Answer key

11/17/25

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?

$$\text{molar mass} = \frac{(\text{Density})\,RT}{P}$$

$R = 0.08206 \frac{L \cdot atm}{mol \cdot K}$

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

$P = 914$ torr ~ 1.20 atm

$T = 137°C \sim 410K$

CF_4

$$D = \frac{mm \times P}{RT} = \frac{(88.003 g/1 mol)(1.20\ atm)}{\left(0.08206 \frac{L \cdot atm}{mol \cdot K}\right)(410K)}$$

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

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

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

$T = 23°C \sim 296K$

$P = 864$ torr ~ 1.137 atm

$N_2 = 28.014 g/mol$

$$D = \frac{(28.014 g/1 mol)(1.137\ atm)}{\left(0.08206 \frac{L \cdot atm}{mol \cdot K}\right)(296K)}$$

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

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

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.

$T = 325K$

$m = 12.5g$

$V = 4.0L$

$P = 550$ mmHg ~ 0.724 atm

$$mm = \frac{DRT}{P}$$

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

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

$$mm = \frac{(3.125 g/L)\left(0.08206 \frac{L \cdot atm}{mol \cdot K}\right)(325K)}{0.724\ atm}$$

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

Volume is 46 L and nitrogen gas is at 2.35atm and 33.0°C. How many grams of NaN_3 must be decomposed?

$$2NaN_3\,(s) \longrightarrow 2Na\,(s) + 3N_2\,(g)$$

$V = 46\,L$
$P = 2.35\,atm$ } N_2
$T = 33.0°C \approx 306\,K$
$g\ NaN_3 = ?$

1) $\frac{PV}{RT} = \frac{nRT}{RT}$ $\quad n = \frac{PV}{RT}$ $\quad n = \frac{(2.35\,atm)(46\,L)}{\left(0.08206\,\frac{L\cdot atm}{mol\cdot K}\right)(306\,K)}$

$= 4.305\ mol\ N_2$

2) $\frac{4.305\,mol\,N_2}{} \left| \frac{2\ mol\ NaN_3}{3\ mol\ N_2} \right| \frac{65.011\ g\ NaN_3}{1\ mol\ NaN_3} = \boxed{1.9\times10^{2}\ g\ NaN_3}$

How many liters of NH_3 (g) at 760°C and 3.00 atm are required to react with 2.00 mol of O_2 (g) in this reaction?

$$4NH_3\,(g) + 5O_2\,(g) \longrightarrow 4\,NO\,(g) + 6H_2O\,(g)$$

$V = ?$
$P = 3.00\,atm$ } NH_3
$T = 760°C \approx 1033\,K$
$n = 2.00\ mol\ O_2$

1) $\frac{2.00\,mol\ O_2}{} \left| \frac{4\ mol\ NH_3}{5\ mol\ O_2} \right. = 1.6\ mol\ NH_3$

2) $PV = nRT$

$V = \frac{nRT}{P} = \frac{(1.6\,mol)\left(0.08206\,\frac{L\cdot atm}{mol\cdot K}\right)(1033\,K)}{3.00\,atm}$

$= \boxed{45\,L\ NH_3}$

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

→ 1 mol = 22.4 L

$\frac{5.50\ mol\ Ar}{} \left| \frac{22.4\ L}{1\ mol} \right. = \boxed{123\,L\ Ar}$

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

$$MgCO_3\ (s) \longrightarrow CO_2\ (g) + MgO\ (s)$$

8.45g $MgCO_3$	1 mol $MgCO_3$	1 mol CO_2	22.4L	
	84.313g $MgCO_3$	1 mol $MgCO_3$	1 mol CO_2	= $\boxed{2.24L\ CO_2}$

What is Dalton's Law of partial pressures?

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

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?

$n_{H_2} = 4.5\% \rightarrow 0.045$ mol H_2

$n_{O_2} = 76\% \rightarrow 0.76$ mol O_2

$n_{N_2} = \frac{19.5\%}{100\%} \rightarrow \frac{0.195 \text{ mol } N_2}{1.00 \text{ mol}}$

$$P_{H_2} = \left(\frac{n_{H_2}}{n_t}\right)P_t = \left(\frac{0.045\text{mol}}{1\text{ mol}}\right)(2.3\text{atm})$$

$$= \boxed{0.10\text{ atm } H_2}$$

$$P_{O_2} = \left(\frac{0.76\text{ mol}}{1\text{ mol}}\right)(2.3\text{atm})$$

$$= \boxed{1.7\text{atm } O_2}$$

$$P_{N_2} = \left(\frac{0.195\text{ mol}}{1\text{ mol}}\right)(2.3\text{atm})$$

$$= \boxed{0.45\text{ atm } N_2}$$

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?

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

$n = 5.00g\ H_2$

$n = 8.00g\ N_2$

$T = 273K$

$V = 15.0L$

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

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

$P\ H_2 = \frac{(2.48mol)(0.08206)(273K)}{15.0L}$

$= 3.70\ atm\ H_2$

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

$= 0.427\ atm\ N_2$

$P_t = 3.70\ atm\ H_2 + 0.427\ atm\ N_2$

$= \boxed{4.13\ atm}$

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 ~~mak~~ 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