BURNING

Science background for teachers

VOCABULARY

Heating, burning, reversible, irreversible, oxygen, carbon dioxide, chemical reaction, fuel, hazard, toxic, temperature, flammable, ignite

Children often confuse the terms 'heating' and 'burning' so it is worthwhile clarifying the difference with them. When something burns a flame is usually seen but this is not the case with heating. Burning is a chemical reaction, a chemical change. Heating is raising the temperature of a material and this can be reversed. Burning is a chemical process, is not reversible and a new material is formed as a result. For example common fuels such as wax produce carbon dioxide, water and soot. For burning to take place there has to be fuel, oxygen and a high enough temperature, this is often called the 'fire triangle'. At normal room temperatures most materials will not burn because the fire triangle is incomplete, it takes heating to raise the temperature of the fuel enough to start the fire. Forest fires start because of the intense heat of the sun which raises the temperature of easily combustible material such as very dry grass (as the fuel) to make the conditions right. When we strike a match this causes friction and some of the chemical energy is transferred to heat energy and the combustible material in the head of the match ignites. When this is done in the presence of a fuel, burning takes place. Different materials require different temperatures to ignite which is why some burn more easily than others do. Some are so unstable that they will ignite at fairly low temperatures. A few materials such as white phosphorus ignite at room temperature. It is stored under water to keep out the oxygen and as soon as it is removed from the water it bursts into flames. Other materials, for example most metals, require extremely high temperatures to burn.

A candle is a good example to observe and consider when understanding the burning process. Both the wick initially and the wax are the fuel. The burning wick supplies the heat to the main fuel which is the wax, which melts around the wick, vaporises then burns at the top of the wick. Capillary action then causes more molten wax to rise up the wick and the flame begins to glow brighter as a result of the increased fuel supply. (This can easily be seen in a glass spirit burner.) If the wick is too small it will produce insufficient heat to ignite the fuel and the candle goes out. A wick that is too big produces too much wax vapour for the available oxygen to burn it, the burning process is incomplete and a sooty smoke is produced. Children often confuse gas and smoke, both of which may be produced as a result of burning, but smoke is a mixture of solid particles suspended in a gas, eg carbon suspended in air.

The natural gas that is burnt in our homes is methane.

In addition to fuel and heat, oxygen is required. This is demonstrated when a fire is extinguished by smothering it to block off the oxygen. A burning candle will eventually go out if you cover it with a beaker because the oxygen supply has been cut off. If the burning candle is stood in a dish of water, the water rises up inside the beaker until the candle goes out. Part of the explanation for this is that the water replaces the oxygen that has been used, but it is not that simple and by no means the whole explanation. Initially when the beaker is put over the candle, the warm air expands and may bubble out into the water. Carbon dioxide and water vapour are produced as a result of combustion and oxygen is used up. Some carbon dioxide dissolves in the water and the water vapour condenses on the inside of the beaker occupying much less volume than before. The pressure inside is then less than outside, and water is forced into the beaker.

It is important to discuss the hazards of burning with children so that they understand the dangers. Older children can discuss the hazards and risks of some of the activities. Some materials burn very easily and others, especially some plastics, produce toxic fumes, so children can look at furniture and fabric hazard labels. Children should be made aware of situations in their lives that are based on the scientific facts that they learn; for example, opening a window in the presence of a fire increases the oxygen supply and fans the fire, smothering it with a blanket can put it out. Water on a fire lowers the temperature and will put it out, especially if it is a solid fuel fire. However there are dangers with water and certain types of fire and children need to understand the reasons for this. Water is a conductor of electricity and if sprayed onto a fire caused by an electrical fault may cause an electric shock. Oils and petrol do not mix with water and may float on the surface. If they are burning, they will continue to do so and spread further. Hot fat has a very high temperature and will turn water into steam immediately and explode, sending the fat flying everywhere, where it could easily ignite.

SKILLS

- Using equipment carefully and working cooperatively.
- Understanding, planning and carrying out a fair test.
- Observing and recording with accuracy.
- Constructing a line graph.

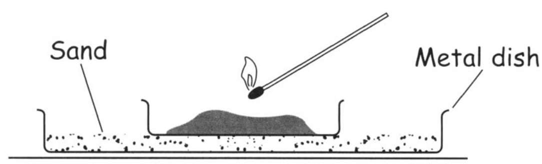
When materials are burned a new material is formed and the process is not reversible

Safety!

