Mixtures of Gases and Partial Pressures

$\underbrace{\text{Partial Pressures}}$ Pressure of any individual gas in a mixture of gases

Dalton's Law of Partial Pressures

Air - N_2 78%
O_2 21%
$\left.\begin{matrix} CO_2 \\ H_2O \end{matrix}\right\}$ 1%

$P_{Total} = P_{N_2} + P_{O_2} + P_{CO_2} + P_{H_2O}$

– 0.188 mol of gas A and 0.563 mol of gas B are placed in a 15.0 L vessel at 0°C. Calculate the total pressure inside the vessel.

$$P_A = \frac{0.188\ mol \cdot 0.08206\ Latm/Kmol \cdot 273.15\ K}{15\ L}$$

$$P_B = \frac{0.563\ mol \cdot 0.08206\ Latm/Kmol \cdot 273.15\ K}{15\ L}$$

$$P_{Total} = (0.188 + 0.563)\,mol \cdot \frac{0.08206\ Latm/Kmol \cdot 273.15\ K}{15\ L}$$

$= 1.12\ atm$

Water Vapor

$H_2O(l) \rightleftharpoons H_2O(g)$

Equilibrium

$P^*_{H_2O}$ - Vapor pressure of water at equilibrium

Relative humidity - $\frac{P_{H_2O}}{P^*_{H_2O}}$

100% when $P_{H_2O} = P^*_{H_2O}$

Gas Laws and Stoichiometry

Consider the thermal decomposition of sodium bicarbonate:

$$2\ NaHCO_3\ (s) \rightarrow Na_2CO_3\ ([redacted]\ s) + CO_2\ (g) + H_2O\ (g)$$

Calculate the mass of solid $NaHCO_3$ (84.01 g/mol) required to produce enough CO_2 gas and H_2O vapor to occupy a total volume of **11.8 L** at **25°C** and **1 atm** pressure.

V   T=298.15K   P

Step 1- Calculate moles

$$n = \frac{PV}{RT} = \frac{1\,atm \cdot 11.8L}{0.08206\ Latm/Kmol \cdot 298.15K} = 0.48\ mol\ CO_2,\ H_2O$$

Gas Laws and Stoichiometry

Step 2- Calculate moles of $NaHCO_3$

$$0.48\ mol \cdot \frac{1\ CO_2}{2\ CO_2 + H_2O} \cdot \frac{2\ NaHCO_3}{1\ CO_2} = 0.48\ mol\ NaHCO_3$$

Step 3- Calculate mass of $NaHCO_3$

$$0.48\ mol\ NaHCO_3 \cdot \frac{84.01g}{1\ mol} = 40.5g\ NaHCO_3$$

[redacted]