# PHYSICS

## Methodology

## How to Measure Pressure Using Dynamometer

We measure a force needed to pull a plunger of a syringe using a dynamometer and a syringe. After measuring the diameter of the plunger it is possible to estimate the air pressure by calculation.

(We thank to Miroslav Jílek who conducted this measurement on Physics Teachers' Inventions Fair 2015 for this idea.)

## What you need

- a syringe (you can use the syringe from the Vernier PS-ACC)
- Vernier DFS-BTA dynamometer
- a ruler



## Tasks

1. Connect the dynamometer to your computer and run the Vernier Logger Lite programme.
2. Set the Sampling Rate to 50 Hz and a check *Continuous Data Collection*
3. Place the dynamometer in a vertical position with the hook facing upward and in the menu *Experiment* choose *Zero*.
4. Follow the picture. Place the syringe plunger to 0 ml; let the nozzle of the syringe loose and draw the plunger using the hook of the dynamometer into the second extreme position (maximum volume). Try to keep the motion of the piston uniform. Now you measure the friction force between the plunger and the syringe body.

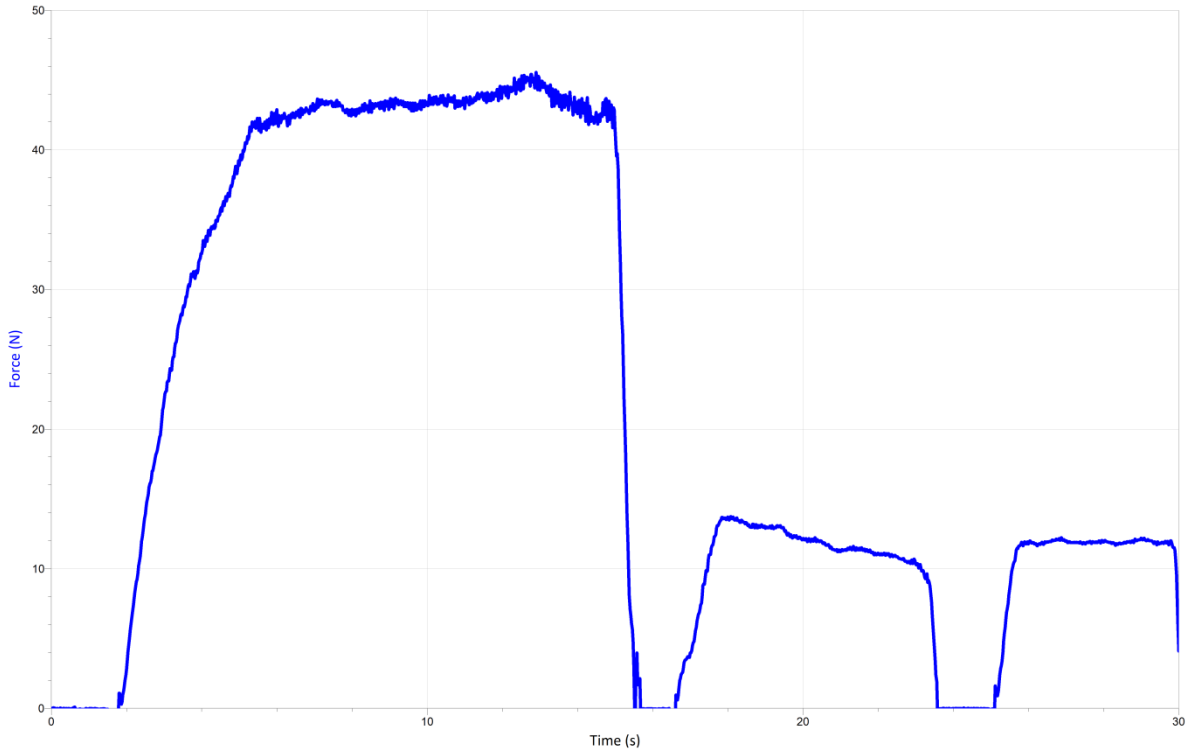
Without stopping the measurements push the plunger back to zero and then block the nozzle of the syringe with your thumb. Again, draw the plunger of the syringe using the hook of the dynamometer uniformly to the second extreme position. This time, in addition to the friction forces, it is needed to overcome the pressure force of atmosphere.

5. Store the latest run. Drag the cursor over the horizontal section of the graph corresponding to the uniform drawing of the plunger by the dynamometer and click on the icon *Statistics* - Then read off the average value of force. Repeat this step for each relevant section of the graph separately (one corresponds to drawing without blocking the nozzle, the other corresponds to drawing with the blocked nozzle).

6. Basing on the measured values calculate air pressure and compare your result with the normal atmospheric pressure. You have to work out the procedure - if you need any further information or values, measure them or look them up.

## Notes for teachers

A typical graph looks like this:




The first "peak" corresponds to the measurement with **blocked** nozzle of the syringe. The other two measurements were **without blocking.** The middle measurement has failed, the line is not horizontal – the motion of the plunger was not uniform. Therefore, the measurement was repeated.

To calculate the pressure, the relation $p = F/S$ is required. Students obtain the force from the graph. The area is calculated from the equation $S = \pi R^2$ where the radius $R$ (or, more practically the diameter $2R$) must be measured.

In our case the diameter of the plunger was 2 cm and the forces were 43.5 N and 11.9 N. Therefore, for the estimation of air pressure the relationship $p = \frac{43.5 - 11.9}{3.14 \cdot 0.01^2} = 100637.9 \text{ Pa}$ applies. The value corresponds well to the normal pressure which is about 100 kPa (it is slightly dependent on the weather and altitude).