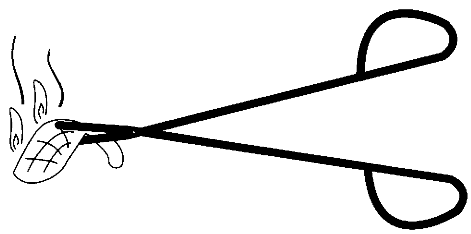
- Discuss the hazards and risks with the children before doing any of the activities to highlight potential dangers.
- Carry out activities in small groups or use extra classroom assistance.
- Be aware of the location of fire extinguishers or blankets. A bowl of water is a useful standby.
- Goggles or safety glasses should be worn, long hair tied back.
- Care when burning any material, the activity should be closely supervised.
- Hot plastics are dangerous because they melt and are sticky when heated or burnt. Many plastic materials give off seriously toxic fumes, and should be avoided.

(a) **Prepare a selection of different materials for the children to burn and observe** (This could be carried out as a demonstration.) Only very small quantities (a 2 cm square) are needed. The children can either hold them in metal tongs or set them alight in small metal containers standing in a sand tray. Individual foil baking cases, old baking trays, or the metal containers from used nightlights are suitable for this. Some suggestions for materials are: different papers, dry twigs or dead matches, sawdust, straw, cotton material, polyester, wool, birthday candle, wire wool, steel nail, flame retardant material. The children need to closely observe what happens and chart the results taking into account what is left at the end.
Were there any smells given off?
How easily did it ignite?
For how long did it burn?

Be safe!
Wear goggles.



Metal dish in a sand tray



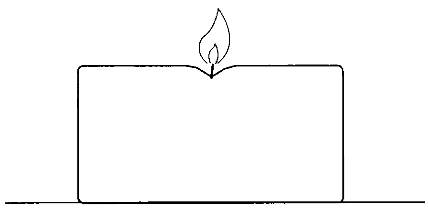
I can see smoke and it smells.

(b) **Investigate** whether the weight of a material changes after burning, is some of the original material 'lost', if so where? This should be closely supervised and is for older, more able children. Repeat the above activity using only one or a few materials to **investigate** Weigh the material before and after burning using electronic scales accurate to at least one decimal place. Avoid synthetics for this activity as a larger quantity of material is needed to register a reasonable weight and they give off toxic fumes.

Material	Did it ignite easily?	How did it change? Observations	Any smells?	Burning time in secs	What is left?
Paper					
Cotton fabric					
Wire wool					
Wood spill					
Tin-foil					

(c) **Burning a candle** Use a household candle or a nightlight and get the children to closely observe it burning at all stages and note down what is happening. Discuss this with the children to explain the molten wax being absorbed by the wick. Showing them a small, glass spirit lamp might help this concept.

The wick burns first and melts the wax.



The melted wax is absorbed by the wick. It vapourises and then burns.

What has happened to the weight of the candle?

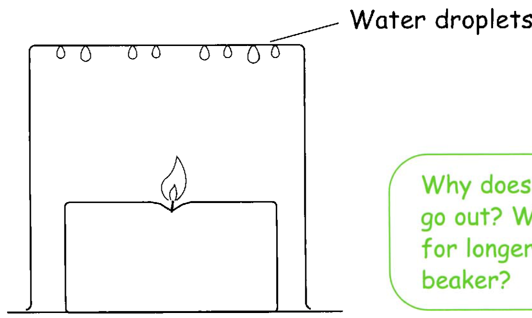
Safety!

- Candles should be stood in a metal tray in sand or water.

Air (oxygen) is needed for burning to take place

(a) Repeat the activity **Burning a candle.** Allow it to burn for a minute or so and then place a heatproof beaker or a big glass jar over the top (so the flame doesn't touch the glass). Carefully observe what happens. Why does the candle go out? What do you see on the inside of the jar? This could be an **investigation** that the children plan themselves. **Investigate** that burning needs air (oxygen) to take place.

Why are there water droplets on the inside of the beaker?

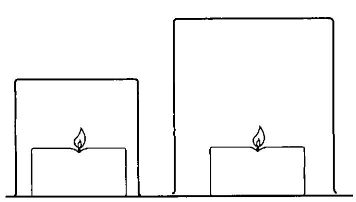


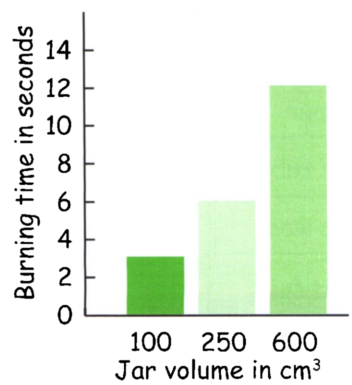
Why does the candle go out? Will it burn for longer in a bigger beaker?

(b) **Investigate** 'Does a candle burn longer in a bigger beaker?' The children can plan this investigation for themselves and construct a bar graph of the time the candle burns and the size of the different beakers.

Use the same type of candle each time. Nightlights are very safe and work well.

