01 - Equation of state for an Ideal Gas

0412220030 Emre Enercan

Goals

In this experiment, we study the properties of gases, specifically for

- The pressure-volume relation in fixed temperature
- The temperature-volume relation in fixed pressure
- The pressure-temperature relation in fixed volume

Data and Graphs

For the first experiment, we read the length of the column to extrapolate the volume, and the length difference between the two columns to extrapolate the pressure with the relations

$$V = V_L + V_R = \pi\left(\frac{d}{2}\right)^2 L + 1.01ml$$

$$V = \pi\left(\frac{11.4}{2}\right)^2 L + 1.01$$

And the pressure can be calculated from the height difference with the relation

$$p = p_{atm} + \Delta p$$

$$p = 1013hPa + 0.133kPa\ mm^{-1}\Delta h$$

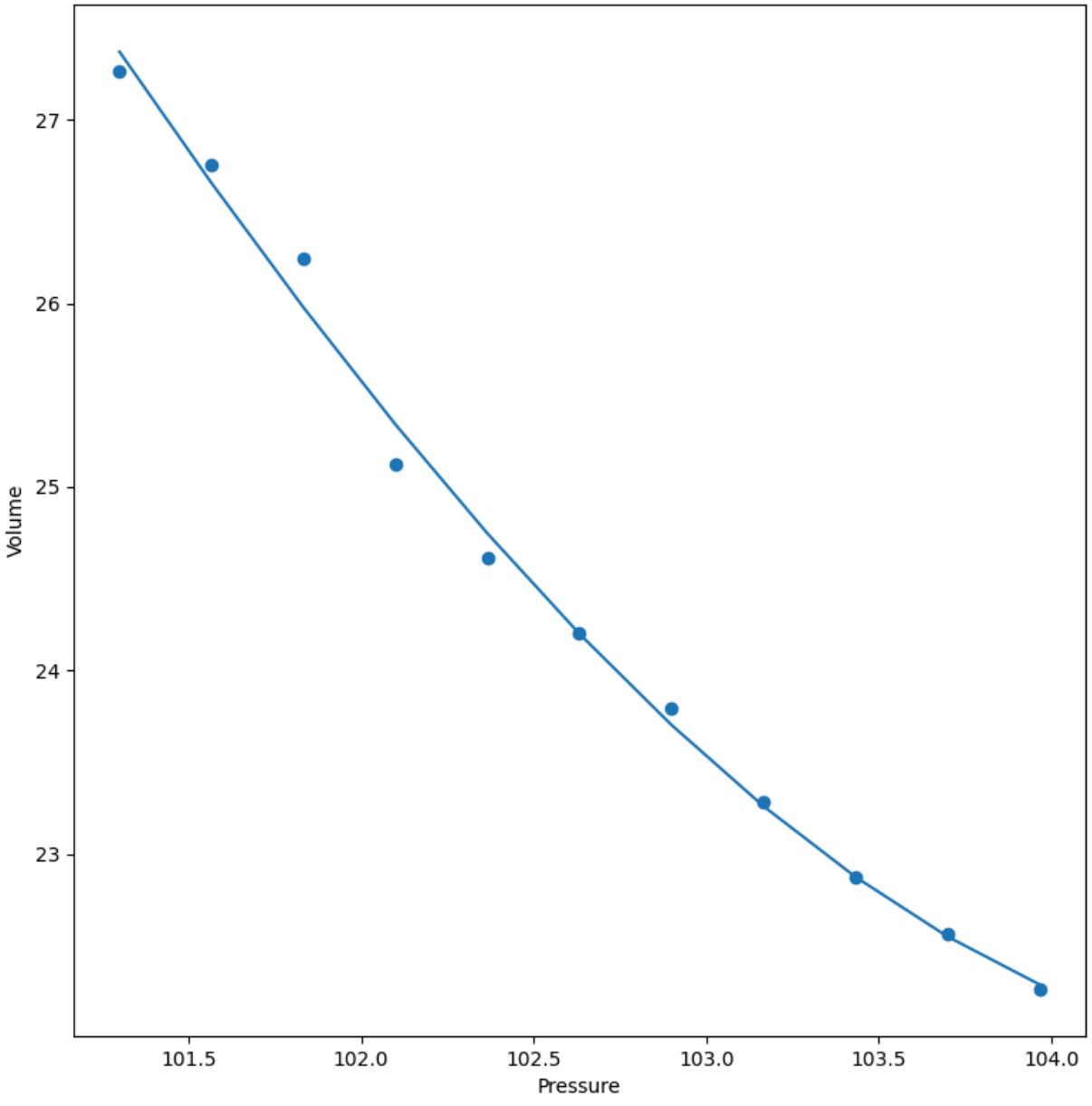
knowing the amount of gas we have, we know n=0.9536, and for the first experiment, we start with t = 30c, so we can calculate R by making use of the ideal gas law

