BOYLE'S LAW USING SEALED SYRINGES

A. French. 10/10/2020. P5. Winchester College.

p0 /Pa 100700

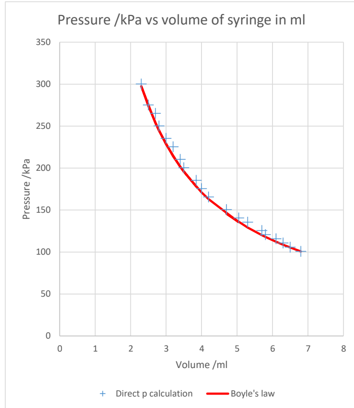
V /ml	Mass added /kg	V0/V - 1	Pressure /kPa	P = p0*V0/V
6.8	0	0	100.7	100.7
6.5	0.1	0.046154	105.6845	105.3477
6.3	0.2	0.079365	110.6689	108.6921
6.1	0.3	0.114754	115.6534	112.2557
5.8	0.4	0.172414	120.6378	118.0621
5.7	0.5	0.192982	125.6223	120.1333
5.3	0.7	0.283019	135.5912	129.2
4.7	1	0.446809	150.5445	145.6936
5.05	0.8	0.346535	140.5756	135.596
4.2	1.3	0.619048	165.4979	163.0381
4	1.5	0.7	175.4668	171.19
3.5	2	0.942857	200.389	195.6457
3.2	2.5	1.125	225.3113	213.9875
2.8	3	1.428571	250.2335	244.5571
2.5	3.5	1.72	275.1558	273.904
2.3	4	1.956522	300.078	297.7217
2.7	3.3	1.518519	265.1869	253.6148
3	2.7	1.266667	235.2802	228.2533
3.4	2.2	1	210.3579	201.4
3.85	1.7	0.766234	185.4357	177.8597

Very straight line!

$\boxed{\text{Boyle's law}}$

$\boxed{pV = \text{constant}}$

(ie ideal gas $pV = nRT$ and # moles n and temperature T = constant)



$$\boxed{P = P_0 + Mg/\pi r^2}$$

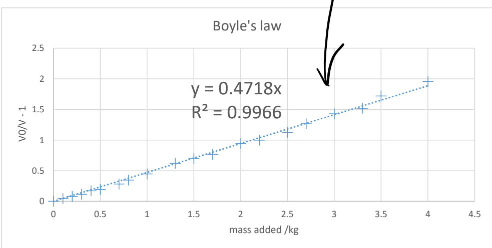
Atmospheric pressure

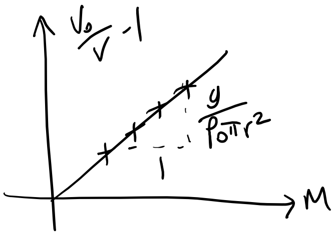
$$\text{So } \left(P_0 + \frac{mg}{\pi r^2}\right)V = P_0 V_0$$

$$\therefore \quad P_0 + \frac{mg}{\pi r^2} = \frac{P_0 V_0}{V}$$

$$1 + \frac{mg}{P_0 \pi r^2} = \frac{V_0}{V}$$

$$\boxed{M \times \frac{g}{P_0 \pi r^2} = \frac{V_0}{V} - 1}$$





So can use the data to calculate atmospheric pressure P_0 (should be close to 10^5 Pa)

$$\text{So } \frac{g}{P_0 \pi r^2} = 0.4718$$

$$\therefore \quad P_0 = \frac{g}{0.4718 \pi r^2}$$

$$= \frac{9.81}{0.4718\pi(14.83\times10^{-3}/2)^2}$$

change to 15.83

$$= 105{,}648 \text{ Pa}$$

According to my barometer watch $P_0 = 1007$ hPa ie 100700 Pa

So estimate is a bit on the high side. But r is likely to be an underestimate

120,000 Pa if 2r=14.83

(Perhaps 1 mm larger ie $2r = \boxed{15.83\text{mm}}$)

Perhaps easier to measure P_0 and calculate r!!