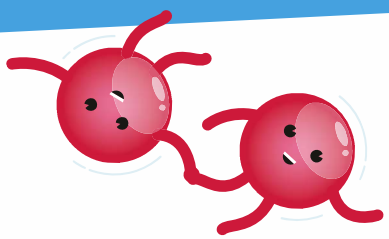
# 8. Plane oxygen

## Demonstrating the emergency generation of oxygen possible in aeroplanes



## Overview

**Using a catalyst, hydrogen peroxide ($H_2O_2$) can rapidly decompose into water and oxygen. When channelled through a narrow necked bottle this reaction sends a stream of water vapour a couple of metres up into the air.**

## What's happening?

Hydrogen peroxide is constantly decomposing into water and oxygen over time via 'disproportionation' (when a compound undergoes oxidation and reduction simultaneously, essentially self-oxidising/reducing).

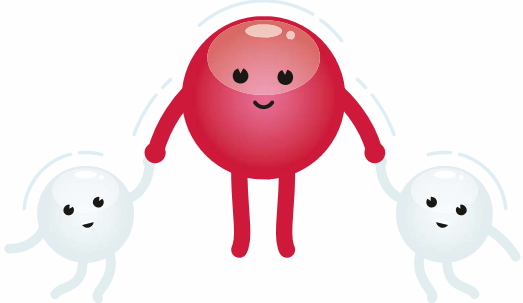
$2H_2O_2 \rightarrow 2H_2O + O_2$

This reaction generally takes a few years but speeds up dramatically with the addition of a catalyst in the form of manganese dioxide. When the catalyst is added, oxygen, water and water vapour is rapidly released and the whole process gives off heat (is exothermic). The oxygen and water vapour can then be collected in a balloon.

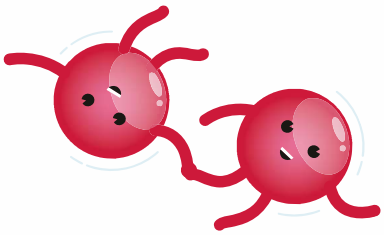
## Why is this important?

Compounds that readily generate oxygen by a chemical method are known as 'oxygen candles'. Common oxygen candles include hydrogen peroxide (used for bleach and disinfectant), barium peroxide (often used in fireworks), potassium chlorate (see 'Blazing Wotsits' activity) and sodium chlorate (previously used as a common weed killer).

One important but little known use of a chemical method of generating oxygen is for the production of emergency oxygen on aeroplanes. Tanks of oxygen stored on the plane would be heavy and bulky. Therefore, on an aeroplane, iron and sodium chlorate are often used. Tugging the mask starts the chemical process which releases the oxygen. The reaction of sodium chlorate with iron filings produces sodium chloride (table salt), iron oxide (rust) and enough oxygen to keep someone alive for about six hours with the quantities used.



> Oxygen is also the third most abundant element in the universe



## More stories to tell

### Breathing oxygen from the atmosphere

Oxygen makes up nearly half of the Earth's crust. However, the oxygen in our atmosphere comes not only from chemistry occurring outside living systems, but also from photosynthesis, a biochemical process, one which occurs inside living organisms. Tiny ocean-living photosynthetic organisms called cyanobacteria started producing oxygen at least 2.7 billion years ago. Over the course of millions of years these tiny organisms terraformed planet Earth, raising the concentration of atmospheric oxygen to where it is today (21%) and at points even higher. 300 million years ago, in the Carboniferous period, oxygen made up about 32.3% of the atmosphere. This oxygen-rich atmosphere allowed for the existence of giant insects, with ancient dragonflies the size of seagulls.

### Is there oxygen in Space?

For any future exploration beyond our planet, we will have to transport oxygen with us. On the International Space Station (ISS), most of the oxygen is generated through electrolysis, the splitting of water to gaseous hydrogen and oxygen using electricity. However, there are back up oxygen-generating candles on board the ISS which use potassium perchlorate. One candle provides one day's worth of oxygen for one crew member.

Oxygen is also the third most abundant element in the universe, forged in the core of stars larger than the sun that are able to sustain stable oxygen fusion. However, there is no (known) natural process that can sustain such a high concentration of atmospheric oxygen as there is in our atmosphere other than photosynthetic life. Therefore, when astrobiologists look to the atmospheres of other planets, a high concentration of oxygen is used as a biomarker: the possible signature of alien life.

## The Activity

**Before the show:**

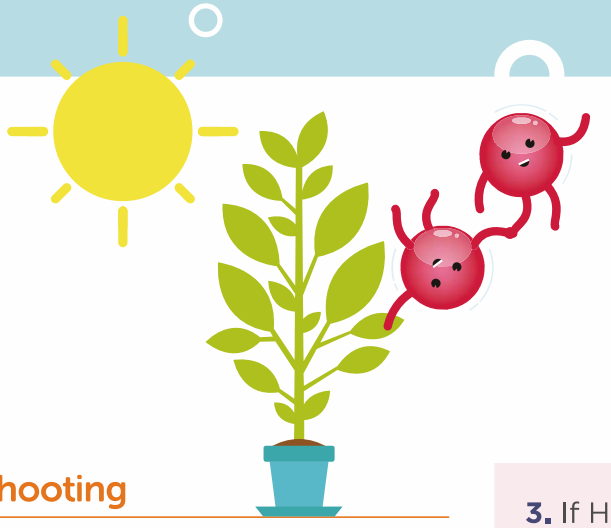
**1.** Measure out 30 mL of hydrogen peroxide ($H_2O_2$) (30 %) into a 500 mL conical flask or 1 L volumetric flask.

**2.** Prepare 4 g of manganese dioxide.

**During the show:**

**1.** Add the manganese dioxide and step back.

**2.** You may want to try collecting the oxygen produced, which can be done via a large (18 inch) balloon throughout the show.



## Troubleshooting

**1.** Always use fresh (under six months old) $H_2O_2$ which has been stored in a cold place (such as a fridge) for best effect.

## Health and Safety

Every delivery centre must undertake their own risk assessments for the specific audiences, locations and conditions they are presenting in. Sample assessments are available on The Secret World of Gases website. Below is a guide to the key risks and hazards:

**1.** Hydrogen peroxide is harmful if swallowed, causes serious eye damage and is harmful to aquatic life with long-lasting effects.

**2.** Wear protective gloves/protective clothing/ eye protection.

**3.** If $H_2O_2$ is swallowed rinse mouth with water and call a poison centre or doctor if you feel unwell.

**4.** If you get $H_2O_2$ in your eyes immediately call a poison centre/ doctor, rinse cautiously with water, remove contact lenses (if present and easy to do so) and continue rinsing.

**5.** If $H_2O_2$ gets on skin it should be rinsed off immediately, it may cause bleaching of skin but shouldn't have a long lasting effect.

**6.** Avoid putting your face over the jet – it will have unreacted $H_2O_2$ in it as well as water vapour and oxygen.

**7.** The reaction is exothermic so will get hot!

**8.** The plume of water vapour will be enriched with oxygen so must be kept away from sources of ignition or burning materials.

## SECRET GAS FACT

**Although oxygen** for passengers is supplied by a chemical oxygen generator, the pilots will have a separate supply from an oxygen tank as it is essential the pilots have a stable, long-lasting and quicker supply of oxygen which can best be supplied from a tank.