

Using chemistry

Before starting this unit, you should already be familiar with these ideas from earlier work.

- In a chemical reaction, new materials are formed. List some signs that tell you a chemical reaction is happening.
- We describe chemical reactions using word equations or symbol equations.
- Some reactions give off a gas. We can test to see which gas it is.
- Burning is a chemical reaction. The burning material reacts with oxygen in the air. New compounds called **oxides** are formed.
- We can list metals in order according to how reactive they are. What do we call this list?

You will meet these key ideas as you work through this unit. Have a quick look now, and at the end of the unit read them through slowly.

- Many chemical reactions give out heat energy. A particularly useful one is the burning of a fuel, and we use this **oxidation** reaction to provide us with heat energy.
- Instead of giving out heat energy, we can sometimes arrange a chemical reaction so that it gives out electrical energy. This is the basis of the batteries that power many devices you use, and car batteries which allow drivers to start their cars.
- Some chemical reactions take in heat energy, and we can use these to cool things down.
- We use chemical reactions to make new products. Chemists are skilled at designing and making new materials, some synthetic and some natural. Plastics, drugs, foods, building materials and countless other products central to our lives depend on the work of chemists.
- In a chemical reaction, the total amount of material does not change. The mass of the products is the same as the mass of the reactants.
- The particle model explains this idea of **conservation of mass**. In a reaction, the particles are rearranged. No particles are added, and none are lost.
- Mass is also conserved when materials change state or dissolve.

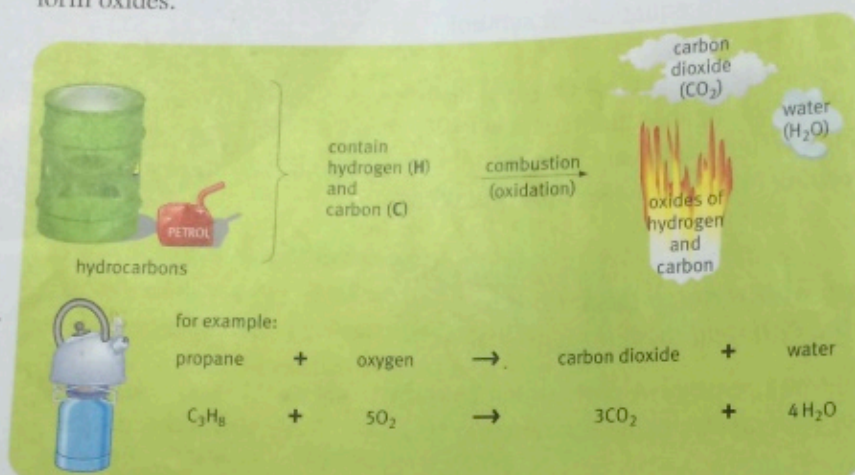


What chemical reactions take place when fuels burn?

Burning fuels

A **fuel** is a substance that we burn to provide us with heat energy. This energy is what makes fuels valuable resources. Burning is also known as **combustion**.

Combustion is an **oxidation** reaction. The fuel reacts with oxygen to form oxides.

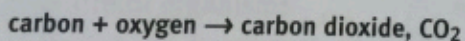


Many fuels are **hydrocarbons** – they contain carbon and hydrogen. Hydrocarbons burn to produce carbon dioxide and water.

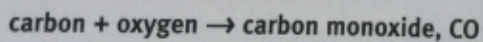
Complete and incomplete combustion

When we burn a fuel, we want to release as much energy from it as we can. To do this the fuel needs to burn completely, forming just carbon dioxide and water. This is called **complete combustion**.

Sometimes there is not enough oxygen getting to the fuel as it burns, and then **incomplete combustion** may take place. This wastes the fuel, because not all the energy is released from it, and it also causes more pollution. The equations show what happens with coal, which is carbon.



complete combustion



incomplete combustion

As well as carbon monoxide, incomplete combustion can produce unburned carbon as soot.

What's the best fuel?

There are many fuels, and each has its own advantages and disadvantages. Look at the following table.



For lift-off the main engines burn hydrogen. Additional thrust comes from solid fuel in the white boosters.

Guess what?

Carbon monoxide is a dangerous, poisonous gas. It may be produced by the incomplete combustion of natural gas in badly maintained gas heaters. Carbon monoxide stops the blood carrying oxygen to the body cells. It often kills people while they are asleep.



A simple carbon monoxide detector saves lives.

Fuel	State	Advantages	Disadvantages
coal	solid	gives out a lot of heat energy per kilogram of fuel	non-renewable fuel, sulphur impurities contribute to acid rain
<i>If you use coal you have to carry it inside, and clean out the ash.</i>			
natural gas (methane)	gas	pipled to your door, clean and convenient	not available everywhere, not sold in portable bottles
<i>Natural gas is very convenient, but it is not available everywhere.</i>			
wood	solid	cleaner burning than coal	need to plant more trees to replace those used
<i>Wood needs to be cut and carried inside, but some people like a wood fire and trees grow again quite quickly.</i>			
oil	liquid	useful for areas without natural gas	has to be delivered by tanker
<i>Heating oil can be delivered to homes where gas is not available.</i>			
butane	gas	bottled, so very portable	has to be delivered by tanker



This helicopter needs to fill up with kerosene (paraffin) fuel every few hours of flying.

- Copy and complete using words from the Language bank:
Burning is also called _____. A fuel is a substance that reacts with oxygen to form oxides and release _____. If oxygen is limited, fuels may undergo _____. This produces the poisonous gas _____.
- What fuel would be best to heat a top-floor flat in the middle of a city?
 - On a remote Scottish island there is no natural gas supply. What might be the best fuel to use here?
 - Explain why coal would be an unsuitable fuel for a helicopter.
- In some ways hydrogen is an ideal fuel, because it burns to produce only water, giving out lots of energy. Use the Internet or textbooks to find out about the advantages and disadvantages of hydrogen as a fuel. Could it be the fuel of the future?

Language bank

carbon monoxide
combustion
complete combustion
energy
fuel
hydrocarbons
incomplete combustion
oxidation