Purpose:

- Determining the mass of one litre of air.
- Use paper to determine the mass (using the proportionality between the mass and the paper surface according to its quality).
- Realize that the Archimedean buoyant force also exists in the air.

Material:

- One apothecary balance. (Whether you use the laboratory balance, or you construct your own one).
- One PVC bottle (1 L) with the cap.
- One small bicycle air tube valve.
- One bicycle pump.
- Some printing 80 g/m^2 paper.
  (Note: if you copy the document, take care that the printing machine is fed with 80 g/m^2 paper).
- Some objects (nuts, slices or other to tare the bottle)
- One very fines plastic bag (a bit more than one litre volume) and a small rubber band.

Procedure:

- Prepare the cap of the bottle.
  Make a small hole at the centre of the cap, and insert the valve.
  !!! Take care to keep the rubber slice that must be placed inside the cap to guarantee proper sealing. Place another rubber slice on the cap around the valve. Place the nut and tighten.
  Screw securely the cap onto the bottle. Totally compress the bottle and check no air is coming out.

- Prepare the paper sheet.
  Draw about 20 rectangles of 0,1 g on the sheet, for example 20 rectangles of 2 cm x 6,25 cm. See the model on last page.

  You can also do it on a computer using a word file.
  Create a table (by clicking on the icon) of 2 columns and 10 lines.
  Select all the boxes of the table.
  In the tool bar, click on "Table", then click on "Table Properties", click on the tab "Column"
  Activate the box in front of "Preferred Width", then, replace the value in the window by 6,25 (! Not 6.25).
  Click then on the "Line" tab.
  Activate the box in front of "Specify Height", and key in the following box: 2 cm (in place of 0).
  Click on "OK".

You have now 2 columns of 10 lines of 6,25 cm x 2 cm. Each rectangle corresponds to 0,1 g.
You can key it in every cell of the table:
Write 0,1 g in one cell. Then copy-paste it in every cell.
Select the whole table. Click on the centring icon. Then click in the tool bar on "Table" then on "Table Properties"; select the "Cell" tab then click on the "Centred" icon.

- Using the pump.
  Accurately measure the travel "h" of the piston and the inside diameter "d" of the pump.
  The air volume driven back by the pump corresponds to $V=\frac{\pi d^2}{4}\cdot h$
  By dividing 1 litre by "V", you can determine how many pump strokes "N" you need to obtain one litre of air.

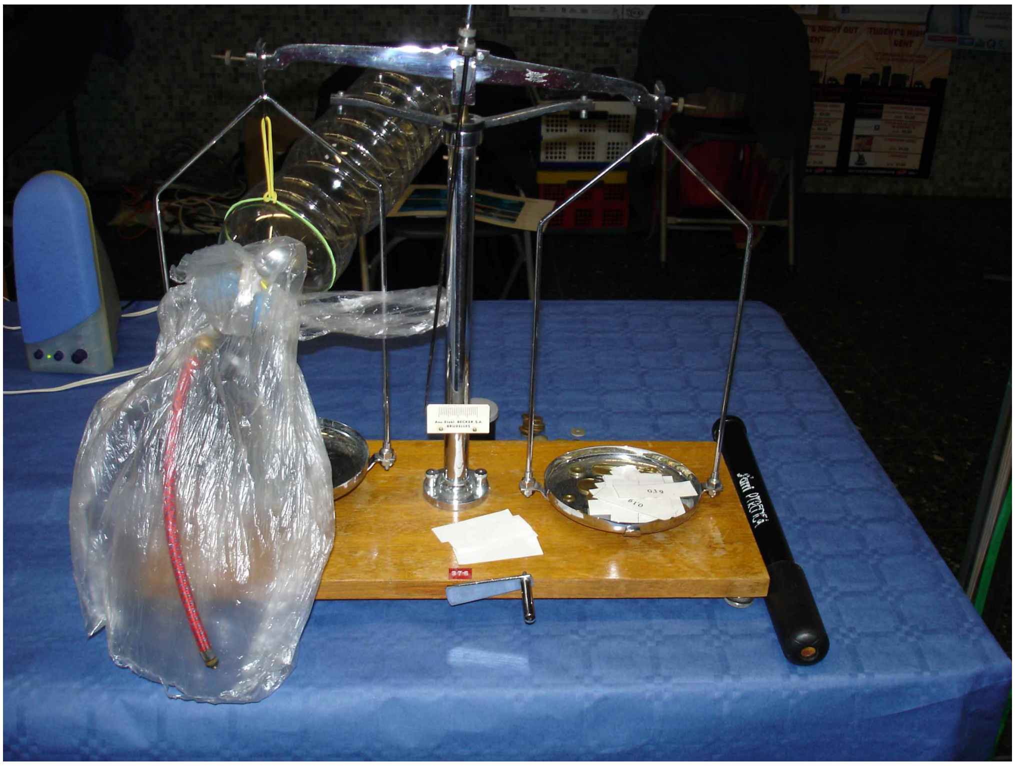
- Determining the mass of one litre of air.

  Cut carefully the rectangles on the paper sheet in order to obtain 0,1 g masses.
  Place the bottle with its cap supplied with the valve on one of the platform of the balance.
  (Note: there are small and big valves.
  By using small valves, you can unscrew the pump fitting from the valve.
  By using big valves, it deflates when taking out the fitting. You should then leave it on the bottle and unscrew the fitting at the pump level)

  Stabilize the balance using nuts, slices, or other objects.
  Withdraw the bottle and secure the pump and the fitting on the valve.
  Slowly (to avoid air overheating) perform "N" pump strokes. One litre of air has been introduced into the bottle at the atmospheric pressure.
  Replace the bottle on the platform and balance it again using the small paper rectangles of 0,1 g.
  Count the rectangles. (They should be about 13 of them)
  The mass of one litre of air is then equal to 1,3 g, that is to say, that the mass of one m^3 of air is equal to 1,3 kg!

- Archimedean Buoyant Force.

  Attach the small plastic bag using the rubber band (take care to eliminate the maximum of air out of the bag by compressing it in your hands).
  Tare again the whole assembly.
  Deflate the bottle by pushing on the small rod at the centre of the valve. The litre of air leaves the bottles and enters the plastic bag. This litre of air is subject to the Archimedean buoyant force. The balance is unbalanced again. (see picture)



To equilibrate the balance again, just remove the small paper sheets that were used to determine the mass of the air litre introduced into the bottle.
The Archimedean buoyant force is then equal to the weight of the air that was moved.

0,1 g	0,1 g
0,1 g	0,1 g
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