# Measuring atmospheric parameters

***An overview of some experiments illustrating the concepts of atmospheric pressure, temperature and humidity***

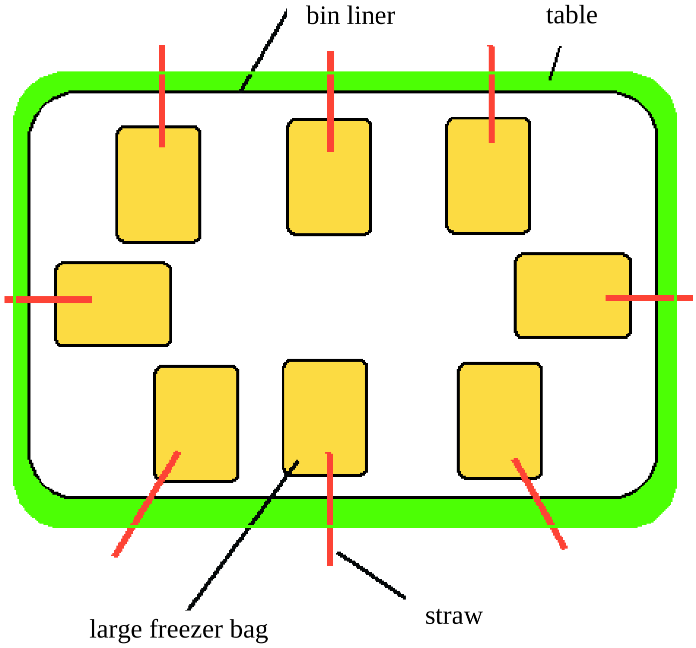
## Pressure

A convincing demonstration of the forces engaged in atmospheric pressure can be performed with very little equipment while still showing students very clear results.

We use a large bin liner in which eight holes are punched, to enable eight hermetically-sealed freezer bags inside it to be linked to the outside via eight straws.

*Here we see Dianne Robinson with a course participant (holding the bag) preparing one of the eight bags with the straw carefully taped to make it as airtight as possible.*

The eight bags are placed as shown in the following diagram:




The freezer bags are all placed inside the bin liner with only the straws poking through. The whole set-up is then placed on a table in such a way that each straw extends beyond the edge of the table.

A second table is then placed over the set-up and a student or even an adult climbs up and sits on the table: see photograph.

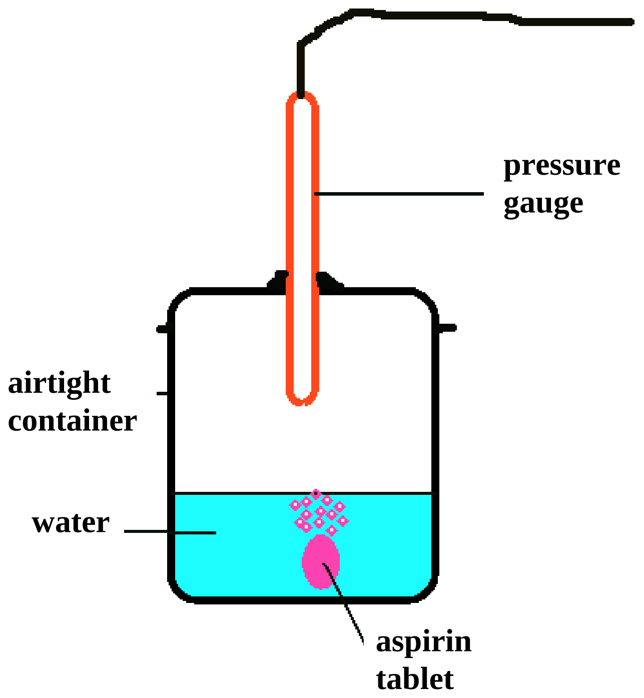
The result is very convincing: as soon as eight people blow into the straws, the upper table is lifted easily, along with the person sitting on it!

This experiment illustrates the notion of pressure, after which sensors can be used, either those seen previously (http://www.calibration.fr/) or any other sensors.

Another simple experiment shows the force of atmospheric pressure. A wooden ruler is placed over the edge of a table, partly covered by sheets of newspaper (spread out wide and smoothed flat). When the end of the ruler sticking over the edge of the table is struck sharply, it usually snaps in half!

