Pressure

Biscuit Tin Balloon

(Ireland)

Background

This demonstration links particle theory and pressure concepts. The expansion and contraction of particles when heated and cooled, can cause pressure differences that can be explored in interesting ways.

You will need….

- ✓ 1 balloon
- ✓ 1 cylindrical biscuit tin (e.g. SMA babyfood tin)
- ✓ Approximately 15 cm^2 of newspaper
- ✓ Matches
- ✓ Oven gloves
- ✓ Half-full basin of water

Follow these steps:

1. Half-fill a shallow basin with water
2. Blow up and tie off a balloon such that it sits into the rim of your tin, without falling into it.
3. Holding the mouth of the tin to students ask: “Is this tin empty?”. Students need to keep their answer to this part in mind for later.
4. Light a roughly 15 cm x 15 cm piece of newspaper, place in your tin and allow to burn until the embers stop glowing.
5. Sit the balloon on the rim of the tin. For students: “Why did the balloon not burst?”
6. Using heat gloves, and gently holding the balloon in place, place the tin into the basin of water. For students: “This water will cool the tin, so what do you think is happening inside the tin at the moment?”

7. After ~2 minutes the whole apparatus can be lifted at the balloon knot. The balloon can also be bounced up and down without the tin slipping off the balloon. For students: “Thinking about your answers to previous questions, can you explain why the balloon and tin do not separate, even when I bounce them up and down vigorously?”

So what happened?

The tin is full of gas particles (air), which gain energy when the burning newspaper is placed inside the tin. This heat energy causes the already moving gas particles to move faster and with increased kinetic energy. The many particles escape the tin, leaving a reduced number inside.

Placing the balloon on the rim seals the tin, preventing any further particles from escaping. Placing the tin into a basin of water cools down the particles in the tin rapidly. Removing the heat energy means they begin to slow down and stop moving apart, and come closer together.

As there are now less gas particles inside the tin but the same number of gas particles outside (atmospheric gas), the balloon is partly forced into the tin. There is no suction.

The pressure outside the tin is greater than the pressure inside, but not so great it can compress the balloon enough to force it completely into the tin.

What next?

As well as revision of particle theory concepts this demonstration can be used to

- Reinforce/review pressure concepts
- Show the interrelationships of particle theory concepts, pressure and density in a conceptual manner
- Internal pressure differentials are used in a number of ways:
    - Venturi suction pumps that can attach to lab taps
    - Venturi effect within Bunsen burners
    - Negative pressure of biohazard labs – the internal pressure is lower than atmospheric pressure to help prevent pathogens from escaping
    - Positive pressure biohazard suits – the internal pressure of the suits is higher than atmospheric pressure to prevent pathogens form entering the suit if there is a rip/tear.