

# **Unit 8: Chemical reactions**



## **8.1: Exothermic reactions**

## In this topic you will:

- learn about chemical reactions that give out energy
- plan and carry out an investigation.

## Getting started

This word equation shows the reaction between carbon and oxygen that takes place when carbon burns:



Answer these questions and then compare answers with a partner. Be prepared to share your answers with the class.

- Name a reactant.
- Name a product.
- How many atoms make up a particle of carbon dioxide?
- How many of these atoms are carbon?
- How do you know that burning releases energy to the environment?

## Key words

combustion  
dissipate  
exothermic reaction  
fuel  
oxidation reaction  
preliminary work



# Review



# Burning of wood

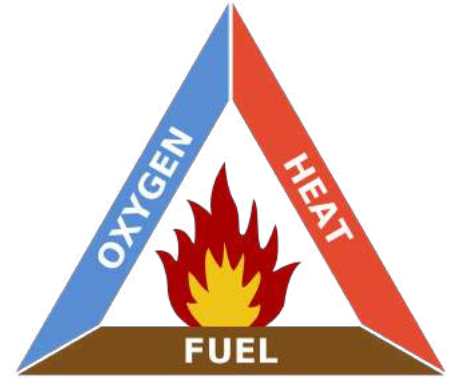


# Burning of wood

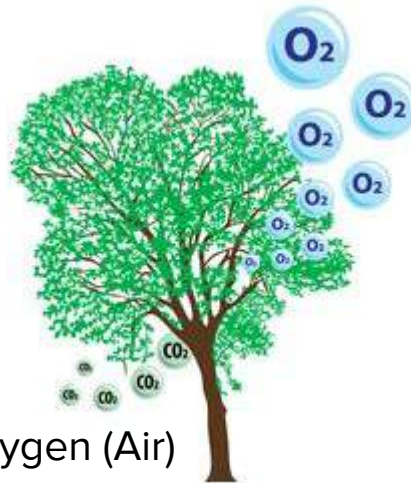
What is required for burning to take place?

Burning is a chemical reaction. It needs three things to make it happen.

- material to burn, called the **fuel**
- a supply of **oxygen**
- a source of **heat** to set fire to, or ignite, the fuel



Fuel (Trees)



Oxygen (Air)



Heat (Lightning stroke)

# Burning of wood

How can you stop any fire?

Fire fighters take away the heat- by spraying huge amounts of water over the fire, or

They can take away the fuel- by creating treeless areas (firebreaks).

When the fire reaches this break it burns itself out because it runs out of fuel.

During the fire the trees are used up but new substances have been produced.



# Burning of wood

Ash may form, accompanied by heat (energy),  $\text{CO}_2$  and water vapor

It is the powdery residue left after the burning of a substance.

It contains new substances called **oxides**.



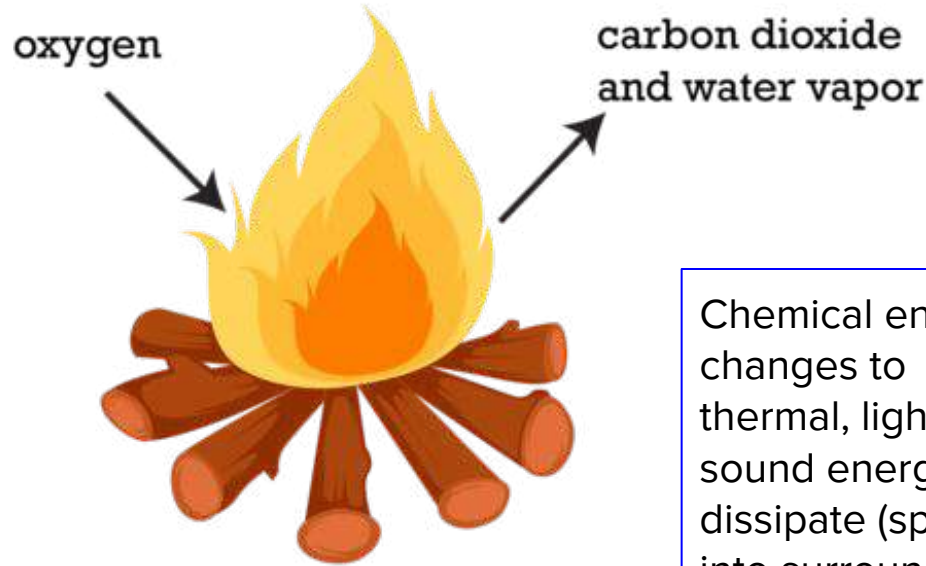
**Oxides** are chemical compounds with one or more oxygen atoms combined with another element.

