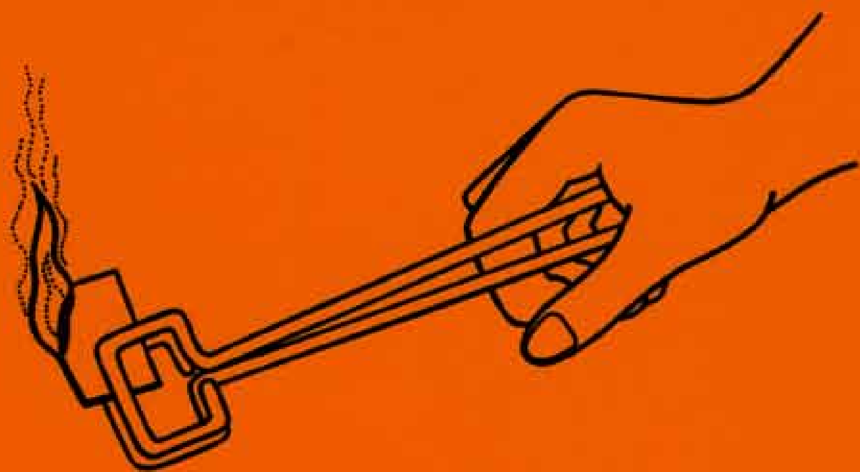
Book 2

Year 10



Science

Science

Year 10 Book Two

GOVERNMENT OF SĀMOA
MINISTRY OF EDUCATION, SPORTS AND CULTURE

Acknowledgements

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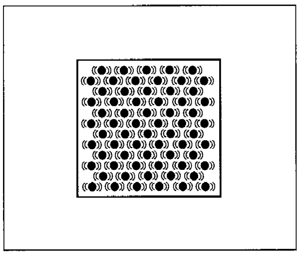
Unit 1: REVISION

Introduction

In this unit, you will go over the information that is in the Year 9 book on materials.

Structure of materials

All materials are made up of particles called atoms. The atoms can be by themselves or joined together in molecules.



Materials can exist as one of the three states of matter: solid, liquid or gas. Solids are dense, cannot be poured and have a fixed shape and volume. The particles are held tightly together and vibrate. Solids cannot be compressed.

Diagram 1.1
Solids.

Liquids are dense, can be poured, have a fixed volume and take the shape of their container. The particles are held close but are able to move around. Liquids cannot be compressed.

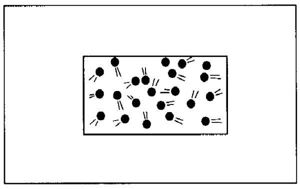
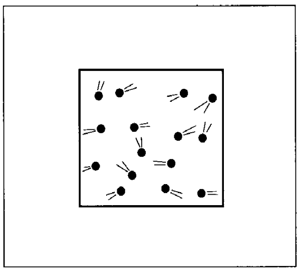


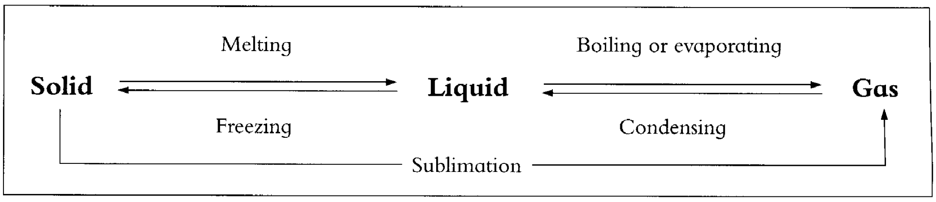
Diagram 1.2
Liquids.



Gases are less dense, can be poured, take the shape of their container and their volume changes depending on the size of the container they are in. The particles are far apart and easily move around. Gases can be compressed.

Diagram 1.3
Gases.

Adding heat energy to some materials causes them to change state. Each material has its own set temperature and when it reaches that temperature it changes state. These temperatures are called the boiling and melting points. Each of the changes of state has a special name. These are shown below:



Elements, compounds and mixtures are different types of materials. Elements are pure materials made up of only one type of atom. The elements are listed on the periodic table in order of their atomic number. The atomic number of an element is the number of protons in the nucleus of each atom of the element.

Compounds are made up of the atoms from two or more elements chemically joined together to form a molecule.

Mixtures are formed from elements and compounds mixed together but not chemically joined. The materials in a mixture are able to be separated using the properties of the materials in the mixture. Dissolving, evaporating, decanting, filtering, sieving, distilling and magnetism are all methods used to separate the materials in a mixture.

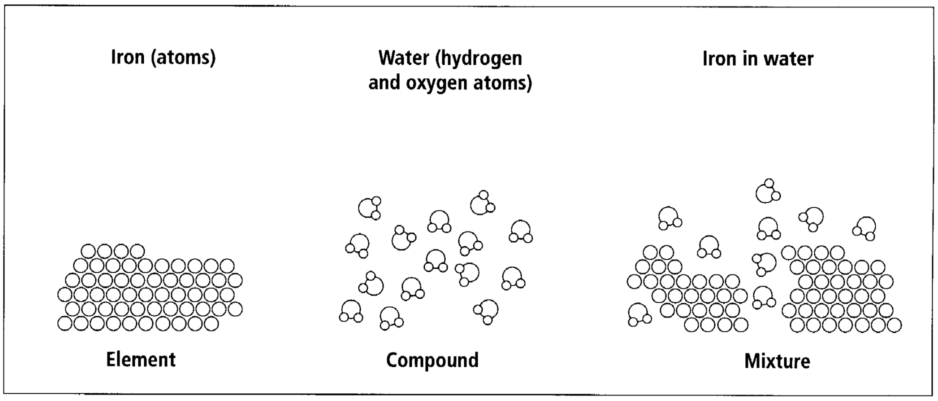


Diagram 1.4
Elements, compounds and mixtures.

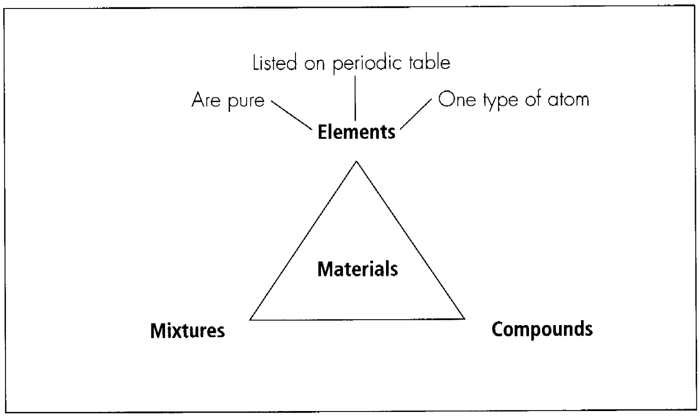
Activity 1 Structure Of Materials

Aim: To revise information about the structure of materials.

1. Work in pairs and explain to each other the differences in the properties of solids, liquids and gases.
2. Copy Diagrams 1.1, 1.2 and 1.3 showing the particles in solids, liquids and gases.
3. Divide a page into three columns and label as shown below. Write the names of as many solids, liquids and gases you can think of. Share your ideas with others and add to your lists.

Solids	Liquids	Gases

4. Copy and complete the following diagram to show the differences between elements, compounds and mixtures. The term 'elements' has been done for you.



5. Divide a page into three columns and label as shown below. Write the names of as many elements, compounds and mixtures as you can think of. Share your ideas with others and add to you lists.

Elements	**Compounds**	**Mixtures**

6. The following table gives the temperature of ice as it is heated until it melts and then boils. Draw a graph of this information.

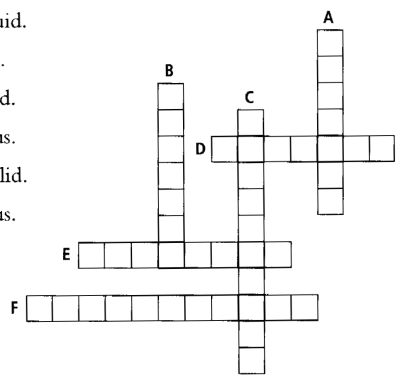
Time (mins)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Temp (°C)	0	0	4	9	16	35	55	75	90	96	100	100	100	103	107

7. Describe the shape of the graph drawn in question six.

8. Explain what is happening to the water at zero to one minutes and at 10 to 12 minutes.

9. Copy and complete the crossword with the names for the following changes of state:

a. From solid to liquid.
b. From solid to gas.
c. From gas to liquid.
d. From liquid to gas.
e. From liquid to solid.
f. From liquid to gas.



Activity 2

Materials needed:

Mixtures such as salt and sand; iron filings, sugar and sand; polystyrene, sugar and sand;
Beakers;
Water;
Magnets;
Evaporating dishes;
Funnels;
Filter paper.

Separating Mixtures

Aim: To practice separating the materials in a mixture.

Use the equipment provided to separate the different materials in the mixture you are given.

Materials and change

Each material has its own physical and chemical properties that make it different from other materials.

Physical properties are all the properties that do not involve chemical reactions. Physical properties include: colour, temperature, ability to conduct heat and electricity, volume, density, melting point, freezing point, boiling point.

Chemical properties involve all the chemical reactions that the material will take part in and what sort of products it will form. Some materials will react with oxygen and some will not. A chemical property of hydrochloric acid is that it will react with some metals to form hydrogen gas and a chloride salt.

The properties of a material undergo a chemical change when it takes part in a chemical reaction. Four signs that a chemical change has occurred are: colour change, bubbling or fizzing, energy change, precipitation formed.

The materials present at the beginning of a chemical change are called **reactants** and those formed by the chemical change are called **products**.

The gas tests can be used to identify which gas is being given off from a chemical reaction.

Gas	Hydrogen	Oxygen	Carbon dioxide
Test with	Lit match or stick.	Glowing stick.	Solution of limewater.
Positive result	Pop sound.	Stick relights.	Limewater goes milky.

- There are several different types of chemical change. Some common ones are:

Burning — During burning (combustion) a flame is present and the material joins with oxygen.

Corrosion — Is like burning but it happens slowly without the flame. In corrosion a metal joins with oxygen to form an oxide coating.

Rusting — Reaction between iron and oxygen to form iron oxide.

Decomposition — Carbonates break down when heated and give off carbon dioxide gas.

Neutralization — Acids and bases react to form a metal salt and water. Metals react with acids to form a salt and hydrogen gas. Carbonates react with acids to give a salt, carbon dioxide and water.

- Word equations are a short way of recording the reactants and products of a chemical reaction. They are written with the reactants on the left and the products on the right. An arrow is used to join the two parts of the equation. For example:

Magnesium + sulfuric acid $\longrightarrow$ Magnesium sulfate + hydrogen gas

- Physical changes are changes in the physical property of a material. No new materials are formed in a physical change. Types of physical changes include:

Change of state — Melting, evaporating, boiling, condensing, freezing, sublimation.

Changing from lumps to powder — Flour is sieved when baking.

Dissolving — A soluble solid 'disappears' into a liquid. The solid is called a solute, the liquid is called a solvent and the resulting material is called a solution. Some materials are insoluble and do not dissolve.

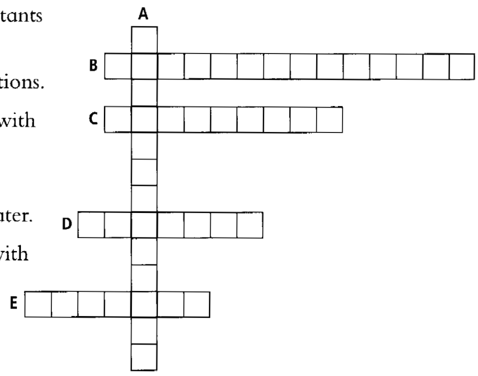
- Physical and chemical changes are used to make materials that people can use.

Activity 3 Materials And Change

Aim: To revise information about materials and change.

1. Write a sentence to describe each of the following physical properties: colour, temperature, can conduct heat, can conduct electricity, volume, density, melting point, freezing point, boiling point, mass, state.
2. Explain what these four things are showing you about a change: colour change, bubbling or fizzing, energy change, precipitation formed.
3. What is the difference between reactants and products?
4. Draw diagrams to show how you would test for hydrogen gas, carbon dioxide gas and oxygen gas.
5. Copy the crossword into your exercise book, then use the clues to name the different types of reactions:

   a. When the reactants break down.
   b. Acid base reactions.
   c. Slow reaction with oxygen.
   d. Reaction with oxygen and water.
   e. Fast reaction with oxygen.



6. Copy the following diagram and add notes to explain what happens to the atoms and molecules when a material dissolves.

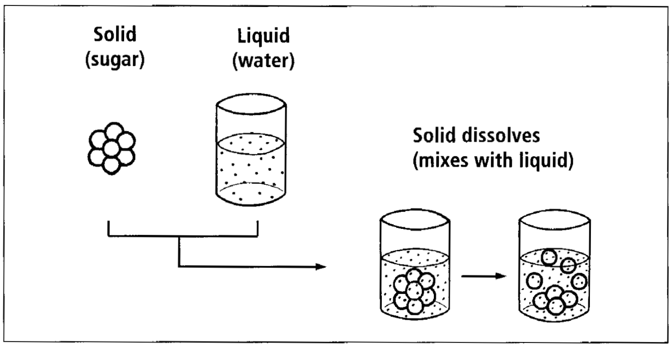


Diagram 1.5
Dissolving.

Metals and non-metals

There are over 100 elements, which can be divided into metals and non-metals. Metals are shiny, strong, good conductors of heat and electricity, malleable and ductile, have high melting points and are solids except for mercury, which is a liquid at room temperature. Most metals are silver or grey in colour.

Metals are made up of a tightly packed lattice of atoms that have some electrons free to move from one atom to the next. This lattice structure can be used to explain the physical properties of metals.

Chemical properties of metals include their reaction with acid, water and oxygen.

Metal + acid ⟶ metal salt + hydrogen gas

Metal + water ⟶ metal hydroxide + hydrogen gas

Metal + oxygen ⟶ metal oxide

Metals have similar but slightly different properties and it is these properties that people make use of. Aluminium can be used for boats because of the unreactive oxide coating that forms on the outside of the aluminium. Lead is used to finish a roof because it is soft and able to be shaped to fit into the shape of the iron.

The non-metals have a wide range of melting points and are solid, liquid or gas at room temperature. The solids are many different colours and their surfaces can be dull, not shiny. Non-metals do not conduct heat and electricity except for carbon, which conducts electricity. They have low density and are brittle.

