

Mixtures of Gases and Partial Pressures

Pressure of any individual gas in a mixture of gases

Dalton's Law of Partial Pressures

Air - N₂ 78% P_{Total} = P_{N₂} + P_{O₂} + P_{CO₂} + P_{H₂O}
 O₂ 21%
 CO₂ } 1%
 H₂O }

- 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.

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

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

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

$$= 1.12 \text{ atm}$$

Water Vapor



Equilibrium

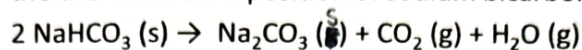
$P_{\text{H}_2\text{O}}^*$ - Vapor pressure of water at equilibrium

$$\text{Relative humidity} = \frac{P_{\text{H}_2\text{O}}}{P_{\text{H}_2\text{O}}^*}$$

100% when $P_{\text{H}_2\text{O}} = P_{\text{H}_2\text{O}}^*$

Gas Laws and Stoichiometry

Consider the thermal decomposition of sodium bicarbonate:



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.

$V = 11.8 \text{ L}$ $T = 298.15 \text{ K}$ $P = 1 \text{ atm}$

Step 1- Calculate moles

$$n = \frac{PV}{RT} = \frac{1 \text{ atm} \cdot 11.8 \text{ L}}{0.08206 \text{ L atm / K mol} \cdot 298.15 \text{ K}} = 0.48 \text{ mol CO}_2, \text{H}_2\text{O}$$

Gas Laws and Stoichiometry

Step 2- Calculate moles of NaHCO_3

$$0.48 \text{ mol} \cdot \frac{1 \text{ CO}_2}{2 \text{ CO}_2 + \text{H}_2\text{O}} \cdot \frac{2 \text{ NaHCO}_3}{1 \text{ CO}_2} = 0.48 \text{ mol NaHCO}_3$$

Step 3- Calculate mass of NaHCO_3

$$0.48 \text{ mol NaHCO}_3 \cdot \frac{84.01 \text{ g}}{1 \text{ mol}} = 40.5 \text{ g NaHCO}_3$$

~~Step 4~~