For example, Carbon dioxide ( $\text{CO}_2$ ), Iron oxide ( $\text{Fe}_2\text{O}_3$ )

Can ash be changed back into wood?

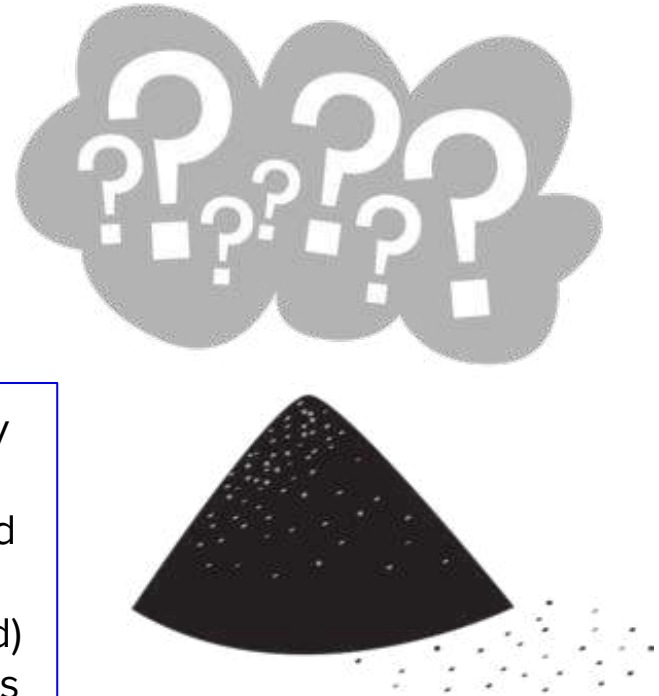


# Burning of wood is a chemical reaction.



Start

Chemical energy  
changes to  
thermal, light and  
sound energy →  
dissipate (spread)  
into surroundings



End

**Exothermic reaction - thermal energy is given out**



# Burning of paper



When fire is held to paper  
1. Molecules that are bound closely to one another on the surface of the paper are ...



2. ... loosened by the heat. They move further apart from one another becoming a gas.