Graphing package



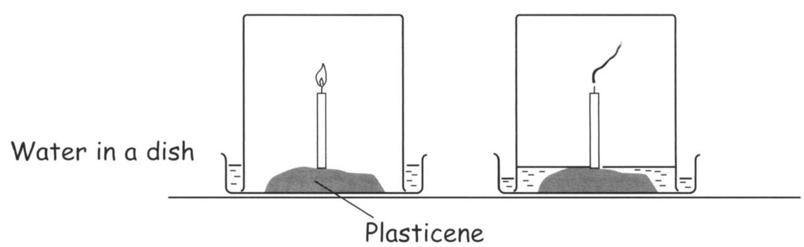


(c) **Investigate** 'Is twice as much air (oxygen) needed for two candles to burn, three times as much for three candles to burn?' This requires careful timing of the candles burning in the same size beaker (jar), so choose a big one to start with or use birthday candles stuck into plasticene. The more candles in the jar, the quicker they go out, because the more oxygen they use.

(d) **Candle, beaker, water activity** This could be a directed activity or a demonstration. Stand the candle in a dish of water and allow it to burn for a minute. Then cover with a beaker or jar and observe the water enter the beaker. **Investigate** 'Does the water increase in proportion to the number of candles burnt?'

Try burning more than one candle.

Birthday candles in plasticene



To identify and assess the risks associated with burning and understand the consequences of actions taken to control burning

(a) Look at different materials and everyday situations and discuss safety in relation to this. Children could look at different 'home situation' pictures and discuss the burning hazards there. Look at hazard labels from fabrics to recognise the potential dangers, for example standing near a fire wearing a nightdress.

(b) From their own experience in their 'burning activities' and from class discussion, children can list materials that burn easily, and which give off toxic gases when burnt. They could design a poster or leaflet illustrating these dangers for a specific audience eg 'The under fives'.

(c) Look at the labels and contents of different types of fire extinguishers to raise their awareness of treating different types of fires in different ways. Discuss this with them.

(d) Children could design a safety poster showing the ways in which different fires may be treated.

Star Poetry
by Michael Rosen

Barbecues Barbecues are fine in your own garden, other peoples pollute the air!

Berlam Bam Boola Burning driftwood changes shape and only ashes are left behind.

Barbecues

When it began to drizzle
I thought the whole thing would fizzle
out.
But there was no need to grizzle
about it, because soon the stuff started to sizzle
and in the end it was
GREAT!

I love it when **we** have barbecues
in the garden but it really doesn't amuse
me when the next door neighbours use
theirs. I refuse
to believe our one makes as much
smell and smoke as their one –
which **I HATE!**

Berlam Bam Boola

That night
we made a fire
on the beach
and Alan danced about
singing:
Berlam bam boola
Berlam bam boola
tooty fruity

I found
a bit of drift wood
that looked like
a cow's skull
and it burned up bright
Berlam bam boola
berlam bam boola
tooty fruity

When we found
the remains of the fire,
in the ashes
I could just make out
the shape of a cow's skull.

Links to History and ideas & evidence in science

Victorian Britain – Humphry Davy (1778-1829) and the safety lamp

Sir Humphry Davy was an English chemist and much of his important work in the first decade of the 19th century focused on the relationship between chemistry and electricity.

At this time, mining was an important industry, providing coal to power the new machines and for domestic heating. It was however a dangerous occupation due to the frequent explosions which occurred underground. The decomposition of plants to form coal, which takes place over millions of years, produces a gas called methane. It is trapped in the coal strata and escapes when the coal is mined. Methane mixed with air is known as 'firedamp' by the miners. It accumulates in the mine galleries and is explosive. Before the electric light, the only means of illumination underground was candlelight or oil lamps, which would cause the 'firedamp' to explode. Men were often thrown up through the mineshaft, pit props collapsed and there was a tremendous loss of life.

In the August of 1815, after a particularly serious accident, Davy was approached by a safety society to investigate the problem. He discovered that methane was the least readily combustible of all the inflammable gases and required the highest temperature to ignite. It did not explode when in contact with red hot iron or charcoal and the heat produced from it when it burnt was less than that from other inflammable gases. He found that if the gas was ignited in a narrow glass tube or particularly a metallic fine mesh tube, it was contained and did not explode. The metal wires quickly conduct heat away from the hot gases passing through the spaces of the mesh and it becomes too cool to burn on the other side of the mesh.

He designed a safety lamp, which was made of copper gauze and burnt Greenland whale oil. In the presence of methane, it does not explode but the appearance of the flame changes, thus also acting as a 'gas detector'. This was used in the pits in the January of 1816 with great success. Explosions occurred then, only because the miner's removed the gauze! This was because the illumination wasn't that good. So the lamp was eventually refined in design and although electric lamps are used today, the safety lamp is still used as a 'gas detector'.

This topic of burning can be linked to other curriculum areas, as shown in this example.

The Original Safety Lamp design