Lascells Free Experiments – Boyle's Law

This experiment explores the relationship between the pressure and volume of a gas.

Boyle's Law is defined as:

The absolute pressure exerted by a given mass of an ideal gas is inversely proportional to the volume it occupies if the temperature and amount of gas remain unchanged in a closed system.

Boyle's Law can be stated mathematically as:

$$P \propto \frac{1}{V}$$

where P is the pressure, and V is the volume of the gas. In this activity, we will use the Lascells Boyle's Law apparatus to directly measure the pressure of a gas as we incrementally change its volume, and plot this data to confirm the relationship between P and V.

Equipment:

LA30-217 Lascells Digital Boyle's Law Apparatus

9/899 wellington road rowville 3178 victoria australia
p 03 9764 3638 e contact@ciderhouse.com.au
/ciderhousetech /ciderhousetech www.ciderhousetech.com.au

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Method:

1. It is useful to vent the sensor to atmospheric pressure and reset the syringe to a midpoint to achieve a good range of readings. To do this, slide the whole syringe to the right, disconnecting the tube from the sensor – the display will now read current atmospheric pressure (~101 kPa). Set the syringe to around half way (1.5 mm) and reconnect the tube by sliding the syringe to the left – ensure the connecting tube has sealed around the sensor.
2. Adjust the volume in the syringe using the plunger, and take readings of pressure at 0.1 ml increments of volume. You can decide which part of the syringe you use as your reference point on the volume scale, but stay consistent with this across the whole data set.
3. Record your values for pressure and volume in a table, similar to that shown in Table 15. You will note that in Table 15, there is another column for V + 0.2 ml. It is important to add on 0.2 ml to all your values for volume, to account for the extra volume of air which is enclosed in the connecting tube and the internal volume of the pressure sensor.
4. It is possible to convert the above data into SI units, e.g. Pressure in Pa and Volume in m3 . The pressure in Pascals, P (Pa), can be calculated from the pressure in kiloPascals, P (kPa) via:
5. P (Pa) = P (kPa) x 1000 (23)
6. Similarly, the volume in cubic metres, V (m3), can be calculated from the volume in millilitres, V (ml) via:
7. V (m3) = V (ml) x 1000, 000 (24)
8. Some sample data collected from the Lascells Digital Boyle's Law apparatus is included in Table 15, and this data is plotted in Figure 11.

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Pressure (kPa)	Volume (ml)	V + 0.2 (ml)	V + 0.2 (m^3)	1 / V +0.2 (m^{-3})
189.8	0.8	1.0	0.0000010	1000000.0
169.9	0.9	1.1	0.0000011	909090.9
156.8	1.0	1.2	0.0000012	833333.3
143.5	1.1	1.3	0.0000013	769230.8
131.8	1.2	1.4	0.0000014	714285.7
124.1	1.3	1.5	0.0000015	666666.7
116.6	1.4	1.6	0.0000016	625000.0
108.2	1.5	1.7	0.0000017	588235.3
102.5	1.6	1.8	0.0000018	555555.6
97.1	1.7	1.9	0.0000019	526315.8
91.9	1.8	2.0	0.0000020	500000.0
87.6	1.9	2.1	0.0000021	476190.5
83.5	2.0	2.2	0.0000022	454545.5
79.6	2.1	2.3	0.0000023	434782.6
76.3	2.2	2.4	0.0000024	416666.7
73.0	2.3	2.5	0.0000025	400000.0
70.3	2.4	2.6	0.0000026	384615.4
67.7	2.5	2.7	0.0000026	370370.4

Table 15: Sample pressure and volume data, taken from the Lascells Digital Boyle's Law Apparatus.

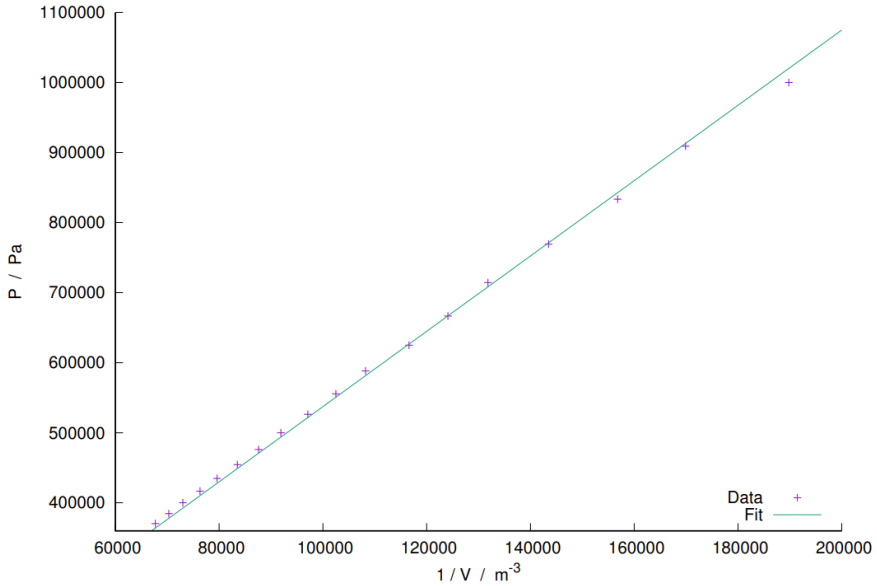

Figure 11: Plot of sample data collected from the Boyle's Law apparatus, confirming the linear relationship between pressure, P, and 1/volume, 1/V.

The suitability of this experiment for a particular learning activity is up to the end user to assess based on their knowledge of the participants and the equipment, resources and safety standards available. While every experiment has been tested, by undertaking the activity, the end user accepts any and all risk. It is recommended that a risk assessment be conducted prior to any experimental activity being undertaken.

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