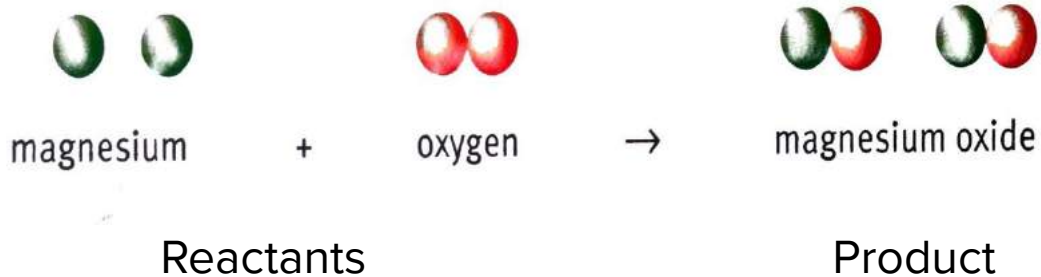


3. The gas molecules combine with oxygen molecules in the air and the paper begins to burn.

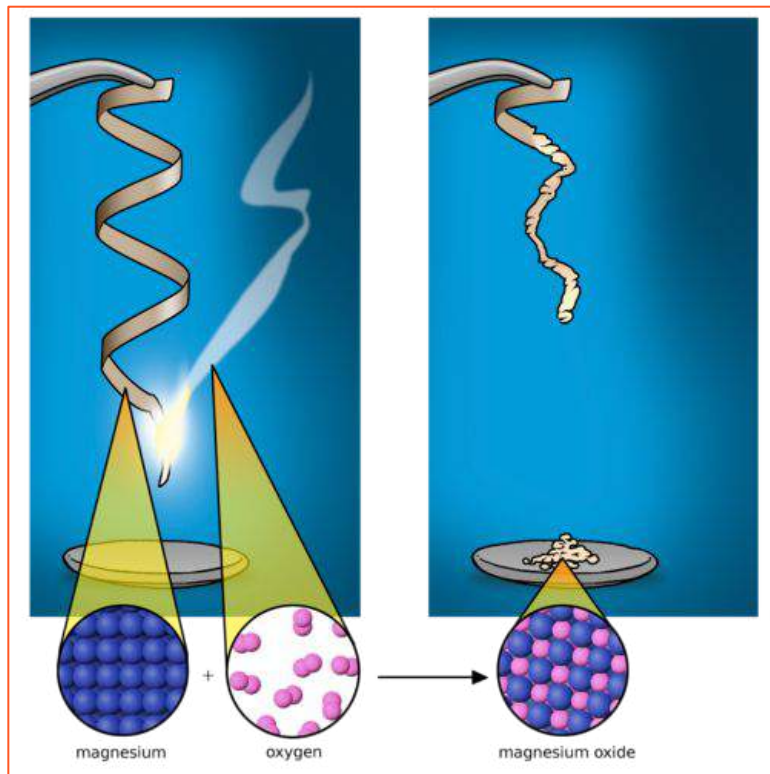


# Burning Magnesium (metal)

- When we burn magnesium metal, a white powder forms - **magnesium oxide**
- A **new substance** has formed from magnesium and oxygen.
- **Oxidation reaction** - reaction in which a substance combines with oxygen



# Burning Magnesium



## Magnesium and Oxygen Reaction



C. Ophardt, c. 2003

Magnesium Ribbon



Magnesium burning in the air (with oxygen), very exothermic - heat and light producing reaction.

Magnesium + Oxygen → Magnesium Oxide

2 Mg

+ O<sub>2</sub>

2 MgO



+



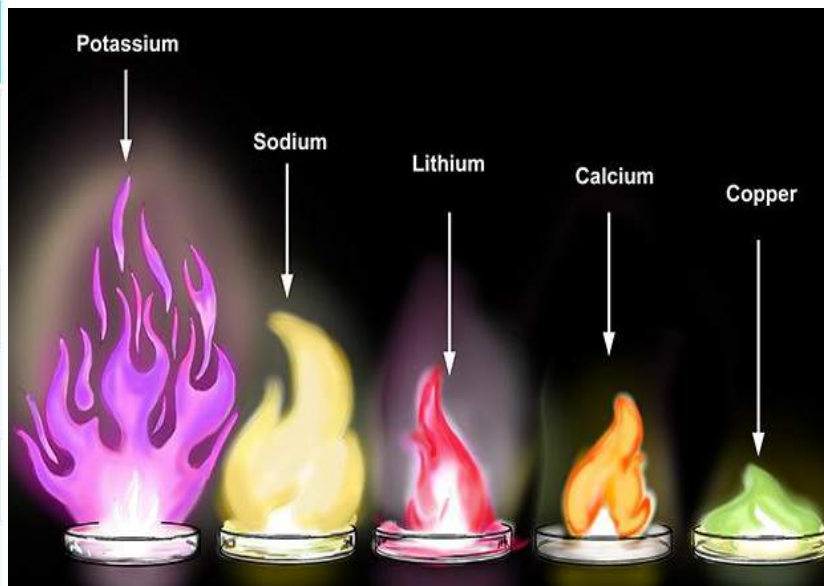
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# Examples of burning different metals in air



