Gases → Ideal gas Law $PV = nRT$ (where did this come from?)

equation of state – contains all info needed to describe system

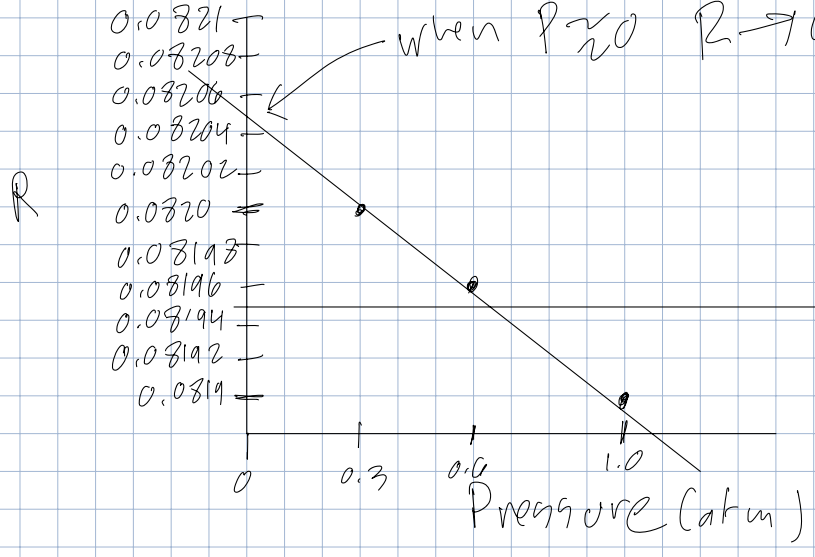
$\bar{V}$ = molar volume $= \frac{V}{n}$ commonly used

$P\bar{V} = RT \rightarrow R = \frac{P\bar{V}}{T}$ $\quad R = 0.08206 \frac{L\,atm}{mol\,K}$

P (atm)	$\bar{V}$ (L/mol) at 300.00 K
1.000	24.57
0.600	40.98
0.300	82.00

R
0.0819
0.08196
0.0820

Avg = 0.08195



as we approach $P = 0$ we approach ideal conditions

If $\frac{P\bar{V}}{T} \neq 0.08206$

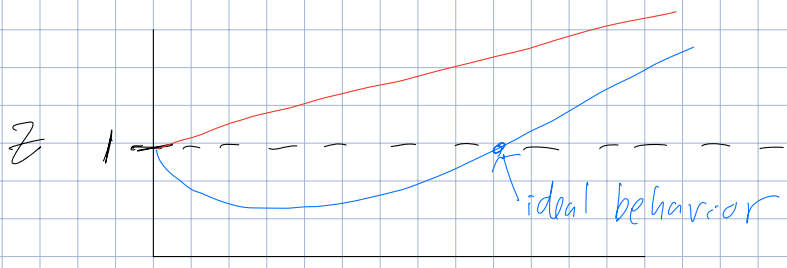
gas is not ideal

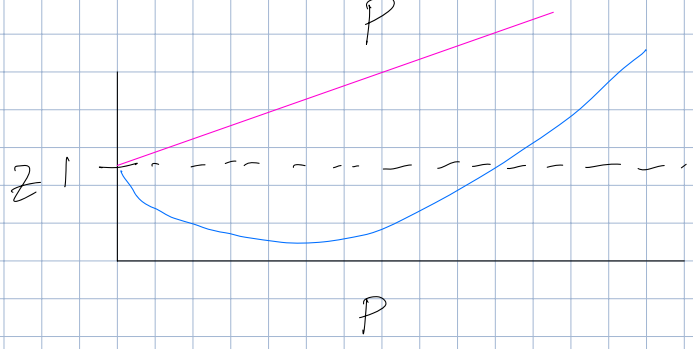
When $P > 0$ gas behavior deviates from ideal gas law behavior

$\frac{P\bar{V}}{RT}$ is called Z (compressibility)

If gas behaves ideally $Z = 1$

If $Z \neq 1$ gas is not behaving ideally





$$Z = \frac{P\bar{V}}{RT}$$

$Z = 1 \quad P\bar{V} = RT$

$Z > 1 \quad P\bar{V} > RT$

$Z < 1 \quad P\bar{V} < RT$

$Z = 1 \quad \bar{V}_{actual} = \bar{V}_{ideal}$

$Z > 1 \quad \bar{V}_{actual} > \bar{V}_{ideal}$

$Z < 1 \quad \bar{V}_{actual} < \bar{V}_{ideal}$

Why is $\bar{V}_{actual} \neq \bar{V}_{ideal}$

(1) size of molecules (IGL says infinitely small)

high pressure - lots of molecules in small volume will take up more space in reality than predicted by IGL $\bar{V}_{act} > \bar{V}_{ideal}$

(2) interactions between molecules (IGL says there are none)

- attractive interactions cause $\bar{V}_{actual} < \bar{V}_{ideal} \Rightarrow Z < 1$

  repulsive interactions causes $\bar{V}_{actual} > \bar{V}_{ideal} \Rightarrow Z > 1$