Non-metals are important around us in the atmosphere and in a variety of chemicals. Each non-metal has very different properties that make it useful to people.

It is important to use materials in safe and appropriate ways. Sometimes the property of a material that is being used can also cause harm if not used correctly. Instruction labels should be read carefully before use and storage guidelines carefully followed.

Activity 4 Metals And Non-Metals

Aim: To revise information about metals and non-metals.

1. Copy the following table and then write each of these properties under the correct heading:

Metals	Non-metals

solid or gas	low density	ductile
different colours	shiny	dull
solids	silver or grey	brittle
malleable	conduct heat	do not conduct heat

2. Copy down the three general word equations that show the chemical properties of metals.
3. Explain how the properties of metals and non-metals are used by people.

Unit summary

Copy out each sentence and fill in the missing word(s). The capital letter is the first letter of the missing word.

Structure of materials

1. The small particles in all materials are called (A _ _ _ _).
2. Materials that are dense, can't be poured and have a fixed shape and volume are called (S _ _ _ _ _).
3. Materials that are dense, can be poured, have a fixed volume and take the shape of their container are called (L _ _ _ _ _ _).
4. Materials that are less dense, can be poured, and their shape and volume change to fit their container are called (G _ _ _ _).
5. When heated some materials change (S _ _ _ _) at fixed temperatures called (B _ _ _ _ _ _) and (M _ _ _ _ _ _) points.
6. Going from liquid to gas is called (E _ _ _ _ _ _ _ _ _ _) or (B _ _ _ _ _ _).
7. When a material goes from solid to gas it is said to (S _ _ _ _ _ _).
8. Hydrogen, sodium and oxygen are all (E _ _ _ _ _ _ _).
9. Water, salt and sugar are all (C _ _ _ _ _ _ _ _).

10. Air, wood, and salt + water are all (M _ _ _ _ _ _ _).
11. The number of protons in an atom is the (A _ _ _ _ _ N _ _ _ _ _).
12. Separation of oil and water by pouring is called (D _ _ _ _ _ _ _ _).
13. Separation using different boiling points is called (D _ _ _ _ _ _ _ _ _ _ _).
14. Separation of mixtures using the different size of particles is called (F _ _ _ _ _ _ _ _) or (S _ _ _ _ _ _).

Materials and change

1. Colour, state and ability to conduct heat are all (P _ _ _ _ _ _ _ P _ _ _ _ _ _ _ _ _).
2. Ability to react with other materials is called a (C _ _ _ _ _ _ _ P _ _ _ _ _ _ _).
3. A sign that a chemical change has occurred is the formation of a solid (P _ _ _ _ _ _ _ _ _ _).
4. A sign that a chemical change has occurred and a gas has be formed is (B _ _ _ _ _ _ _) or (F _ _ _ _ _ _).
5. Materials at the start of a chemical change are the (R _ _ _ _ _ _ _ _) and those formed are called (P _ _ _ _ _ _ _).
6. The chemical used to test for the presence of carbon dioxide is (L _ _ _ _ _ _ _ _).
7. To test for hydrogen gas use a (L _ _ M _ _ _ _) and use a (G _ _ _ _ _ _) one to test for oxygen.
8. The difference between burning and corrosion is that burning has a (F _ _ _ _).
9. Metals react with bases to form a (S _ _ _) and (H _ _ _ _ _ _ _) gas.
10. A sieve is used to change (L _ _ _ _) to (P _ _ _ _ _).

Metals and non-metals

1. Metals are solids except for (M _ _ _ _ _ _).
2. Metals are made up of a (L _ _ _ _ _ _) of atoms that have some free (E _ _ _ _ _ _ _ _).
3. Aluminium forms an unreactive (O _ _ _ _) coating that stops further reaction.
4. Carbon is unusual because it is a non-metal that conducts (E _ _ _ _ _ _ _ _ _ _).
5. To use materials safely and appropriately read the (I _ _ _ _ _ _ _ _ _ _ _) and (S _ _ _ _ _ _) labels carefully.

Unit 2: ATOMS AND GASES

Introduction
In this unit, you will look at the different models that scientists have used to describe atoms and name the parts in the current standard model of an atom. You will also investigate the properties, preparation and uses of the gases oxygen, carbon dioxide and hydrogen.

For over two thousand years people have thought that materials are made up of very small particles called **atoms**. Atoms are too small to be seen with our eye so studying them has been very difficult. A range of special equipment needs to be used to find out more about atoms. Scientists' understanding of what atoms are like has increased as they have made new and better equipment to research this field further.

Models for the structure of the atom
History records that the first theory about atoms was written by Democritus, a Greek scientist who lived between 460–370 B.C. He developed the theory that the universe is empty space and an infinite number of small particles which differ from each other in form, position, and arrangement. He thought all materials were made of particles, called atoms, that could not be broken down any further.

Scientists have used **models** to show others what they think atoms are like. In 1830 John Dalton suggested an 'atomic theory' which said that materials were made up of atoms that were solid and shaped like a round ball. Although this model of the atom was later found to be incorrect, it still helped scientists to understand how atoms are arranged in molecules and crystals.

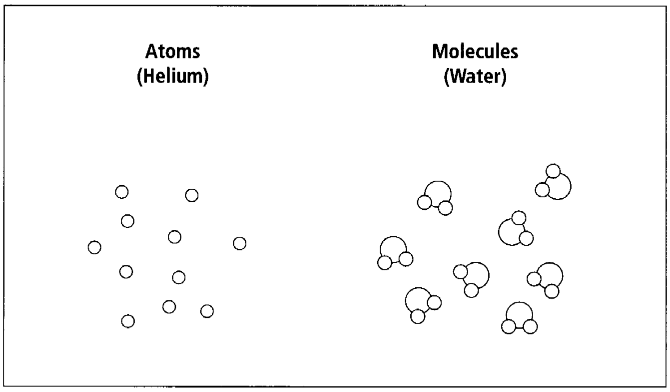


Diagram 2.1
Atoms drawn as solid balls.

This way of drawing atoms is so important that there is an international colour and size code for drawing atoms. Plastic models of atoms also use the international code and the balls are made to these standard colours and sizes.

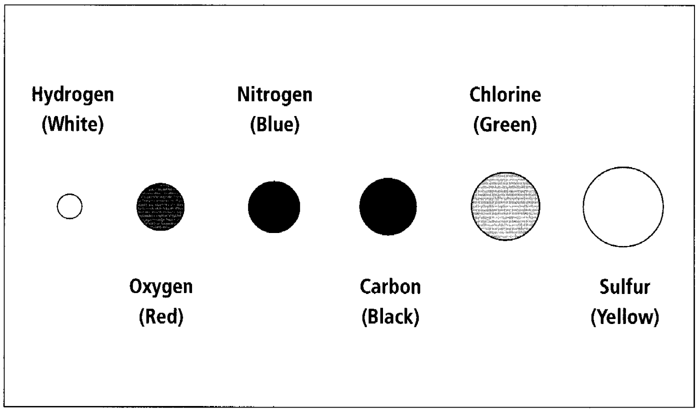


Diagram 2.2
Colour and size codes for atoms.

The increase in understanding of the structure of atoms was linked with the study of electricity and magnetism that scientists were carrying out. In 1874 G. J. Stoney discovered that electricity was made up of small particles with a negative electrical charge. He called these particles **electrons**.

In 1897 and 1898 J. J. Thomson was studying electrons and particles called protons while Ernest Rutherford and Marie Curie were studying radio-activity. The information from these discoveries helped to form a better understanding of atoms. They also proved that Dalton's idea of atoms as solid balls was incorrect.

In 1898 Thomson put forward his 'plum-pudding' model of the atom. This model said that the atom is a slightly positive sphere with small, raisin-like negative electrons inside.

In 1903 a scientist called Nagaoka further developed the 'Saturnian' model of the atom starting from an idea suggested by another scientist. He said that an atom had flat rings of negatively charged electrons circling around a positively charged particle.

In 1911 Ernest Rutherford used very thin gold foil to investigate atoms. He discovered that atoms have a very small, dense, positively charged centre he called a **nucleus** but most of the atom was empty space. He thought, just as Nagaoka did, that each atom had a number of small electrons moving around in the space surrounding the nucleus.

Niels Bohr worked with Rutherford and in 1913 put forward a theory called the 'Planetary' model of the atom. This theory said that electrons only travel in certain orbits. He suggested that the outer orbits could hold more electrons than the inner ones, and that these outer orbits determine the atom's chemical properties.

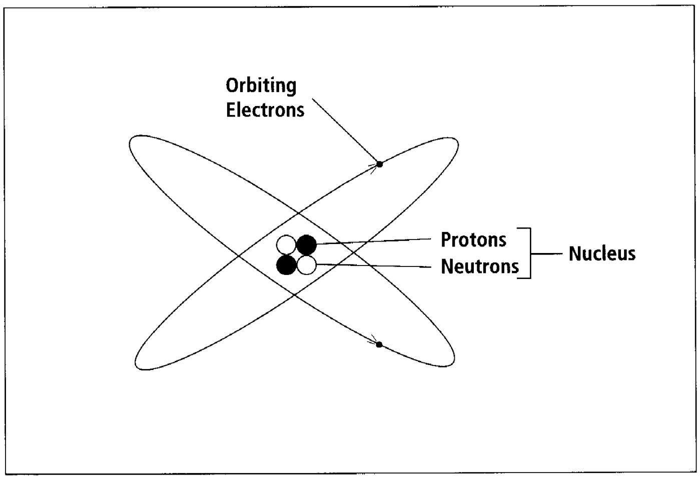


Diagram 2.3
Planetary model of atom structure.

In 1932 James Chadwick discovered a neutral atomic particle with a mass the same as a proton. The particle was called a **neutron**. Neutrons are found in the nucleus and act as a 'glue' that holds the positively charged protons together.

A current model for the structure of the atom is called the Nuclear Model. It has protons and neutrons in a nucleus that is surrounded by electrons that occupy shells as they orbit around the nucleus. The shells are really areas of space where the electrons are likely to be found. The shell closest to the nucleus is small and can only hold two electrons. The next shell can hold eight. The number of electrons in the outside shell causes some of the chemical properties of an atom.

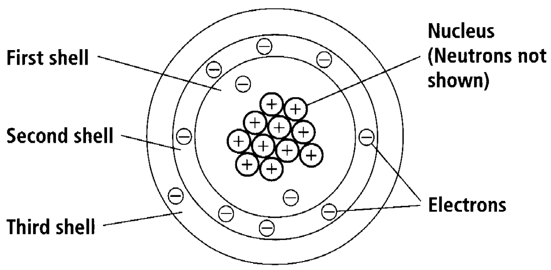


Diagram 2.4
Standard model of atom structure.

Originally protons, electrons and neutrons were thought to be the smallest particles but in research between 1953 and 1957 scientists showed that the electrical charge inside a proton is not even. The electrically neutral neutrons were also found to be uneven. This resulted in much further study and the discovery of a number of other particles given names such as positrons, leptons, neutrinos, pions, and quarks. More can be read about the history and recent discoveries at *Particle Adventure* — an internet site with the following address:

http://particleadventure.org/particleadventure/other/history/index.html

Activity 1 Development Of Understanding About Atoms

Aim: To record information about past and current models of atom structure.

1. Arrange the following models for the structure of the atom in order of when they occurred. Record the names of the five models in order from first to current in the table below.

- Standard model.
- Plum pudding model.
- Planetary model.
- Saturian model.
- Solid ball model.

2. Use the information about the models on pages 15–18 to complete the rest of the table.

Name of model	When	Name of scientist	Features of atoms described in the model

A closer look at the Nuclear model

The Nuclear model of atom structure is used in schools because it provides scientists and science students with a model that can be used to explain the chemical properties of materials. Here is a summary of the Nuclear model:

- Atoms have a small nucleus in the centre and the rest of the atom is almost all empty space.
- The nucleus is made up of positively charged protons and neutral neutrons. The neutrons act as glue to hold the nucleus together.
- Different types of atoms have a different number of protons. This is called their **atomic number**. The number of neutrons plus the number of protons in the atoms of each element is called the **mass number**. The number of neutrons in the atoms of an element can change so the mass number of an element can change.

- Very, very small electrons are moving around the nucleus through the empty space. The number of electrons in an atom equals the number of protons.
- Each electron orbits the nucleus in an electron shell. An electron shell is just the area where the electron is most likely to be found. The first electron shell, which is closest to the nucleus, can hold two electrons. The second shell can hold eight.

The following table compares the properties of protons, neutrons and electrons.

Particle in the atom	**Found**	**Charge**	**Relative mass***
Proton	In nucleus	Positive	1
Neutron	In nucleus	Neutral	1
Electron	Orbiting nucleus	Negative	1/1840

* Relative mass is a term used to mean how heavy each is compared to the others.

Different types of atoms are called **elements**. The Periodic table shown below gives the atomic number, name and symbol for the first 20 elements. The atomic number tells the number of protons and also the number of electrons the atom has.

1 Hydrogen H							2 Helium He
3 Lithium Li	4 Beryllium Be	5 Boron B	6 Carbon C	7 Nitrogen N	8 Oxygen O	9 Fluorine F	10 Neon Ne
11 Sodium Na	12 Magnesium Mg	13 Aluminium Al	14 Silicon Si	15 Phosphorus P	16 Sulfur S	17 Chlorine Cl	18 Argon Ar
19 Potassium K	20 Calcium Ca						

Diagrams are often drawn to show the arrangement of protons and neutrons in the nucleus and electrons orbiting.

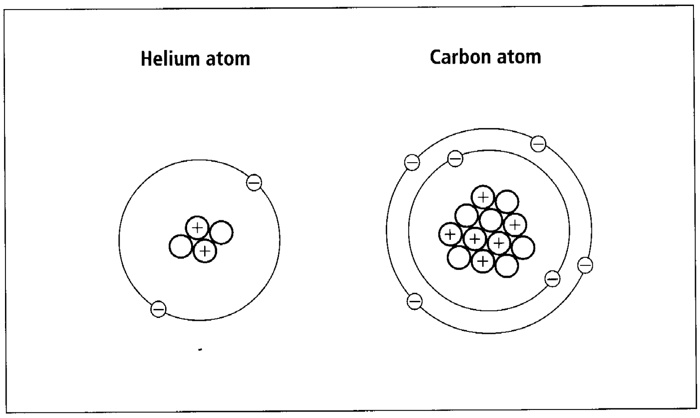


Diagram 2.5
Atoms of Helium and Carbon.

