D | Mayow's experiment

Today we know that cells use oxygen to release the energy stored in a type of sugar called **glucose**. We get glucose from digesting **carbohydrates** in our food. The release of energy occurs in a series of chemical reactions called **aerobic respiration** (aerobic means requiring air).

Respiration happens in all parts of our bodies and some of the released energy keeps our bodies warm. We can sum up aerobic respiration as follows:

oxygen + glucose ⟶ carbon dioxide + water + energy

reactants products

The **word equation** for the **combustion** (burning) of glucose is the same, but aerobic respiration occurs in a different way, using a series of slower reactions.

5 Beaker X contains peas that are starting to grow. Beaker Y contains boiled peas. In which beaker will:

a| the temperature rise? Explain your reasoning.

b| carbon dioxide be made? Explain your reasoning.

6 a| Suggest how aerobic respiration is like burning.

b| Suggest one way in which aerobic respiration and burning are different.

7 a| Write out the word equation for aerobic respiration.

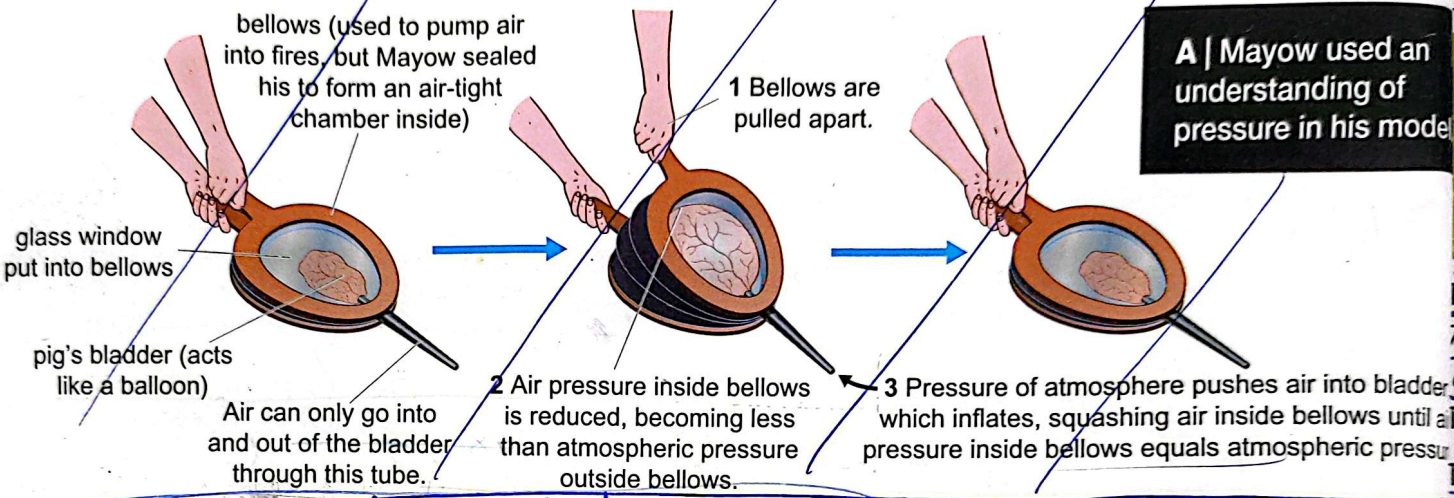
b| Suggest one way in which this is a good model for respiration and one way in which it is a poor one.

I can ...

- recall what happens in aerobic respiration.

HOW ARE GASES EXCHANGED IN THE LUNGS?

John Mayow built a model to show that it is the moving of the ribs and **diaphragm** that causes the lungs to get bigger and smaller (it is not the lungs themselves).

