P. Chem I

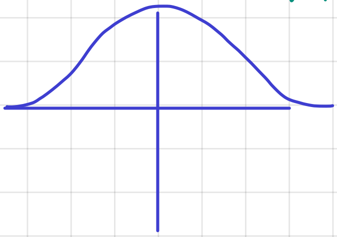
4/3/23
Monday

$P_1 = \frac{mV_{x,i}}{L_x(L_yL_z)} = \frac{mV_{x,1}}{V} \rightarrow P_{Tot} = \sum_{i=1} P_i = \frac{M}{V}\sum_{i=1} V_{x,i}$

$V^2 = \underline{V}\cdot\underline{V} = V_x^2 + V_y^2 + V_z^2 = 3V_x^2$

$P = P_{Tot} = \frac{1}{3}\frac{M}{V}\sum_{i=1}^{N} V_i^2$ define $\langle V^2\rangle = \overbrace{\frac{1}{N}}^{\text{average}}\sum_{i=1}^{N} V_i^2$

$P = \frac{1}{3}\frac{mN}{V}\langle V^2$



$\langle V_x\rangle = 0$

$\langle V\rangle = (0,0,0)$

$PV = \frac{mN\langle V^2\rangle}{3} = nRT$

$\langle V^2\rangle^{1/2} = V_{rms}$ $\langle V^2\rangle = \frac{3nRT}{mN} = \frac{3RT\ N/N_A}{N\ M/N_A} = \boxed{\frac{3RT}{M}} = \langle V^2\rangle$

A, B: ① $\langle V_x^2\rangle = \frac{RT}{M} = \frac{k_BT}{m} = \int_{-\infty}^{\infty} V_x^{2 \rightarrow 2} f(V_x)\, d_2V_x$ $k_BN_A = R$, $mN_A = M$

② $\int_{-\infty}^{\infty} f(V_x)\, dV_x = 1$

$\rightarrow f(V_x) = \left(\frac{m}{2\pi k_BT}\right)^{1/2} e^{-mV_x^2/2k_BT}$

Add in V_y, V_z

P_1 = prob. during class that Dr. Nielsen is writing on doc. camera = 0.6

P_2 = prob. Dr. Nielsen is blinking

50 min · $\frac{12\text{ blinks}}{\text{sec}}$ = $\frac{1}{3}$ s = 600 = 200 s

50min · 60sec = 3000sec $\frac{200}{3000} = 0.067$

P_3 = Prob. asking/answering a questions = 0.1

$\boxed{\text{Joint}}$ prob. that he's writing and blinking = $P_1P_2 = 0.04$ — If events are independent, you multiply. dependent, you can't

prob that he's writing and questions $\neq P_1P_3$

$$f(v_x, v_y, v_z) = f(v_x)\, f(v_y)\, f(v_z)$$

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

removed direction

want $f(x)$ where $v = (v \cdot v)^{1/2} = \sqrt{v_x^2 + v_y^2 + v_z^2}$ makes a sphere (shell)

v_x, v_y, v_z values which yield the same speed v_0, satisfy $v_x^2 + v_y^2 + v_z^2 = v_0^2$

$\frac{4}{3}\pi v_0^3$ = filled volume

↓ derivative

$4\pi v_0^2\, dv$ = shell spere

dv is thickness

$$f(x) = \left(\frac{m}{2\pi k_B T}\right)^{3/2} 4\pi v_0^2\, e^{\frac{-mv^2}{2kT}}$$ Maxwell-Boltzman

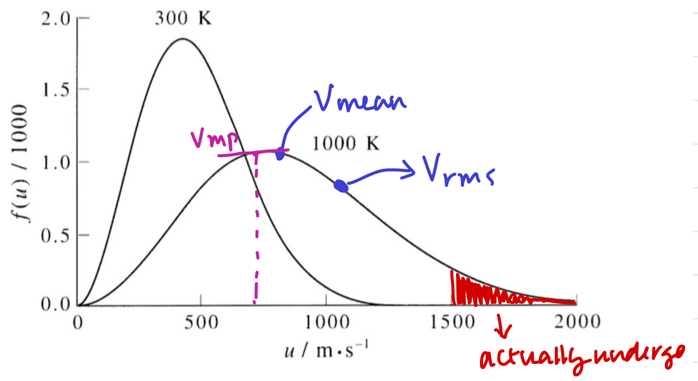


FIGURE 27.2
The distribution of molecular speeds in nitrogen at 300 K and 1000 K.

$$v_{rms} = \langle v^2 \rangle^{1/2} = \left(\int_{-\infty}^{\infty} v^2 f(x)\, dv\right)^{1/2}$$

$$= \left(\frac{3k_BT}{m}\right)^{1/2}$$

$$= 944 \text{ m/s}$$

$$k_BT = \frac{RT}{m} = \frac{8.31 \cdot 1000K}{28 \text{ g/mol}} = 2.97 \times 10^5 \frac{m^2}{s^2}$$

$$v_{mean} = \int_{-\infty}^{\infty} v f(v)\, dv = \left(\frac{8}{\pi}\frac{kT}{m}\right)^{1/2}$$

$$= 870 \text{ m/s}$$

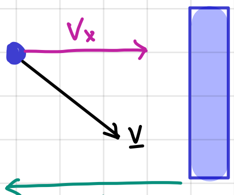
why is $v_{rms} > v_{mean}$?
enhancing big #s in v_{rms}
do we have big molecules?

v_{mp} (most probable) $= \frac{df(x)}{dv} = 0 = \left(\frac{2kT}{M}\right)^{1/2} = 770$ m/s

won't really use.

Collisions with walls:

time Δt



Collision volume : $V = A \cdot v_x \Delta t$

$d \leq v_x \Delta t,\ v_x \geq 0$

*visit this next class