As the number of protons and neutrons gets bigger it becomes more and more difficult to show the neutrons and protons so sometimes only the number of protons is shown. For example:

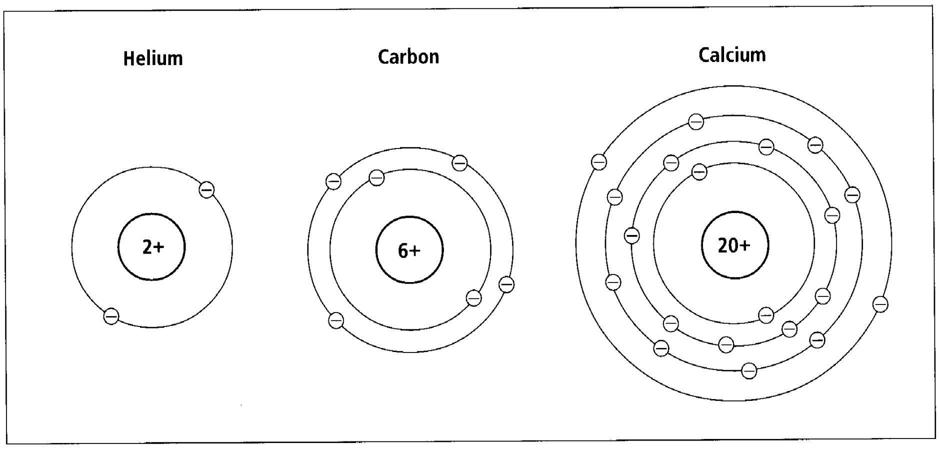


Diagram 2.6
Drawing atoms.

Electron arrangement

The electrons fill the shells around the nucleus starting with the closest to the nucleus. When it has two electrons in it, the next shell begins to fill. When it has eight electrons in it, the third shell starts to fill. When the third shell has eight electrons in it, the fourth shell starts to fill. There is a way of writing the electron arrangements of atoms to show where the electrons can be found.

The electron arrangement for lithium is 2, 1 which means that there are two electrons in the first shell and 1 in the second giving a total of three electrons.

For calcium it is 2, 8, 8, 2. Calcium has an atomic number of 20, which means it has 20 electrons. Two electrons in the first shell, eight in the second, eight in the third and two in the fourth.

The electron arrangement for oxygen is 2, 6 and for magnesium it is 2, 8, 2.

Hydrogen only has one electron so its electron arrangement is written as '1'.

Activity 2 The Nuclear Model

Aim: To record information about the standard model of atom structure.

1. Copy Diagram 2.4 into your book.
2. Use the five bullet points about the Nuclear Model to check that you have recorded all the key information about this model in the table for Activity 1. Copy down any points that you have missed and the new information the bullet points contain: *e.g. Mass number.*
3. Copy into your exercise book the table on page 20 that compares the properties of protons, neutrons and electrons.
4. Draw up a table like the one below. Record the first 20 elements in order of their atomic number. The first three have been listed for you. Complete the table to give the electron arrangements of the first 20 elements.

Name of element	Electron arrangement
Hydrogen	
Helium	
Lithium	

5. Copy Diagram 2.5 of helium and carbon atoms into your book.
6. Draw diagrams, like those in Diagram 2.6, of nitrogen, silicon, chlorine and potassium. In the nucleus of each atom write the number of protons it has.

Oxygen

Oxygen gas makes up 21% of the air around us. It is made up of two oxygen atoms joined together which means its chemical symbol is O_2. When we breathe in, our lungs absorb the oxygen from the air into our blood. The oxygen travels in the blood to the body cells where it is used in a series of chemical reactions called respiration. The reactions release energy from the sugars in food so that the muscles and other cells in the body can use the energy. Plants also use oxygen for respiration. The word equation for respiration is:

sugar + oxygen ⟶ carbon dioxide + water

This equation shows that respiration is like burning. The difference is that respiration is carried out by living things, and the reaction happens in a series of small steps, so that the energy from the reaction is held in other chemicals and not given out as heat and light as it is when burning occurs.

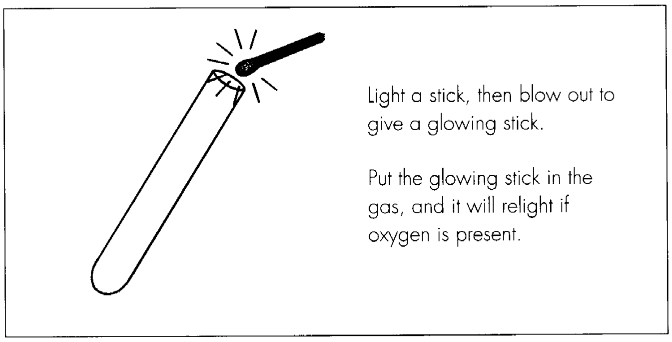


Diagram 2.7
Testing for oxygen.

Activity 3

Materials needed:
Burner;
Potassium permanganate;
Test tube or conical flask, and tight fitting one hole stopper;
Two or three boiling tubes;
Glass and rubber delivery tubing;
Container filled with water;
Test tube holder or retort stand and clamp.

Making Oxygen

Aim: To make oxygen and investigate its properties.

Note: Oxygen can be made by mixing manganese dioxide and hydrogen peroxide.

1. Place a small amount of potassium permanganate in a test tube or flask and close with a stopper with one hole in it.
2. Fill two boiling tubes with water and carefully stand them upside down in the container of water.
3. Connect a delivery tube from the test tube or flask to under the mouth of a boiling tube as shown in the Diagram 2.8.

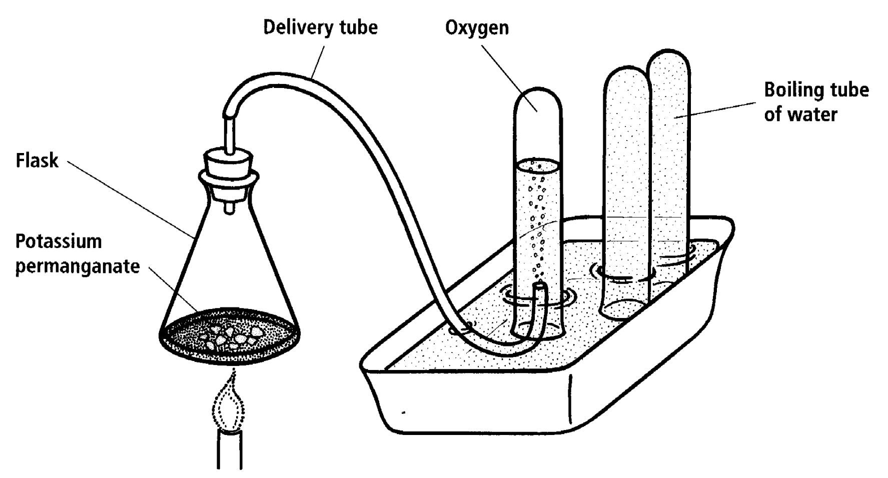


Diagram 2.8
Making oxygen.

4. Heat the potassium permanganate and collect the gas given off.
5. Read the information in Diagram 2.7, then test the gas given off to see if it is oxygen.
6. Draw a diagram to show how you made oxygen gas.
7. Investigate and record as many properties of oxygen as you can — what does it look like? Does it dissolve in water?
8. Record any observations and results.

Activity 4

Materials needed:
Burner;
Gas jar or jar of air;
Deflagrating spoon;
Sulfur;
Universal Indicator;
Water.

Burning Sulfur

Aim: To investigate the burning of sulfur.

1. Add water to the bottom of the jar until it is about 2 cm deep. Add drops of Universal Indicator until it shows green. Check that the deflagrating spoon will be above the water level when sitting in the jar.
2. Place sulfur on the deflagrating spoon and use the burner to set it alight. Take care because the flame is a very pale blue and is difficult to see.
3. Immediately place the spoon with the burning sulfur into the jar of air.

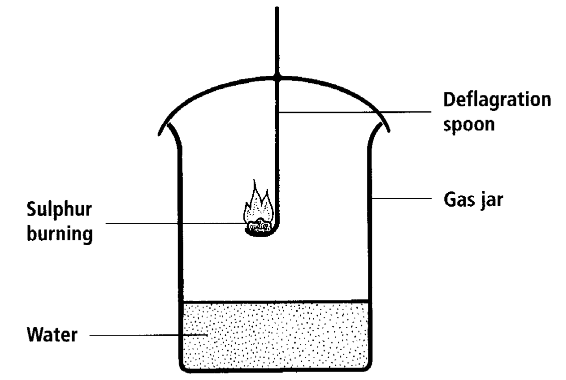


Diagram 2.9
Deflagrating spoon correctly set up.

4. Gently swirl the water and observe the Universal Indicator colour change.
5. Record observations of the reaction between sulphur and air and write a conclusion.

Sulfur joins with the oxygen in the air to form sulfur dioxide.

$S + O_2 \longrightarrow SO_2$

Sulfur dioxide dissolves in water to form an acid solution, which is why the Universal Indicator turns red.

Activity 5

Materials needed:
Jar of air;
Jar of oxygen gas;
Burning spoon;
Burner or matches;
Steel wool or paper or wood;
Universal Indicator;
Water.

Burning Investigation

Aim: To investigate the differences between burning steel wool in air and in oxygen.

Plan and carry out an investigation into the differences between burning steel wool, or another material, in air and in oxygen. Use the method used in Activity 4 as a model, and change it to suit this investigation. Record your observations and write a conclusion. Also write a word equation for the reaction.

Uses and chemical reactions of oxygen

Oxygen is a very common material. It is a colourless gas with no smell. It keeps living things alive and makes up 50 % of the soil, sand, clay, rock and other material in the Earth's crust. It is also part of the water that makes up the oceans, lakes, rivers and streams.

Oxygen is very reactive. It is found in many different materials and it will react with almost every other element. Burning is an example of oxygen reacting. During burning the atoms of the material join with oxygen and lots of heat and light are released. When materials such as wood and petrol burn, the oxygen joins with carbon to form carbon dioxide and with hydrogen to form water. The rest of the material forms ash. When a metal such as magnesium burns, it joins with oxygen to form an oxide.

Pure oxygen is made by separating it from all the other gases in air. It is used in industries and to help people who are sick.

- Oxygen is used in hospitals when people are having difficulty breathing and when people are being operated on.
- Scuba divers have oxygen in the tanks on their backs which they breath from when diving under water.
- There is not much air on very high mountain tops, so people that climb these mountains sometimes carry oxygen tanks with them.
- People who fly planes very high in the atmosphere also have to take oxygen with them, because there is not enough oxygen high in the atmosphere to keep them alive.
- Oxygen is mixed with acetylene and used to cut metals and weld metals together.
- Oxygen is needed when iron ore is made into steel.

Activity 6 Information About Oxygen

Aim: To record information about oxygen.

1. Use the information about oxygen and the results of Activities 3, 4 and 5 to make a bullet point list of the key points about oxygen.

Carbon Dioxide

Carbon dioxide makes up about 0.04% of the gases in the air around us. Carbon dioxide is made up of one carbon atom joined to two oxygen atoms. Its chemical formula is CO_2. Plants take carbon dioxide from the air into their leaves and use it and water to make sugars. This process is called photosynthesis. The word equation for photosynthesis is:

$$\text{Carbon dioxide} + \text{water} \xrightarrow[\text{chlorophyll}]{\text{light}} \text{sugar} + \text{oxygen}$$

The equation shows that light and chlorophyll need to be present for the reaction to happen. Chlorophyll is the chemical that gives plants their green colouring. The equations for photosynthesis and respiration show that they are the opposite of each other.

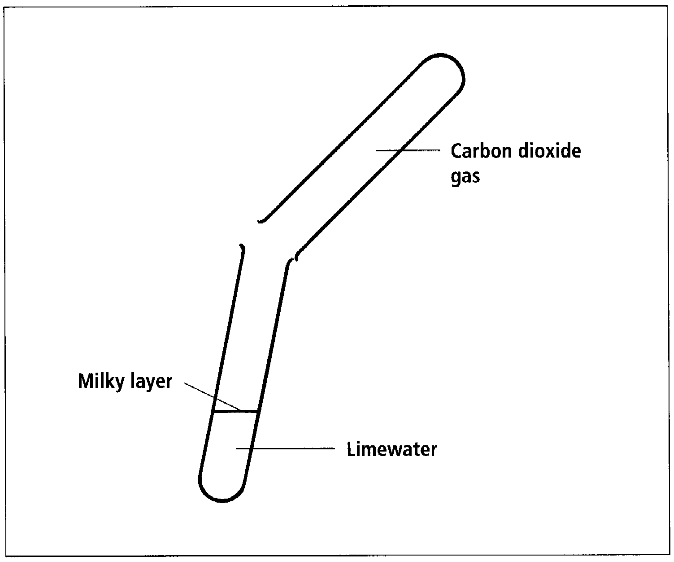


Diagram 2.10
Testing for carbon dioxide.

Activity 7

Making Carbon Dioxide

Materials needed:

Burner;

Calcium carbonate or shells or baking soda;

Hydrochloric acid or vinegar;

Test tube and tight fitting one hole stopper, or conical flask and tight fitting one hole stopper;

Two or three boiling tubes with stoppers;

Glass and rubber tubing in the form of a delivery tube;

Test tube holder or retort stand and clamp;

Limewater.

Aim: To make carbon dioxide and investigate its properties.

1. Place a small amount of calcium carbonate in a test tube or flask and close with a stopper with one hole in it.
2. Connect a delivery tube from the test tube or flask down to the bottom of a boiling tube as shown in Diagram 2.11.

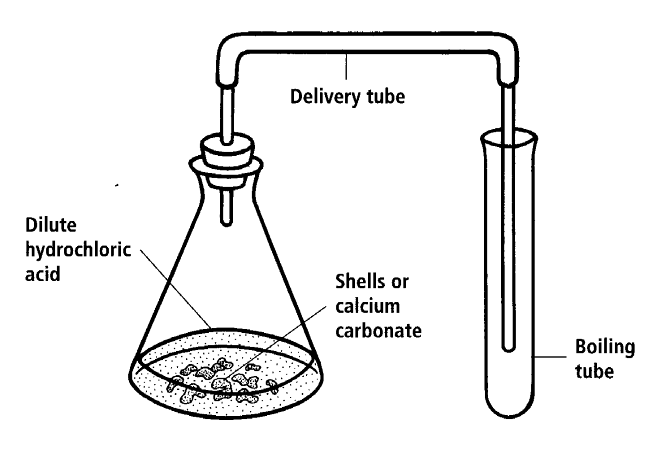


Diagram 2.11
Making carbon dioxide.