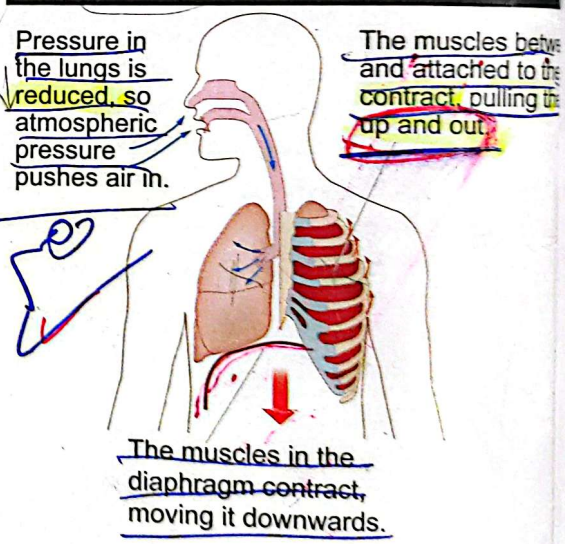


A | Mayow used an understanding of pressure in his mode

Breathing is when muscles between the ribs and in the diaphragm change the size of the lungs. The movement of air into and out of the lungs is called **ventilation**. Diagram B shows how inhalation (breathing in) happens. During exhalation (breathing out), the reverse occurs.

1. What do the bellows and bladder in Mayow's model represent?
2. What do muscles in the diaphragm do to cause inhalation?
3. Write three labels that could be added to the last drawing in diagram A, explaining why air leaves the bladder when the bellows are closed.

B | inhalation (breathing in)

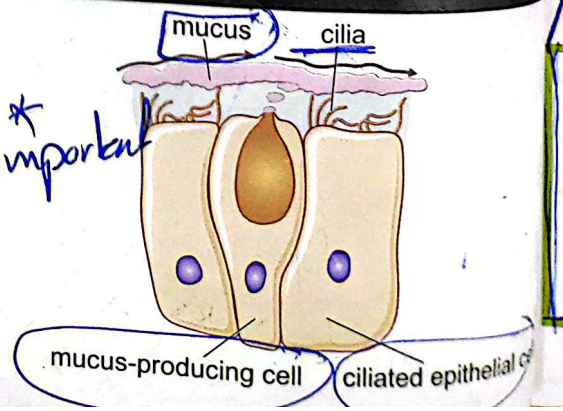


To work well, the lungs need to be kept clean. Some cells in the tubes in the lungs produce a sticky liquid called **mucus**. It traps dirt, dust and microorganisms. Tiny hairs on other cells, called **cilia**, sweep the mucus out of the lungs and into the gullet where it can be swallowed.

The chemicals and heat in cigarette smoke stop the cilia working. Mucus then collects in the lungs.

4. How are cells in the gas exchange system specialised to keep the lungs clean?

C | Ciliated epithelial cells help to keep the lungs clean.



In the lungs, some of the oxygen from the air enters the blood. At the same time, some of the carbon dioxide in the blood plasma enters the air in the lungs. This swapping of gases is called **gas exchange**.

Gas exchange occurs by **diffusion**, when there is an overall movement of particles from a place where there are a lot of them to a place where there are fewer of them.

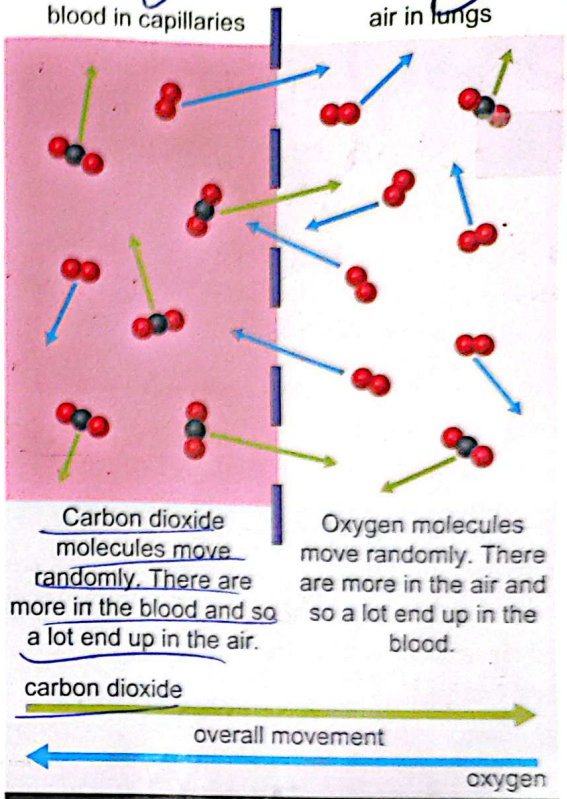
5 What happens during gas exchange in the lungs?

