- finish balloon.

**Gas Density**

\[
D = \frac{\text{mass}}{\text{volume}}
\]

\[
\text{MW (M)} = \frac{\text{mass}}{\text{mole}} = \frac{m}{n}, \quad n = \frac{m}{M}
\]

\[
P = \frac{nRT}{V}
\]

\[
\Rightarrow \quad \frac{m}{V} = \frac{PM}{RT} = D
\]

**Molar mass of a gas:**

Solve for \( M \):

\[
\frac{PV}{M} = \frac{mRT}{M} \quad \Rightarrow \quad M = \frac{mRT}{PV}
\]

- \( m \): weight \( \text{M} \) mass then weigh w/g.
- \( R \): \( \text{const} \)
- \( T \): \( \text{temp} \)
- \( P \): \( \text{pressure (known)} \)
- \( V \): \( \text{known volume of the container} \)

5.5 **Gas Stoichiometry**

\( PV = nRT \) is just another offramp for mole superhighway: \( n = \frac{PV}{RT} \)

What mass of solid \( \text{NH}_4\text{Cl} \) is formed when 73.0 g of \( \text{NH}_3 \) mixed with equal mass of \( \text{HCl} \)?

\[
\text{NH}_3 + \text{HCl} \rightarrow \text{NH}_4\text{Cl}
\]

\[
\frac{73.0 \text{g} \text{NH}_3}{17.03 \text{g} \text{mol} \text{NH}_3} = 4.2866 \text{ mol NH}_3
\]

\[
\frac{73.0 \text{g} \text{HCl}}{36.46 \text{g} \text{mol} \text{HCl}} = 2.0022 \text{ mol HCl}
\]
NH₃ is leftover

\[ 2 \text{ mol RXN} \rightarrow 1 \text{ mol NH₃} \quad \text{5.3397 g NH₃} = 107. \text{ g NH₃} \]

What volume of gas remains @ 140°C & 752 mmHg

\[ PV = nRT, \quad V = \frac{nRT}{P} = \frac{(4.3866 \text{ mol NH₃} \cdot 2.002 \text{ mol RXN})(0.0821 \text{ atm} \cdot \text{L} \cdot \text{mol}^{-1} \cdot \text{K}^{-1}) (273.15 + 140)}{(752 \text{ mmHg}) (\frac{1 \text{ atm}}{100 \text{ mmHg}})} \]

\[ = 54.43 \text{ L} \]

\[ n? = 32.4 \text{ L/mol}, \quad \text{and yes} \checkmark \]

**Henry's Law: Gas Solubility**

How does a gas exert pressure?

- gas molecules are zooming around & hit the wall, bouncing off
- puts a force on the wall.

\[ PV = nRT, \quad P = \frac{nRT}{V} \]

- more moles \( \rightarrow \) more dances \( \rightarrow \) up
- high temp \( \rightarrow \) faster zooming \( \rightarrow \) faster dances \( \rightarrow \) up
- high volume \( \rightarrow \) less time hitting wall \( \rightarrow \) fewer dances \( \rightarrow \) down
- \( R \): could be calculated from mass of molecules & stuff
One concept that arises from this is that each gas molecule exerts its own pressure.

Or, for a given substance gas, each one exerts its own pressure.

→ For mixtures, we get Dalton's Law of Partial Pressures.

→ \( P_{\text{Total}} = P_{\text{gas}1} + P_{\text{gas}2} + \ldots \)

with gases \( A, B \):

\[ P_T = P_A + P_B \]

\[ \begin{align*}
P_A &= 50 \text{ mm Hg} \\
P_B &= 50 \text{ mm Hg}
\end{align*} \]

→ same volume

\[ P = 100 \text{ mm Hg} = P_A + P_B \]

\[ P_T = P_A + P_B \]

\[ P_A = \frac{n_A RT}{V}, \quad P_B = \frac{n_B RT}{V} \]

\[ P_T = \frac{n_A RT}{V} + \frac{n_B RT}{V} \]

\[ = \left( \frac{n_A + n_B}{V} \right) \cdot \frac{RT}{V} \]

\[ n_{\text{tot}} = n_A + n_B \]

\[ P_T = \frac{n_T RT}{V} \]
What about fraction of a given gas?

\[ \frac{P_A}{P_T} \times 100\% \] would be percent from the mixture

\[ \rightarrow \text{percent by moles} \]

When we do fractional moles, we don't do %:

\[ \text{mole fraction}(X) \text{ from 0.000 \rightarrow 1.000, represents mole of A subst \over total moles} \]

\[ X_A = \frac{n_A}{n_T} = \frac{n_A}{n_A + n_B} \]

San Dalton:

\[ \frac{P_A}{P_T} = \left( \frac{n_A}{n_A + n_B} \right) \left( \frac{RT}{X} \right) = \frac{n_A}{n_T} = \frac{n_A}{n_A + n_B} \]

Humid Air

Water is partially a gas at normal temperatures

Water vapor ranges from 4.58 mmHg @90°C into 760 mmHg @100°C

\[ \rightarrow \text{This is def. of boiling point where vapor pressure of} \]

\[ \text{a subst. is equal to atm.} \]

\[ \rightarrow \text{If we collect gas above water, we need to account for H}_2\text{O. \ see figure in book (HINT HINT)} \]