3. Remove the stopper, add a small amount of hydrochloric acid and replace the stopper.
4. Collect the gas given off and put a stopper in the tube. Collect as many boiling tubes of gas as you can to use in the next investigation.
5. Read the information in Diagram 2.10 then test the gas given off to see if it is carbon dioxide.
6. Draw a diagram to show how you made carbon dioxide gas.
7. Record any observations and results.
8. Discuss any difficulties you had with the equipment or procedures.

Activity 8

Materials needed:
Boiling tubes of carbon dioxide gas;
Candle or stick;
Matches or burner;
Beaker;
Drinking straw;
Limewater;
Universal Indicator or litmus paper;
Water.

Properties Of Carbon Dioxide

Aim: To investigate the properties of carbon dioxide. Complete the following tests to investigate these properties.

1. Describe carbon dioxide gas. What does it look like? Smell like? Does it have any taste?
2. Does carbon dioxide burn? Pour a boiling tube of carbon dioxide onto a burning candle or burning stick that is being held inside a beaker (see Diagram 2.12). Record your observations.
3. Look at how the carbon dioxide is being collected in Diagram 2.11. What does this tell you about CO_2? Is it heavier or lighter than air?

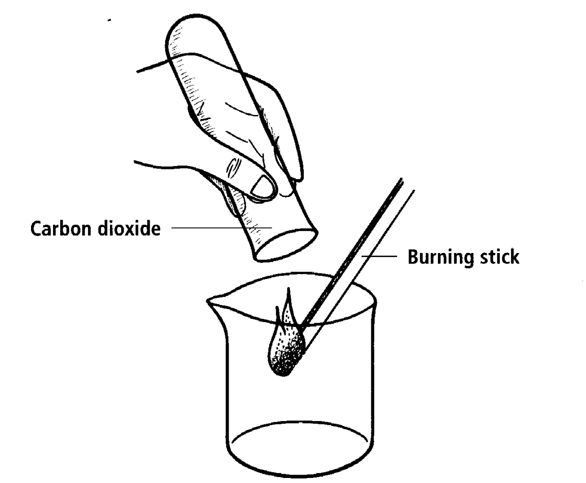


Diagram 2.12
Does CO_2 burn?

4. Do people breathe out carbon dioxide? Blow through a straw into limewater. If it turns milky you are breathing out carbon dioxide.
5. Does carbon dioxide dissolve in water? Put water into a beaker until it is 3 cm deep. Add **Universal Indicator** to the water until you can see the green colour. This means that the water is neutral. Pour a test tube of carbon dioxide into the beaker of water. Swirl the water. Does the colour of the Universal Indicator change? It will turn red if the carbon dioxide dissolves in the water. Check if more will dissolve by blowing through a straw into the water. Does the carbon dioxide from your breath dissolve in the water? Look for a red colour.

6. How heavy is carbon dioxide? Make some more carbon dioxide and fill a gas jar or large jar until it is full. Set up the beaker and balance it as in the diagram and adjust the pointer so that it reads zero. Pour the gas jar of carbon dioxide into the breaker on the balance. Record what happens to the pointer on the balance. What does this tell you about the weight of carbon dioxide compared to air.
7. Write a conclusion to describe the properties of carbon dioxide gas.

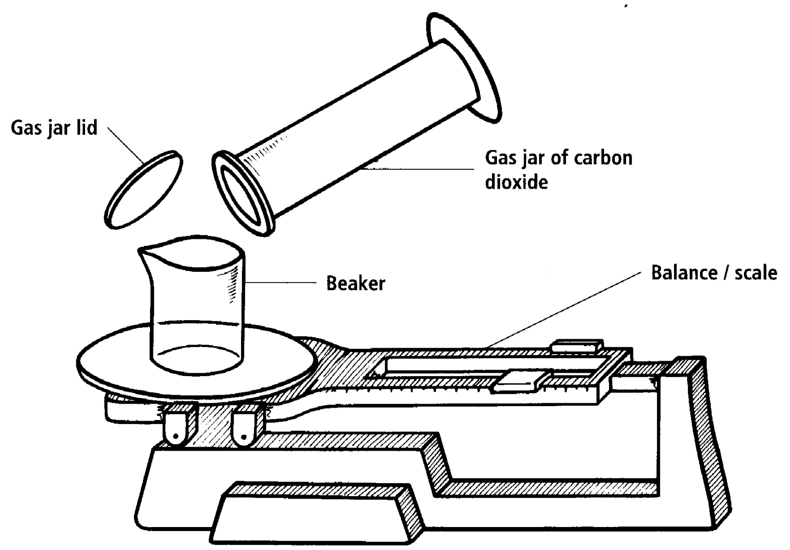


Diagram 2.13
Measuring the weight of CO_2.

Activity 9

Materials needed:
Small pot;
Sugar;
Golden syrup;
Baking soda (sodium bicarbonate);
Gladwrap or lunch wrap paper;
Tablespoon;
Teaspoon;
Burner or stove top.

Hokey Pokey

Aim: To investigate the effects of carbon dioxide in cooking.

1. Mix five tablespoons of sugar and two tablespoons of golden syrup in the pot.
2. Gently heat the mixture until it boils.
3. Boil slowly for four minutes, stirring occasionally.
4. Stop heating and add one teaspoon of baking soda. Stir quickly until the mixture foams up then pour it out onto the gladwrap or lunch wrap.
5. Leave to cool then break it into pieces and eat.

6. Record your observations. What effect did the baking soda have on the mixture? When baking soda is heated it gives off carbon dioxide gas. Use this information to explain why the mixture changed when the baking soda was added.

Properties and uses of carbon dioxide

Carbon dioxide is a colourless gas with no smell. It is made by all living things during respiration and is used by plants in photosynthesis. Carbon dioxide is denser than air so it can be collected using a delivery tube into an upright test tube. Because it is heavy it pushes the less dense air up and out the top of the test tube.

Some uses of carbon dioxide are:

- It does not burn so can be used to put out fires. Some fire extinguishers are filled with carbon dioxide.
- Carbon dioxide is slightly soluble in water. It dissolves in water to form carbonic acid which is a weak acid. The bubbles in fizzy drinks are carbon dioxide and the carbonic acid adds to the flavour of the drink.
- Carbon dioxide can be cooled down until it becomes a solid. It is then called 'dry ice' because it sublimes back to a gas and doesn't turn into a liquid. Dry ice is used to keep things cold and is used in videos to make a scene look like there is mist on the ground.

Activity 10

Information About Carbon Dioxide

Aim: To record information on the uses of carbon dioxide.

1. Use the information in the three bullet points above to make notes about the uses of carbon dioxide.

Hydrogen

Hydrogen is a common material in living things and is the fuel that keeps the stars burning. Hydrogen gas is formed when two hydrogen atoms join together. The chemical formula of hydrogen gas is H_2.

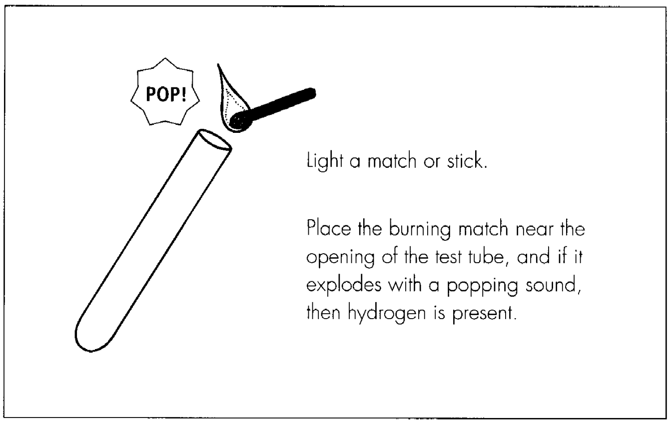


Diagram 2.14
Testing hydrogen.

Activity 11

Materials needed:
Plastic bottle, test tube or flask;
Hydrochloric acid;
Zinc or magnesium metal;
Stopper and delivery tube;
Two boiling tubes;
Large container of water.

Making Hydrogen

Aim: To make hydrogen and investigate its properties

1. Place a small amount of zinc in a plastic bottle, test tube or flask and close with a stopper with one hole in it.
2. Fill two boiling tubes with water and carefully stand them upside down in the container of water.
3. Connect a delivery tube from the test tube or flask to under the mouth of a boiling tube as shown in the diagram below.

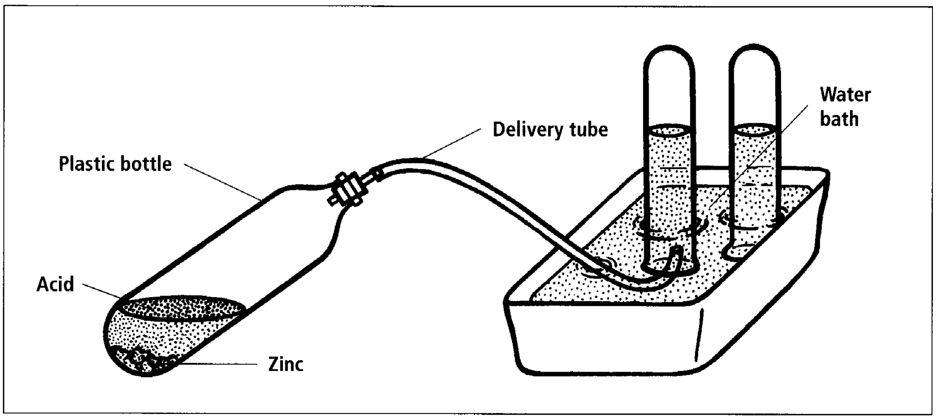


Diagram 2.15
Making hydrogen.

Take care, as hydrogen can explode when burned!

4. Remove the stopper and add hydrochloric acid to the zinc then replace the stopper. Collect the gas given off.
5. Read the information in Diagram 2.14 then test a small amount of the gas given off to see if it is hydrogen.
6. Draw a diagram to show how you made hydrogen gas.
7. Investigate and record as many properties of hydrogen as you can. What does it look like? What does it smell like? Does it dissolve in water? Is it heavier or lighter than air?
8. Record any observations and results.

Properties and uses of hydrogen

Hydrogen is a colourless gas with no smell. It is the lightest gas. It burns very easily and when mixed with oxygen it will explode if lit. Some uses of hydrogen are:

- It is used as a rocket fuel during the launch of spacecraft such as the Space Shuttle.
- Hydrogen is used in industries to make many products such as plastics, margarine, candles, drugs, dyes and fertilizers.
- In the past it was used to fill balloons and airships but because of its explosive property people now use helium gas instead of hydrogen.

Activity 12 Information About Hydrogen

Aim: To record information on the uses of carbon dioxide.

1. Use the information in the three bullet points above to make notes about the uses of carbon dioxide.

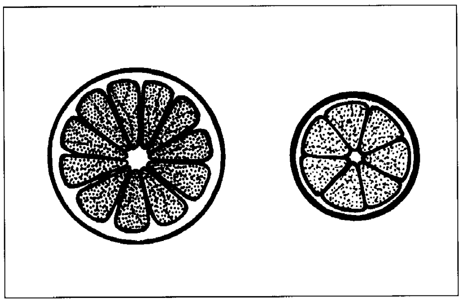
Unit summary

- All materials are made out of atoms.
- Over the years a number of models for the structure of the atoms have been used. These include, in order of oldest to youngest: **Solid ball model**, **plum pudding model**, **saturian model**, **planetary model**, and the **nuclear model**.
- Scientists are still discovering new particles that are found in atoms so the model will continue to change in the near future.
- The nuclear model of atom structure states that an atom has a dense core called a nucleus. The protons and neutrons are found in the nucleus. The rest of the atom is mostly empty space.
- The space inside an atom is divided into areas called electron shells which is where the electrons are most likely to be found.

- The atomic number of an element is the number of protons in the nucleus. The mass number is the number of protons and neutrons.
- Protons are positively charged. A neutron has the same mass as a proton but is neutral. Electrons are very small compared to protons and have a negative charge.
- The electron shell closest to the nucleus can hold two electrons and the second shell can hold up to eight. The third shell holds eight electrons before filling the fourth shell.
- The arrangement of electrons written as 2, 8, 8, 1 means that the atom has the first three shells full: i.e. 2, 8 and 8. It has one electron in the forth shell which gives a total number of electrons of 19. The number of electrons in an atom equals the number of protons so this must be the element with an atomic number of 19. Potassium has an atomic number of 19.
- Oxygen is in the air, water, rocks and living things around us. It can be made by heating potassium permanganate and tested using a glowing stick which will relight in oxygen. Two oxygen atoms join together to form oxygen gas in the air. It is a colourless gas with no smell.
- Oxygen is used by living things in respiration and involved in burning. Materials burn more quickly in oxygen than they do in air. When materials burn they join with oxygen to form an oxide.
- Carbon dioxide gas is used by plants to make sugars in the process called photosynthesis and is released by plants and animals as a waste product of respiration. Carbon dioxide is made by reacting an acid with a carbonate. Limewater is used to test for carbon dioxide. Limewater will turn milky when mixed with carbon dioxide.
- Carbon dioxide is a colourless gas with no smell that makes up a very small percentage of the gases in air. It is denser than air, so it will sink to the bottom of a container. It is used in fire extinguishers and fizzy drinks. Solid carbon dioxide or dry ice is used to keep things cold.
- Hydrogen is found in water and a number of other compounds. It forms a colourless gas with no smell that contains two hydrogen atoms. It can be made by reacting a metal with an acid. When a burning stick is placed near it, it explodes with a pop noise. It is used to make a number of other compounds such as plastics, dyes and margarine.

