3 Everyday reactions

Planning page

- **Getting started**
- **3.1 What is a chemical reaction page 44**
  - Investigate 6 Observing reactions
  - Investigate 7 Reaction rate
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- **3.2 Some common gases page 52**
  - Investigate 8 Making hydrogen
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  - Animation Fire extinguisher
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- **Review**
  - Chapter 3 test

Essential Learnings for Chapter 3

Essential Learnings	References		
	Student book (page number)	Workbook (page number)	Teacher Edition CD (Assessment task)
Knowledge and understanding *Science as a human endeavour* Immediate and long-term consequences of human activity can be predicted by considering past and present events	page 48 page 59		
Natural and processed materials Reaction rate is affected by various factors, including temperature, concentration and surface area	page 49 Investigate 7 page 49		Assessment task 3 Chemical reactions
Chemical reactions can be described using word and balanced equations	pages 48, 53, 56	Exercise 4 page 25	
Earth and beyond Global patterns of change on earth and in its atmosphere can be predicted and modelled	page 59		
Ways of working Conduct and apply safety audits and identify and manage risks	Investigate 6 pages 45–47 Investigate 7 page 49 Investigate 8 page 54 Investigate 9 page 55 Investigate 10 pages 57–58		
Identify problems and issues, formulate scientific questions and design investigations	Investigate 7 page 49		
Draw conclusions that summarise and explain patterns, and that are consistent with the data and respond to the question	Investigate 7 page 49 Investigate 8 page 54 Investigate 9 page 55		Assessment task 3 Chemical reactions

QSA *Science Essential Learnings by the end of Year 9*

Vocabulary

atmosphere
carbon dioxide
chemical
combustion
electricity
equation
extinguisher
fermenting
greenhouse
hydrogen
oxygen
photosynthesis
physical
precipitate
reactant
reaction

Focus for learning

Make observations of the changes that occur when a sparkler burns (page 43).

Equipment and chemicals (per group)

Investigate 6 Part A page 46 1 M HCl, 1 M NaOH, 1 M H_2SO_4, sodium thiosulfate crystals (hypo), 2 small pieces of magnesium ribbon, 0.1 M $CuSO_4$, 0.1 M $BaCl_2$, marble chip, 0.001 M $KMnO_4$, hydrogen peroxide (3% solution), 7 test tubes, 2 test tube racks, test tube holder

Investigate 6 Part B page 47 lemon, strip of copper (10 mm × 80 mm), strip of magnesium, aluminium or a large steel nail, 250 mL beaker, millivoltmeter or multimeter, 2 connecting wires with alligator clips

Investigate 7 page 49 1 M HCl, marble chips, 3 test tubes, test tube rack, 250 mL beaker or bottle, ice, thermometer (optional)

Investigate 8 page 54 test tube rack, 3 test tubes, 1 cm of magnesium ribbon, 1 M HCl, taper and matches, test tube holder

Investigate 9 page 55 manganese dioxide, hydrogen peroxide, 2 test tubes, test tube rack, test tube holder, wooden splint and matches

Investigate 10 pages 57–58
Part A: 3 test tubes and test tube rack, stopper, one-holed stopper fitted with U-shaped piece of glass tubing, taper and matches, drinking straw, limewater (calcium hydroxide solution), 2 or 3 marble chips, 1 M HCl
Part B: 3 birthday candles of different lengths, large ice-cream container, baking soda, vinegar, beaker or jar, teaspoon
Part C: 3 large test tubes, sachet of powdered yeast, 2 teaspoons of sugar, teaspoon, four 250 mL beakers or jars
Part D: 4 sultanas, soda water or lemonade, glass or jar

3 Everyday reactions

Getting Started

Your teacher will give you a sparkler, some matches and safety glasses.

- Record as many observations of the sparkler as you can (include measuring its mass). Call this *Observations before lighting*.

  Put on the safety glasses and light the sparkler.
- Record your observations of the burning sparkler. Call this *Observations of a burning sparkler*.
- When the sparkler has finished burning, make another list of observations. Call this *Observations of a burnt sparkler*.

  Caution: Let the sparkler cool for 5 minutes before you find its mass.
- In small groups, discuss the changes that occurred in the burning sparkler. Make a list of these changes.

Keep your notes as you will use these later in the chapter.

Starting point

Start the lesson with some visual demonstrations. For example:

- Add sodium to water, with a few drops of indicator in the water. (This is best done behind a safety screen.)
- Add glycerine to potassium permanganate. (Put 2 to 3 g of potassium permanganate crystals on a tin lid sitting on a heatproof mat. Make a well in the pile of crystals and add 1 mL of glycerine. In about 20 seconds the mixture will heat up and purple flames will appear. Do this in a fume cupboard or behind a safety screen.)
- Burn magnesium ribbon. (Tell students not to look directly at the burning magnesium.)
- Light some candles.

Be sure to discuss safety procedures before the demonstrations.

After doing the Getting Started activity, write the word *reaction* on the board or on butcher's paper. Ask students to work in groups or as a class, and see how many other terms, concepts and ideas this word triggers. Then discuss what students think chemical reactions are and where in our everyday life we see them occur.

Ask students to scan the chapter quickly. They will see that there are a number of laboratory investigations to do. Then ask them to recall the safety and laboratory rules from earlier chapters and stress the importance of them while they are doing the investigations in this chapter.

Also recall the skills they learnt in Chapter 2: Making observations, inferences and predictions.

Hints and tips

Sparklers are potentially hazardous. They remain hot for quite a while after they have finished burning. Make sure you have clear rules about keeping the burning sparklers away from clothes and skin.

Hints and tips

A chemical reaction is usually the interaction of two or more substances resulting in chemical changes in the substances. However, under certain conditions there may be only one reactant. For example, when heated, calcium carbonate (limestone) decomposes to form calcium oxide (lime) and water. Water decomposes to hydrogen and oxygen when electricity is passed through it.

Reinforce the concept that chemical reactions result in new substances being formed and that it is usually very difficult, if not impossible, to bring the reactants back to their original form. Use the analogy of a cake.

When we bake a cake, the eggs, milk, and flour do not just disappear. They change to form a new product.

eggs + flour + milk → cake

Using everyday examples familiar to students makes the learning in this chapter more relevant and interesting. It also encourages students to share their experiences.

3.1 What is a chemical reaction?

You may have observed that a burning sparkler gives off light, heat, sound and gases, and the burnt sparkler looks quite different from the original one. The changes that occurred in the burning sparkler are called chemical changes or **chemical reactions**.

In a chemical reaction one or more new substances are formed. For example, in the burning sparkler, the black crusty substance and the white smoke are new substances, whose properties are completely different from those of the original sparkler. The reaction also produced heat, light and sound.

The rusting of iron is another chemical reaction. It produces a new brown substance, with properties different from the original grey iron.

Chemical reactions cannot easily be reversed. You cannot get the sparkler back once you have burnt it, and you cannot change rust back to iron without another chemical reaction and an input of energy.

Signs of a chemical reaction

The signs for recognising when a chemical reaction has occurred are listed below. Sometimes only one of these things happens, at other times several things happen.

Signs of a chemical reaction

1 *Gas is produced.*
2 *Permanent colour change occurs.*
3 *Solid is formed.*
4 *Heat, light, sound or electricity are produced.*

Burning is a chemical reaction called combustion, which produces new substances.

Images © CSIRO

Learning experiences

1 Students could make their own set of flash cards for each section of this unit, starting with 'signs of a chemical reaction'. They could continue making cards as they progress through the chapter.
2 Ask students to write a list of chemical reactions that occur in the kitchen when dinner is being prepared and ask them to explain why they are chemical reactions.
3 As an extension, students could find out what the words *exothermic* and *endothermic* mean and use them in sentences.

Physical changes

When water freezes, ice forms. Ice is a solid. Does this mean freezing is a chemical change?

The freezing of water to ice is called a **physical change**. During a physical change some of the properties of the substance change, but the substance is still the same. For example, water is a liquid and can be poured. Ice is a solid and cannot be poured, but it is still water.

Also, you can usually reverse a physical change. For example, when liquid water boils to form gaseous water vapour, its properties change. It is now a gas but it is still water. And it can be easily changed back to liquid water by cooling it.

WEBwatch

Go to www.scienceworld.net.au and follow the links to **Physical change**. There are many interesting sections and mini-movies at this site.

Investigate 6 OBSERVING REACTIONS

Aim

To observe a variety of chemical reactions.

