circuits and note down your observations.



Results table

Test	Observations		
Testing for pH	Colour of the universal indicator:		
	At the start	During experiment	At the end
Testing with magnesium			
Testing with marble chips			
Testing for conductivity	With de-ionised water	With hydrochloric acid	

Follow-up questions

1. Choose the correct word to complete the sentence.

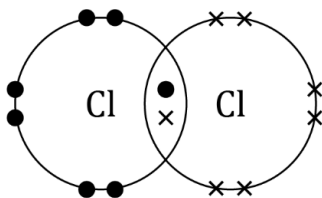
solid liquid gas
green red colourless

Hydrogen chloride is a _____ at room temperature.

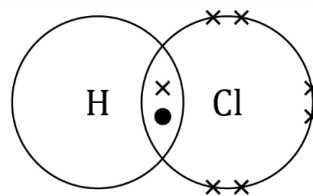
It is _____.

2. Hydrogen chloride exists as a covalent molecule. Which dot and cross diagram represents the HCl molecule?

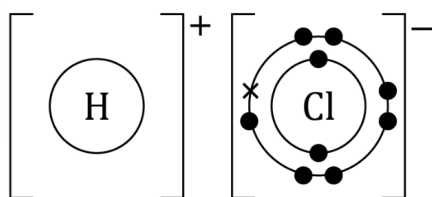
A



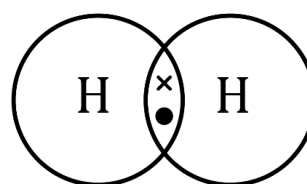
B



C



D





3. Hydrogen chloride is very soluble in water.

(a) State the meaning of the term **soluble**.

(b) When hydrogen chloride dissolves, it forms a soluble ionic substance. Which test did you carry out that confirms this?

(c) Complete the equation by selecting the correct state symbols for HCl gas and HCl acid.

l g aq s



(d) Choose the correct words to complete the sentences.

A hydrogen chloride molecule consists of a hydrogen atom **covalently/ionically** bonded to a **hydrogen/chlorine** atom. They share an **electron/neutron/proton** pair. When hydrogen chloride dissolves in water, each chlorine atom **gives/takes** an electron from each hydrogen atom, forming a **negatively/positively** charged chloride ion and a **negatively/positively** charged hydrogen ion. The new solution is called **hydrochloric/sulfuric** acid.

4. When sodium hydroxide is added to hydrochloric acid, a chemical reaction takes place.

(a) State the type of reaction

(b) Write a word equation for the reaction.

_____ + _____ → _____ + _____

5. When zinc is added to hydrochloric acid, a gas is produced.

Hint: zinc behaves in the same way as magnesium did in the class practical.

(a) Name the gas.

(b) Describe a test that could confirm your previous answer.



(c) Write a word equation for the reaction.

_____ + _____ → _____ + _____

6. When washing soda, Na_2CO_3 , is added to hydrochloric acid, a gas is produced.

Hint: washing soda behaves in the same way as marble chips did in the class practical.

(a) Name the gas.

(b) Describe a test that could confirm your previous answer.

(c) Write a word equation for the reaction.

sodium carbonate + _____ → sodium chloride + _____ + _____

7. Choose the correct words to complete the sentences:

Hydrogen chloride is a covalently bonded **ion/molecule**. There are no free **electrons/particles** in the structure to act as charge carriers. Therefore, it **can/cannot** conduct electricity.

When hydrogen chloride dissolves in water, **H^+/H^-** and **Cl^+/Cl^-** ions are produced, forming hydrochloric acid. Hydrochloric acid can conduct electricity because the **atoms/ions/molecules** are free to move in the solution and act as **electrical current/charge carriers**.