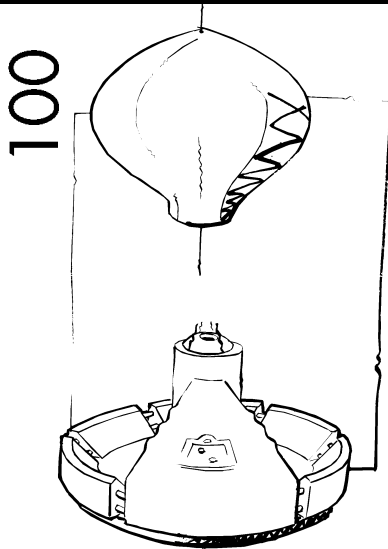


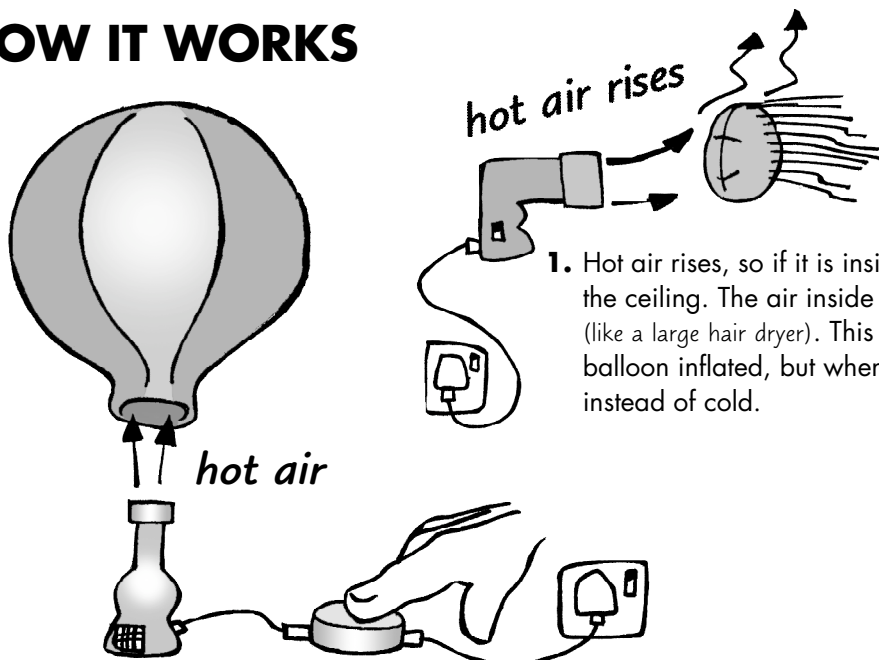
## Hot Air Balloon

**What to do:** Press the red button to heat the air inside the balloon. When the air is at about 90°C, press the green button.

**What happens:** The balloon rises majestically into the air and comes down again when the air has cooled.



### HOW IT WORKS

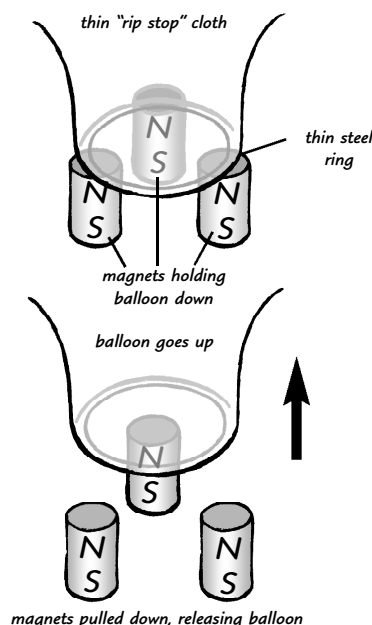


1. Hot air rises, so if it is inside a balloon, it might be able to lift it up to the ceiling. The air inside the balloon is heated by a powerful blower (like a large hair dryer). This blows cold air all the time to keep the balloon inflated, but when you press the red button, it blows hot air instead of cold.

2. The balloon is made of lightweight sail material and a set of magnets attract a thin steel ring round the bottom of the balloon.

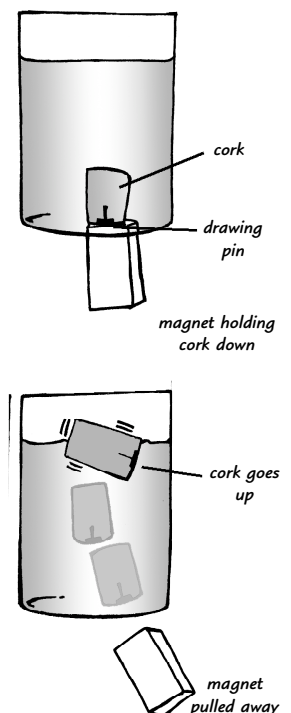
3. When you press the red button, the air is heated, so that the balloon fills up with hot air. You probably know that air expands when you heat it. So the balloon is soon full of expanded air, which is much lighter than the cold air outside the balloon.

4. When you press the green button, the magnets are pulled away. If the air in the balloon is at 80°C or hotter, the entire balloon (including the hot air inside) will be lighter than the surrounding cold air, so will float upwards like a cork in water.

