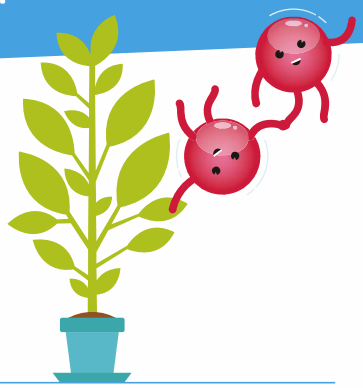
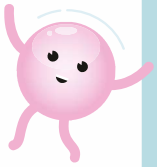
3. Liquid air

Making invisible air around us visible!





Overview

Building on 'Shrinking balloons', this demonstration clearly shows the audience the condensed liquid air.

What's happening?

When air is cooled to -196 °C with liquid nitrogen it condenses into a liquid. This liquid is a mixture of liquid oxygen and liquid nitrogen, alongside a small amount of water ice and carbon dioxide ice. By pouring this liquid into a borosilicate gas trap (a large boiling tube), we can make the hidden mixture of gases in the air around us visible. The liquid air will rapidly boil back into a gas as it warms within the boiling tube.

Why is this important?

Gases in the air can be extracted using this process of changing state. When air is cooled it can be separated into pure nitrogen, oxygen, argon and carbon dioxide. First pioneered by Carl von Linde in 1895, cryogenic air separation is the primary method of extracting the various gases we use every day in the applications discussed in this handbook. The physical properties of the individual gases can be harnessed in many different processes. For example, nitrogen at a low temperature can used to preserve biological samples. Argon is used in non-LED electric lighting and double glazing, and oxygen has many uses in medical science, the steel industry, manufacturing chemicals and even rocket science. See 'Further Ideas and Information' for more uses of these gases and an overview of industrial Air Separation Units.

The Activity

Before the show:

1. Inflate a large sausage balloon with air.

2. Attach the balloon to the gas trap (a large borosilicate boiling tube) with a glass adapter and quick-fit clip. It will need an elastic band for extra security.

During the show:

1. Reveal the balloon assembly, being careful to support the gas trap.

2. Submerge the balloon into liquid nitrogen following the process used with shrinking balloons, until a substantial amount of air has condensed inside the balloon.

3. Slowly pour the liquid air into the gas trap.

4. Switch to the HD web camera so that more of the audience can see the liquid air.

Troubleshooting

1. Always check that the balloon you are using has a small enough diameter to fit into the dewar or other liquid nitrogen receptacle.

2. See Troubleshooting section for 'Shrinking balloons' for recommendations on the type of balloon to be used.

3. The cold borosilicate boiling tube will cause the air around the tube to condense and form a frost on the surface of the tube. This may need to be wiped away to ensure the audience can view the liquid inside.

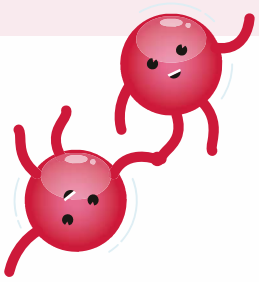
Health and Safety

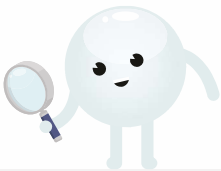
Every delivery centre must undertake their own risk assessments for the specific audiences, locations and conditions they are presenting in. Sample assessments are available on The Secret World of Gases website. Below is a guide to the key risks and hazards:

1. Please see all the risks listed under 'Shrinking balloons' activity.

2. Please see risks associated with handling liquid nitrogen in 'Additional Resources'.

3. The borosilicate boiling tube will get very cold during this process. It is recommended that it is clamped for this process and that the demonstrator wears cryogenic gloves.





SECRET GAS FACT

21% of liquid air is liquid oxygen. Liquid oxygen is pale blue in colour and is visibly paramagnetic! Paramagnetic means it is attracted by a magnetic field, but does not remain magnetic outside this field. Interestingly, gaseous oxygen is also paramagnetic but the molecules are moving too fast to be attracted.