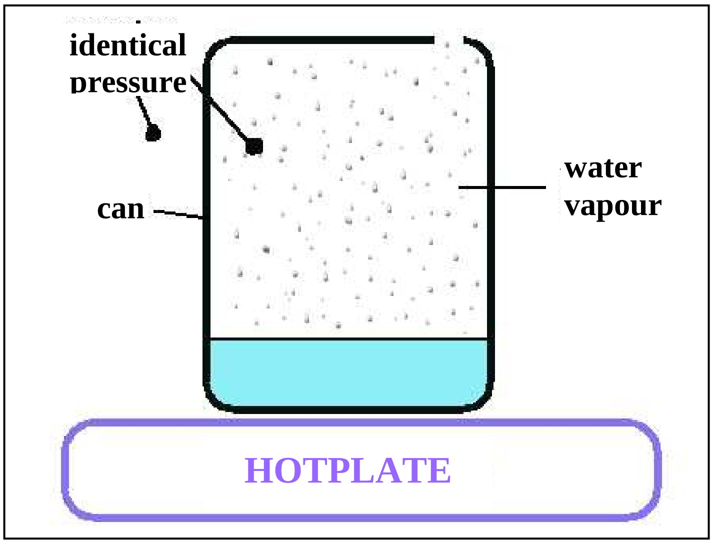
**Measuring increases in pressure:**

Any suitable airtight container can be used, such as a photographic film-case, as long as a pressure gauge can be inserted through the cap:
Gas released inside will modify the pressure and the gauge will indicate the changes.

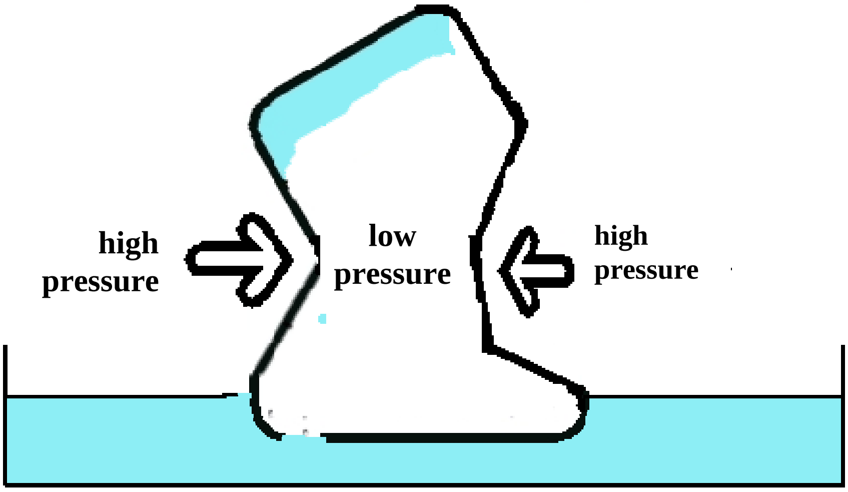



If one (or more) “Mentos” mint sweets are added to a bottle of fizzy drink, the gases dissolved in the liquid condense around them and revert to a gaseous state, causing such a huge increase in pressure inside the bottle that the result is a geyser!

**Measuring decreases in pressure and how this is linked to cooling:**

| | |
|---|---|
|   | Here we show how a decrease in pressure can cause a solid container to be crushed by the simple effect of the difference in external and internal pressure.<br><br>A beer or fizzy drink can containing a little water is heated for at least 10’ so that it is completely filled with hot water vapour.<br><br>The pressure and temperature inside the can may be measured if desired. |

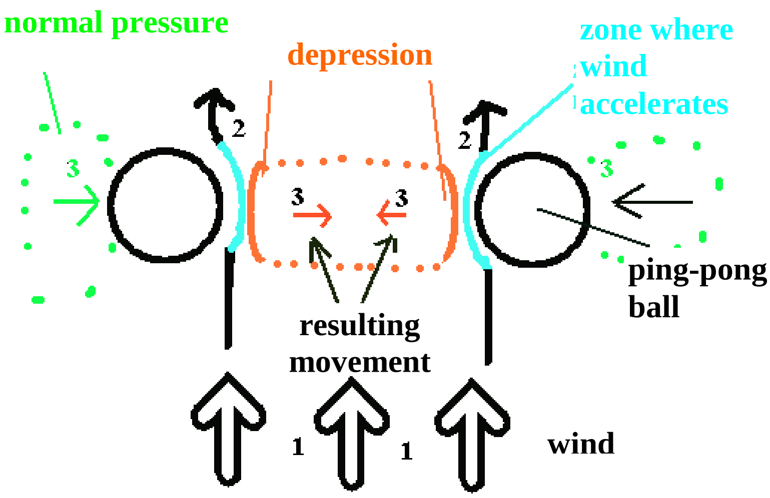
The second operation is trickier: the can must be turned upside-down very quickly onto a tray containing cold water. Here we see Paul Adams and M. Andreou doing this, and you will notice that Paul has taken the precaution of wearing a glove to hold the can. The result is spectacular, because the can literally implodes: the very hot water vapour is cooled so suddenly that it condenses at once, causing the internal pressure to drop considerably; the external pressure is therefore much higher and crushes the walls of the can, which can be seen to lose its shape.



