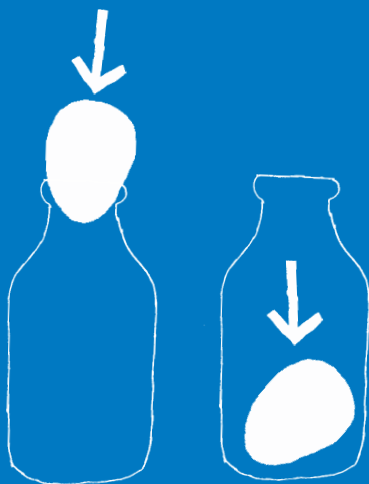


CHANGING STATES



CHANGING STATES

SCIENCE
CHALLENGE

01

Designed by Charles,
Design engineer at Dyson

The brief

Make an egg fit into a bottle without breaking it.

The method

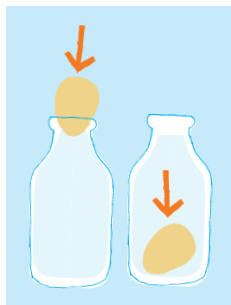
1. Submerge the egg in a glass of vinegar for two days: the shell will become rubbery.
2. Heat the bottle in hot water – remember to use gloves or a tea towel when handling it.
3. Rest the egg on the neck of the bottle.
4. As the air inside the bottle cools down, it will contract and suck the egg down.

Top tip

Try lubricating the egg with cooking oil or washing up liquid.

Materials

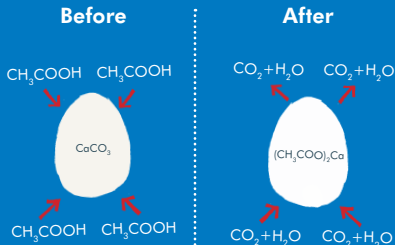
.....
An uncooked egg
.....
A pan of boiling water
(with adult supervision)
.....
A glass of vinegar
.....
A wide-mouthed
glass bottle



How does it work?

Eggs are rich in protein. When heat is applied, chemical bonds within the protein molecules are broken, and new bonds are formed between adjacent molecules. This creates a network of inter-connected proteins which causes the egg to go hard.

Vinegar contains acetic acid (CH_3COOH) that dissolves the calcium carbonate (CaCO_3) shell but leaves behind the egg's springy membrane.



SCIENCE
CHALLENGE

02

UNDERWATER VOLCANO



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UNDERWATER VOLCANO

SCIENCE
CHALLENGE

02

Designed by Ian,
Design engineer at Dyson

The brief

Create a colourful underwater volcano.

The method

1. Cut a two foot length of string with a pair of scissors. Tie a knot around the neck of a salt shaker with one end of the string. Double-knot it to ensure the knot is secure. Repeat this process with the other end of the string, resulting in a handle to lower your shaker.
2. Empty and clean a large jar. Fill the clean jar about three quarters full with cold water.
3. Fill the salt shaker with hot water (with adult supervision) – as hot as you can get from your tap – to just below the neck. Add three to four drops of red food colouring.
4. Hold your salt shaker over the mouth of the jar by the string handle. Slowly lower the salt shaker into the jar until the shaker is completely submerged and resting upright on the bottom of the jar. Observe how the coloured water erupts from the shaker into the cold water.

Materials

String

Scissors

(with adult supervision)

An empty salt shaker

A large jar

Food colouring



How does it work?

This shows how convection currents work. A convection current is the way that heat rises and falls in liquids and gases.

Design icons

Hot air balloons use convection currents. As hot air rises, so too does the balloon.



SCIENCE
CHALLENGE

03

FLOATING PING-PONG BALLS



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FLOATING PING-PONG BALLS

SCIENCE
CHALLENGE

03

Designed by Alex,
Design engineer at Dyson

The brief

Make two ping-pong balls float in the air flow of a hair dryer at the same time, without hitting each other.

The method

1. Switch on your hairdryer, making sure it is on the cool setting.
2. Hold it with the nozzle pointing upwards.
3. Place one of the ping-pong balls into the stream of air.
4. Try and place another ball into the same stream of air – on top of the first ball.

Materials

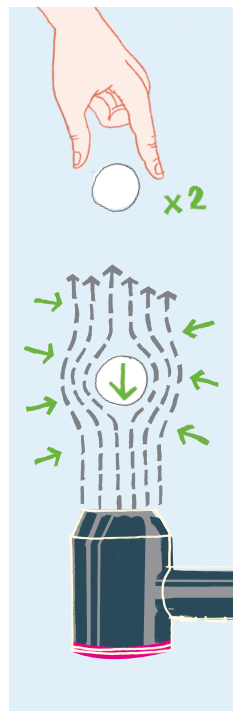
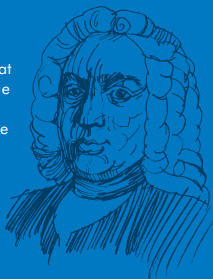
Two ping-pong balls

A hairdryer
(on cool setting)

How does it work?

The hair dryer produces a high velocity stream of air with low pressure. The surrounding air is at a higher pressure which keeps the ball inside the stream. When the upward force of the air equals the weight of the ping-pong ball the ball is said to be in 'equilibrium'.

The theory at work here is Bernoulli's principle. This is an equation linking air pressure, velocity and density with particle weight.



SCIENCE
CHALLENGE

04

BALLOON KEBABS



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BALLOON KEBABS

SCIENCE
CHALLENGE

04

Designed by Phil,
Design engineer at Dyson

The brief

Push a wooden skewer through a balloon without popping it, creating a “balloon kebab”.