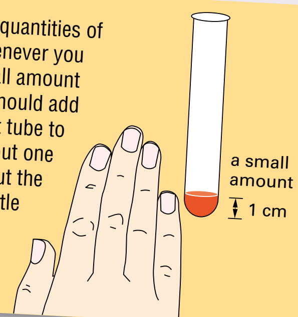
Planning and Safety Check

Carefully read the instructions for each of the four parts.

- Which safety precautions will be necessary? (Check pages 7 and 8.)

In your notebook, design and draw up a large data table to record your observations. Note that there are three different reactions in Part A.

Use only small quantities of chemicals. Whenever you read 'add a small amount of liquid', you should add liquid to the test tube to the depth of about one centimetre (about the length of your little fingernail).



Hints and tips

Emphasise that a physical change is very different from a chemical change as it can be reversed and the reactants can be retrieved through separation techniques or heat. For example:

- salt and water—evaporation
- sand and water—filtration
- methylated spirits and water—distillation.

Students get very excited when doing laboratory work, so remember to enforce the lab rules, making sure you have the students' full attention at all times. You may wish to have a key word or phrase that you use to gain their attention. This is a good safety technique to use in the lab.

Lab notes

Read through the instructions with the class and point out anything of importance.

Remind students about the safety issues and techniques for mixing chemicals. For example:

- use very small amounts of solutions (fingernail high)
- follow all instructions
- observe reactions carefully and record observations.

Make sure students prepare data tables to record their observations.

Allow for clean-up time. Cleaning up is just as important as preparing and doing practical work. Leave approximately 10 minutes for clean-up and putting equipment away. Students need to be aware of the correct ways to dispose of chemicals and to clean equipment.

Lab notes

Part A

- Reaction 1: Good lab management is important here to ensure that students focus on safe procedures.
- Cleaning the magnesium ribbon is important. It is best to use sandpaper or a scourer.
- Reactions 3 and 4: It is important that students feel the test tube to observe heat production.
- Reaction 6: Make sure the remaining marble chips are washed and dried and go back in the container.
- Reaction 7: Use about one rice-grain-sized amount of potassium permanganate.
- Make sure that the 3% hydrogen peroxide is made up fresh or it will not work very well.

PART A

Materials

- dilute **hydrochloric acid** (1 M)
- dilute **sodium hydroxide** solution (1 M)
- dilute **sulfuric acid** (1 M)

Corrosive

- sodium thiosulfate crystals (hypo)
- 2 small pieces of magnesium ribbon
- **copper sulfate** solution (0.1 M)
- **barium chloride** solution (0.1 M)

Toxic

- marble chip
- potassium permanganate solution (0.001 M)
- hydrogen peroxide (3% solution)
- 7 test tubes and test tube racks
- test tube holder

Wear safety glasses.

Method

1 Number the seven test tubes.

2 Carry out the seven reactions below.
For each reaction describe the changes you see, noting any of the five signs that a reaction has occurred. (Feel the test tube to detect any change in temperature.)
Draw up a data table for your results. Put what you did on the left-hand side, and what you observed on the right.

Reaction 1

Put a piece of magnesium in the test tube and add a small amount of dilute hydrochloric acid. Don't forget to point the test tube away from yourself and other people, and wear safety glasses.

Reaction 2

One-third fill the test tube with copper sulfate solution. Add a piece of magnesium.

Reaction 3

One-third fill the test tube with water. Add about a spatula of hypo crystals and shake to dissolve.

Reaction 4

Add a small amount of copper sulfate solution to a test tube. Then add a small amount of sodium hydroxide solution (caustic soda) and let the test tube stand for a few minutes.

Reaction 5

Add a small amount of barium chloride to a test tube. Then add a small amount of sulfuric acid.

Reaction 6

Put a marble chip in the test tube and add a small amount of dilute hydrochloric acid.

Reaction 7

Add a small amount of potassium permanganate solution to a test tube. Then add 2 or 3 drops of hydrogen peroxide.

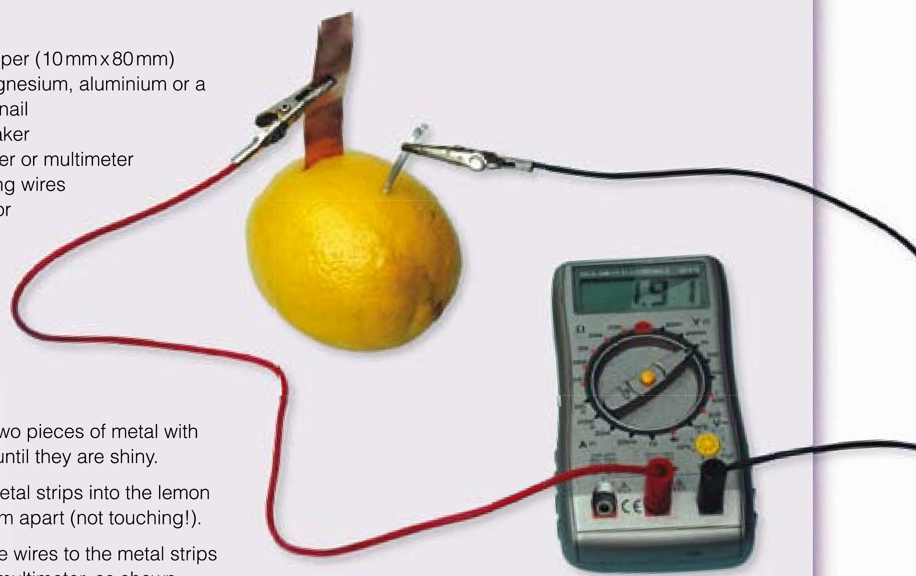
Discussion

1 For each reaction, list which of the signs of a chemical reaction (see page 44) occurred.
2 In which test tube reactions did you notice a temperature change?
3 Sort the reactions into groups so that each group contains similar types of reactions.

PART B

Materials

- lemon
- strip of copper (10 mm x 80 mm)
- strip of magnesium, aluminium or a large steel nail
- 250 mL beaker
- millivoltmeter or multimeter
- 2 connecting wires with alligator clips



Method

1. Clean the two pieces of metal with steel wool until they are shiny.
2. Push the metal strips into the lemon about 10 mm apart (not touching!).
3. Connect the wires to the metal strips and to the multimeter, as shown. Record your observations.

Discussion

1. Was there a chemical reaction? How do you know?
2. After some time the multimeter will read 0. Suggest why.
3. Take the metal strips out of the lemon. Are there any signs that a chemical reaction has occurred?

try this

Do this activity outdoors.

You need a clear plastic bottle and a stopper or cork that fits well. Put about three heaped teaspoons of baking soda in the bottle. Moisten the stopper with water. Get about half a cup of vinegar. Now be prepared to work quickly.

While your partner holds the bottle and stopper, pour the vinegar into the bottle. Put the stopper in immediately, but not too tight! Make sure you point the bottle away from people or things that could break.

Lab notes

Part B

If you use multimeters you will need to use the smallest voltage scale. It is a good idea to preset them for the students.

Students could try different combinations of metals and record the voltages produced. Ask students why they need to clean the metals before use.

Hints and tips

Baking soda is the same as bicarbonate of soda. Its correct chemical name is sodium hydrogen carbonate ($NaHCO_3$).

Try this notes

- Safety glasses are important here to avoid getting vinegar in the eye.
- An alternative version of the **Try this** is to use *Diet Coke* and a few *Mentos* lollies. This will produce a drink fountain. The record height for this fountain is 5.8 metres.

Homework

Ask students to use the internet to find out what chemicals and equipment were used to make the very first electric cells (like the one they made in Part B). How could they make a battery at home using ordinary household items?

Hints and tips

- Remind students what a chemical reaction is.

  It is very important to teach students that the reactants are used up in a chemical reaction and, although the product may look different, nothing is lost or disappears. Remind students of the cake analogy (page 44).
- Many chemical reactions occur when two or more reactants interact. Reinforce this concept to the students by asking them questions like: 'When a metal post rusts or silver jewellery turns black, what is it reacting with?' The students should recognise water (moisture) or air as reactants. However, under certain conditions only one reactant is needed for a chemical change. See the note on page 44.

Reactants and products

You can divide the substances in any chemical reaction into two groups—**reactants** and **products**. The reactants are the substances you start with and which react with each other. The products are the new substances produced in the reaction. For example, if you did the outdoors activity in Try this on the previous page, vinegar reacted with baking soda to produce bubbles of gas that caused fizzing. So in this case the vinegar and baking soda are reactants, and the gas (called carbon dioxide) is the product.