Magnesium	Very fast	Magnesium oxide (white)
Aluminium	Very fast (vigorously)	Aluminium oxide (white)
Zinc	Fast	Zinc oxide (yellow when hot, white when cool)
Iron	Fast	Iron oxide (dark brown)
Lead	Moderately fast	Lead oxide (black)
Tin	Slow	Tin oxide (black)
Copper	slow	Copper oxide (black)



# Burning hydrogen in oxygen

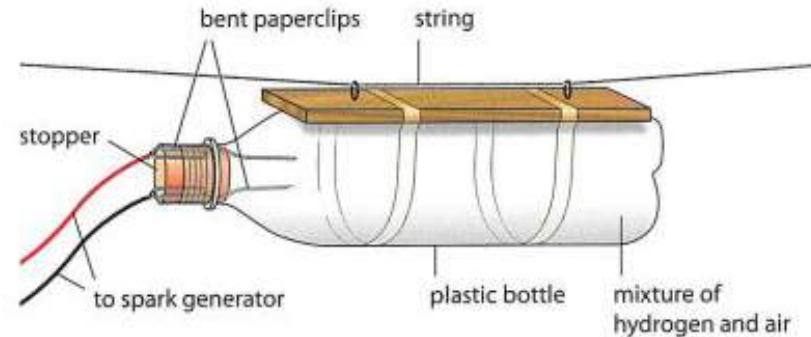
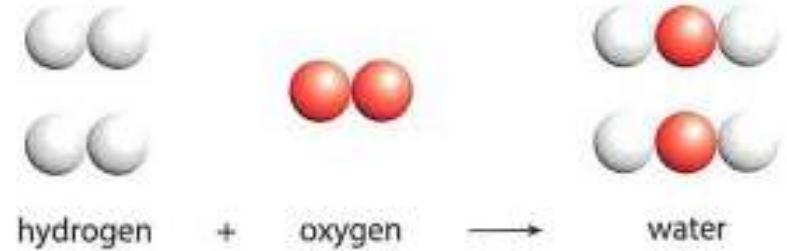
Hydrogen - fuel in modern rocket

Combustion - hydrogen and oxygen combine to form water

Plastic bottle filled with hydrogen and air → stopper has wires to allow spark to generate → hot spark provides energy to start reaction

Reaction gives out lot of energy

<https://www.youtube.com/watch?v=98Vkl1YnNFs>

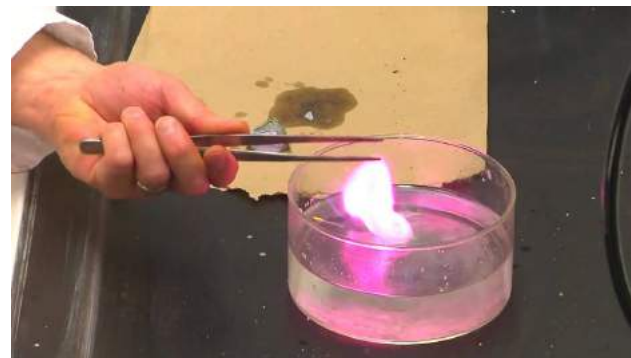
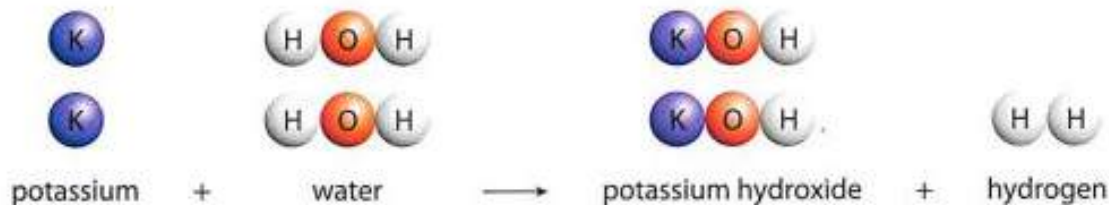


