$$PV = N \cdot k_B \cdot T$$

Ideal gas:

isolated particles $\rightarrow$ atoms / $\rightarrow$ moleculars

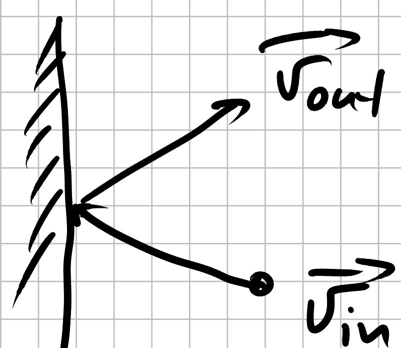
free to move

molecular interaction is seldom

all interactions are elastic

$P \leftrightarrow$ pressure

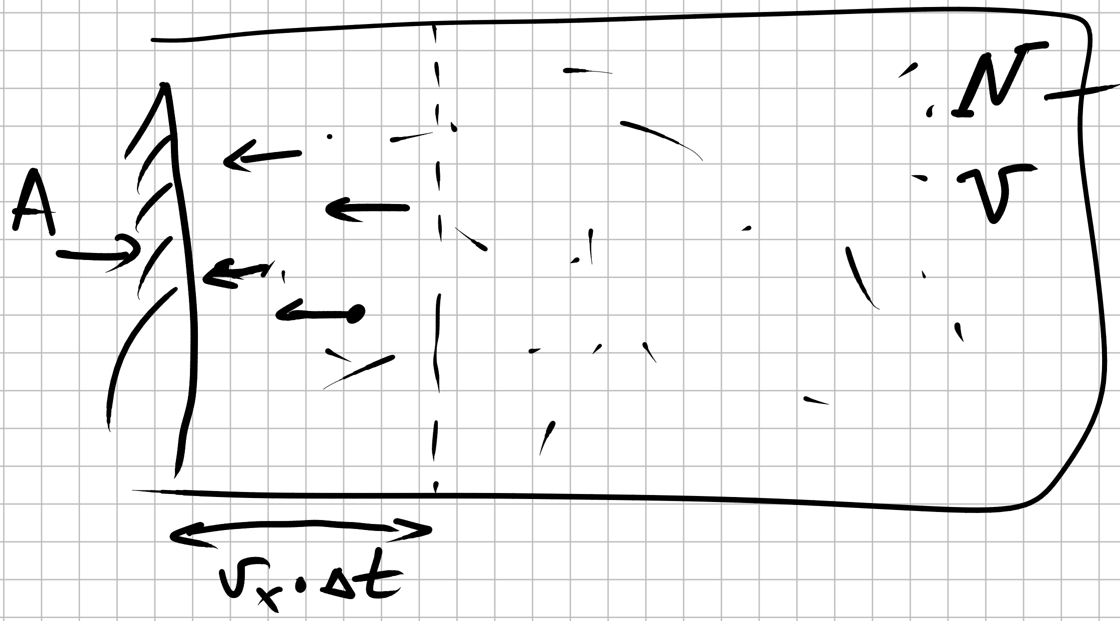
$p \leftrightarrow$ momentum



$v_{out} = v_{in}$ speed is the same

$$v_{x_{in}} = - v_{x_{out}}$$

$$P = \frac{F}{A} = \left| \frac{m\vec{v}_{out} - m\vec{v}_{in}}{\Delta t \cdot A} \right| = \frac{2 m v_x}{\Delta t \cdot A}$$



particles #

n – number density

$$n = \frac{N}{V}$$

$$N_{Hits} = A \cdot \Delta l \cdot n =$$
$$= A \cdot v_x \cdot \Delta t \cdot n$$

$$\underset{\text{all hits}}{F} = \frac{2 m v_x}{\Delta t} \cdot N_{hits} = \frac{2 m v_x}{\Delta t} \cdot A v_x \Delta t \cdot n$$

averaged

$$P = \frac{F}{A} = \frac{1}{2} \, 2 m v_x^2 \cdot n = m \langle v_x^2 \rangle \cdot \frac{N}{V}$$

only half of particles move to a given wall

$$\langle v^2 \rangle = \langle v_x^2 \rangle + \langle v_y^2 \rangle + \langle v_z^2 \rangle = 3\langle v_x^2 \rangle$$

$$P = 2\underbrace{\frac{m}{2}\frac{\langle v^2 \rangle}{3}}_{\langle E_K \rangle} \cdot \frac{N}{V}$$

$$\boxed{\begin{aligned} P &= \frac{2}{3} \cdot \frac{N}{V} \cdot \langle E_K \rangle \\ P &= \frac{N}{V} \cdot k_B T \end{aligned}} \Rightarrow \boxed{\langle E_K \rangle = \frac{3}{2} k_B T}$$

$$= \underbrace{\frac{N}{N_a}}_{n_{moles}} \frac{1}{V} \underbrace{N_a \cdot k_B}_{R} \cdot T = n_m \cdot \frac{RT}{V}$$

Boltzman distribution

probability to have $v_x \sim e^{-\frac{m v_x^2}{2 k_B T}}$

$$f(\cancel{\vec{v}}) = f(v_x, v_y, v_z) = f(v_x)\cdot f(v_y)\cdot f(v_z)\cdot dv_x dv_y dz$$

$$= e^{-\frac{m}{2}\frac{v_x^2}{k_B T}} \cdot e^{-\frac{m}{2}\frac{v_y^2}{k_B T}} \cdot e^{-\frac{m}{2}\frac{v_z^2}{k_B T}} \cdot dv_x dv_y dv_z$$

$$= e^{-\frac{m}{2 k_B T}(v_x^2 + v_y^2 + v_z^2)} = e^{-\frac{m}{2 k_B T} v^2} \underbrace{\cdot dv_x dv_y dv_z}_{4\pi v^2 dv}$$

$$\underset{\text{const}}{c}\cdot\int_0^\infty f(v)\cdot dv = 1$$

Maxwell - Boltzman distribution

$$\boxed{f(v) = 4\pi v^2 \left(\frac{m}{2\pi k_B T}\right)^{3/2} e^{-\frac{m}{2k_BT}v^2}}$$