6 a| What is diffusion?

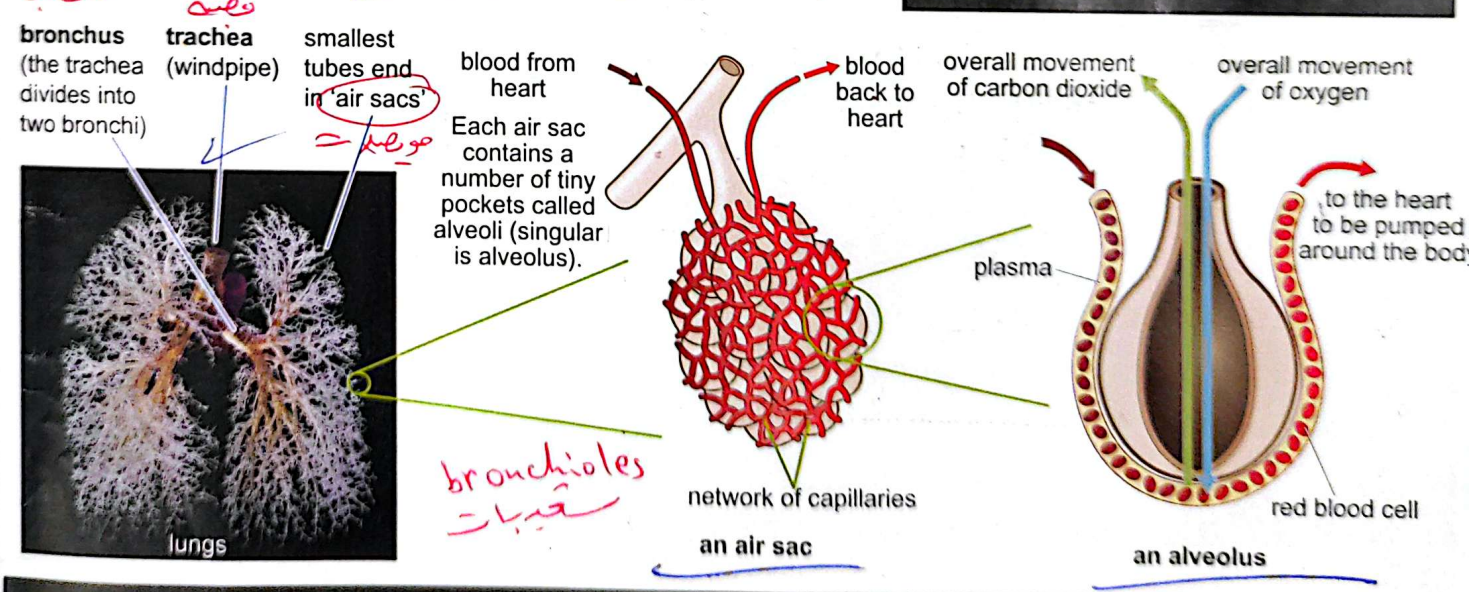
b| What causes some oxygen molecules to move into the blood and other molecules to move out of it?

The lungs are adapted for gas exchange by having about 700 million little pockets called alveoli (pronounced '*al-vee-O-lee*'). This gives the lungs a large **surface area**. The larger the surface area, the faster diffusion occurs.

The alveoli have walls that are only one cell thick. The blood **capillaries** surrounding them also have thin walls. These thin walls mean that diffusion happens more quickly.



D | Gas exchange happens by diffusion.



E | There are thousands of tiny, branched tubes inside the lungs. These tubes end in air sacs, which contain the alveoli.

