Pouring CO₂ & Fire Extinguishers

This is a fun demonstration particularly if someone is celebrating a birthday and a cake and candle is available – put the candle out without blowing by pouring an invisible gas over the cake! This introduces the concept of combustion and fire extinguishers and also shows that CO₂ and water vapour are heavier than air.

**Things you need**
- Jug (provided with chilly science pack)
- Ice Cage (provided with science pack)
- Gloves (provided with science pack)
- Polycarbonate Scoop (provided with science pack)
- Optional: birthday cake, candles

**Time**

10-15 minutes

**Instructions**

Place 10 - 20g of dry ice in the jug and cover the top of the jug with a cloth or paper napkins. Prepare this before the class starts so that the dry ice has sublimed completely and filled the jug to the brim. As CO₂ gas is invisible the jug will now appear empty. **Timing is important:** if you prepare this too early the CO₂ gas will diffuse away, and if you leave it too late there will be residual dry ice pellets spoiling the illusion. Suggest prepping 10 minutes before the demonstration.

Pour the ‘empty’ jug over a lit candle and extinguish the candles. This is also a nice effect if it is someone’s birthday and you have a cake available!

Repeat this demonstration this time adding a small quantity of dry ice to the jug and pour hot tap water over it, approximately in the ratio of 30g of dry ice to 200ml of water. You will immediately see white ‘smoke’ being produced. Hold the jug and tilt it a little being careful not to pour any liquid out. The white vapour is an aerosol of tiny water droplets being carried in a stream of CO₂ gas. Observe as the gas flows out of the jug and sinks to the floor.

For younger students you can fill the ice cage supplied in the science pack with dry ice and repeat the experiment. The Ice Cage retains the dry ice in a safe enclosure so that it will not escape. In this way you could give the students a ‘fog shower’ by pouring the fog over them as you go around the classroom – taking care not to tip out the water, (the ice cage will keep all the dry ice imprisoned and is an important safety feature, particularly in this case.) For younger students we have found that this is very popular.
Pour the CO\textsubscript{2} and moisture mix over the flame of a candle and watch it go out. The flame will be extinguished as the area is starved of oxygen.

**Class Discussion**

Why is the fog flowing downwards?

The fog is heavier than air. The fog consists of CO\textsubscript{2} gas (which we know is invisible) and water droplets. CO\textsubscript{2} gas is 50% heavier than air. (Molecular weight of air is 29; molecular weight of CO\textsubscript{2} is 44.)

Why did the candle go out?

Fuel needs oxygen to burn and a candle is no different. When the CO\textsubscript{2} fog pours over the flame it pushes the air away and so starves the flame of oxygen and hence the flame is extinguished.

How do candles work?

You may wish to ask the students to think about how a candle works. Candles are amazing - lighting systems which carry their own fuel! The chemical energy contained in the wax is melted by the heat of the flame and this liquid fuel travels up the wick by capillary action until it reaches the flame where it burns locally heating more wax and so keeping the system going!

**Fire Extinguishers**

Ask students to carefully examine the fire extinguisher in the classroom. Some fire extinguishers release CO\textsubscript{2} gas which is heavier than air and therefore displaces oxygen at the base of a fire. CO\textsubscript{2} gas is also non-toxic and so does not present a new hazard to fire fighters. CO\textsubscript{2} gas is not always the correct choice for putting out fires, this is because CO\textsubscript{2} gas leaves a fire extinguisher at high velocity and whilst it starves flames of oxygen it can also push ignited materials such as paper and actually spread the fire! CO\textsubscript{2} is great for dealing with electrical fires as the oxygen is displaced quickly and the CO\textsubscript{2} gas dissipates without causing further damage to electric equipment. There is a special type of fire involving the metal where CO\textsubscript{2} would be a terrible choice for reasons discussed in the Magnesium and Dry Ice Volcano experiment.

You can identify which agent is stored in a fire extinguisher from the colour: (black) contain carbon dioxide and are used on flammable chemical or electrical fires. Other extinguishers contain water (red), cream (foam) or dry powder (blue).

Out of interest CO\textsubscript{2} is stored as a liquid in a fire extinguisher. How is this possible with all this talk of sublimation? It’s all to do with pressure and can be explained by looking at the CO\textsubscript{2} phase diagram in the section ‘Introducing Dry Ice and Carbon Dioxide’ at the front of this booklet.