

Gases Cont.

What is the equation for density of a gas?

$$\text{Density} = \frac{\text{molar mass} \times \text{Pressure}}{R T}$$

What is the equation for molar mass of a gas?

$$\text{molar mass} = \frac{(\text{Density}) R T}{P}$$

What is the density of carbon tetrafluoride vapor at 914 torr and 137°C?

$$P = 914 \text{ torr} \sim 1.20 \text{ atm}$$

$$T = 137^\circ\text{C} \sim 410 \text{ K}$$



$$D = \frac{m \times P}{R T}$$

$$= \frac{(48.003 \text{ g/mol}) (1.20 \text{ atm})}{(0.08206 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}}) (410 \text{ K})}$$

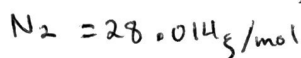
$$\frac{914 \text{ torr}}{760 \text{ torr}} \times 1 \text{ atm} = 1.20 \text{ atm}$$

$$= \boxed{3.14 \text{ g/L}}$$

Calculate the density of nitrogen gas at 23°C and at a pressure of 864 torr.

$$T = 23^\circ\text{C} \sim 296 \text{ K}$$

$$P = 864 \text{ torr} \sim 1.137 \text{ atm}$$



$$D = \frac{(28.014 \text{ g/mol}) (1.137 \text{ atm})}{(0.08206 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}}) (296 \text{ K})}$$

$$\frac{864 \text{ torr}}{760 \text{ torr}} \times 1 \text{ atm} = 1.137 \text{ atm}$$

$$= \boxed{1.3 \text{ g/L}}$$

A gas sample at 325 K has a mass of 12.5g. Calculate the molar mass of the gas which is confined in a 4.0 L tank at a pressure of 550 mmHg.

$$T = 325 \text{ K}$$

$$m = 12.5 \text{ g}$$

$$V = 4.0 \text{ L}$$

$$P = 550 \text{ mmHg} \sim 0.724 \text{ atm}$$

$$m = \frac{D R T}{P}$$

$$D = \frac{m}{V} = \frac{12.5 \text{ g}}{4.0 \text{ L}} = 3.125 \text{ g/L}$$

$$\frac{550 \text{ mmHg}}{760 \text{ mmHg}} \times 1 \text{ atm} = 0.724 \text{ atm}$$

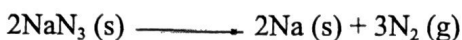
$$m = \frac{(3.125 \text{ g/L}) (0.08206 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}}) (325 \text{ K})}{0.724 \text{ atm}}$$

$$= \boxed{1.2 \times 10^2 \text{ g/mol}}$$

Volume is 46 L and nitrogen gas is at 2.35 atm and 33.0°C. How many grams of NaN₃ must be decomposed?

$$\begin{aligned} V &= 46 \text{ L} \\ P &= 2.35 \text{ atm} \\ T &= 33.0^\circ\text{C} \sim 306 \text{ K} \end{aligned} \left. \vphantom{\begin{aligned} V &= 46 \text{ L} \\ P &= 2.35 \text{ atm} \\ T &= 33.0^\circ\text{C} \sim 306 \text{ K} \end{aligned}} \right\} \text{N}_2$$

g NaN₃ = ?



$$1) \quad \frac{PV}{RT} = \frac{nRT}{RT} \quad n = \frac{PV}{RT} \quad n = \frac{(2.35 \text{ atm})(46 \text{ L})}{(0.08206 \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}})(306 \text{ K})} = 4.305 \text{ mol N}_2$$

$$2) \quad \begin{array}{c|c|c} 4.305 \text{ mol N}_2 & 2 \text{ mol NaN}_3 & 65.011 \text{ g NaN}_3 \\ \hline & 3 \text{ mol N}_2 & 1 \text{ mol NaN}_3 \end{array} = 1.9 \times 10^2 \text{ g NaN}_3$$

How many liters of NH₃ (g) at 760°C and 3.00 atm are required to react with 2.00 mol of O₂ (g) in this reaction?



$$\begin{aligned} V &= ? \\ P &= 3.00 \text{ atm} \\ T &= 760^\circ\text{C} \sim 1033 \text{ K} \end{aligned} \left. \vphantom{\begin{aligned} V &= ? \\ P &= 3.00 \text{ atm} \\ T &= 760^\circ\text{C} \sim 1033 \text{ K} \end{aligned}} \right\} \text{NH}_3$$