There is a shorthand way of describing what happens in a chemical reaction. It is called a **chemical equation**. Instead of saying baking soda reacts with vinegar to produce carbon dioxide you write:

baking soda + vinegar → carbon dioxide

The reactants are on the left-hand side of the equation, and the product is on the right-hand side. Sometimes there is only one reactant and sometimes there are two or more. The same goes for the products. The reactants and products can be solids, liquids or gases. Sometimes it is hard to know exactly what the reactants and products are. For example, when wood burns it reacts with oxygen (an invisible gas present in the air), and produces another invisible gas—carbon dioxide.

Forming solids

Two of the reactions in Investigate 6 (on page 46) formed solids. When you added caustic soda to copper sulfate (in Reaction 4), a pale blue solid formed. Because it did not dissolve in water, the solid falls to the bottom of the test tube. A solid formed like this from a liquid is called a **precipitate** (pre-SIP-it-ate).

In Reaction 5 another precipitate formed when you added sulfuric acid to barium chloride solution. This precipitate is barium sulfate. The equation for this reaction is:

barium chloride + sulfuric acid → barium sulfate + hydrochloric acid

When do reactions occur?

Chemical reactions occur only under certain conditions.

Firstly, you need to have the right substances present. Iron will not rust without air and water. This is why rusting does not occur on the Moon—there is no air or water. The photo below shows a military truck that has been in the desert for many years. It has not rusted very much because there is very little water.

Secondly, you quite often need heat to cause a chemical reaction. To fry an egg you need to heat it in a pan. To get dough to rise you need to put it in a warm place, and to get a sparkler to burn you have to heat it with a match.

Thirdly, you sometimes need electricity to cause a chemical reaction. This is what happens when you charge a car battery. The electricity produces changes in the chemicals inside the battery.

Homework

Ask students to write down chemical reactions that they see occur in everyday life. Have them write each event in the form of a word equation.

Learning experience

Students could write a concise three-point summary giving their own example of a reaction occurring using the information from **When do reactions occur?**

Reaction rate

Some reactions are slow, like rusting. Others occur quickly, like the ones you observed in the last investigation. Explosions are chemical reactions that occur very quickly and produce large amounts of heat, light and sound.

The speed of a reaction is called its **reaction rate**. A slow rate means the reaction takes a long time. A fast rate means it takes only a short time. In Investigate 7 below you can investigate the way in which the temperature affects the reaction of acid on marble chips.

Fig 10 This fireball formed when a bottle of liquid petroleum gas (LPG) leaked and reacted explosively with the oxygen in the air.

Hints and tips

A rate is considered to be a quantity divided by time. How fast or how slow is a measure of speed, not time. If one reaction took a shorter time than another, then we can say that the reaction was faster.

Investigate 7 REACTION RATE

This investigation is a little different from the others you have done. In this one you have to work in a small group to write the method.

Planning

The aim of this investigation is to see how temperature affects the reaction rate.

- For the reaction use a marble chip in some hydrochloric acid.
- Try three temperatures—room temperature, ice water and hot tap water (although you might have other ideas!).
- Pour the hydrochloric acid into the test tubes and sit them in hot or cold water for at least 5 minutes before you add the marble chip.
- Make it a fair test! Use the same amount of acid and the same size marble chip in all test tubes.

Wear safety glasses.

Getting started

1 Write the TITLE, AIM, PLANNING AND SAFETY CHECK, MATERIALS REQUIRED and METHOD.

2 Show your write-up to your teacher before you start. Your teacher has to sign your investigation.

3 Make sure you have designed data tables to record your results.

Writing your report

1 Remember to include RESULTS, DISCUSSION and CONCLUSION in your report.

2 Work in a group to compile the report but write your own to show to your teacher.

Lab notes

This is the first open-ended investigation some students may have attempted, and guidance will be needed. Make sure you read through the students' investigation plan, and sign it before they start.

- Emphasise the need to use the same size and number of chips.
- Do not allow students to light a burner to heat the acid. Use water baths as suggested.

Learning experience

Ask students to suggest other factors that could also affect the rate of reaction. You could demonstrate the following:

- The effect of surface area. Time how long it takes to dissolve a sugar cube as opposed to sugar grains or caster sugar.
- The effect of concentration. Observe how quickly zinc or magnesium reacts with different concentrations of hydrochloric acid (0.1 M, 0.5 M, 2 M HCl).

Hints and tips

Compile a list of everyday *wanted* and *unwanted* reactions. Discuss with the class reasons why the reactions are or are not desirable. Can the students think of any more everyday reactions that can be included in the list?

Assessment task

Assessment task 3: Chemical reactions, found on the CD, could be set at the end of this section.

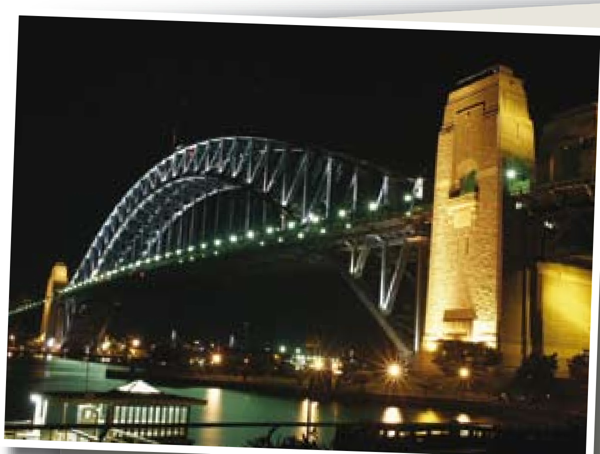
Wanted and unwanted reactions

All life depends on chemical reactions. Plants use the chemical reaction called photosynthesis to make food. Chemical reactions occur in your bodies to digest the food you eat. And further reactions are needed to produce energy for your body cells. Fuels such as coal and oil are also used to provide energy; for example, petrol is burnt in the engine of a car.

Most of the materials we use every day are made by chemical reactions. For example, synthetic rubber, plastics, detergents, fertilisers, paints and some medicines are made from chemicals found in oil. And the chemical reactions that occur in batteries allow us to produce electricity anywhere.

Some chemical reactions are unwanted. For example, house fires and bushfires are uncontrolled reactions that cause loss of life and property. Rusting and other forms of corrosion cause millions of dollars worth of damage. Tooth decay is caused by chemical reactions between your teeth and acids in food.

Reactions that occur in homes, in cars and in factories all create products that can harm our environment if not carefully controlled. Every year we learn more about the properties of materials we use. For example, we now know that CFCs (chlorofluorocarbons), once used in aerosols and refrigerators, can destroy the ozone layer by reacting with it.



Painting the bridge

The Sydney Harbour Bridge is the largest steel bridge in Australia. Construction of the bridge started in 1924 and it took 1400 men 8 years to complete.

The 52 800 tonnes of steel in the bridge would cover an area of about 60 football fields. But there is one major problem with a steel bridge—it rusts. This is an unwanted chemical reaction.

To stop the steel reacting with the air, the steel is painted. The first painting in 1930 took 272 000 litres of paint to give the bridge three coats of paint. This amount of paint would fill seven petrol tankers. The bridge is continually being painted to stop it rusting.

Learning experience

Students working in small groups could research a chemical reaction that occurs in industry, in their body or in the environment. They should record the word equation, explain why it is important, and describe the impact it has on society.

Learning experience

As a challenge exercise you may like to ask students to investigate other possible ways of preventing the steel in the Sydney Harbour Bridge from rusting. They could investigate what causes corrosion, how it can be reduced and which metals are least likely to corrode. (Rusting is only one form of corrosion.) Ask them why they think steel was chosen for the Sydney Harbour Bridge.

Check!

1 Copy and complete these sentences.
   a Two types of changes that substances undergo are ______ and ______ changes.
   b When a chemical reaction takes place ______ ______ are formed.
   c Chemical reactions cannot easily be ______.
   d Fizzing means that a ______ has been produced.
   e ______ and light may be produced in a chemical reaction.
   f In the reaction hydrogen + oxygen → water the reactants are ______ and ______. The product is ______.

2 How do the properties of an egg change when it is fried?

3 Draw up two columns using the headings *Physical changes* and *Chemical changes*. Put the following in the correct columns.
   a ice-cream melting
   b an apple rotting
   c milk going sour
   d an egg being poached
   e dynamite exploding
   f clothes drying on a clothes line
   g a toaster element becoming red hot
   h gas burning in a stove
   i sugar dissolving in water
   j a lamp filament glowing

   Think of one more example for each column.