7 In order, list the organs through which air passes when we inhale.

8 Explain what effect a decrease in lung surface area would have on the speed of gas exchange.

9 Explain why gas exchange can be reduced in smokers.

I can ...

- recall the functions of the organs in the gas exchange system
- explain how the structure of the lungs allows efficient gas exchange.

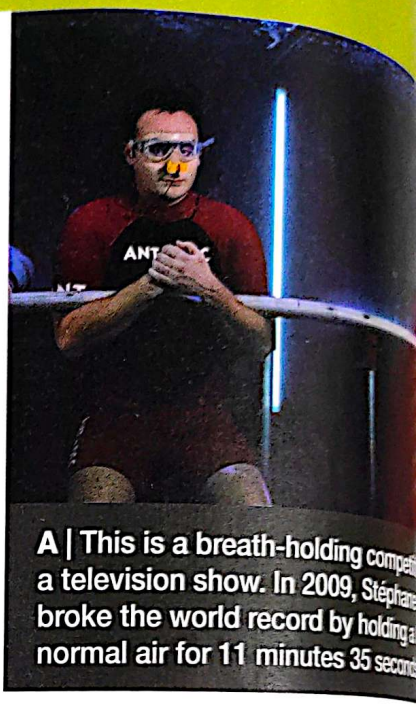
8Ce ANAEROBIC RESPIRATION

HOW DOES ANAEROBIC RESPIRATION OCCUR?

If you hold your breath, the amount of carbon dioxide in your blood plasma increases. If it reaches a certain level, your brain causes breathing to occur. This is why you cannot hold your breath for too long, although people can train themselves to hold their breath for longer times.

1. What substances does aerobic respiration produce?
2. Explain why the competitors in photo A remain motionless.

Oxygen is stored by haemoglobin in red blood cells, so it can be carried around your body. Your muscle cells can also store some oxygen. After holding your breath for a long time, you breathe faster to get rid of the extra carbon dioxide in your blood and to replace the oxygen used up from your blood and muscles.



A | This is a breath-holding competition for a television show. In 2009, Stéphane broke the world record by holding a normal air for 11 minutes 35 seconds.

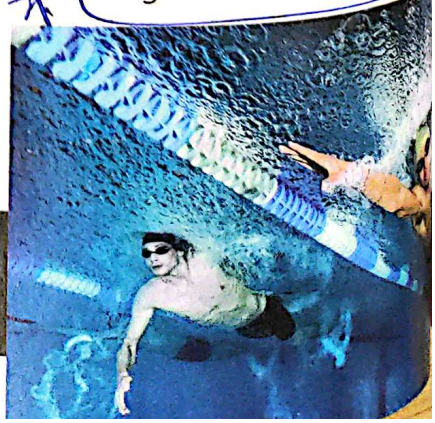
B | Underwater hockey players rely on anaerobic respiration to swim fast suddenly without breathing.

Exercise

During **aerobic exercise** your body continuously gets enough oxygen to replace the oxygen being used by **contracting** muscle cells. You can do aerobic exercise, such as slow swimming, for long periods of time.

During strenuous exercise, oxygen is used faster than it is replaced. When this happens **anaerobic respiration** occurs in the cytoplasm of your muscle cells. This does not need oxygen. We can summarise anaerobic respiration in humans as:

glucose → lactic acid



C | Taking breaths slows swimmers down. So in short sprint events competitors only breathe once or twice and some do not breathe at all.

Anaerobic respiration does not release as much energy from glucose as aerobic respiration. Anaerobic respiration also causes muscles to get tired more quickly than aerobic respiration. However, anaerobic respiration allows animals to move suddenly and very quickly (for example, to sprint away from a predator).

3 What processes use up glucose in underwater hockey players as they sprint for the puck?

4 a| Suggest why sprint swimming is an anaerobic exercise.
b| Why can't a swimmer sprint for a long time?

5 Write a paragraph to compare aerobic and anaerobic respiration. Use a table of similarities and differences to plan your paragraph.