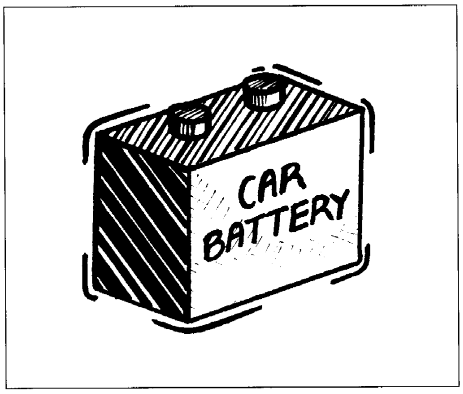
Unit 3: ACIDS AND BASES

Introduction
In this unit, you will identify acids and bases using indicators and investigate the physical and chemical properties of acids and bases.



Acids
Foods that have a sharp or sour taste often contain acids. Lemons and limes contain citric acid, and vinegar is acetic acid. These acids are called **organic acids** because they come from living things and they contain the element carbon. **Mineral acids** are those, such as the sulfuric acid in car batteries.

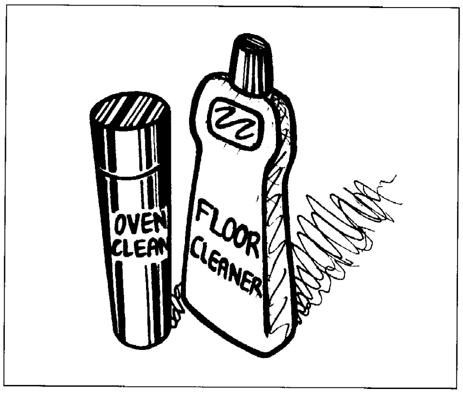
Diagram 3.1
Citric acid in lemons and limes.



Acids are grouped together as a type of material because they are compounds that contain hydrogen atoms and when they dissolve in water the hydrogen is released to form a **hydrogen ion** or H^+. Not all materials that have hydrogen in them are acids. Only those that dissolve in water to release the hydrogen ions are acids. Acids can be solids, liquids or gases. The table on next page gives examples of some acids.

Diagram 3.2
Sulfuric acid in a car battery.

Acid	Type of acid	Chemical formula	Found in or used for
Hydrochloric acid	Mineral.	HCl	In your stomach — where it helps digest food.
Sulfuric acid	Mineral.	H_2SO_4	Car batteries.
Nitric acid	Mineral.	HNO_3	Making fertilizers.
Ethanoic acid	Organic.	CH_3COOH	Vinegar.
Citric acid	Organic.	$C_5H_7O_5COOH$	Lemons and other citrus fruit.
Tartaric acid	Organic.	$C_3H_5O_4COOH$	Grapes and used in baking.



Bases

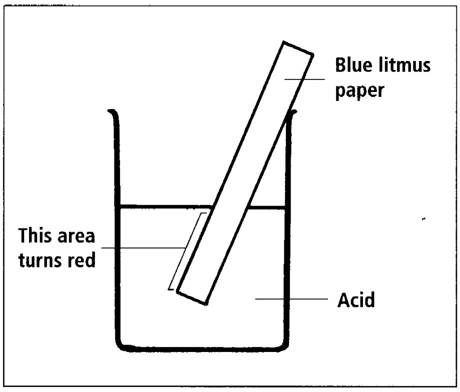
There is another group of materials called bases. **Bases** are often called the 'acid opposites' because they are able to react with acids to 'neutralise' the properties of an acid. Some bases are able to dissolve in water. If a base is able to dissolve in water it is called an **alkali**. When bases dissolve in water they release hydroxyl ions (OH^-). The table below gives some examples of bases.

Diagram 3.3
Some cleaners are bases.

Base	Type of base	Chemical formula	Found in
Sodium hydroxide	Alkali	$NaOH$	Cleaners
Ammonium hydroxide	Alkali	NH_4OH	Cleaners
Calcium hydroxide	Base, not alkali	$Ca(OH)_2$	White wash
Magnesium hydroxide	Alkali	$Mg(OH)_2$	Indigestion medicine

Identifying acids and bases

It is not possible to tell if a material is an acid or base by looking at it. Special chemicals called indicators are used. **Indicators** are materials made from plant dyes that turn different colours when they are put in solutions of acids and bases. The common indicators used in science laboratories are litmus paper and Universal Indicator.



Litmus paper is a common indicator. It comes in two colours, blue and red. Blue litmus turns red when put in an acid and red litmus turns blue when put in a base.

Universal Indicator is a green solution or yellow paper that is a mixture of different indicators. It is able to change a range of different colours so it can measure how strong the acid or base is. The following information shows the colour that it changes to in different strength acids and bases.

Diagram 3.4
Litmus paper indicator.

Acid indicator

Red	Very acidic.
Orange/yellow	Moderately acidic.
Yellow-green/pale green	Slightly acidic.

Neutral indicator

Green	Neutral (not acidic or basic).

Base indicator

Purple	Very basic.
Blue/dark blue	Moderately basic.
Pale blue/blue-green	Slightly basic.

Warning: Take care when handling acids and bases!
If strong acids and bases come in contact with your skin they will burn you because of their corrosive properties. Place the skin under running water for several minutes to remove any spilt acid or base.

Activity 1

Acids, Bases And Indicators

Aim: To record information on acids, bases and indicators.

- Copy and complete the following:

1. Acids in food have a ________________ or ________________ taste.
2. Organic acids are made by ________________ ________________.
3. Acids are ________________. They contain ________________ atoms and they dissolve in water to release ________________ ________________.
4. Bases are ________________ opposites. They react with ________________ to form a neutral solution.
5. When bases dissolve in water they release ________________ ions.
6. ________________ are bases that are able to dissolve in water.

- Copy the tables showing examples of acids and bases.
- Explain what an indicator is.
- Explain how litmus shows if a material is an acid or base.
- Explain how Universal Indicator works.

Activity 2

Materials needed:

Litmus paper, Universal Indicator solution or paper;

Acid solution such as vinegar, lime juice or hydrochloric acid;

Bases such as baking soda, cleaners or indigestion medicine;

Water;

Test-tubes or jars or beakers;

Different materials to test;

Tools to crush solid materials.

Testing indicators

Aim: To use indicators to test if chemicals are acids, bases or neutral.

Part A

Testing litmus

1. Copy the following table into your exercise book:

Solution used	Blue litmus	Red litmus
Acid (*e.g. Vinegar.*)		
Base (*e.g. Baking soda.*)		
Neutral (*e.g. Water.*)		

2. Place small pieces of blue litmus paper in an acid, a base and water to find out how it is used as an indicator. Use the words 'Turns red' or 'Stays blue' to complete the table.
3. Repeat using small pieces of red litmus and complete the table using the words 'Turns blue' or 'Stays red'.

Part B

Testing Universal Indicator paper or solution.

1. Copy the following table into your exercise book:

Solution used	Colour change	Acid, base or neutral
Vinegar		
Baking soda		
Water		
Other material		

2. Place small pieces of Universal Indicator paper or three drops of Universal Indicator solution into different materials and record the colour change.
3. Complete the table using the colour change to say if the material is an acid, a base or neutral.
4. Write a conclusion about the use of indicators and which materials are acids, bases and neutral.

Activity 3

Materials needed:

A strong acid;

A strong base;

Water;

Tea and beetroot juice;

Tools to chop and grind different plant material;

Range of different plant material — leaves and flowers;

Three Beakers, jars, test tubes or plastic containers;

Hot plate or burner, tripod and gauze, or hot water.

Making And Using Your Own Indicators

Aim:To test a range of plant materials to find out if any are good indicators.

1. Make a strong cup of tea using the beaker and hot water. Divide the tea into three containers.
2. Test one lot of tea by adding a strong acid drop by drop. Compare the colour of this solution with the tea solution. Does the colour change as acid is added?
3. Test the second lot of tea by adding a strong base drop by drop. Compare the colour of this solution with the tea solution. Does the colour change as base is added?

4. Copy and complete the following table:

Solution	Original colour	Colour in acid	Colour in base
Tea			
Beetroot juice			

5. Test the beetroot juice with an acid and a base. Then complete the table.
6. Chop and grind up another type of plant material. Boil the chopped up material in water. Divide it into three lots then test one with acid and one with base to see if it is a good indicator. Add it to your table.
7. Repeat step 6 using another type of plant material.
8. Add the results of the other groups in the class to your table.
9. Write a conclusion saying what you have found out about different plant material indicators.
10. Use your best plant material indicators to test if a range of materials are acids or bases. Record your results in a table.

Measuring Acidity

Not all acids and bases are the same strength. Some acids, such as the mineral acids, are **strong acids**. This means they release lots of hydrogen ions when they dissolve in water. Some acids are weak or very **weak acids** because they only release a few hydrogen ions when dissolved. Most organic acids such as citric acid are weak.

Acids have a pH of less than 7. Materials that have a pH of 7 are called neutral, which means they are neither an acid nor base. Pure water has a pH of 7, so is neutral. Bases have a pH of greater than 7.

Activity 4

Measuring pH

Materials needed:
Universal Indicator solution or paper;
Test-tubes or jars or beakers;
Different materials to test if they are acid, base or neutral.

Aim: To use Universal Indicator solution or paper to measure the pH of different materials.

1. Plan an investigation to find out the pH of different materials. Record your results in a table.
2. Write out lists of materials under each of the following headings: **Acids**, **Neutral**, **Bases**.
3. Write a conclusion in which you comment on any patterns you can see in the list of acids and bases.

Chemical properties of acids and bases

Strong acids and bases are very **corrosive**. The acids that are used in science laboratories are diluted with water but are still able to cause harm to eyes and skin.

The chemical property of acids that make them acids is their ability to release hydrogen ions when dissolved with water. Hydrochloric acid dissolves in water to give chloride ions and hydrogen ions.

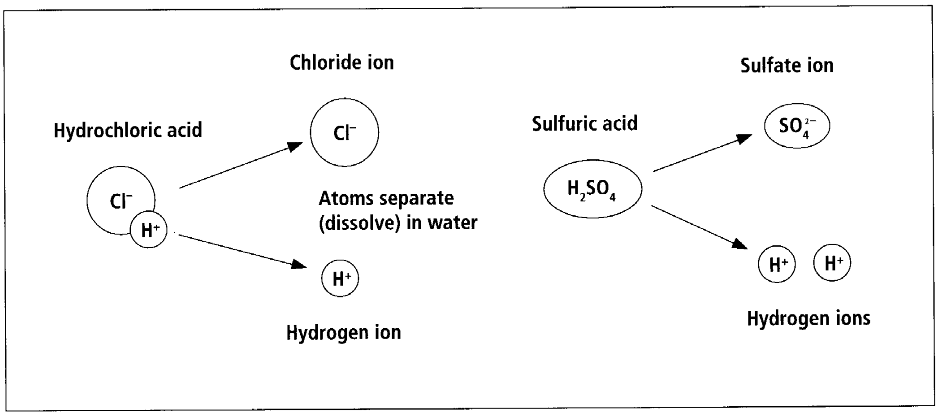


Diagram 3.5
Hydrochloric acid and sulfuric acid dissolved.

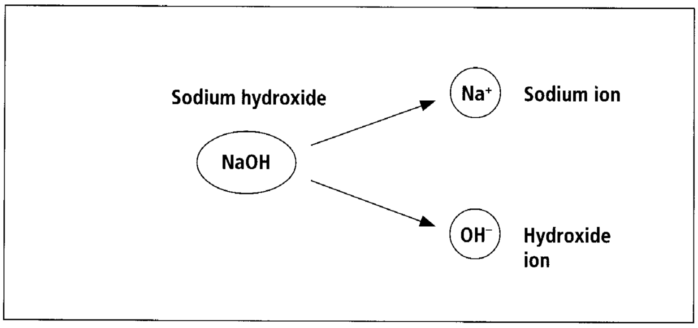


Diagram 3.6
Sodium hydroxide releases hydroxide ions.

Acid base reactions
The chemical property of bases that make them bases is their ability to react with acids. When dissolved in water they release hydroxide ions.

Hydroxide ions react with hydrogen ions to form water. Here is the word equation for this part of the reaction:

Hydrogen ion + hydroxide ion $\longrightarrow$ water molecule

This reaction is called a **neutralisation reaction** because the acid and base particles react together.

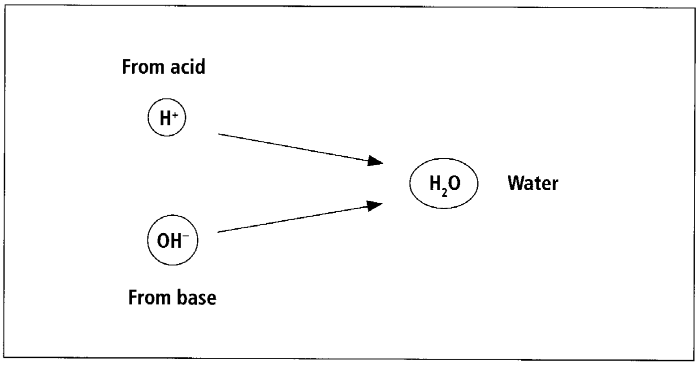


Diagram 3.7
Acid/base reaction forms water.

A metal salt is also formed when an acid and base react. A salt is a chemical that has a metal and a non-metal part. Each acid reacts to form a different type of salt.

Hydrochloric acid gives a chloride salt.

Sulfuric acid gives a sulfate salt.

Nitric acid gives a nitrate salt.

Ethanoic acid gives an ethanoate salt. Ethanoic acid used to be called acetic acid, so some books refer to acetate salts.

Citric acid gives a citrate salt.

- The general equation for the whole reaction between an acid and base is written as:

  Acid + base ⟶ metal salt + water

An example of this reaction is:

Hydrochloric acid + sodium hydroxide ⟶ sodium chloride + water

The balanced symbol equation for this reaction is:

$HCl + NaOH \longrightarrow NaCl + H_2O$

Another example is:

Hydrochloric acid + magnesium hydroxide ⟶ Magnesium chloride + water

$2HCl + Mg(OH)_2 \longrightarrow MgCl_2 + 2H_2O$

- Acids react with some metals and not others. When they do react there is fizzing or bubbling as hydrogen gas is produced. The reaction is:

  Acid + metal ⟶ metal salt + hydrogen gas

An example of this reaction is:

Hydrochloric acid + magnesium ⟶ Magnesium chloride + hydrogen gas

$2HCl + Mg \longrightarrow MgCl_2 + H_2$

- Acids react with carbonates to release carbon dioxide gas. A metal salt and water is also formed. If the water is evaporated away salt crystals are left. The reaction between an acid and a carbonate is:

  Acid + metal carbonate → metal salt + carbon dioxide gas + water

An example of this reaction is:

Hydrochloric acid + calcium carbonate → Calcium chloride + carbon dioxide gas + water

$2HCl + CaCO_3 \rightarrow CaCl_2 + CO_2 + H_2O$

Activity 5 Chemical Properties Of Acids

Aim: To record information about the chemical properties of acids.