$n = 2.00 \text{ mol O}_2$

$$1) \quad \begin{array}{c|c} 2.00 \text{ mol O}_2 & 4 \text{ mol NH}_3 \\ \hline & 5 \text{ mol O}_2 \end{array} = 1.6 \text{ mol NH}_3$$

$$2) \quad PV = nRT \quad V = \frac{nRT}{P} = \frac{(1.6 \text{ mol})(0.08206 \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}})(1033 \text{ K})}{3.00 \text{ atm}} = 45 \text{ L NH}_3$$

What is the volume of 5.50 mol of argon gas at STP?

$$\rightarrow 1 \text{ mol} = 22.4 \text{ L}$$

$$\begin{array}{c|c} 5.50 \text{ mol Ar} & 22.4 \text{ L} \\ \hline & 1 \text{ mol} \end{array} = 123 \text{ L Ar}$$

8.45g of magnesium carbonate decomposes into carbon dioxide and magnesium oxide. What is the volume of CO_2 gas at STP?



8.45g MgCO_3	1 mol MgCO_3	1 mol CO_2	22.4L	=	2.24L CO_2
	84.313g MgCO_3	1 mol MgCO_3	1 mol CO_2		

What is Dalton's Law of partial pressures?

$$P_t = P_1 + P_2 + P_3 + \dots$$

What is the equation for finding mole fraction?

$$\text{mole fraction} = \frac{\text{part mol}}{\text{total mol}}$$

A mixture of 4.5% H_2 , 76% O_2 , and 19.5% N_2 has a total pressure of 2.3 atm. What is the partial pressure of hydrogen gas, oxygen gas, and nitrogen gas?

$$n_{\text{H}_2} = 4.5\% \rightarrow 0.045 \text{ mol } \text{H}_2$$

$$P_{\text{H}_2} = \left(\frac{n_{\text{H}_2}}{n_t} \right) P_t = \left(\frac{0.045 \text{ mol}}{1 \text{ mol}} \right) (2.3 \text{ atm})$$

$= 0.10 \text{ atm } \text{H}_2$

$$n_{\text{O}_2} = 76\% \rightarrow 0.76 \text{ mol } \text{O}_2$$

$$P_{\text{O}_2} = \left(\frac{0.76 \text{ mol}}{1 \text{ mol}} \right) (2.3 \text{ atm})$$

$= 1.7 \text{ atm } \text{O}_2$

$$n_{\text{N}_2} = \frac{19.5\%}{100\%} \rightarrow \frac{0.195 \text{ mol } \text{N}_2}{1.00 \text{ mol}}$$

$$P_{\text{N}_2} = \left(\frac{0.195 \text{ mol}}{1 \text{ mol}} \right) (2.3 \text{ atm})$$

$= 0.45 \text{ atm } \text{N}_2$

What is the total pressure exerted by a mixture of 5.00 g of H_2 (g) and 8.00 g of N_2 (g) at 273 K in a 15.0 L vessel?

$$m = 5.00 \text{ g } H_2$$

$$m = 8.00 \text{ g } N_2$$

$$T = 273 \text{ K}$$

$$V = 15.0 \text{ L}$$

$$\frac{5.00 \text{ g } H_2}{2.016 \text{ g } H_2} \times 1 \text{ mol } H_2 = 2.48 \text{ mol } H_2$$

$$\frac{8.00 \text{ g } N_2}{28.014 \text{ g } N_2} \times 1 \text{ mol } N_2 = 0.286 \text{ mol } N_2$$

$$PV = nRT \Rightarrow P = \frac{nRT}{V}$$

$$P_{H_2} = (2.48 \text{ mol}) (0.08206) (273 \text{ K})$$

$$\frac{15.0 \text{ L}}{= 3.70 \text{ atm } H_2}$$

$$P_{\text{total}} = 3.70 \text{ atm } H_2 + 0.427 \text{ atm } N_2$$

$$= \boxed{4.13 \text{ atm}}$$

$$P_{N_2} = \frac{(0.286 \text{ mol}) (0.08206) (273 \text{ K})}{15.0 \text{ L}}$$

$$= 0.427 \text{ atm } N_2$$

What are the five parts to the Kinetic-Molecular Theory?

- 1) Gases move in continuous, random motion
- 2) Combined volume of the gas molecules is negligible compared to the total volume of the container
- 3) Gases don't ~~have~~ have forces on each other (no attract or repulsive forces)
- 4) Average kinetic energy of the gas molecules does not change if temp is constant (energy transferred b/w molecules during collisions)
- 5) Average kinetic energy of the gas molecules is proportional (related) to the temp

What size molecules will have a greater speed; small or large molecules?

Small molecules