FACT

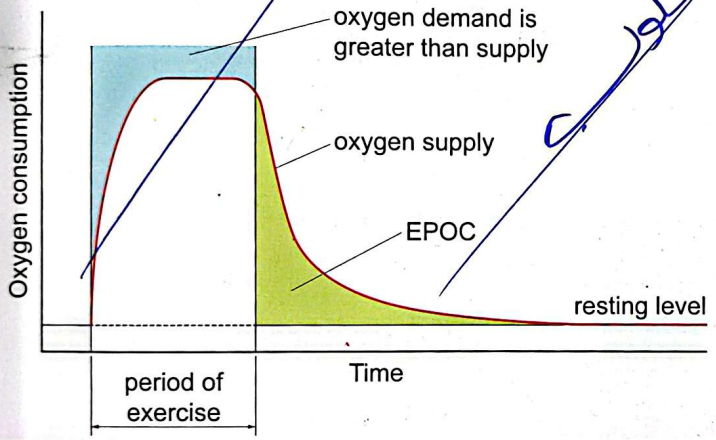
Scientists are still not sure why muscles become sore a day or so after doing strenuous exercise. One hypothesis is that the body damages some cells in overworked muscles in the process of rebuilding these muscles.

EPOC

Lactic acid from muscles enters the blood and is carried to the liver, where it is converted back into glucose. This process needs a lot of energy, which can come from aerobic respiration in liver cells.

After exercise you need extra oxygen for many processes, including helping to turn lactic acid back into glucose and replacing the oxygen lost from blood and muscle cells. This need for extra oxygen is called **excess post-exercise oxygen consumption** – or **EPOC** for short. It is also sometimes called the **oxygen debt**. Your breathing and heartbeat rates remain high after you stop exercising to get extra oxygen to your cells.

The effect of exercise on demand for oxygen



D | EPOC occurs if your body does not get enough oxygen during exercise.

6 Describe one way in which the body gets rid of lactic acid.

7 After hard exercise, why does your:
a| breathing rate remain high
b| heartbeat rate remain high?

8 What causes EPOC? Give as many reasons as you can.

E | Sports scientists can find out how much anaerobic respiration happens in an athlete's body by measuring lactic acid levels in the blood.

I can ...

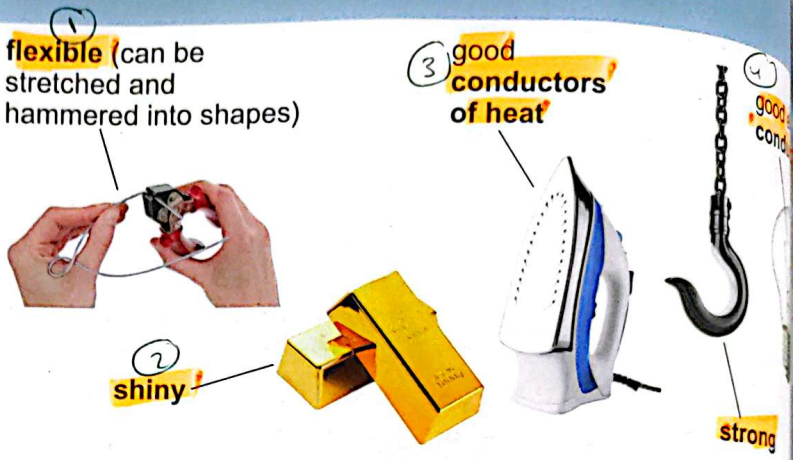
- recall what happens in anaerobic respiration
- describe the effects of anaerobic respiration during and after hard exercise.

8Ga METAL PROPERTIES

WHAT MAKES METALS USEFUL?

Metals are elements. You can tell the difference between metals and **non-metals** by their common **physical properties**.

1. List four physical properties of a typical metal.
2. For each of the following, name the element and explain why it is unusual:
   a| a liquid metal
   b| a non-metal that conducts electricity.