Burning hydrogen can propel a plastic bottle like a rocket

# Reaction of metal with water

When water reacts with potassium, forms potassium hydroxide and hydrogen gas

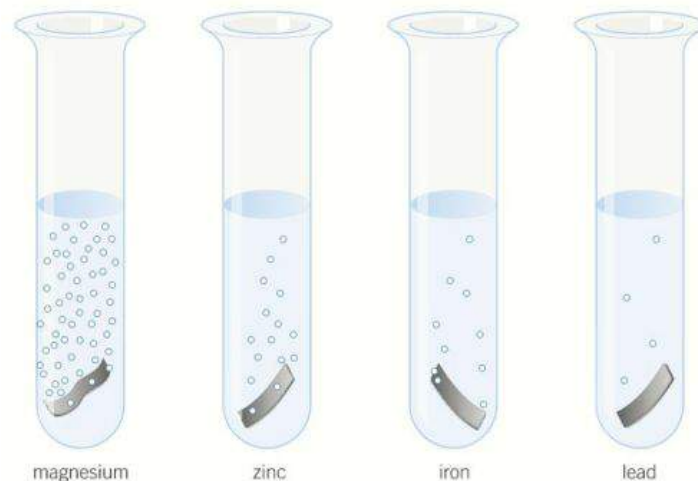
Stored chemical energy is changed to thermal energy, which dissipates into environment



# Reaction of metal with acid

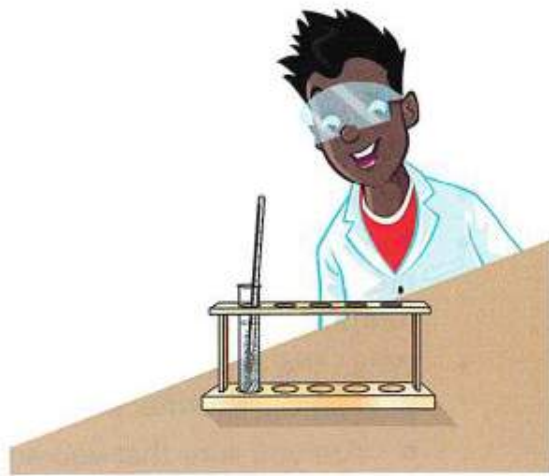
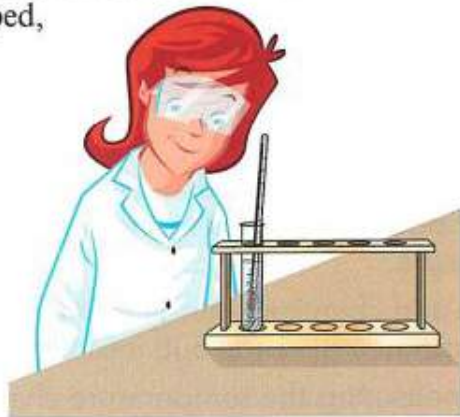
When magnesium to dilute hydrochloric acid, test tube gets hot

Stored chemical energy is changed to thermal energy, which dissipates into environment



# Measuring temperature rise during reaction

Sofia and Marcus each measured  $10\text{ cm}^3$  of dilute hydrochloric acid into a test tube and measured the temperature. Then they each added an identical piece of magnesium ribbon to their test tube of acid. When the reaction stopped, they each measured the temperature again.



Measuring the rise in temperature when magnesium reacts with hydrochloric acid

Sofia's results	
Start temperature in $^{\circ}\text{C}$	End temperature in $^{\circ}\text{C}$
18	42

Marcus's results	
Start temperature in $^{\circ}\text{C}$	End temperature in $^{\circ}\text{C}$
21	45



# Measuring temperature rise during reaction

## Questions

- 4 What are the products when magnesium and hydrochloric acid react?
- 5 How did Sofia and Marcus know when the reaction had finished?
- 6 Marcus thought that more chemical energy had been changed to thermal energy by his reaction because, in his experiment, the end temperature was higher. Sofia thought that both reactions changed the same quantity of chemical energy to thermal energy. Whose idea is correct? Explain why?
- 7 Explain why it is a good idea to wear safety glasses whilst carrying out this investigation.
- 8 Sofia and Marcus wondered how they could produce a higher temperature change. Their ideas included adding more magnesium, using a different metal and using a different acid.

Write each of these three ideas as a scientific question to be investigated.