4 The teacher heated some orange-coloured crystals in a test tube. The crystals crackled and turned to a green powder. Give two reasons why you think a chemical reaction occurred.

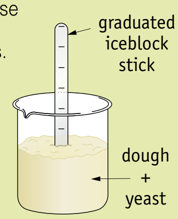
5 Maya said that an Alka-Seltzer tablet fizzing in water is a chemical reaction, but sugar dissolving in water is not. Do you agree with her? Give reasons.

6 Give three examples of wanted reactions and three examples of unwanted reactions.

7 What is a precipitate?

challenge

1 Go back to your results for Investigate 6 (on page 46). Write equations to describe what happened in Part A Reactions 2 and 4.
2 Use your knowledge of chemical changes to explain why batteries go flat.
3 When nitric acid is added to a piece of copper, a brown gas (nitrogen dioxide) is formed. A blue substance called copper nitrate is also formed, plus some water. Write a chemical equation for the reaction.
4 Ian investigated the reaction that occurs when yeast is added to dough. He measured the height that the mixture rose up a graduated iceblock stick. Here are his results.



Temperature (°C)	15	20	25	30	35
Distance up stick (cm)	0	0	5	10	16

Draw a line graph of 'distance up stick' against 'temperature'.
   a Explain the shape of your graph.
   b The dough did not rise until the temperature reached 20 °C. Write an inference to explain this.

Check! solutions

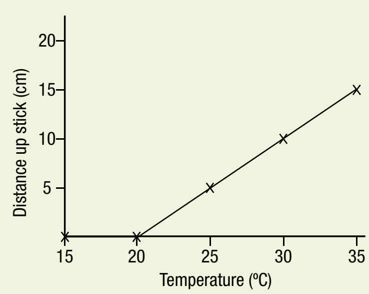
1 a Two types of changes that substances undergo are **physical** and **chemical** changes.
   b When a chemical reaction takes place **new substances** are formed.
   c Chemical reactions cannot easily be **reversed**.
   d Fizzing means that a **gas** has been produced.
   e **Heat** and light may be produced in a chemical reaction.
   f In the reaction hydrogen + oxygen → water, the reactants are **hydrogen** and **oxygen**. The product is **water**.
2 When an egg is fried chemical reactions occur and new substances are formed. For example, the clear liquid part of the egg turns into a white solid.
3

Physical changes	*Chemical changes*
a	b
f	c
g	d
i	e
j	h
ice melting	toast burning

4 The colour change and the crackling sound both indicate that a new substance has been formed and that a chemical reaction has occurred.
5 Maya is correct. The fizzing indicates that a gas is produced, but when sugar dissolves no new substance is formed.
6 Three examples of wanted reactions are: digestion of our food, burning petrol in cars, and burning coal to produce electricity.
   Three examples of unwanted reactions are: bushfires, rusting, and tooth decay.
7 A precipitate is an insoluble solid which is produced in a chemical reaction.

Challenge solutions

1 magnesium + copper sulfate → brownish copper + colourless solution
   copper sulphate + sodium hydroxide → bluish solid precipitate
2 Batteries go flat because when the chemicals are used up no more electricity is produced.
3 nitric acid + copper → nitrogen oxide + copper nitrate + water
4



   a The graph shows a steady increase in the distance up the stick as the temperature increases.
   b A likely inference is that below 20ºC the temperature was not warm enough for the yeast to work.

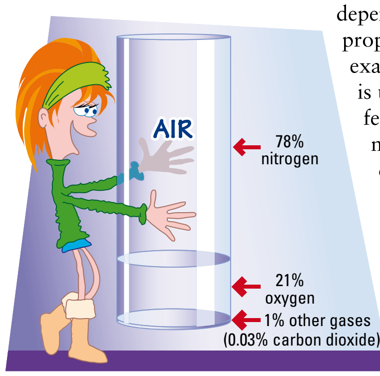
Hints and tips

The atmosphere surrounding the Earth helps to block out harmful ultraviolet radiation from the Sun. The atmosphere is the air we breathe and is a mixture of gases which becomes thinner and thinner until it reaches space. Its composition is nitrogen (78%), oxygen (21%) and other gases (1%). Some of the oxygen has changed over time, forming ozone, and it is this ozone layer that filters out the Sun's harmful UV radiation.

3.2 Some common gases

Surrounding the Earth is a thin layer of air called the atmosphere. This atmosphere protects us in several different ways. It causes meteors to burn up before hitting the Earth. It also contains a gas called ozone that protects us from harmful ultraviolet radiation. Beyond the atmosphere is space.

The air in our atmosphere is a mixture of colourless gases. These gases can be separated from each other and used in various ways depending on their properties. For example, nitrogen is used to make fertilisers, and liquid nitrogen is used to cool things. The unreactive gas argon is used in light bulbs to stop the filament from burning.



Surprisingly, there is very little hydrogen in our atmosphere, even though it makes up about 90 per cent of the total universe. The Sun and stars are mainly hydrogen, and so are the outer planets.

Fig 16 Divers wear SCUBA tanks filled with compressed oxygen gas.

Oxygen

We cannot live without oxygen—our bodies need a constant supply of it. Oxygen is needed to get energy from food in the process of respiration. We use about 20 litres every hour when we are resting, and much more when we are active.

Oxygen is used to help people breathe in difficult situations such as after car accidents and in hospitals during operations. It is also used in places where there is not enough oxygen to breathe normally. For example, divers, jet plane pilots, mountain climbers and fire fighters carry a supply of oxygen.

Oxygen (O_2) is a colourless gas that has no smell. It is very reactive, meaning it reacts with many substances. Burning (or *combustion*) is the process in which oxygen combines rapidly with other substances, producing light and heat. Corrosion of metals, eg rusting, is mostly due to metals reacting slowly with oxygen in the air.

In space there is no oxygen, so rockets have to carry their own supply in the form of liquid oxygen. In the oxy-acetylene torch, acetylene gas is burnt with oxygen to produce temperatures above 3000°C.

Fig 17 In an oxy-acetylene torch, heat from the burning gas melts metal.

Learning experience

Students could design their own fact sheets about the atmosphere, oxygen, hydrogen and carbon dioxide. Award marks for accurate and concise information, creativity and presentation.

Learning experience

Ask students to draw up a table in their books, as shown below. They should list as many gases as they can, from their own knowledge or using the internet.

Gas	Uses

Design posters on the different types of gases. Each poster should include the name of the gas, its uses and applications. These posters should be colourful and can be displayed around the room.

Hydrogen

In the early part of the 20th century, airships were a popular form of transport. They were filled with hydrogen to give them lift. In 1937 a large German airship called the *Hindenburg* caught fire as it landed on the east coast of the United States. The hydrogen in the airship reacted violently with the oxygen in the air, and 35 of the 97 passengers and crew were killed. After this accident, airships quickly lost their popularity.

Hydrogen (H_2) is a colourless gas which is at least 15 times lighter than any other substance. This is why it was used in the early airships and balloons. It is still used today to fill weather balloons, but modern airships use helium gas because it is not flammable.

In the presence of a flame, hydrogen reacts so rapidly with the oxygen in the air that it explodes.

hydrogen + oxygen → water

This same reaction is used in the rocket engines of the space shuttle. Some people believe hydrogen will be used as a fuel in the future because when it burns in air the only product is water, which does not cause air pollution.

Hydrogen is used in industry to make many different everyday materials. For example, the flowchart below shows how it is used to make margarine from vegetable oil.

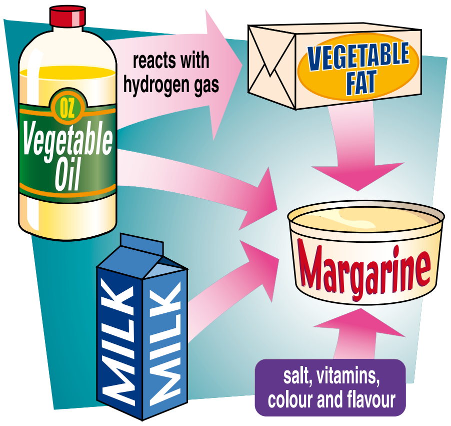


Fig 19 How hydrogen is used in making margarine (Some margarines do not contain milk.)