1. Copy out the general equation, word equation and the balanced symbol equation for each of the three types of reactions that show some of the chemical properties of acids.
2. Copy and complete the word equations below and write balanced symbol equations for each of the reactions.

Zinc + ______________ → zinc chloride + hydrogen gas

Magnesium + ______________ → magnesium sulfate + ______________

______________ + ethanoic acid → sodium ethanoate + ______________

______________ + calcium hydroxide → calcium chloride + water

Sulfuric acid + magnesium hydroxide → ______________ + ______________

______________ + ______________ → ammonium sulphate + ______________

Sulfuric acid + ______________ → calcium sulfate + ______________ + ______________

______________ + sodium carbonate → sodium nitrate + ______________ + ______________

Hydrochloric acid + sodium carbonate → ______________ + ______________ + ______________

Activity 6

Physical And Chemical Properties Of An Acid Or Base

Materials and equipment needed:

A range of acids or bases;

Universal Indicator paper or solution;

Different types of metals;

Shells, coral and other types of carbonates;

Test tubes or beakers or jars.

Aim: To investigate the physical and chemical properties of an acid or a base.

1. Select an acid or base that is available for this investigation.
2. Record as many physical properties of the acid or base as you can.
3. Test the reaction of the acid or base with bases or acids as appropriate and with metals and carbonates.
4. Record your results and observations.
5. Write a report on the physical and chemical properties of the acid or base you have investigated. Share your report with others in the class.

Unit summary

- Acids are a group of materials that dissolve in water to release hydrogen ions. Acids can be solids, liquids or gases and when in foods they give it a sharp or sour taste. They turn litmus red and have a pH of less than 7.
- Organic acids, such as acetic acid, are made by living things. Mineral acids, include sulfuric acid.
- Bases are acid opposites. This means that they contain hydroxide ions that react with the hydrogen ions from acids to form the neutral material, water. Bases that can dissolve in water are called alkalis. Bases turn litmus blue and have a pH of greater than 7.
- Indicators, such as litmus and Universal Indicator are used to find out if a material is an acid, base or neutral. Indicators are made from plant material. A number of different types of plant material, such as tea and the dyes from some flowers, can be used as indicators.
- Acids are corrosive on metals and skin. If accidently spilt, acid should be washed off the skin in running water immediately.
- Some acids are strong, others are weak. Strong acids release more H^+ ions than weak acids when dissolved in water.
- Some bases are stronger than others which means they release more OH^- ions than weaker bases.
- Acids and bases react together to form a salt and water. This is called a neutralisation reaction because the reaction removed the acid particles (H^+ ions) and base particles (OH^- ions).
- Each acid forms a different family of salts. For example hydrochloric acid forms chloride salts.
- Acids react with some metals to form a salt and hydrogen gas.
- Acids react with carbonates to form a salt, carbon dioxide gas and water.

Unit 4: USES OF MATERIALS

Introduction

In this unit, you will investigate the physical and chemical properties of a group of materials and how people make use of these properties.

Use of materials

The ways in which people use materials are related to the chemical and physical properties of the materials. Each material has a different range of properties that make it more or less suitable for a particular use. The spines of coconut leaves are a material that is strong, flexible, durable or unreactive and does not dissolve in water. This makes it very good for the making of brooms for sweeping floors. Pots are made out of metals that conduct heat well and do not react with water so they can be used for cooking food.

Chemical properties of a material are those that relate to the type of chemical it is and therefore the way it reacts or does not react with other materials. For example, some metals react with water and others do not. Some materials burn and others do not. Some materials are acids, some are bases and some are neither.

The physical properties of the material are those related to things such as:

- Melting and boiling points.
- Colour.
- Density (light or heavy).
- Lustre (shine).
- Strength (hardness or softness).
- Texture (rough or smooth).
- Flexible or brittle.
- Malleability or ductile.
- Heat and electrical conduction.
- Transparent (can be seen through), opaque (can not be seen through), translucent (lets some light through but objects can't be seen clearly through it).

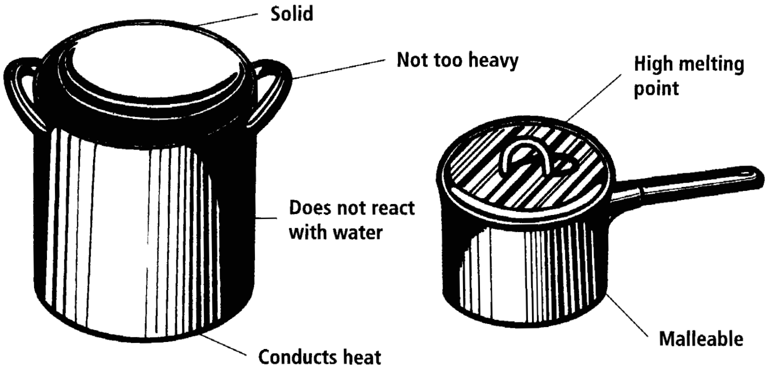


Diagram 4.1
Properties of the metals used to make pots.

Activity 1 Use Of Groups Of Materials

Aim: To report on how the physical and chemical properties of a material make it suitable for a use.

Split the class into six groups. Each group is to complete **ONE** of the following:

1. List the materials used to make the equipment needed to play kirikiti. What are the physical and chemical properties of each material that make it suitable for use in that piece of equipment? Produce a poster of the information and report back to the class.
2. List the materials used to build a fale. What are the physical and chemical properties of each material that make it suitable for use as part of a building? Produce a poster of the information and report back to the class.
3. List the materials used to make a bus. What are the physical and chemical properties of each material that make it suitable for use in that part of the bus? Produce a poster of the information and report back to the class.
4. List the materials used to make fishing equipment. What are the physical and chemical properties of each material that make it suitable for use in that piece of equipment? Produce a poster of the information and report back to the class.

5. List the materials used to build a church. What are the physical and chemical properties of each material that make it suitable for use as part of a church? Produce a poster of the information and report back to the class.
6. List the materials used to make a place for sleeping. What are the physical and chemical properties of each material that make it suitable this use? Produce a poster of the information and report back to the class.

Properties and uses of water

One of the most common materials people use is water. It has a range of chemical and physical properties that make it very useful. One of the most important properties is that it is not poisonous, so it can be used as a drink and for cooking and mixing a range of foods. The table on the next page lists more properties of water and ways people use that property.

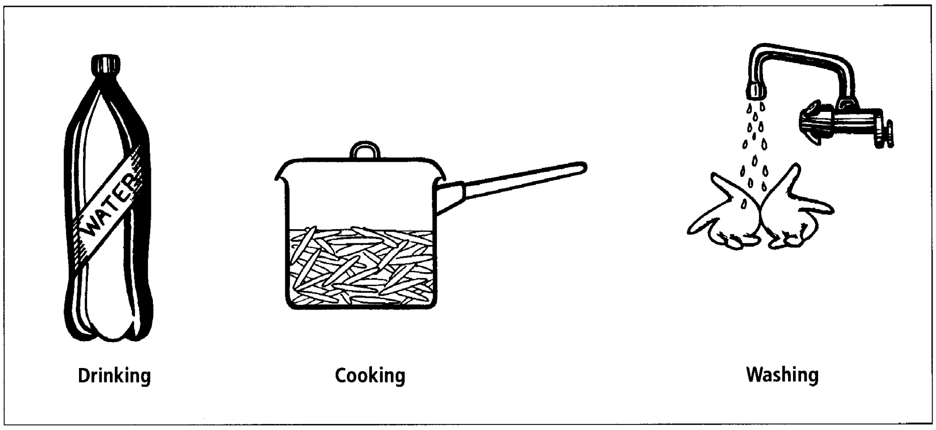


Diagram 4.2
Using water.

Property of water	Example of a use relating to the property
Liquid at room temperature (physical property)	Water can be used for washing hands and surfaces such as floors. As a liquid it can be moved easily over the surface with a cloth or broom.
Dissolves lots of other materials (physical property)	Water can be used for washing clothes. The dirt in the clothes dissolves in water and is removed from the solid cloth. Soap also dissolves in water and can be used to get more dirt off the clothing.
Water evaporates quickly at air temperature (physical property)	After water has being used to remove the dirt from clothes, the clothes can be placed flat or hung up. The water will evaporate leaving the clothes dry again.
Water can be frozen (physical property)	Water turns to ice at 0°C. It can be frozen in a freezer and then used to keep drinks and food cool. It is also used to treat sports injuries.
Water can be boiled (physical property)	Water boils at 100°C. It can be heated in a pot or electric jug. Then it can be used to dissolve koko or kofe and sugar to make hot drinks.
Water does not burn (chemical property)	Because water does not burn it can be used to put out fires.
Water reacts with some metals (chemical property)	Water reacts with zinc. Therefore zinc is used to cover the iron in roofing iron so that the iron does not react with water quickly.
Water and air react with iron to form rust (chemical property)	When the zinc coating on roofing iron is gone the iron reacts with water and air to form a red-brown chemical called iron oxide or rust.

Activity 2 Water

Aim: To record information about the properties and uses of water.

1. List the ways that you and other people in your village or school use water.
2. Select three uses of water from your list. Make sure at least one use is related to a chemical property of water. Copy and complete the table on the next page.

How water is used	Property of water being used	Type of property
		Physical or chemical
		Physical or chemical
		Physical or chemical

More properties of water

Some properties of water are caused by differences in the adhesive and cohesive forces between water molecules and other materials. **Adhesive forces** are those that occur between two different materials and **cohesive forces** are internal forces resulting from attraction between the molecules of the material itself.

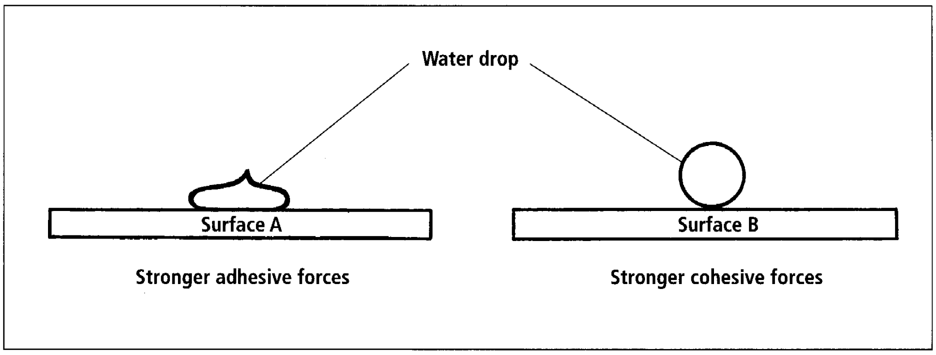


Diagram 4.3
Adhesive and cohesive forces.

When water forms a droplet that is round in shape it is because the cohesive forces between the water molecules are stronger than the adhesive forces between the water and the material the droplet is sitting on. If the water droplet is flat then the adhesive forces between the water and the other material are stronger than the cohesive forces between water molecules.

When two pieces of glass are placed together with water between them they are hard to pull apart. This is because there is a large area of contact between the water and the glass and the adhesive forces between glass and water are strong.

Activity 3

Investigating More Properties Of Water

Equipment needed:
Cup of water;
Dropper;
Aluminium foil, piece of metal or desk top;
Stick or toothpick;
Detergent;
Coin;
Pinch of chalk dust.

Aim: To investigate the adhesive and cohesive properties of water.

1. Place two drops of water on a piece of aluminium foil. Observe the shape of the drops. Draw the shape of a drop of water looking down on it. Draw a side view of a drop of water. Make a comment about the shape of the drops of water.
2. Carefully move your finger slowly down toward the drop of water until your finger is just above a drop of water and observe what happens. Record your observations.
3. Place several more drops of water next to the ones already on the foil and observe what happens as the drops move together. Record your observations.
4. Place a small drop of detergent onto one of the big drops of water on the foil. Compare the shape of this drop with another drop of similar size which has no detergent on it. Draw what you see. What do you think has happened?
5. Place a small coin on your table. Record how many drops of water you think will stay on the coin before falling off the edge of it. Now, carefully add one drop of water at a time to the top of the coin and see how many drops will stay on the coin. Record the number of drops that did stay on top of the coin. Comment on the difference between the number of drops you thought would stay on and the actual number.
6. Carefully place a pinch of chalk dust on top of the water in the cup. **DON'T** mix the chalk dust into the water. Put a small drop of detergent on the end of a stick and touch it to the centre of the dust. Describe what happened.
7. Write a conclusion to this investigation in which you use the terms adhesion and cohesion to explain your results.

Activity 4 Use Of Groups Of Materials

Aim: To investigate how the physical and chemical properties of a material are related to how it is used by people.

1. Select a common material or group of materials that is used by local people. Examples of possible materials include: foods, household cleaners, plastics, perfumes, soaps or detergents, insecticides, fabrics, plant fibres (siapo, fala, nui), fuels, timber, shells or amu, paints, dyes, leather or bones.
2. Find out how and why people use the group of materials.
3. Describe the chemical and physical properties of the material and say how each property is important to how and why the material is used by people. Use the information above about the properties and uses of water as an example of some of the properties that might be relevant to the material you are investigating. The Year 9 book on materials has information about the properties of metals and non-metals.

Unit summary

- People use different materials in different ways because they have different physical and chemical properties.
- The chemical properties of a material are related to the way it reacts or does not react with other materials.
- The physical properties of the material are those related to things such as: changes of state, melting and boiling points, colour, density, lustre, strength, hardness or softness, texture, flexiblity, malleability or ductility, heat and electrical conduction, and transparency.
- Water is a material that has lots of properties that are used by people. It is: not poisonous, a liquid at room temperature, able to dissolve lots of other materials, evaporates quickly at air temperature, can be frozen and boiled easily, does not burn, reacts with some metals not others, reacts with air and iron to form rust.
- Water also has adhesive and cohesive properties. Adhesive means how strongly attracted the water molecules are to other materials. Cohesive means how strongly the water molecules are attracted to each other.

Unit 5: CHEMICAL REACTIONS

Introduction
In this unit, you will investigate the changes that occur during chemical reactions and the different factors that affect how quickly reactions happen.