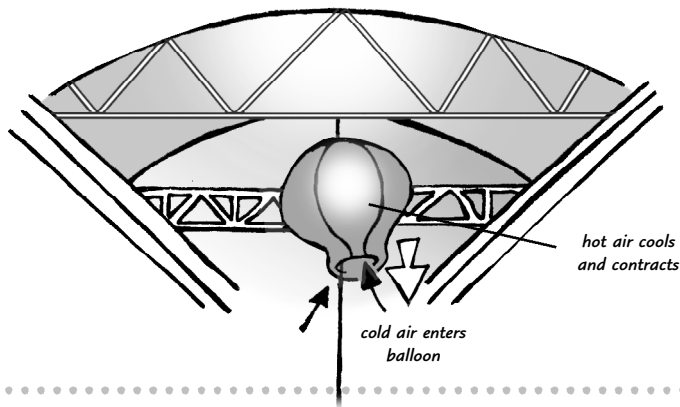


magnets pulled down, releasing balloon

*the balloon acts like a cork in water*

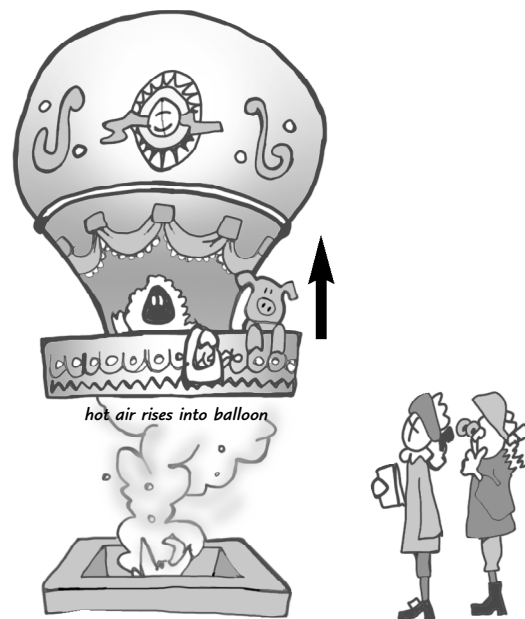
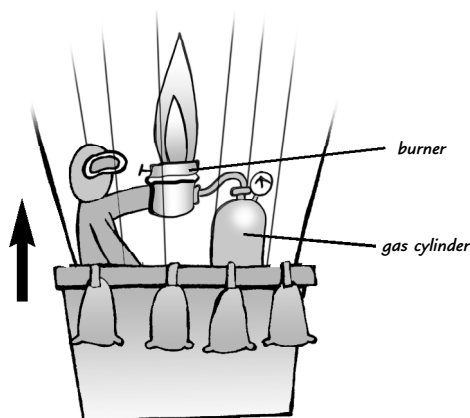


5. As the balloon rises, the air inside it cools down and contracts. Cold air then comes in from outside, so the balloon gets heavier and descends, ready for the next trip.



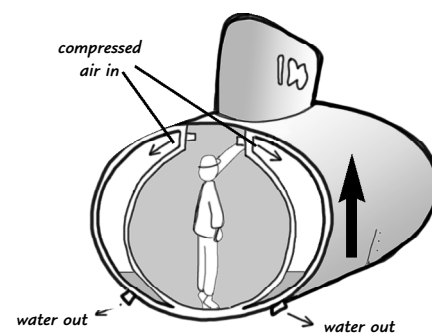
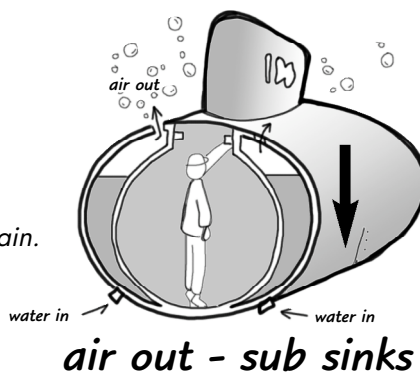
## DID YOU KNOW?

- The first hot air balloon was built by the brothers Montgolfier in France in 1794. They were paper makers, so their balloon was made of paper on a frame and the air was heated with a small fire - a recipe for disaster! The first passengers were farmyard animals which returned safely to earth after a short flight. The two brothers made the first manned flight themselves later the same year.
- Modern hot air balloons are made of the same sort of fabric as our exhibit and carry big gas cylinders to produce the flame to heat the air inside them.



- You may be surprised that air has weight! There is about 4.25 kilogram of air inside the balloon when it is cold ( $20^{\circ}\text{C}$ ) and only about 3.5kg of air when it is hot ( $90^{\circ}\text{C}$ ). If the heating had been done in the balloon itself, 0.75kg of air would have expanded out of the open end of the balloon. The balloon fabric and metal ring weighs about 0.5kg so that there is a net force of about 0.25kg to lift the balloon upwards through the air. You now know why balloons have to be huge if they are going to lift passengers and big gas cylinders!

- Submarines behave like underwater balloons! They have tanks which are filled with water to make the boat heavier, so that it dives. When this water is blown out of the tanks with compressed air, the boat rises again.



air in - sub rises

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