Fig 18 The airship Hindenburg crashes in flames in 1937.

Homework

Students could investigate the hydrogen car. If hydrogen is so flammable, how safe are the cars? Where will the hydrogen come from? How do you fill up, and how is the hydrogen stored?

Learning experience

You could do the following preparation of hydrogen as a demonstration. Make hydrogen gas using caustic soda and aluminium foil. Combine both in a conical flask and quickly place a balloon over the mouth of the flask to collect the gas. Once the reaction has stopped or the balloon has a sufficient amount of gas in it, tie it off. Then take the class outside. Tie a string to the balloon and tie it to a post or rubbish bin. Tape a splint to a metre rule or long stick. Light the splint and bring it close to the balloon. This will demonstrate how explosive hydrogen is!

Learning experience

Students could investigate what safety precautions are taken by the Bureau of Meteorology when filling weather balloons, and present their findings to the class.

Lab notes

- Ask students to read and answer the Planning and Safety Check questions. Remind them of the safety and laboratory rules.
- A quick demonstration of the investigation will prevent any uncertainties and reduce the safety risk.
- Remind students that they need to be ready to collect the gas as soon as the magnesium has been placed into the acid, and to place the second test tube firmly over the lip of the reacting test tube.
- Some students may choose to hold the test tubes during the reaction. However, make them aware that the base of the reacting test tube can become very warm, so holding it halfway up would be a good idea.
- It is safer to use pyrex test tubes if they are available.
- Be sparing with the magnesium ribbon. Students should be given only one small piece each.
- The hydrogen will escape quite quickly, so hold the openings of the tubes together or use a stopper or finger to seal the collecting tube.
- Burning wax tapers can make test tubes and benches harder to clean. A little time with a craft knife and some balsa wood, ice-cream sticks or old wooden rulers is a good way to make tapers.

Investigate

8 MAKING HYDROGEN

Aim

To make and test hydrogen gas.

Materials

- test tube rack
- 3 test tubes
- 1 cm of magnesium ribbon
- dilute **hydrochloric acid** (1 M)
- taper and matches
- test tube holder

Corrosive

Planning and Safety Check

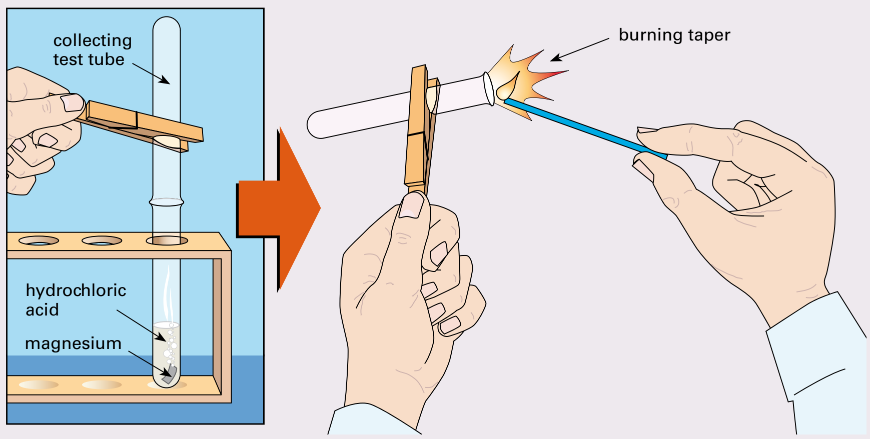
Read the investigation carefully.

- Why is it essential that you wear safety glasses when doing this experiment?
- Why do you turn the collecting test tube upside down over the first test tube?

Method

1 Put a test tube in the test tube rack and one-third fill it with dilute hydrochloric acid.

2 Put the magnesium ribbon into the acid. Then use a test tube holder to hold the empty test tube upside down over the mouth of the first test tube, as shown.



3 Ask another person to light a taper. Then remove the top test tube, tilt it upward slightly and *immediately* put the burning taper near its mouth. A 'pop' or 'squeak' indicates that the gas in the tube is hydrogen.

What do you observe on the inside of the test tube?

4 If necessary, repeat the experiment.

Discussion

1 What evidence is there that a chemical reaction occurred in the test tube?

2 After a while no more hydrogen is produced. Why is this?

3 How can you explain the presence of water droplets inside the mouth of the test tube after you 'pop' the hydrogen?

4 Why did you tilt the test tube upwards before bringing the burning taper near?

5 Suggest why you didn't hold the collecting test tube in your hand when you tested for hydrogen.

Wear safety glasses.

Homework

Students should try to write the word equation for the reaction taking place.

Investigate

9 MAKING OXYGEN

Aim

To make oxygen gas and test it.

Materials

- one-holed stopper fitted with U-shaped piece of glass tubing as shown
- manganese dioxide
- hydrogen peroxide
- one-holed stopper fitted with U-shaped piece of glass tubing as shown
- 2 test tubes
- test tube rack
- test tube holder
- wooden splint and matches

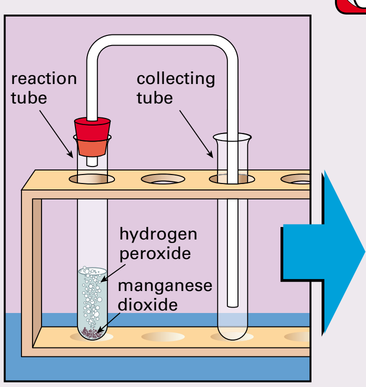
Planning and Safety Check

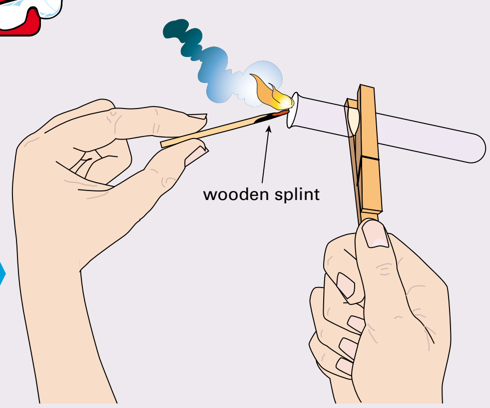
This investigation is similar to the last one except that you will use a piece of U-shaped tubing to collect the gas.This time you have to write the METHOD.

Read through the investigation carefully and use the diagram as a guide to write a step-by-step method to make oxygen gas. (It is best to work in a small group for this.)

Show the method to your teacher before proceeding.

Wear safety glasses.





Hints for writing the method

1 Use a pea-sized amount of manganese dioxide powder in the test tube.
2 Use a small amount of hydrogen peroxide (see page 45).
3 To test for oxygen gas, light a wooden splint, let it burn for a short while then blow it out, so that it still has a glowing tip. Immediately put the glowing splint into the test tube. The splint should burst into flame.

Discussion

1 Why is it that the splint only glowed in air, but burst into flame in oxygen gas?

2 The black manganese dioxide powder was not a reactant in the reaction. It speeds up the reaction but is not used up.
Predict what would happen if you placed the manganese dioxide remaining in the test tube into a new test tube containing hydrogen peroxide. Give a reason for your answer.

3 In the reaction that produced oxygen, water was also produced. The hydrogen peroxide was used up. Which were the products in the reaction? Which were the reactants? Try to write an equation for the reaction.

Lab notes

- In this investigation, students have to write the Method before they start. They could do this for homework on the previous night and discuss it in their groups at the start of the lesson. It is important to sign their Method write-up before they start.
- Again, a quick demonstration would help students with the techniques of collecting and testing oxygen.
- In the first printing of *Science World 1* the method used for collecting oxygen in this investigation was based on the method used for collecting hydrogen. The more efficient method for collecting the oxygen shown here uses U-shaped tubing and a collecting tube.
- Only a small amount of manganese dioxide is required. Too much will cause the bubbles and froth to rise in the test tube and can become very messy.
- The peroxide needs to be stored in a dark bottle in the fridge and be fresh or it will not work.
- The splint needs to be substantial and still glowing red or it will not re-ignite.

Learning experience

To show students that water is made from hydrogen and oxygen, you could use a Hofmann voltameter for the electrolysis of water. Test each gas that is produced by using the glowing splint test and pop test. With more able students you could talk about the importance of the 2:1 volume ratio.

Carbon dioxide

In the the Try this activity on page 47, when baking soda and vinegar were mixed, the gas produced built up pressure in the bottle and the cork was blown out. This gas was carbon dioxide.