Chemical reactions
Chemical reactions occur when the chemical bonds between atoms in one or more chemicals are rearranged and the atoms become bonded to other atoms. For example, when iron rusts the iron atoms become bonded to oxygen atoms. **Chemical bonds** are the attractive forces that hold atoms together in molecules.

The following diagram shows the rearrangement of chemical bonds when a hydrogen molecule reacts with a chlorine molecule.

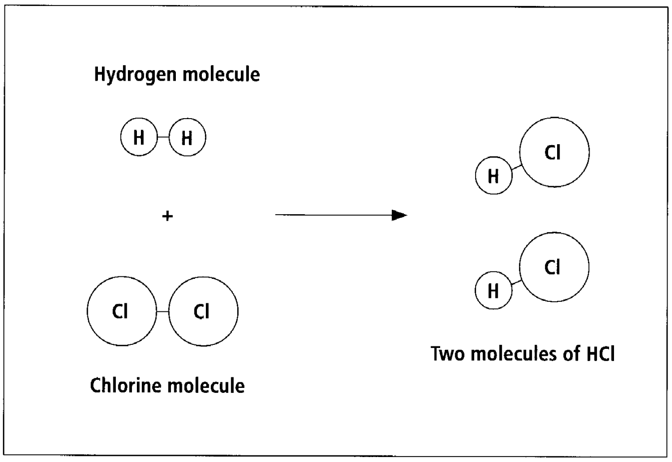


Diagram 5.1
Rearrangement of bonds when hydrogen reacts with chlorine.

The diagram shows that before the reaction two hydrogen atoms were bonded together and two chlorine atoms were bonded together. After the reaction the bonds have been rearranged. Now one hydrogen atom is bonded to one chlorine atom to make a molecule of hydrochloric acid. There are also enough atoms to make a second molecule of hydrochloric acid.

Chemical reactions are described in word and symbol equations. For example:

carbon + oxygen ⟶ carbon dioxide

$C + O_2 \longrightarrow CO_2$

These equations show how the atoms in the reactants, present at the start of the reaction, are rearranged into the products that are present at the end of the reaction.

Chemical reactions and physical changes

Often it is very difficult to tell if a chemical reaction or a physical change has occurred. Careful observations have to be carried out and sometimes the reactants have to be compared with the material present at the end to see if it is a different material or not. Often materials are heated to cause a chemical reaction but there are four different things that can happen when a material is heated. These are:

- **Burning** — The material can react with the oxygen in the air. This reaction gives out heat and light.
- **Decomposition** — The material can break up into smaller chemicals. This reaction often gives a colour change because different materials are formed. Sometimes gases are given off. For example, oxygen can be made by heating potassium permanganate until it decomposes.
- **Change of state** — No chemical reaction occurs, but the material changes state, for example, from a solid to a liquid.
- **The material gets hotter** — Materials with high melting and boiling points get hotter and hotter. Some materials, for example iron, change colour as they heat up. Iron changes from dark to red, to yellow, then white as it gets hotter and hotter. When it cools down again it goes back to the original colour. This is not a chemical reaction.

The first two bullet points above describe chemical reactions and the third describes a physical change. This shows that when you are looking for chemical changes you need to observe very carefully and think about what you are doing and what could be happening. Remember to identify a chemical change, look for observable signs such as colour change, bubbling and fizzing, precipitation, light, smoke and heat, a new smell, and coldness. You will also have to use your knowledge of the chemical properties of the materials you are using to help you decide if a chemical reaction has occurred.

A **precipitation** occurs when an insoluble solid forms when two liquids are mixed. After a short time the precipitate will sink to the bottom of the test tube.

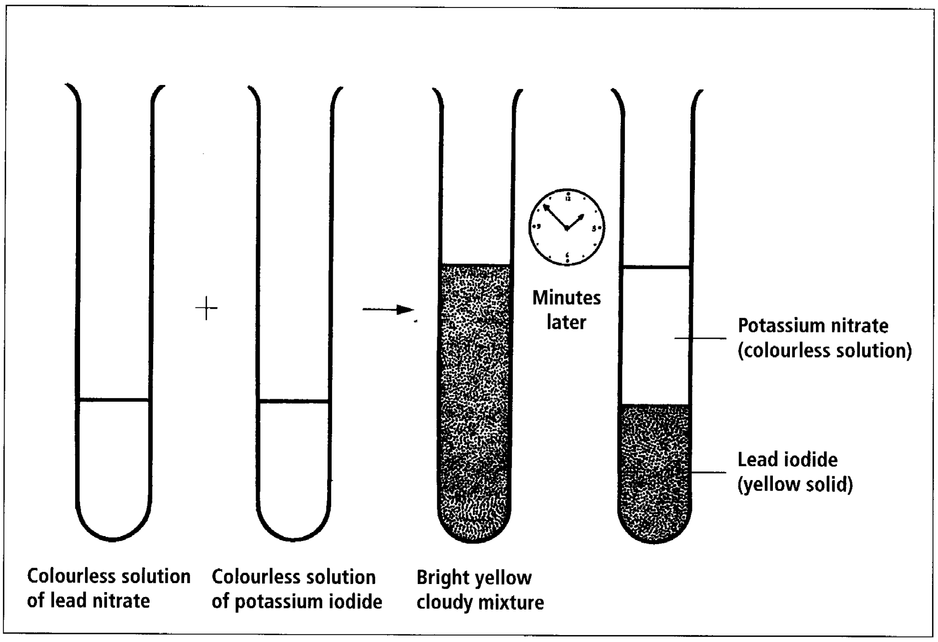


Diagram 5.2
A precipitation reaction between lead nitrate and potassium iodide.

Both lead nitrate and potassium iodide are soluble in water but when they are mixed the lead and iodide particles bond together and because they are insoluble they form a solid precipitate inside the solution of potassium nitrate.

Activity 1 Chemical Reactions

Aim: To record information about chemical reactions.

Answer the following questions in your exercise book.

1. What happens to the atoms during a chemical reaction?
2. What are 'chemical bonds'?
3. Draw a diagram similar to Diagram 5.1 for the following four reactions:

Hydrochloric acid + sodium hydroxide ⟶ sodium chloride + water

$HCl + NaOH \longrightarrow NaCl + H_2O$

Hydrogen + oxygen ⟶ water

$2H_2 + O_2 \longrightarrow 2H_2O$

Magnesium + oxygen ⟶ magnesium oxide

$2Mg + O_2 \longrightarrow 2MgO$

Hydrochloric acid + calcium carbonate ⟶ calcium chloride + water + carbon dioxide

$2HCl + CaCO_3 \longrightarrow CaCl_2 + H_2O + CO_2$

4. Describe the four different things that can happen when a material is heated. Label each as a physical or chemical change.
5. List the things that will tell you a chemical change has occurred.
6. Use the words in the list below to describe how a precipitate is formed.

solution	soluble	solid
liquid	insoluble	

Activity 2

Is It A Chemical Reaction?

Materials needed:
Calcium carbonate powder;
Glucose powder;
Magnesium oxide powder;
Six dry test tubes;
Burner;
Test tube holder;
Limewater;
Acid.

Aim: To practise identifying chemical reactions and physical changes.

1. Working in pairs or groups, heat the three chemicals one at a time in a dry test tube. Use about 1 cm deep of powder. Look for evidence of a chemical reaction. Collect any gas given off.
2. Record your observations and say if your group thinks it is a chemical reaction.
3. Now compare each of the reactants with the product it formed on heating. Do both look the same and behave in the same way? For example, try adding acid to the magnesium oxide and its product. Is the result the same?
4. For each chemical, write a sentence explaining whether or not a chemical reaction occurred on heating and include your reasons. Compare your results with other groups.

Activity 3

Investigating Chemical Reactions

Materials needed:
A range of different chemicals that are available: e.g. Metals, carbonates or shells;
Range of lab equipment for carrying out chemical reactions.

Aim: To investigate the changes that occur during a chemical reaction.

Choose one or more of the following reactions to carry out your investigation on:

- Heating: *e.g. Copper, calcium carbonate, copper carbonate.*
- Acids and bases: *e.g. Sodium hydroxide and hydrochloric acid.*
- Solutions of different chemicals: *e.g. Sodium hydroxide and copper sulfate.*
- Metals and acids: *e.g. Zinc and hydrochloric acid.*
- Metals and water.
- Acids and carbonates: *e.g. Hydrochloric acid and calcium carbonate.*
- Burning powdered metals: *e.g. Aluminium powder.*
- Burning plastics.

1. Plan how you will carry out your investigation. What method will you follow? What will you record? How will you test the materials present to see if they are different to the reactants? You may have to evaporate solutions to get the salt to look at.
2. Carry out your plan after your teacher has checked it.
3. Report your results to others.

Writing formulae and symbol equations

Chemical formulae are used to show the number and type of atoms in molecules of elements and in compounds. There are a small number of chemicals that you should learn the chemical formulae for. These include:

Water	H_2O	Oxygen gas	O_2
Hydrogen gas	H_2	Carbon dioxide gas	CO_2
Hydrochloric acid	HCl	Sulfuric acid	H_2SO_4
Calcium carbonate	$CaCO_3$	Sodium hydroxide	$NaOH$
Sodium chloride	$NaCl$		

Counting the numbers of atoms of each element in a formula

The symbol for each element on the periodic table starts with a capital letter. This is how to tell the difference between two materials. For example Co is the symbol for the element cobalt but CO is the formula for a molecule of carbon monoxide.

The formula for sulfuric acid is H_2SO_4. This shows that each molecule of sulfuric acid has two atoms of hydrogen shown by the H_2, one atom of sulfur shown by the S, and four atoms of oxygen shown by the O_4.

Sometimes formulae are written with numbers in front, such as $4H_2SO_4$. This means four molecules of sulfuric acid. How many atoms are in four molecules of sulfuric acid?

$4 \times 2 = 8$ Hydrogen;

$4 \times 1 = 4$ Sulphur;

$4 \times 4 = 16$ Oxygen;

$8 + 4 + 16 = 28$ Atoms.

There are five atoms in one molecule of aluminium oxide, Al_2O_3. Therefore there would be 30 atoms in six molecules of aluminium oxide.

Sometimes brackets are used in formulae. For example, calcium hydroxide, $Ca(OH)_2$. The bracket means that there is two lots of the OH. Therefore, the number of atoms is one calcium, two oxygen and two hydrogen, which means there are five atoms in one molecule of calcium hydroxide.

Symbol equations

Symbol equations are used to show the number and types of atoms and molecules involved in a chemical reaction. Equations are very useful. Chemists working in industries can use a balanced symbol equation to work out how much of the reactants are needed to make a certain amount of a product.

To write a balanced chemical equation for the reaction of hydrogen with oxygen:

1. First write down the formulae for the reactants.

   $H_2 + O_2$

2. Next work out what the product will be. Knowledge of the chemical reactions of different materials will need to be used. We know that materials react with oxygen to form an oxide. In this case the product will be hydrogen dioxide which we usually call water!

   $H_2 + O_2 \longrightarrow H_2O$

3. Now count the number of each element on each side of the arrow to see if the numbers on each side are even or balanced. This equation is not even. There is an extra oxygen on the reactants side.

   Reactants: Two H and two O

   Products: Two H and one O

4. One oxygen atom can't be added or removed because in oxygen gas they come in pairs but in water they come by themselves. To balance the oxygen another water is needed. This now makes the oxygen correct but gives four hydrogen atoms in the products.

   $H_2 + O_2 \longrightarrow 2H_2O$

   Two H and two O — Four H and two O

5. Another hydrogen molecule is needed on the reactants side to balance the number of hydrogen atoms in the products. The equation is now balanced because it has the same number of atoms of each element on both sides of the arrow between the reactants and the products.

   $2H_2 + O_2 \longrightarrow 2H_2O$

   Four H and two O — Four H and two O

Here is another example of how to write a balanced symbol equation for a reaction.

Magnesium + hydrochloric acid ⟶ Magnesium chloride + hydrogen gas

1. Write out the formula for each of the materials:

   $Mg + HCl \longrightarrow MgCl_2 + H_2$

2. Count the number of atoms of each element on each side of the equation. The number of magnesium atoms on both sides is the same but there are more chlorine and hydrogen atoms on the products side. Add one more molecule of hydrochloric acid and count again.

   $Mg + 2HCl \longrightarrow MgCl_2 + H_2$

   One Mg, two H and two Cl on each side.

   Now the numbers of each type of atom are the same on both sides of the equation, so the equation for the reaction is balanced.

Activity 4 Formulae And Symbol Equations

Aim: To practise writing formula and equations.

1. Copy the table below. Complete it by writing down the names and formulae for each material listed in the table of formulae on page 59. Then beside each record the number of atoms in each element and the total number of atoms. Water has been done for you.

Name	Formula	Number of atoms of each type	Total number of atoms
Water	H_2O	Two hydrogen and one oxygen.	3

2. Copy these names and formulae. How many atoms are there in each of these?

Hydrogen peroxide	H_2O_2
Zinc Chloride	$ZnCl_2$
Glucose	$C_6H_{12}O_6$
Ethanoic acid	CH_3COOH
Four molecules of calcium carbonate	$4CaCO_3$
Two molecules of calcium chloride	$2CaCl_2$
Six molecules of carbon dioxide	$6CO_2$
Vitamin C	$C_6H_8O_5$
Magnesium hydroxide	$Mg(OH)_2$
Aluminium hydroxide	$Al(OH)_3$

3. Copy and balance these equations

$H_2 + Cl_2 \longrightarrow HCl$
$CO + O_2 \longrightarrow CO_2$
$C + O_2 \longrightarrow CO_2$
$Na + Cl_2 \longrightarrow NaCl$
$Mg + O_2 \longrightarrow MgO$

4. Write balanced symbol equations for each of the following reactions:

Hydrochloric acid + sodium hydroxide ⟶ sodium chloride + water

Zinc + hydrochloric acid ⟶ zinc chloride + hydrogen gas

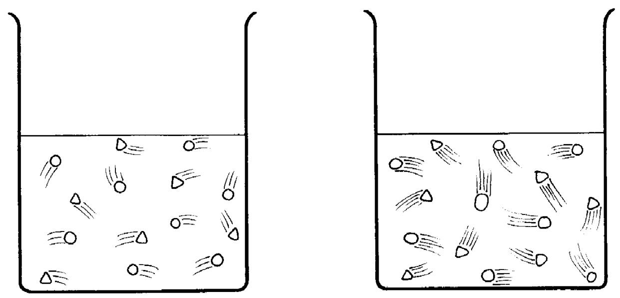
Calcium carbonate + hydrochloric acid ⟶ calcium chloride + water + carbon dioxide

Speeding up and slowing down reactions

For a reaction to occur the reactants must bang into each other with enough energy to break the bonds between the atoms and then reform bonds with other atoms. This is called the **collision theory** and is used to explain how reactions happen.

