Boyles law (PV curve)

Apparatus

400 kPa absolute pressure sensor

25ml syringe (preferred, smaller volumes will work)

3 Way Luer stopcock

Data recording setup.

Single graph pane layout

Recording setup

Snapshot

Manual entry of data

Data series name = Volume

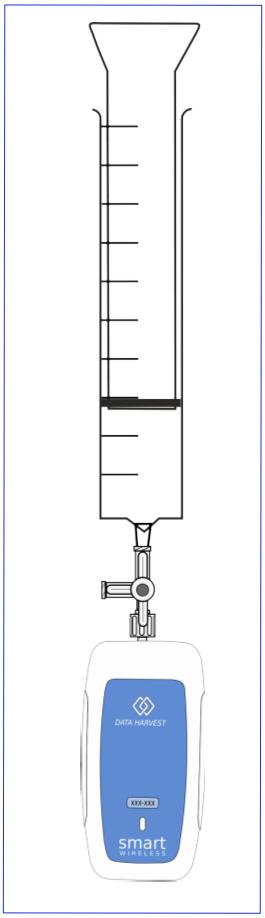
Unit = cm^3 or ml (to match syringe markings)

When start selected. When stop selected

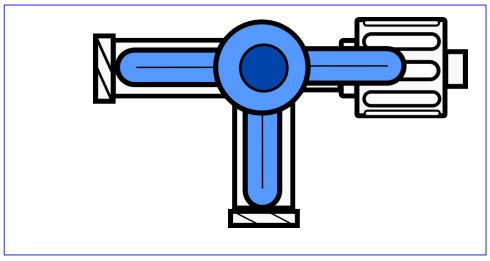
Boyle's law relates the volume and pressure of a fixed mass of gas kept at constant temperature.

The law states "The volume of a fixed mass of gas is inversely proportional to the pressure, provided the temperature remains constant" $P \propto 1/$ Volume.

In this investigation the snapshot mode of the software is used to collect the pressure information for a fixed mass of gas that is being compressed in volume. The calculation tool is then used to produce the graph of P vs. 1/V If Boyle's law is correct the plot of P vs. 1/V will be a straight line.

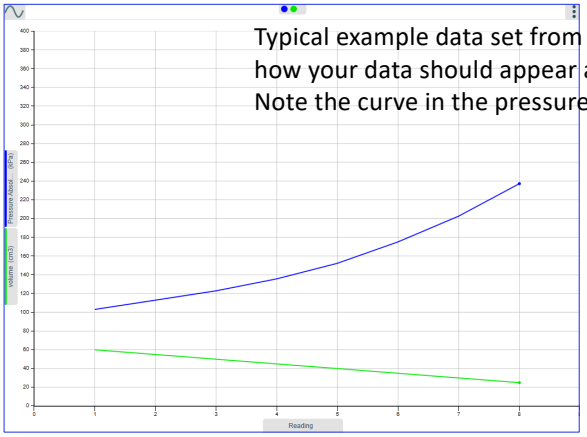


Method

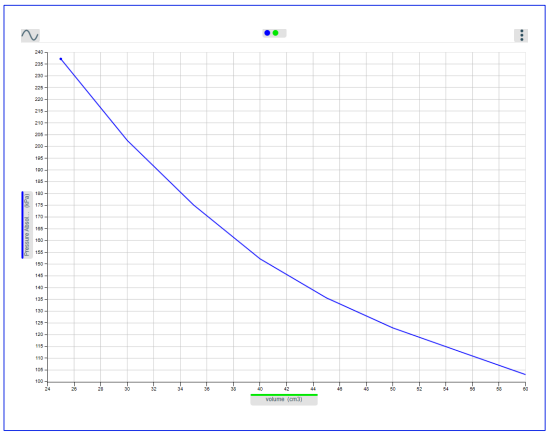


1. Connect the three way tap to the syringe; turn the tap valve to close off air movement into the syringe. For example the blue arms of the valve show you which ports are open, in the diagram all three ports are open as all arms point to a port.
2. Connect the tap to the Pressure sensor; the sensor can be connected directly to the tap using the second Luer connector.
3. Turn the tap valve to allow air to be drawn into the syringe.
4. Fill the syringe to the maximum of the scale on the syringe. Make sure you understand the way the marks on the plunger are used to indicate the volume in the syringe.
5. Start the software and connect the Pressure sensor to it.
6. Set up the recording as described in the data recording setup details at the top of this worksheet.
7. Turn the tap valve to allow air to move between the syringe and pressure sensor only.
8. Click Start to record data, click on the screen and then at the top of the graphing area enter the syringe volume at the plunger black line.
9. Push the plunger to the next major graduation, hold the syringe in this position and click on the graph area to collect the data, record the volume. Repeat for each graduation on the syringe barrel (or half graduation as directed by your teacher)
10. You may need someone to help you with this task, especially as the volume decreases.

11. Repeat step 9 until the plunger is really difficult to depress any further; if you cannot get to the next major graduation, use the volume mark you can get the plunger to as your last reading. As long as you have collected at least 4 readings this should not be a problem.
12. Release the pressure on the plunger and select Stop when you have collected all the pressure readings for the volumes.



Typical example data set from the practical. This how your data should appear after recording. Note the curve in the pressure line



Data after placing volume on the x axis (known variable) and pressure on the y axis (unknown variable).

Auto min - max has been used (or you could use the user scale to define the maximum and minimum points. Sometimes the autoscale option adds a bit too much in its attempts to comply with graphing rules)

You should see the plot shows a slight curve this is the PV curve.

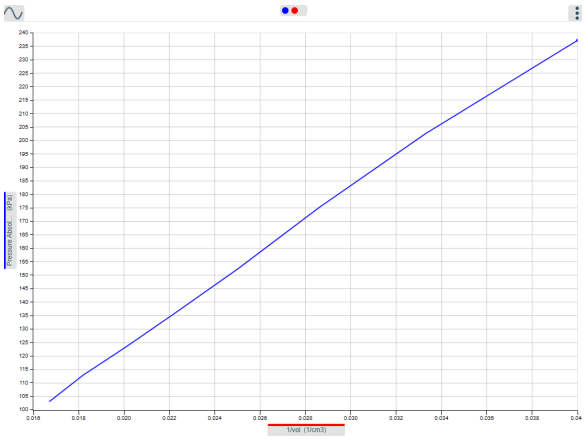
Results and analysis.

You need to produce a plot of pressure against 1/ Volume. Pressure will be on the y axis, it is the unknown variable.

Use Calculate and the function a/x, where a = 1 and x is the volume data series. Fill the details in the calculation, name = 1/Volume, decimals 3, series unit 1/cm3 and apply.

A new data line of 1/Volume will appear.

Click on the axis labels to select pressure on the x axis and 1/Volume on the y axis.



Questions

1. From looking at your graphs, do the pressure and volume seem to be directly or inversely proportional? Does this agree with Boyle's Law?
2. Is there any relationship between the volume and pressure e.g. does pressure double if volume halves?
3. What are possible sources of error or limitations in this experiment? For each one, try to decide what effect it might have on the experimental results.
4. If we know there are no leaks in the system, can you explain why at the end of the experiment, the plunger does not return to its starting point?

Note:

V = absolute pressure, v = relative pressure e.g. pressure change from atmospheric.

Change the display to two panels, leave one as a graph and make the other to a table.

Copy the data to the table below and then use the graph paper to plot your pressure against 1/Volume.

Result	Volume on syringe	Pressure	1/volume	PxV