A | the properties of metals

The properties of metals make them useful in many ways. Since they all have some common properties, different metals can have the same uses. The decision to use one metal rather than another depends on various factors, including cost, appearance and its precise properties. Table B lists some reasons for using particular metals in house building.

B

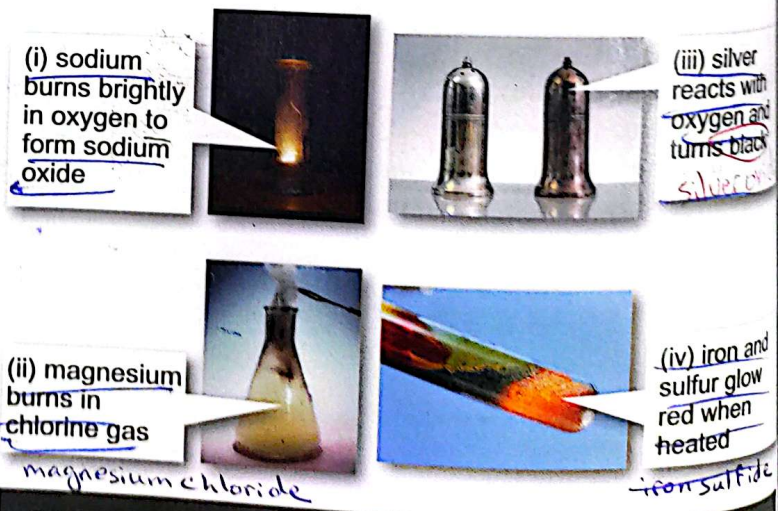
Use	Metal	Reason for choice
building frames	iron	strong, relatively cheap
water pipes	copper	unreactive, non-poisonous, malleable
window frames	aluminium	strong, light
electrical circuits	copper	good conductor of electricity, unreactive

Metals also have common **chemical properties**. For example, most metals react with oxygen. They also react with **halogens** and other non-metals. When metals react, they often form a single solid compound. For example:

lithium + oxygen → lithium oxide

zinc + fluorine → zinc fluoride

Although the reactions are similar, not all metal reactions occur at the same speed, as shown in photo C.



C | Remember, in compounds that contain just two elements, the name of the element furthest to the right in the periodic table is placed last, with its ending changed to -ide.

8Gb CORROSION

WHAT HAPPENS DURING RUSTING AND CORROSION?

Rust is a problem for all structures built from iron, and they often need to be painted to stop them rusting. Painting started on the Forth Rail Bridge as soon as it opened in 1890 and it was famous as the painting job that never finished. Now, with a new three-layer paint system, the painting is over for a few decades.

Corrosion refers to any reaction with oxygen at the surface of a metal. Many metals form an oxide layer when exposed to air:

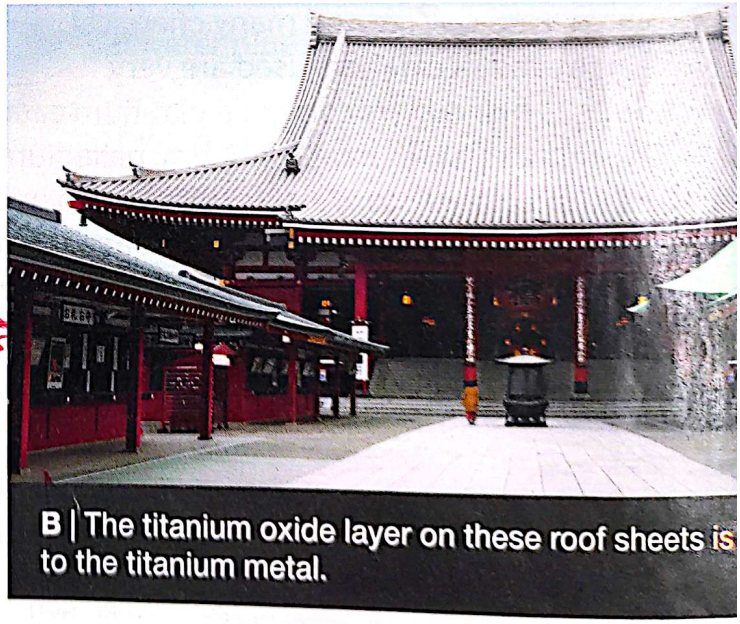
tin + oxygen → tin oxide

Rusting refers specifically to the corrosion of iron.