Carbon dioxide (CO_2) is another invisible gas. It is found in air, but there is not very much of it—only 0.04% of the total of all gases. Despite this, carbon dioxide is a very important gas and has many uses.

Drinks and bread

When yeast and sugar are mixed together in warm water a chemical reaction occurs. Yeast is a type of fungus which changes sugar into alcohol and carbon dioxide. This is why beer and wine bubble when they are *fermenting*. The bubbles contain carbon dioxide gas. Yeast is also used in making bread. The small 'holes' in a slice of bread are produced by bubbles of carbon dioxide which expand in the hot oven.

Carbon dioxide is put into soft drinks under pressure. When you open the can or bottle, the carbon dioxide escapes, causing bubbles.

Fire extinguishers

Carbon dioxide has two important properties—things will not burn in it, and it is much more dense than air so it sinks to the ground. This means it can be used in fire extinguishers. The carbon dioxide is under pressure and when the trigger is pressed the gas rushes out. It forms a 'gaseous blanket' over the fire and stops air getting to it. Without air, the fire soon goes out.

Working with technology: To see how a fire extinguisher works, open the **Fire extinguisher** animation on the CD.

Dry ice

When carbon dioxide is cooled to about −80 °C it freezes to a white solid called *dry ice*. It is called dry ice because it changes directly to carbon dioxide gas, without forming a 'wet' liquid. Dry ice is much colder than water ice, so it is used to keep things cold and dry. It is also used in cloud seeding. In this process tiny particles are dropped from aircraft into clouds to produce rain.

Plants, burning and breathing

Green plants use up carbon dioxide from the air in the process of **photosynthesis**.

carbon dioxide + water + sunlight → plant food + oxygen

There are many ways in which the gas is put back into the air. For example, a lot of carbon dioxide goes into the air from power stations, which burn coal, and from cars, which burn petrol. We also breathe out carbon dioxide produced in our bodies during the process of **respiration** (RES-per-AY-shun).

food/fuel + oxygen → carbon dioxide + water + energy

The total amount of carbon dioxide throughout the world stays about the same. But in recent years it has increased slightly, and people are worried that this could lead to global warming due to the *greenhouse effect*.

Animation

Students should view the animation **Fire extinguisher** on the CD.

Learning experience: carbon dioxide rocket

- Place a small amount of crushed dry ice into a plastic soft drink bottle containing a small amount of water.
- Quickly place a stopper in the bottle, turn it upside down in a metal can and watch the plastic bottle take off. Make sure the students are standing well back.
- Prior to launching, students could make fins and a nose cone to help steer the rocket.
- You can also place the bottle upright and launch the stopper.

Learning experience: rainbow dry ice

- Three-quarter fill a large 1 L measuring cylinder with water.
- Add a few drops of dilute NaOH and a few drops of universal indicator to make the water slightly basic and blue in colour.
- Add some dry ice to the water. As the ice makes its way down, the indicator colour will shift through the colours of the rainbow, as it goes from slightly alkaline to acidic. (The carbon dioxide dissolves in water to form carbonic acid.)

Research

Have students research the different types of fire extinguishers. What do they contain? Which types of fires do they extinguish? Students should also find out why the chemicals contained in the different fire extinguishers are suited for different types of fires.

Investigate

10 MAKING CARBON DIOXIDE

Aim

To make carbon dioxide gas and investigate its properties.

Planning and Safety Check

Read through the four parts and discuss with your teacher which ones you will do and how much time you will spend on this investigation.

PART A

Making and testing carbon dioxide

Materials

- 3 test tubes and test tube rack
- stopper
- one-holed stopper fitted with U-shaped piece of glass tubing as shown
- taper and matches
- drinking straw
- limewater (calcium hydroxide solution)
- 2 or 3 marble chips (calcium carbonate)
- dilute **hydrochloric acid** (1 M)

Corrosive

Method

1 Set up the apparatus as shown. Make sure the collecting tube is dry. Put two or three marble chips into the reaction tube.

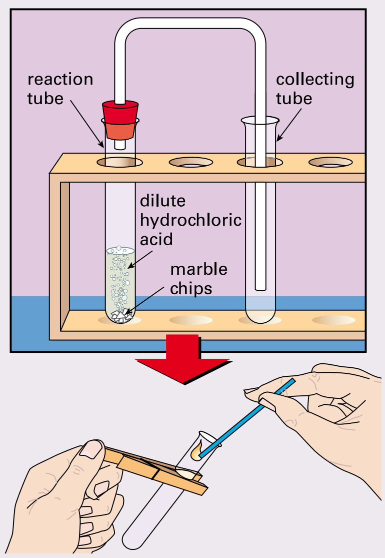
2 Add some hydrochloric acid to the reaction tube, then quickly fit the stopper and tubing. Bubbles of carbon dioxide gas will form. This gas will go to the collecting tube.

3 After about 3 minutes remove the collecting tube and put a stopper in it. Replace it with another tube one-third full of limewater. Allow the gas to bubble through the limewater while you do Step 4.

4 Light the taper, remove the stopper from the collecting tube, and carefully put the taper into the tube as shown.
Record what happens.

5 Now go back and observe the limewater from Step 3.
Record your observations.

Wear safety glasses.



Has there been a chemical reaction? How do you know?

6 Tip out the limewater and wash out the test tube. Then pour in some fresh limewater. Blow gently through a straw into the limewater.
What do you observe?
What can you infer from this observation?

Lab notes

Do a quick demonstration to show students how to set up the equipment to ensure they obtain successful results.

Students can do the four parts in any order. However, it is recommended that they do Part A first.

Part A

- Make sure the stopper is firmly in the reaction test tube to ensure all the carbon dioxide produced is carried over to the receiving tube. It is best to have the U-tubes made up for students. At this stage they don't have the skills to put glass tubing into the rubber stopper.
- The limewater should be made up fresh. Old stock may already be cloudy and this decreases the effectiveness of the results.
- Insist that students recycle the chips rather than put them down the sink.
- It may take up to 5 minutes for the gas to bubble into the limewater before it turns milky or turbid. If the reaction slows, add some more HCl to the test tube.
- The milkiness is due to insoluble calcium carbonate formed when the carbon dioxide reacts with the calcium hydroxide.
- If bubbling continues, a further reaction occurs, the soluble calcium hydrogen carbonate forms and the milkiness disappears.

Lab note

Part B

This procedure relies on the more dense carbon dioxide displacing the air in the container, but is very easily affected by air movements.

PART B
Fire extinguisher

Materials

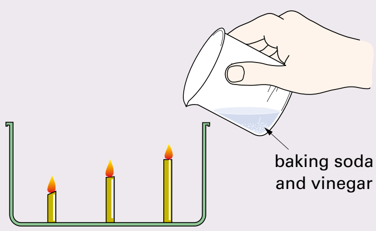
- 3 birthday candles of different lengths
- large ice-cream container (taller than the longest candle)
- baking soda
- vinegar (acetic acid)
- beaker or jar
- teaspoon

Method

1. Put 3 candles of different lengths into a large ice-cream container, as shown. Light the candles.
2. Put two teaspoons of baking soda in a beaker. Then cover the baking soda with vinegar. Tilt the beaker over the container as shown, but don't pour out any froth or liquid.

   What do you observe?

   Write an inference to explain what happened.



PART C
Yeast action

Materials

- 3 large test tubes
- sachet of powdered yeast
- 2 teaspoons of sugar
- teaspoon
- four 250 mL beakers or jars

Method

1. Dissolve 2 teaspoons of sugar in about 100 mL of lukewarm water in a glass jar or beaker.
2. Add about half a sachet of powdered yeast and stir. Put the beaker in a warm place.
3. Prepare the water baths as follows:

   Beaker 1—fill with cold water (add an ice cube if necessary).

   Beaker 2—fill with slightly warm water.

   Beaker 3—fill with hot tap water.
4. Pour equal amounts of the yeast mixture into three test tubes. Then place a test tube in each water bath.
5. Observe the test tubes for 10 to 15 minutes and note any evidence of a chemical reaction.

   Record your observations. In which test tube did the most vigorous reaction occur?

   Under which conditions does yeast work best?

PART D
Sultana bouncers

Materials

- 4 sultanas
- soda water or lemonade
- glass or jar

Method

1. Half fill the glass with soda water.
2. Place the sultanas in the glass.

   Observe what happens to the sultanas. Record your observations.

   In a group try to come up with an explanation of why the sultanas move up and down. (Hint: Do the sultanas sink or float in ordinary water?)