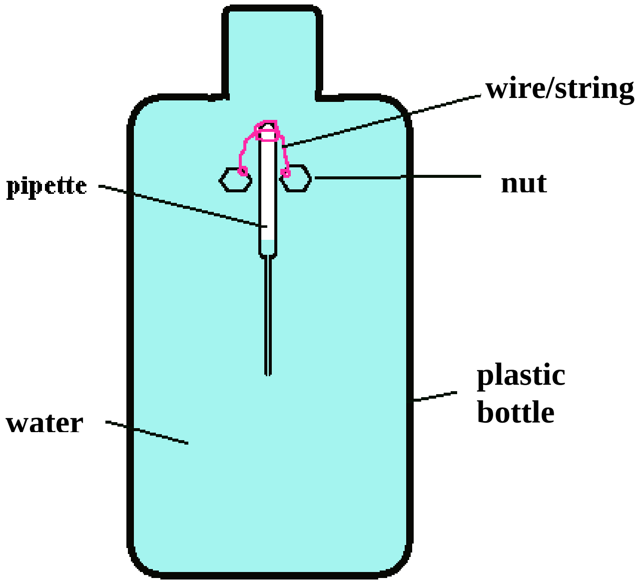

Another simple experiment shows how moving air is related to changes in pressure:

Take two ping-pong balls attached by a string and hold them a few centimetres apart: trying to separate the two balls by blowing between them only causes them to come closer together, as shown in the photo.

The following diagram gives a basic explanation of the phenomenon: when you blow between the ping-pong balls (1) the air in contact with the balls accelerates round the convex surface (2) creating a depression close to the surface and a little further out, causing the balls to move closer together because of the inequality between the depression on one side (3) and the normal pressure on the other (3).

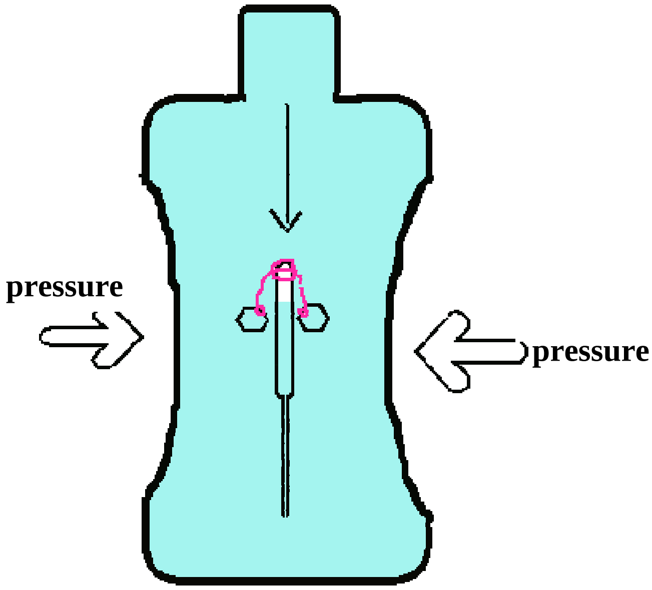


**Compressibility of gases and variations in mass:**
Equipment required: a pipette, a plastic bottle filled with water, two nuts (chosen together with the pipette, so that the combination will float) and wire or string for attaching the nuts to the pipette.
Instructions:




1. Fill the bottle to the brim with water.
2. Quarter-fill the pipette with water as shown in the diagram.
3. Place the pipette in the bottle so that it floats and causes the water in the bottle to overflow. If it does not float, choose different sizes of nut until equilibrium is reached.
4. Cap the bottle so that it is watertight.
5. Compress the sides of the bottle and observe the result:

The pipette sinks: the pressure exerted on the bottle has been transmitted to the water which is incompressible, but as there is air in the pipette (which is compressible) water has been forced into the pipette under pressure and has made it heavier. Therefore, it sinks.




## Temperature:

*In the Calisph'air project, the instruments used to measure atmospheric temperature are protected in a weather station: why?*

We can show how atmospheric temperature varies in different conditions.

Thermometers are placed in a number of cans, each containing a little water as in the earlier experiment, and are then exposed to light:

1. one control can
2. one can painted black (the photo shows Mickaël Andreou and Céline Cossard at work in the rain!)

3. one can wrapped in aluminium foil (see photo)
4. one can wrapped in a damp cloth with a hair-dryer (blowing cold air) directed at it
5. etc.

The cans are then either exposed to heat from a lamp, or plunged into a bucket of ice.

The results obtained show that each can's internal temperature varies according to the conditions: consequently, to obtain standardised values of use to science the instruments must be placed in a sheltered location. French and English instructions for building an instrument shelter can be found at this address:

http://www.globefrance.org/IMG/pdf/Instrument_construction-_site_definition.pdf

<u>NB</u>: another interesting experiment involves showing the stages of phase transition. Heating can be performed in class, while cooling requires a freezer.

A little demonstration shows that perception of temperatures is relative:

3 pots: - one containing ice
- one containing hot water
- one with water at room temperature (the control)

Volunteers are asked to place their hands in the pots of hot and iced water. They then place one hand at a time in the pot of room temperature water and give their impressions of its temperature.