09/01/15

Ideal Gas
① large N, moving @ random speeds
② on avg. far apart from each other
③ interact only via collision
④ perfectly elastic collisions

Chapter 18 Lecture

Pressure is a measure of force (F/A)

remember Lanzara

T↑ pushing up → V↑
moving → v↑

@0: T = 0   v = 0
P = 0

$F_x = \frac{dp_x}{dt} = \frac{d}{dt}(mv_x)$ elastic collision w/wall

$\Delta p = p_f - p_i = mv_f - mv_i$

$\Delta t = \frac{2L}{v_x}$

$v_f = -v_i$
↓
$\Delta p = 2mv_x$ (because reversed directions)

$F_x = \frac{\cancel{2}mv_x^2}{\frac{\cancel{2}L}{v_x}}$ particle goes back & forth

one particle $F_x = \frac{mv_x^2}{L}$

many particles $\langle v^2 \rangle = \langle v_x^2 \rangle + \langle v_y^2 \rangle + \langle v_z^2 \rangle$
↑ avg. velocity $(\overline{v^2})$
$= $ *ideal (all $= v_x^2$)
$= 3\langle v_x^2 \rangle$

$\therefore F = \frac{m\langle v^2 \rangle}{3L}$ $P = \frac{F}{A}$

$= \frac{m\langle v^2 \rangle}{3L^3} = \boxed{\frac{m\langle v^2 \rangle}{3V}}$

$PV = \frac{m}{3}\langle v^2 \rangle N$ ← total particles

$PV = \frac{1}{2}m\langle v^2 \rangle \cdot \frac{2N}{3}$

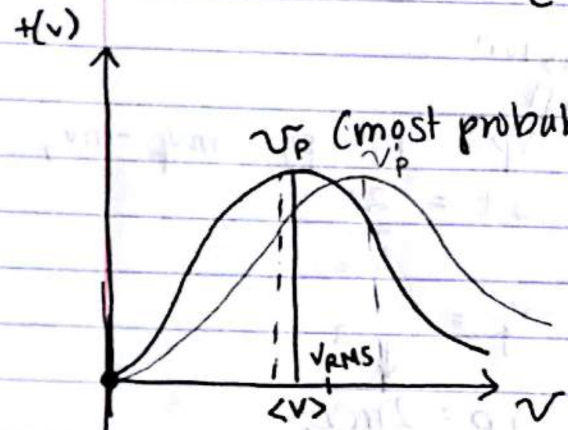
$PV = E_{Kin}\, 2N/3$

continued on next page

$$PV = \frac{2}{3} \cancel{N} E_{kin} = \cancel{N} k_B T$$

$$\boxed{E_{kin} = \frac{3}{2} k_B T}$$

$$f(v) = m^{3/2} v^2 e^{\frac{-mv^2}{2k_BT}}, \quad \int_0^\infty f(v)\,dv = N$$



avg. velocity usualey shifted to right of v_p

$$v_{rms} = \sqrt{\langle v^2 \rangle}$$

(root mean square)

, however, $v_{rms} \neq \langle v \rangle$!!

square root of square — average

$$= \sqrt{\frac{3kT}{m}}$$

big gas = less volume used

$$V_{unavalable} = nb$$

$$V_f = V_i - V_u$$

$$= (V - nb)$$

big gas = attraction = reduced container impact

$$P_{less} = \left(\frac{n}{V}\right)^2 a$$