# Gas Stoichiometry

ex: What volume of $H_2(g)$ is needed to make 37.8g of $NH_3$ according to eq:

p = 8700. mmHg, t = 183°C

$$N_2(g) + 3H_2(g) \longrightarrow 2NH_3(g)$$

(2) coeff.: ? mol $H_2$ ← ? mol $NH_3$

(1) ↑ molar mass $NH_3$: 37.8g $NH_3$

(3) $pV = nRT$ → $V = \frac{nRT}{P}$ → volume?

$NH_3$

1×N = 14.01

3×H = 3×1.008

17.039/mol

$$37.8\text{g } NH_3 \times \frac{1\text{mol } NH_3}{17.03\text{g } NH_3} \times \frac{3\text{mol } H_2}{2\text{mol } NH_3} = 3.33\text{mol } H_2$$

(1) (2)

$$R = 0.08206 \frac{\text{atm}\cdot\text{L}}{\text{mol}\cdot\text{K}} \qquad 8700.\text{mmHg} \times \frac{1\text{atm}}{760\text{mmHg}} = 11.45\text{atm}.$$

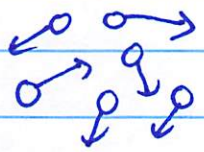
$$T = 183 + 273.15 = 456\text{K}$$

$$V = \frac{nRT}{P} = \frac{3.33\text{mol} \times 0.08206 \frac{\text{atm}\cdot\text{L}}{\text{mol}\cdot\text{K}} \times 456\text{K}}{11.45\text{atm}}$$

$$= 10.9\text{ L}$$

# Kinetic Molecular Theory (KMT)

gases: particles in constant, chaotic motion.