A | The Forth Rail Bridge's new paint job should last 30 years.

1. Which element in the air reacts with tin?
2. Explain the difference between rusting and corrosion.

Aluminium and titanium are used to make roof panels and windows. Both metals corrode naturally in air, forming a surface layer of metal oxide. The oxide coating sticks to the surface, does not affect the strength of the metal and protects it from further corrosion.

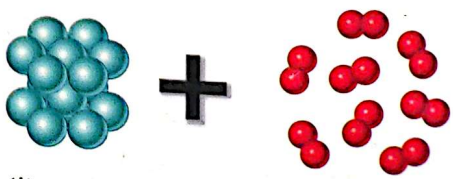


B | The titanium oxide layer on these roof sheets is to the titanium metal.

3. Name one metal that reacts with oxygen:
   a| quickly
   b| slowly
   c| not at all.
4. Give two reasons why the corrosion of titanium roofs is not a problem.

Word and **symbol equations** can be written for t

C



Word equation: titanium + oxygen

Symbol equation: Ti + O_2

The symbol equation uses a **formula** for each reactant and product, rather than their names. The formulae for most elements are just their symbols, so titanium is written as Ti. Oxygen gas, however, is written as O_2, because it exists as molecules containing two oxygen atoms.

Most solids, such as TiO_2, do not exist as molecules but as huge networks of atoms joined together. In this case, the formula shows the ratio of the atoms in the compound. TiO_2 tells us that the ratio of titanium to oxygen is 1:2, so in this compound there are two oxygen atoms for every titanium atom.

5 The ratio of lead to oxygen in lead oxide is 1:1.

a| What is the symbol for lead?

b| What is the formula for lead oxide?

6 The symbol equation for the corrosion of tin is:

$$Sn + O_2 \rightarrow SnO_2$$

a| Write the word equation for this reaction.

b| What does the formula of tin oxide tell us?

FACT

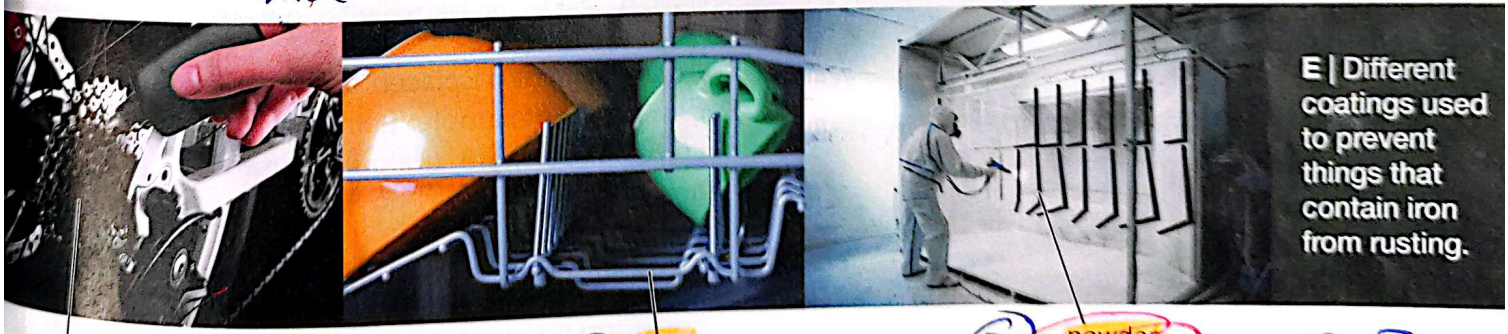
It is estimated that the repair and prevention of rust damage costs the UK nearly £50 billion each year. That is about £750 for every person in the country.

D | What causes rusting?