Some reactions happen quickly, such as when hydrogen and oxygen explode and form water. Some reactions happen slowly, such as iron rusting. How quickly or slowly a reaction happens is called the reaction rate. Each chemical will react at its own rate but there are other factors that affect reaction rate as well. Some of these factors are described below.

Temperature — The hotter the temperature of the reactants the quicker the reaction will go. The particles in materials that are hotter have more kinetic energy. This means that they are moving around more quickly. The reactants will bang into each other more often with more energy so the reaction will happen more quickly.

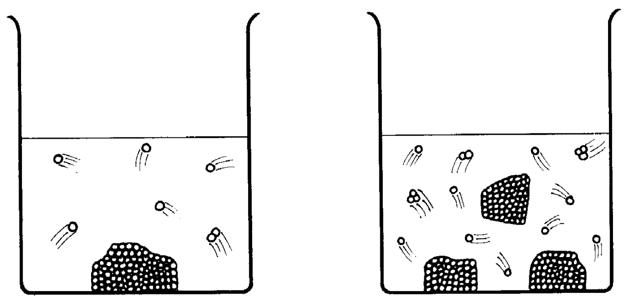


Low temperature — Particles move slowly, therefore a slow reaction rate.

High temperature — Particles move quickly, therefore a fast reaction rate.

Diagram 5.3
Temperature of the reactants.

Surface area — The finer the particles of the reactant have been broken up the quicker the reaction. If one of the reactants is a lump of material only the atoms on the outside of the lump will be able to react. If the lump is crushed it allows more of the atoms to come in contact with the other reactant and the reaction will happen more quickly.

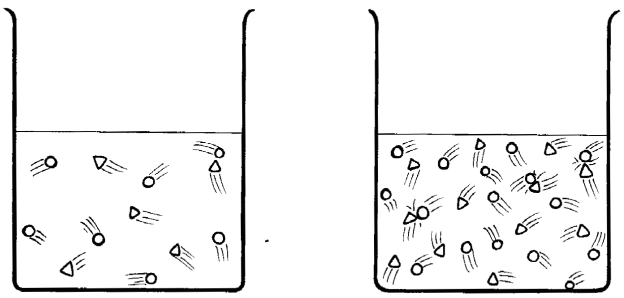


Small surface area — Few particles on surface, therefore a slow reaction rate.

Large surface area — Many particles on surface, therefore a fast reaction rate.

Diagram 5.4
Surface area of the reactants.

Concentration — The higher the number of particles present in a volume of reactant the quicker the reaction will go. The more dilute a reactant is, the fewer the number of particles available to react and the slower the reaction will happen.



Low concentration — Few particles, therefore fewer collisions and a lower reaction rate.

High concentration — Many particles, therefore many collisions and a fast reaction rate.

Diagram 5.5
Concentration of the reactants.

Stirring — If the reactants are kept moving by stirring the reaction will happen more quickly.

Slowing reaction rates down
Rusting and corrosion reactions cause loss of materials so people use lots of ways to slow down these reactions. Iron is often covered in a protective layer of oil, paint, tin or zinc. Tin cans have a thin layer of tin over the iron to stop rusting. The term 'galvanised iron' means the iron is covered with a layer of zinc to stop it rusting. In car engines the iron is covered with oil to stop the rusting. These methods work by stopping air or water or both from coming in contact with the iron and starting the reaction.

Activity 5

Factors That Affect Chemical Reactions

Aim: To record information on factors that affect a chemical reaction.

1. Name three factors that affect reaction rate and draw a diagram to explain how and why they change the reaction rate.
2. Describe the methods people use to slow down rusting.
3. Use notes and diagrams to explain the following:
   a. Forest fires burn more quickly when strong winds bring more oxygen to the fire.
   b. Industries that use baking flour often have the surfaces of buildings and equipment covered with very small particles of flour. Sometimes this flour can react in an explosive way.
   c. Food cooks faster when the oven is hotter.

Activity 6

Materials needed:
Acid;
Shells, pieces or lumps of calcium carbonate;
Detergent;
Test tubes;
Marker pens;
Watch or stop watch.

Measuring Reaction Rate

Aim: To use detergent foam to measure reaction rate.

Foaming reaction set up

1. Mark a test tube with two lines. One line 4 cm from the bottom and the other 1 cm from the top.
2. Fill acid up to the bottom line.
3. Add five drops of detergent and stir gently to mix. Don't make bubbles.

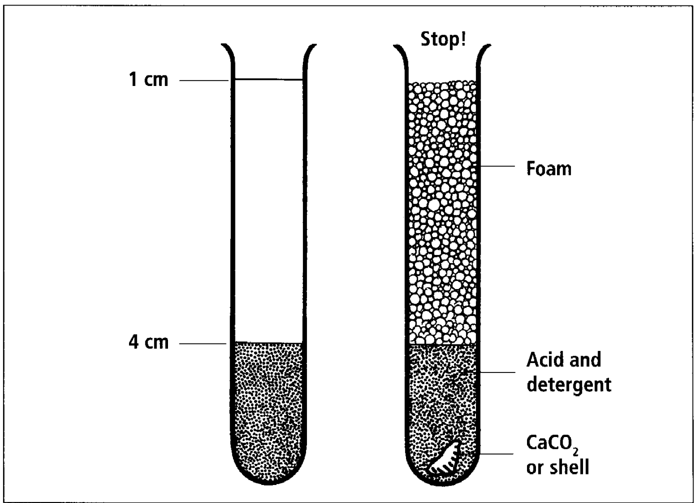


Diagram 5.6
Using detergent to measure reaction rate.

4. Drop in three shell pieces or lumps of calcium carbonate and start the watch.
5. Time how long it takes the foam to reach the top line. Wash out at once to stop the reaction.
6. Repeat twice more, using the same, washed chips.
7. Record the three results and work out the average.
8. Draw a diagram to show how the equipment was set up to use detergent to time the reaction rate.

Activity 7

Materials needed:
Acid (not sulfuric acid);
Shells, pieces or lumps of calcium carbonate;
Detergent;
Test tubes;
Marker pens;
Watch or stop watch;
Thermometer;
Burner or hot water;
Grinding equipment such as a mortar and pestle or hammer.

Checking Out The difference

Aim: To investigate the effect of temperature, surface area and concentration on reaction rate.

Ice bath and water bath temperature

1. To investigate the effect of temperature use ice and hot water baths to change the temperature of the acid before adding the carbonate.
2. Measure the temperature of the acid just before adding the carbonate and then time how long it takes to react.
3. Repeat the reaction at each temperature if possible.
4. Try the reaction at four or five different temperatures.
5. Record your result and write a report.

Surface area

1. Select three lumps of shell or carbonate that are the same size. Grind one piece into a powder. Break the second piece up into smaller pieces.
2. React the powder, pieces and lumps separately with acid. Time how long each takes to foam or watch for the amount of fizzing. Record your results and repeat if possible.
3. Write a report on the investigation.

Concentration

1. Change the dilution of the acid by taking 5 mL of acid and adding small amounts of water to it: *e.g. 0.5, 1.0, 1.5 and 2 mL.* You will need to experiment to get dilutions that work for the acid you have.
2. React equal sized pieces of carbonate in the different dilutions of acid. Time how long each takes to foam or watch for the amount of fizzing. Record your results and repeat if possible.
3. Write a report on the investigation.

Activity 8

Materials needed:

Three test tubes or plastic bottles;

Three iron nails;

Oil;

Boiled water;

Calcium chloride.

Rusting

Aim: To investigate the conditions needed for rusting to occur.

1. Set up three test tubes as shown in the diagram below.

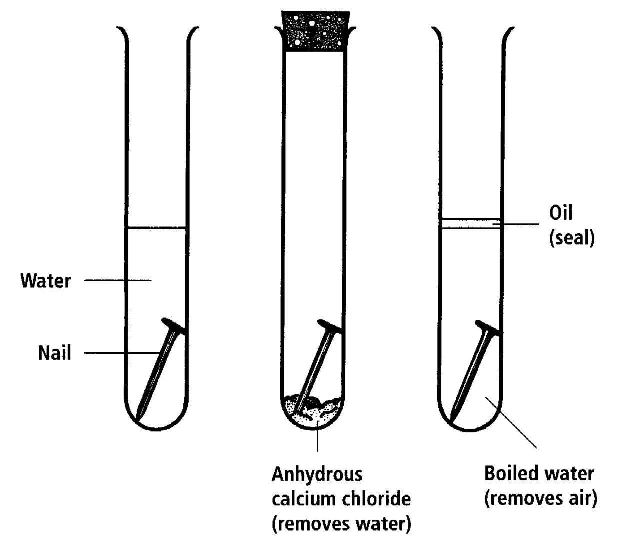


Diagram 5.7
Rusting set-up.

2. Make observations each day, if possible, for several days. Copy the table below into your exercise book, and record your observations.
3. Write a conclusion for this investigation.

Day	Water and air	Air (no water)	Water (no air)
1			
2			
3			

Activity 9

Materials needed:

Iron nails;

Containers — test tubes, beakers, plastic bottles;

Other materials will be required for each different plan.

Rusting Investigation

Aim: To investigate factors that affect rusting of iron.

1. Plan, carry out and report on an investigation to find out how a factor effects the rate at which iron rusts. Here are some possible factors to investigate:

- Temperature.
- Concentration of acid.
- Concentration of salt water.
- Contact with zinc or magnesium.
- Contact with copper.

2. Present your report to the class.

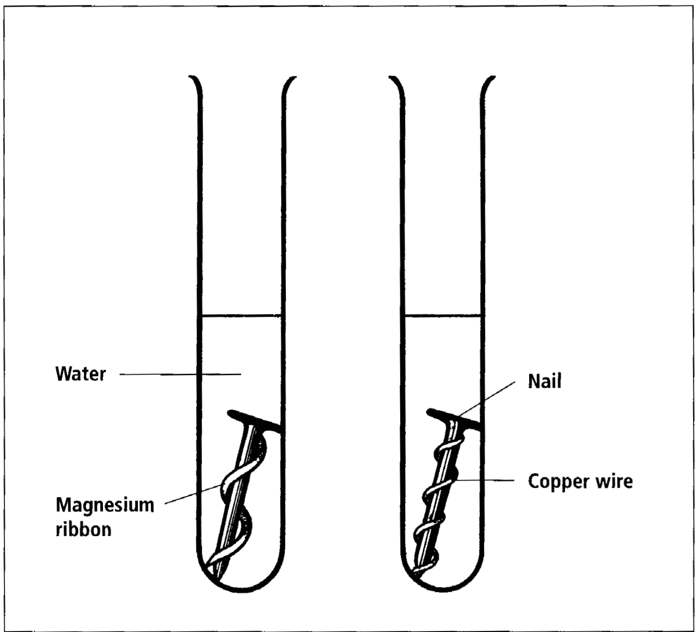


Diagram 5.8
Iron in contact with other metals.

Unit summary

- During a chemical reaction the chemical bonds holding the atoms together are broken and new bonds are formed.
- Chemical bonds are the attractive forces that hold two or more atoms together.
- Sometimes it is difficult to tell if a change is chemical or physical.
- Four things can happen when a material is heated: burning, decomposition, change of state, or the material gets hotter. Burning and decomposition are chemical reactions. Change of state is a physical change.
- Signs of a chemical reaction happening include colour change, bubbling and fizzing, precipitation, light, smoke and heat, a new smell and coldness.
- When water boils it bubbles but this is not a chemical reaction. When iron is heated it changes colour but this is not a chemical reaction. Careful observation, knowledge of the reactants and testing are needed to identify a chemical reaction.
- A precipitation is an insoluble solid that forms when two liquids are mixed.
- Chemical formulae show the number and type of atoms present in a compound. $CaCO_3$ has one atom of calcium, one atom of carbon and three atoms of oxygen.
- $4CaCO_3$ means there are four molecules of calcium carbonate.
- Symbol equations, such as the one below, are used to show the numbers of atoms and molecules involved in a chemical reaction and the products that are formed.

  $H_2SO_4 + Mg \longrightarrow MgSO_4 + H_2$

- Reactions can happen at different rates. Temperature, surface area, concentration, stirring are all factors that change the reaction rate.
- People often try to speed up or slow down chemical reactions. Iron is prevented from rusting using protective coatings of tin, zinc, paint or oil.
- Iron only rusts when both oxygen and water are present. The presence of salt and other metals affect the rate of rusting.

YEAR 10 GLOSSARY

Word/phrase	Meanings
Adhesive forces	Forces between two different materials.
Alkali	A base that is able to dissolve in water.
Atomic number	The number of protons in an atom.
Atoms	The simplest particles materials are made up of.
Bases	Substances that have a pH greater than 7.
Chemical bonds	Attractive forces that hold atoms together in molecules.
Cohesive forces	Forces holding the molecules of the material together.
Electrons	The small particles inside atoms that have a negative electrical charge.
Elements	Different types of atoms listed on the periodic table.
Hydrogen ion	A hydrogen atom that has lost one electron.
Indicators	Materials made from plant dyes that turn different colours when they are put in solutions of acids and bases.
Litmus	An indicator that comes in two different colours, blue and red.
Mass number	The number of protons and neutrons in the atoms of each element.
Mineral acids	The acids that people make.
Models	Scientists use models to show others what they think something is like.
Neutrons	Neutrons are found in the nucleus and act as a glue to hold the protons together.
Nucleus	Very small, dense centre of an atom.
Organic acids	Come from living things and contain carbon.
Photosynthesis	The process where plants make their own food.
Products	Materials present at the end of a chemical reaction.
Reactants	Materials present at the start of a chemical reaction.
Reaction rate	How quickly or slowly a reaction happens.
Respiration	Chemical reactions that give energy in the cells.
Salt	A compound that has two parts: a metal and a non-metal part.
Strong acids	Release lots of hydrogen ions when they dissolve in water.
Universal Indicator	Universal Indicator is a green solution or yellow paper that is a mixture of different indicators.
Weak acids	Weak acids do not release many hydrogen ions when they dissolve in water.