The method

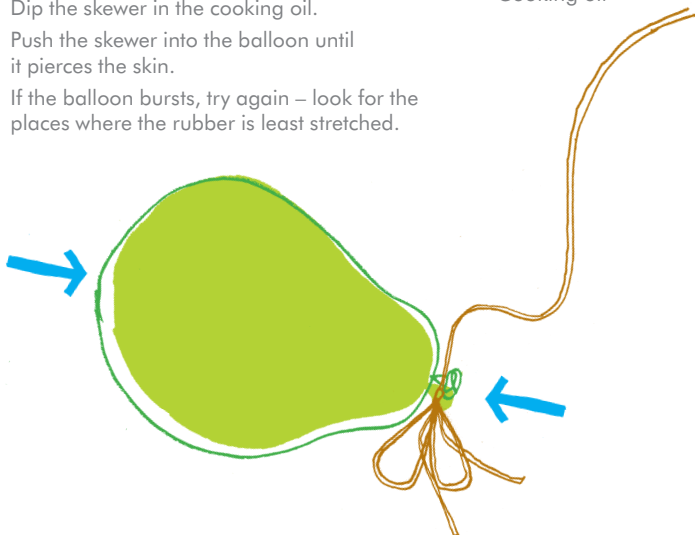
1. Dip the skewer in the cooking oil.
2. Push the skewer into the balloon until it pierces the skin.
3. If the balloon bursts, try again – look for the places where the rubber is least stretched.

Materials

A balloon inflated
until $\frac{3}{4}$ full

A wooden skewer

Cooking oil



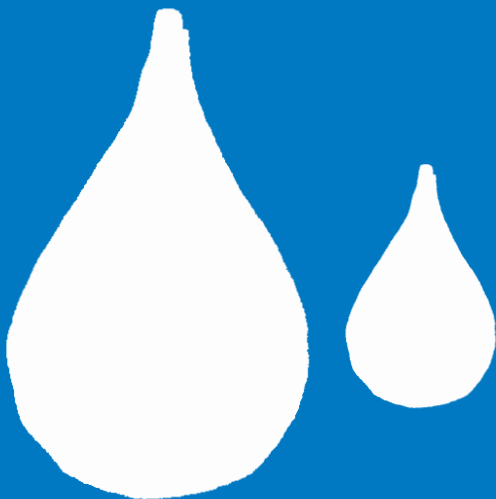
How does it work?

Most of the balloon is stretched evenly, but there are two points where the rubber is least stretched. The tied section and the darker patch at the opposite side of the balloon have the lowest surface tension. Most of the balloon is under high tension, so attempting to push the skewer through just makes the balloon pop. At the low tension sections it is possible to make a small hole without breaking the overall surface of the balloon.

SCIENCE
CHALLENGE

05

LIQUID DENSITIES



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LIQUID DENSITIES

SCIENCE
CHALLENGE

05

Designed by Ben,
Design engineer at Dyson

The brief

Layer different liquids in a tube and discover how and why they settle in a certain order.

The method

1. Start by adding food colouring to the surgical spirit and to the water – using a different shade for each. This will allow you to identify each liquid.
2. Measure out equal quantities of each liquid. Add them to the tube, one by one.

Top tip

Try weighing each liquid before you add it and predict which order the liquids will settle in. The layers may be a little mixed at first. Allow them to settle for a moment and watch the layers start to define.

How does it work?

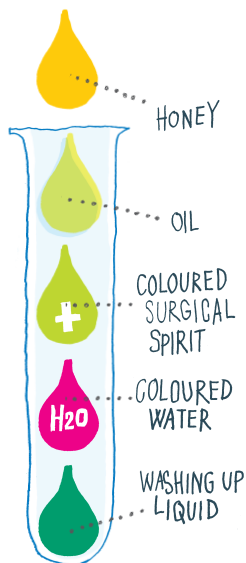
Different liquids have different densities and therefore, different weights. The heaviest liquids will sink, the lighter liquids will rise to the top. Density is a comparison between an object's mass and volume. Remember the equation:

$$\text{DENSITY} = \frac{\text{MASS}}{\text{VOLUME}}$$

Based on this, if the weight – or mass – of something increases but the volume stays the same, the density has to go up. Lighter liquids, like water, are less dense than heavy liquids, like honey, and so float on top of the more dense layers.

Materials

A test tube
Honey
Oil
Surgical spirit
Water
Washing up liquid
Two shades
of food colouring



EXPANDING GASES



EXPANDING GASES

SCIENCE
CHALLENGE

06

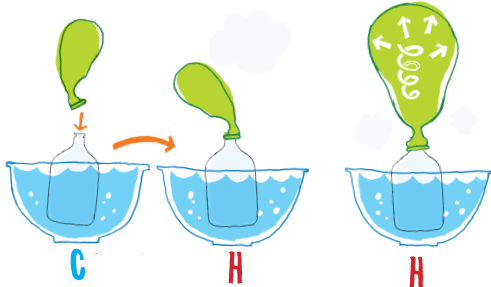
Designed by David,
Senior mechanical engineer
at Dyson

The brief

Find out what happens when gases are heated up or cooled down.

The method

1. Fill two bowls – one with cold water the other with hot water.
2. Put the bottle into cold water.
3. Fit a balloon to the neck of the bottle.
4. Now place the bottle into the hot water.
5. Watch the balloon expand.



Materials

Two bowls

Cold water, hot water
(with adult supervision)

A sturdy plastic bottle

A balloon

How does it work?

Gas expands when it is heated. The rule is, if the pressure of a gas remains constant, the volume of the gas will increase as the temperature increases. So if the temperature increases, the gas takes up more space. This is known as Charles' Law. The principle was first formulated by the French physicist Jacques Alexandre Cesar Charles in 1787.

Design icons

Steam engines heat up air and allow it to expand in cylinders to drive wheels.