$$PV = nRT$$

$$R = \frac{PV}{nT}$$

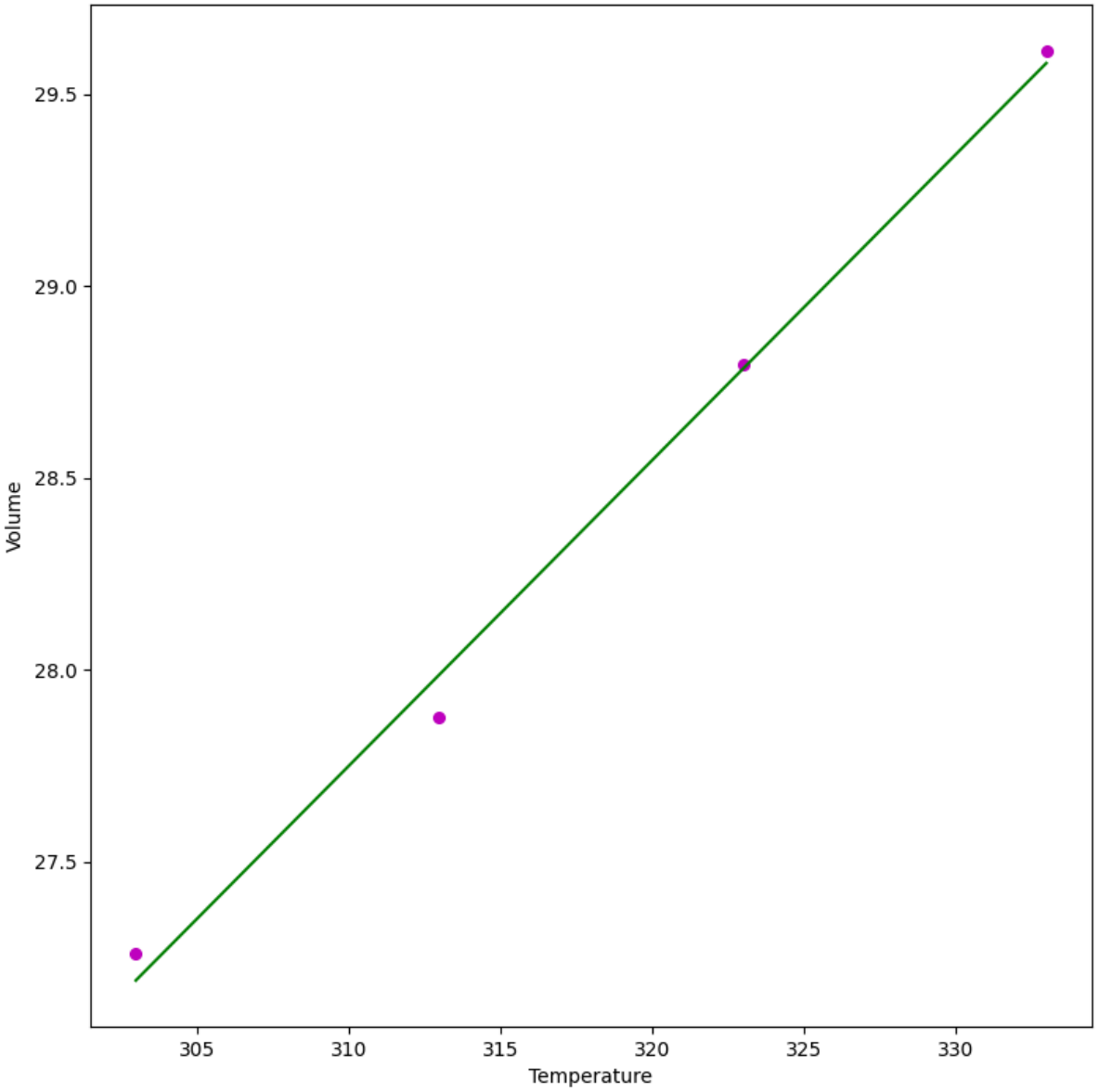
L(cm)	Δh	Volume	Pressure (kPa)	R
26.7	0	27.2	101.3	9.55
26.2	2	26.7	101.5	9.4
25.7	4	26.2	101.8	9.24

L(cm)	Δh	Volume	Pressure (kPa)	R
24.6	6	25.1	102.1	8.87
24.1	8	24.6	102.3	8.71
23.7	10	24.2	102.6	8.59
23.3	12	23.7	102.8	8.18
22.8	14	23.2	103.1	8.31
22.4	16	22.8	103.4	8.18
22.1	18	22.5	103.6	8.09
21.8	20	22.2	103.9	8.01



For the second part of the experiment, we fix the pressure and observe the volume change due to temperature difference.