The rusting of iron is more complex than the corrosion of titanium or lead. The experiment in photo D shows that both oxygen and water must be present for iron to rust. Rust is a complex compound but can be described as iron hydroxide:

iron + oxygen + water → iron hydroxide

Rust is a fragile substance that can weaken and destroy iron structures. The main way of preventing rusting is to use a barrier, such as paint, to keep air and water away from the metal. Some other examples are shown in figure E.



E | Different coatings used to prevent things that contain iron from rusting.

7 a| Name the two other reactants needed for iron to rust.

b| What elements are there in rust?

c| Suggest a reason why metal objects left abandoned in the desert are not usually very rusty.

8 Describe four barrier methods for preventing corrosion. Explain how each works and why we need to use them.

I can ...

- describe what happens during corrosion and rusting
- explain how metals can be protected from corrosion
- identify the products and reactants using a symbol equation.

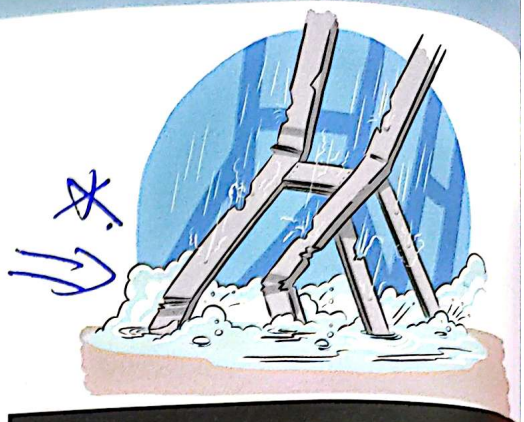
8GC METALS AND WATER

HOW DO METALS REACT WITH WATER?

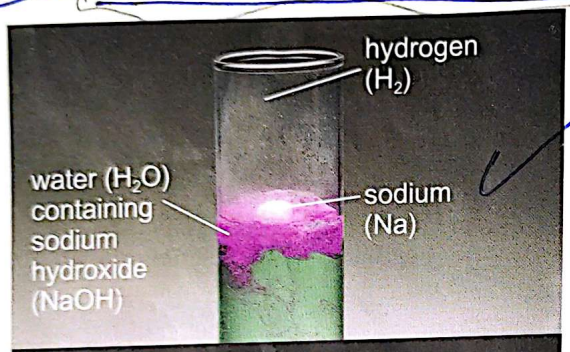
Some metals are just too reactive to use in the building industry. Metals on the far left of the periodic table (such as lithium, sodium, potassium and calcium) all react quickly with cold water and so would be destroyed by the first shower of rain.

When metals react with water they form hydrogen gas and a metal hydroxide. This is the word equation for the reaction of sodium with water:

sodium + water → sodium hydroxide + hydrogen



A | A bridge made from calcium would not last long in our weather.



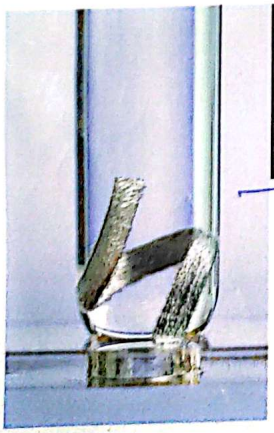
B | Sodium and water react forming hydrogen gas. The indicator turns purple, showing that an alkali, sodium hydroxide, has been formed.

C | Calcium and water reacting: if the gas is collected, it burns with a squeaky pop so proving that it is hydrogen.

1. Name three metals that are too reactive to use for building bridges.
2. What are the formulae for the products of the reaction between sodium and water?

Many metals do not appear to react with cold water. However, most will in fact react, just very slowly. The reaction of magnesium is shown in photo D:

magnesium + water → magnesium hydroxide + hydrogen



D | In water, bubbles slowly form on the surface of magnesium ribbon.

3. Look at photos B, C and D.
   a| In each photo, what evidence tells you that a reaction is taking place?
   b| Describe the test for hydrogen gas.
4. Write word equations for the reactions of potassium and calcium with water.