   Why do the sultanas stop bouncing after some time?

Homework

Ask students to research what the chemical names for marble chips and limewater are. Where are they found, how are they formed and where else are these products used?

Learning experiences

1. Once students have completed all three gas investigations and tests, ask them to design a simple flow diagram that could help a person test whether an unknown gas was oxygen, carbon dioxide or hydrogen.
2. Have students write scientific reports for the parts of the investigation they have done.

science bits

Carbon dioxide — friend or foe?

As you have found in this chapter, there is a very small amount of carbon dioxide in the atmosphere—about 0.038%. This is the amount of the gas measured in 2005. In 1915, less than 100 years ago, the amount was about 0.030%.

The difference between the 1915 and 2005 amount doesn't seem all that much. However, scientists are concerned that there is already too much CO_2 in the atmosphere. Why is this a problem?

CO_2 and the greenhouse effect

The Earth absorbs sunlight during the day and warms up. At night, the heat is released into the air and it becomes cooler. However, if you were on the Moon, the nights are extremely cold. This is because the Moon does not have an atmosphere to trap some of the heat.

The gases in the Earth's atmosphere act like the glass in a greenhouse. The sunlight passes through the glass and heats up the plants and soil in the glasshouse. At night, the heat inside the glasshouse is trapped by the glass. This is called the **greenhouse effect**.

Carbon dioxide traps more heat than the other common gases in the atmosphere. This is why it is called a **greenhouse gas**.

CO_2 and global warming

Many people are concerned about the amount of CO_2 in the atmosphere. Scientists have suggested that the CO_2 produced by power stations, industries, and cars and trucks is trapping too much heat in the atmosphere. This has resulted in an increase in the average temperature around the world, and is called **global warming**. Global warming is now considered to be a very real danger to life on this planet.

It is predicted that global warming will cause flooding as the sea level increases due to the melting of ice in the polar regions. Other problems may also occur—ocean warming and coral death, extinction of animal and plant species, changing climates, droughts, cyclonic weather, and the spread of tropical diseases.

WEBwatch

1 Use the internet to find diagrams of a greenhouse. Draw a model greenhouse. Then write a short report on how the greenhouse effect is good for the Earth but can be bad as well.

2 To find out more about global warming, type in *global warming* in your search engine.
Go to www.scienceworld.net.au and follow the links to **Global warming**, a fun website with lots of information and games.

3 Find out how plants help to reduce global warming. Then write a short report to argue against forest destruction throughout the world.

Issues

Organise students into groups of 4 or 5. Each group is to tackle the problem of atmospheric carbon dioxide and global warming from a particular point of view.

These perspectives could include those of:

- an environmentalist
- a power station owner
- an average person
- a meteorologist
- a politician.

Students should showcase their findings and present an argument to support their case.

Hold a whole-class discussion on ways to reduce greenhouse gas emissions.

Learning experiences

1 Students could draw flow diagrams or cartoons illustrating the greenhouse effect and global warming.

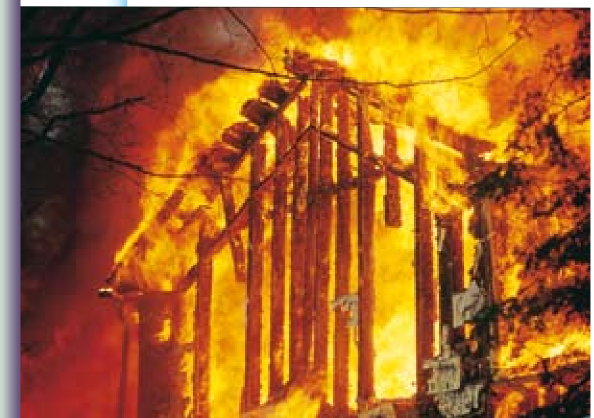
2 Students could write a letter to a friend as if they were in the future (70 years from now) describing what the world they live in is like. Assume no steps were put in place to reduce global warming. What steps would they like to have seen taken in their lifetime to avoid the current state of the world (70 years from now)?

Check!

1 Why are modern airships filled with helium rather than hydrogen gas?

2 Why is oxygen so important to life on Earth?

3 What chemical reaction occurs during combustion?



4 Some oxygen dissolves in water. Why is this important for some living things?

5 Which is heavier—hydrogen gas or oxygen gas? How do you know?

6 You have a test tube containing a colourless, odourless gas. How could you test whether it is hydrogen or oxygen?

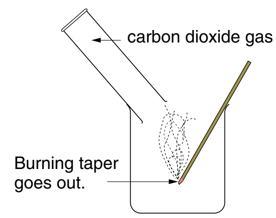
7 Use Fig 19 on page 53 to describe in a few sentences how margarine is made.

8 Write a short paragraph comparing and contrasting the properties of hydrogen and oxygen.

9 Which of the following statements about carbon dioxide are true and which are false? Rewrite the incorrect ones.
- a About 40% of the air around us is carbon dioxide.
- b Carbon dioxide is always a gas.
- c Carbon dioxide is more dense than air.
- d Carbon dioxide helps burning.
- e Humans breathe out carbon dioxide.
- f Vinegar reacts with baking soda to produce carbon dioxide.
- g Carbon dioxide is produced during photosynthesis.

10 List three ways of making carbon dioxide.

11 Which two properties of carbon dioxide are illustrated in the diagram?



12 Which two substances are needed for fermentation to occur?

13 A bottle of soft drink goes 'flat' if it is left open. Why?

14 This equation describes what happened in Investigate 10 Part A.

calcium carbonate + hydrochloric acid → calcium chloride + water + carbon dioxide

- a What are the reactants?
- b What are the products?
- c What was left in the flask?

challenge

1 If you pass electricity through water, the gases hydrogen and oxygen are produced. Write an equation to describe this reaction.

2 How could you distinguish between a bottle of water and a bottle of hydrogen peroxide?

3 Tania burnt some magnesium ribbon in oxygen. A white powder called magnesium oxide was left.
- a Write an equation to describe the reaction.
- b She found that the magnesium oxide had a greater mass than the magnesium she started with. How could she explain this?

Check! solutions

1 Modern airships are filled with helium rather than hydrogen because it is much less likely to catch alight and is therefore safer.

2 Oxygen is so important to life on Earth because all large plants and animals use it for respiration. It is also very important because it is needed to burn things to make engines go, to cook our food and to keep us warm in cold weather.

3 During combustion a substance combines rapidly with oxygen to produce new substances, plus light and heat. For example, hydrogen burns to form water and carbon burns to form carbon dioxide.

4 Most plants and animals need oxygen for respiration. If they live in water then the oxygen must be dissolved in the water.

5 Hydrogen is the lighter gas. We know this because a balloon filled with hydrogen will float in air but one filled with oxygen will not.

6 If you put a burning splint in the mouth of the test tube and it flares up, the gas is oxygen. This means that oxygen does not burn. If it goes 'pop' and water droplets form, the gas is hydrogen.

7 If vegetable oil reacts with hydrogen it forms vegetable fat. If this fat is then mixed with more vegetable oil, milk, salt, vitamins, and colours and flavours, it forms margarine.

8 Hydrogen and oxygen are both colourless and odourless gases. Oxygen is about 20% of the air and essential for most living things, whereas hydrogen is not found at all in the air and is not needed by living things.

9
- a False. About 0.03% of the air around us is carbon dioxide.
- b False. Carbon dioxide may also be a solid.
- c True.
- d False. Carbon dioxide does not help burning.
- e True.
- f True.
- g False. Carbon dioxide is used during photosynthesis.

10 Three ways of making carbon dioxide are:
- adding yeast to sugar
- adding vinegar to baking soda
- burning materials containing carbon.

11 The two properties shown are that carbon dioxide is denser than air and that it does not support burning.

12 The two substances needed for fermentation are sugar and yeast.

13 Soft drink goes 'flat' when the lid is off because the dissolved bubbles of carbon dioxide escape into the air.

14
- a The reactants are calcium carbonate and hydrochloric acid.
- b The products are calcium chloride, water and carbon dioxide.
- c Remaining in the flask was a colourless solution of calcium chloride.

Challenge solutions

1 An equation is:

water $\xrightarrow{\text{electricity}}$ hydrogen + oxygen.

2 Place a few drops of the liquid on manganese dioxide. If a reaction occurs which produces oxygen gas, the liquid is hydrogen peroxide.

3
- a magnesium + oxygen → magnesium oxide
- b The mass is greater because the magnesium has combined with the oxygen.