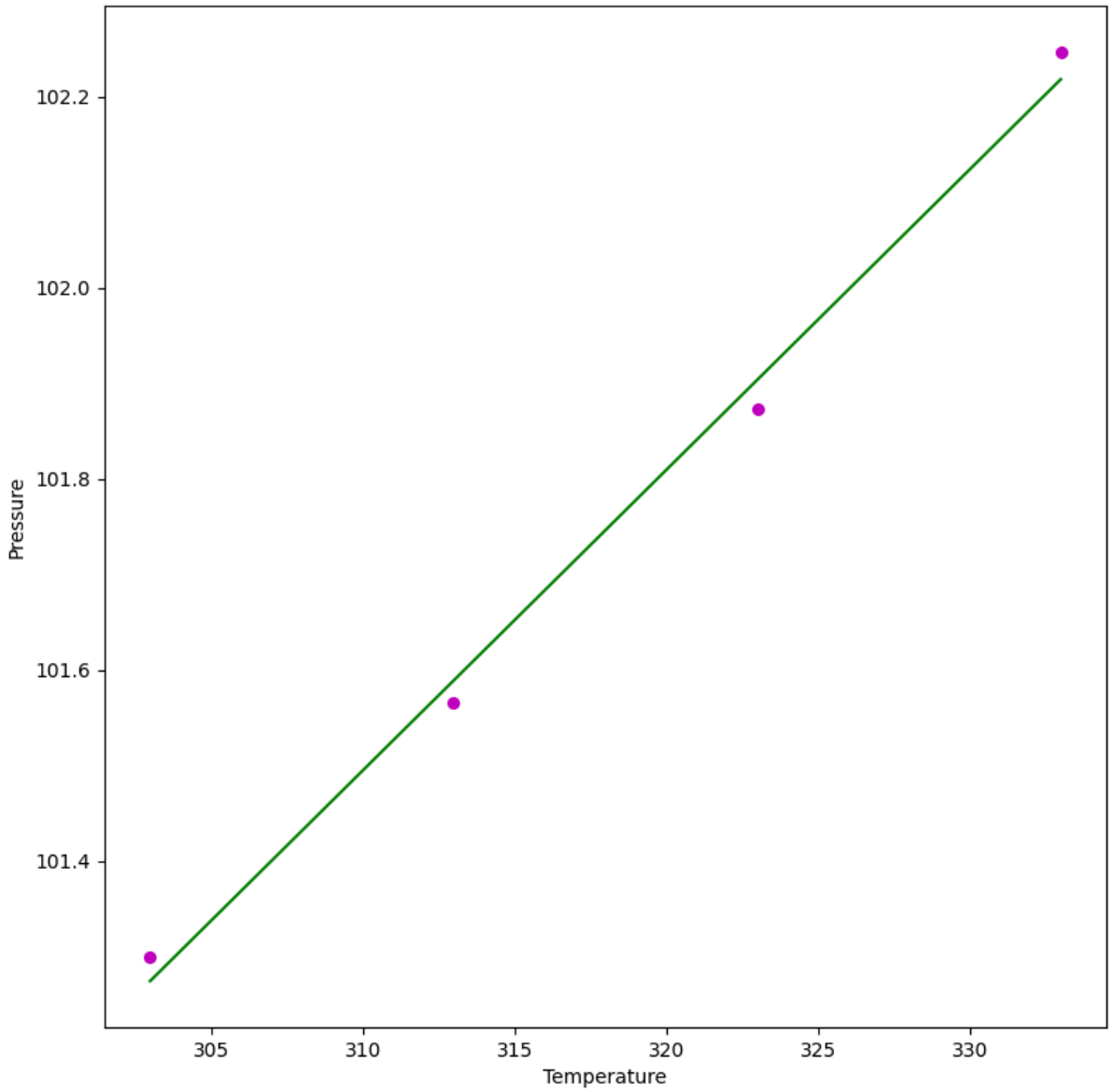
t (c)	L (cm)	V (ml)	T(k)
30	26.6	27.2	303
40	27.3	27.8	313
50	28.2	2.87	323
60	29	2.96	333



And for the third part, we fix the volume and observe the pressure difference with the temperature change.

t (c)	Δh(cm)	P (kPa)	T(k)
30	0	101.3	303
40	2	101.5	313

t (c)	Δh(cm)	P (kPa)	T(k)
50	4.3	101.8	323
60	7.1	102.2	333



Conclusion

With this experiment, we see that pressure and volume have an inverse relation with each other,

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

and both pressure and volume are porportional with temperature,

$$P, V \propto T$$

thus we can construct an equation

$$PV = kT$$

and this constant k can be expressed in terms of the amount of substance n and a constant R, as

$$PV = nRT$$

and with the observed values, we can calculate the R constant by

$$R = R_{average} \pm \Delta R$$

$$R = 8.647 \pm 0.53$$