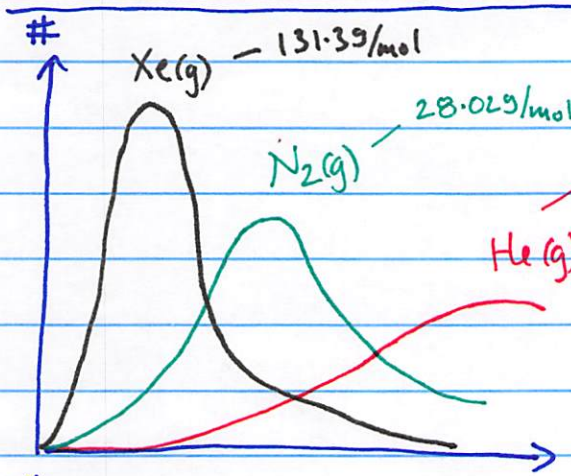
Kinetic energy ∝ temp (K)
due to motion

Collisions between particles are elastic

Distance between particles is large

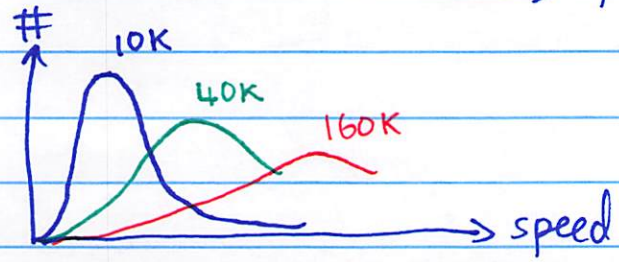
- See molecular animation on website

## Maxwell - Boltzman distribution




$KE = \frac{1}{2} m \cdot v^2$

av'g speed (RMS) $= \sqrt{\frac{3RT}{M}}$



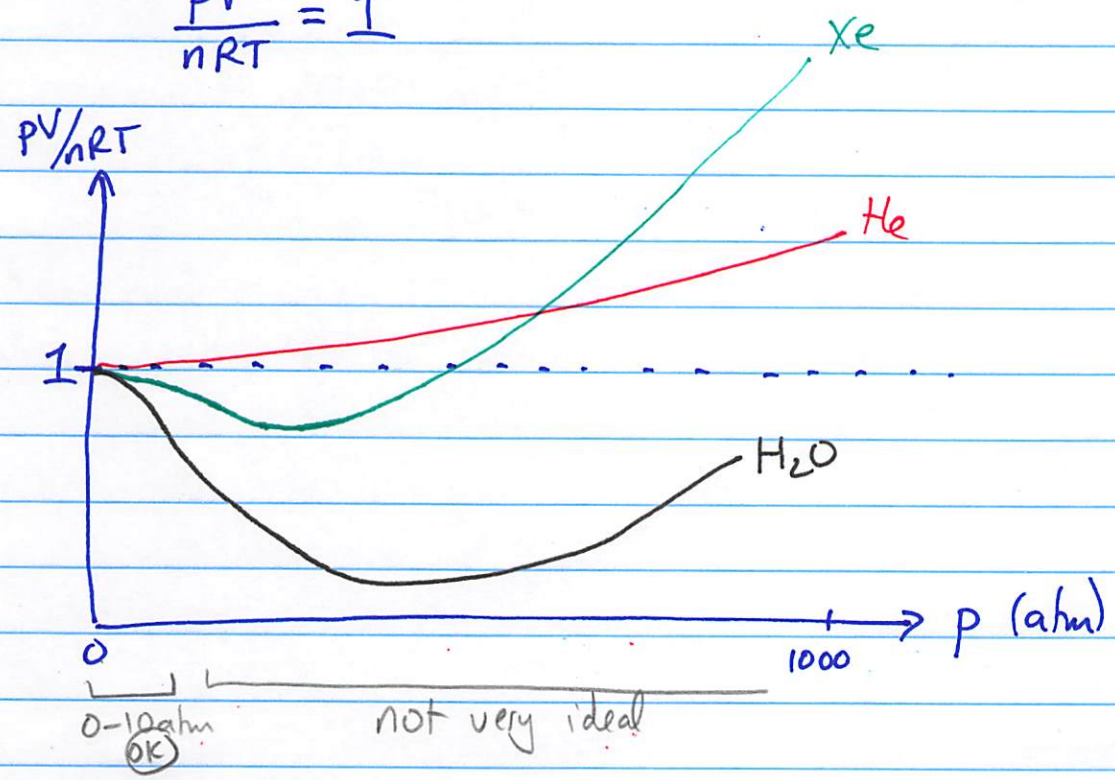
# Real Gases

if gases were ideal, they would perfectly obey

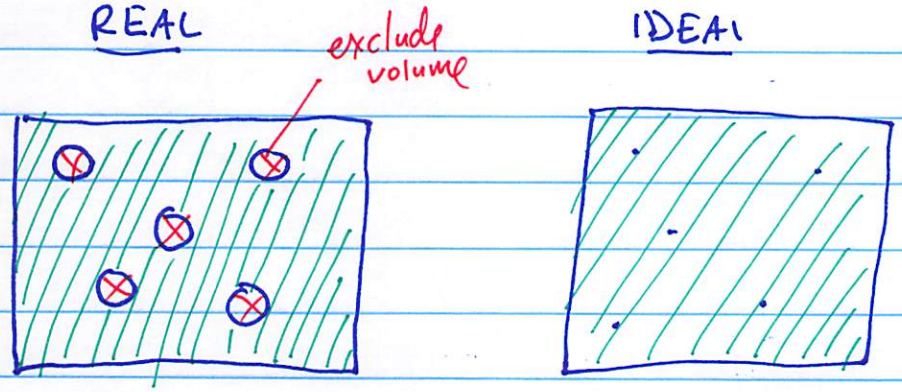
$$pV = nRT$$

then:

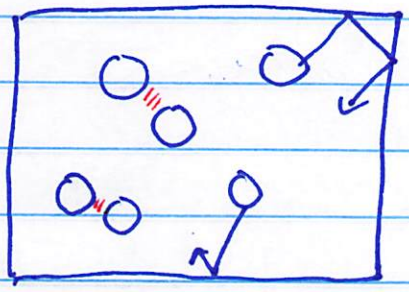
$$\frac{PV}{nRT} = 1$$




WHY?

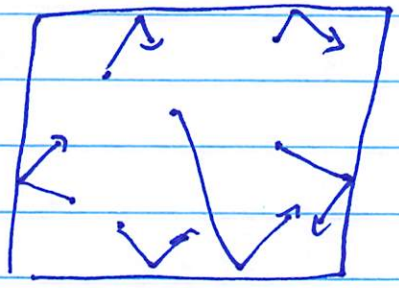


REAL



molecules attract one another...
get a diff't p!
(intermolecular forces)
IMF

IDEAL



no attractions

van der Waals eq: (ideal: $pV = nRT$)

$$\left(p + \frac{an^2}{V^2}\right)\left(V - nb\right) = nRT$$

"attraction" between molecules

size of molecules