4 Merali and Wayne put a candle in a saucer and added some water. They then lit the candle and put a glass upside down over the candle. The candle burnt for a while then went out, but they were surprised when the water rose inside the glass. How can you explain why this happened?

5 Why are some people worried about the amount of carbon dioxide in the Earth's atmosphere?

11 There are a number of ways to make mist on stage. In the photo below, the mist is created using dry ice.

a Why does the dry ice fog usually stay around the performers' feet?

b If carbon dioxide is invisible, how can you see the dry ice fog?

6 Work out a way of showing that the gas bubbles in a bottle of soft drink are carbon dioxide.

7 When carbon dioxide is bubbled through limewater, the solution goes cloudy. Suggest why this happens.

8 Fizzy drink powders contain baking soda and tartaric acid. When this powder is added to water it fizzes.

a Using what you have learnt in this chapter, suggest what chemical reaction has occurred here.

b Why does it fizz only when water is added?

9 How can you explain the 'fizzy' taste of sherbet? It is a mixture of baking soda, citric acid and sugar.

10 When making bread it is important to let the dough rise slowly in a warm place instead of putting it straight into a hot oven. Suggest a reason for this.

WEBwatch

Use the internet to find information on the common gases listed below, eg how we extract them from the air, and how we use them:

hydrogen, oxygen, carbon dioxide, nitrogen, the inert gases (argon, neon, helium, radon and krypton), ozone

You could also search more general topics like *gases in atmosphere* or *composition of atmosphere*.

Summarise your information in a large table.

Research

Using the WebWatch as a guide, ask students to work in groups to set up a display that focuses on any of the gases in the list. They could describe their extraction, uses, chemical symbols and any social or environmental issues they contribute to.

4 As the candle burns it uses up oxygen, decreasing the air pressure inside the glass. The burning candle also heats the air in the glass and the hot air expands. Some of this expanding air escapes under the edge of the glass and you might see some bubbles. When the candle goes out the air in the jar cools down and contracts, reducing the air pressure even further. The atmospheric pressure outside the glass then pushes water into the glass.

5 There are more and more animals, motor vehicles and factories producing carbon dioxide and less and less trees using carbon dioxide. This is causing more carbon dioxide in the air and scientists think that this is causing changes to the climate in many parts of the world.

6 There are several possibilities. One would be to attach a tube to the bottle containing the fizzy drink and see whether the gas will put out a burning candle. Another test is to bubble the gas through limewater and see whether it will turn a white 'cloudy' colour.

7 The solution turns cloudy because a chemical reaction occurs and a white precipitate is produced.

8 a The chemical reaction here is between an acid and a carbonate. It is very similar to the reaction in Getting Started and produces the gas carbon dioxide.

b Many chemical reactions will only occur if the chemicals are dissolved in water.

9 The fizzy taste is produced by the reaction between the baking soda and acid when it mixes with the saliva in your mouth. The sugar provides the sweet taste.

10 If you put the dough straight into the oven the yeast would be killed, the reaction would stop and the bread would not rise.

11 a The fog stays at the performers' feet because it is denser than air and sinks to the floor.

b The 'fog' is actually small droplets of water which have been formed when the water vapour is cooled.

Main ideas solutions

1 properties
2 precipitate, electricity
3 physical
4 equation, products
5 heat
6 rate
7 reactions
8 gases, oxygen

Review solutions

1 B
2 C Some reactions are slow, like rusting.
3 a precipitate formed
b heat produced
c gas produced
d colour change

MAIN IDEAS

Copy and complete these statements to make a summary of this chapter. The missing words are on the right.

1 Chemical changes (reactions) produce new substances with _________ different from the original substances.
2 A chemical reaction may produce a gas, a colour change, a solid called a _________ , heat, light, sound or _________ .
3 A _________ change is one in which no new substances are formed. It can usually be reversed.
4 A chemical _________ shows what you start with (the reactants) and the substances produced (the _________) in a chemical reaction.
5 A chemical reaction occurs only under certain conditions. _________ and electricity may be needed.
6 Some reactions occur slowly, while others occur quickly. The speed of a reaction is called its _________.
7 We use chemical _________ to make many everyday materials, and life processes depend on them.
8 Our atmosphere is a mixture of _________, about 4/5 nitrogen and 1/5 _________. It also includes small amounts of other gases, eg carbon dioxide, ozone and hydrogen.

electricity
equation
gases
heat
oxygen
physical
precipitate
products
properties
rate
reactions

Try doing the Chapter 3 crossword on the CD. Working with technology

REVIEW

1 Which *one* of the following is a chemical reaction?
A melting a block of ice
B burning magnesium ribbon
C magnetising a piece of iron
D expanding air by heating it

2 Which one of the following is *false*?
A Heating sometimes causes a reaction.
B Some reactions produce electricity.
C Reactions take only a few seconds.
D Reactions sometimes produce colour changes.

3 Read the descriptions below of four reactions carried out by Emilia. For each one decide which of these four signs she used to tell there was a chemical reaction:

colour change precipitate formed
gas produced heat produced

a I mixed two clear solutions, and a white solid settled to the bottom of the tube.
b After a while the test tube felt warm.
c When I added water the mixture fizzed.
d When I added the acid it turned red.

REVIEW

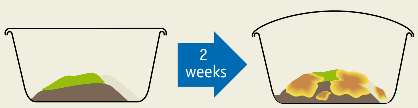
4 The two gases which make up most of the atmosphere are:
A nitrogen and hydrogen
B nitrogen and oxygen
C oxygen and carbon dioxide
D carbon dioxide and hydrogen.

5 Here are some reactions that take place in the home. List them from the fastest reaction to the slowest.
a paint drying
b fruit rotting
c gas burning in a stove
d a cake baking
e a metal can rusting

6 When Kim heated some sugar in a test tube it turned to black carbon. She also noticed some drops of water around the mouth of the tube. Write a word equation to describe the reaction that probably occurred.

7 Which one of the following reactions produces the gas hydrogen?
A baking soda + vinegar
B hydrogen peroxide + manganese dioxide
C marble chips + dilute hydrochloric acid
D magnesium + dilute hydrochloric acid

8 Some food was left in a closed plastic container on the kitchen bench. After 2 weeks, the lid started to bulge. What do you infer from this?



9 Below are four statements, each with a reason. In which case is the wrong reason given?
A Hydrogen is used as a rocket fuel, because hydrogen is the lightest gas known.
B A flame should not be used when making hydrogen, because hydrogen and air form an explosive mixture.
C Pure oxygen is used in an oxy-acetylene torch, because substances burn better in pure oxygen.
D Carbon dioxide is used in fire extinguishers because things will not burn in it.

For questions 10 and 11:

Ian was doing a science experiment. He took a piece of bread and broke it into two equal halves. He then added 10 drops of water to each half and placed each in a similar, sealed glass jar. He put one jar in a dark cupboard and the other on a well-lit window sill. After a week Ian found that mould had grown on the bread placed in the dark cupboard, but none had grown on the bread in the light.

10 The problem Ian was investigating was:
A what effect does moisture have on the growth of bread mould
B what effect does light have on the growth of bread mould
C what is bread mould
D where does bread mould come from?

11 Below are four factors which may or may not influence the growth of bread mould.
Factor 1: The amount of water added to the bread
Factor 2: The temperature in each jar
Factor 3: The type of glass each jar is made of
Factor 4: The amount of light falling on the jars
For each factor choose either A, B, C or D.
A This factor was deliberately varied by Ian.
B This factor could influence the growth of mould, but Ian made special allowance for it so that it would not affect the results.
C This factor could influence the growth of mould, but Ian did not allow for it in his experiment.
D This factor is not important and is unlikely to influence the growth of mould.

Check your answers on page 300.

4 **B**

5 **c** gas burning in a stove (fastest)
d a cake baking
a paint drying
b fruit rotting
e a metal can rusting (slowest)

6 sugar + HEAT → carbon + water

7 **D**

8 The food rotted. This was a chemical reaction that produced new substances. Some of these new substances were gases. It was these gases that caused the lid to bulge.

9 **A** Hydrogen is used as a rocket fuel *because it burns explosively with oxygen*. It is true that hydrogen is the lighest gas known, but this is not the reason it is used as a rocket fuel.

10 **B**

11

1 amount of water added to the bread	B made special allowance
2 temperature in each jar	C did not allow for it
3 type of glass each jar is made of	D not important
4 amount of light falling on the jars	A deliberately varied