Gas Stoichiometry & Dalton's Law of Partial Pressure

Example

- $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4\ H_2O$
- What volume of oxygen gas is needed for the complete combustion of 4.00 L C_3H_8?

Another Example

- How many g of CaH_2 are required to generate 25.0 L of H_2 at STP?
- $CaH_2 + 2H_2O \rightarrow Ca(OH)_2 + 2H_2$

What if you are NOT at STP?

- If you are not at STP, you MUST use your equations
- You MUST look to make sure you are using the right units (including the right gas)

Example

- $N_2 + 3H_2 \rightarrow 2NH_3$
- If 5.00 L of N_2 react completely at 3.00 atm and 298 K, how many grams of ammonia are produced?

Dalton's Law of Partial Pressure

- The total pressure of a mixture of gases = the sum of the pressures that each gas would exert if present alone.
- $P_T = P_1 + P_2 + P_3 + \ldots$
- Also,
- $n_T = n_1 + n_2 + n_3 + \ldots$

Dalton's Law of Partial Pressure

$P_T V = (n_T)RT$

$P_1 V = (n_1)RT$

Example

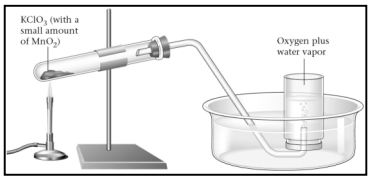
- A gaseous mixture is made from 6.00 g O_2 and 9.00 g CH_4 in a 15.0 L vessel at 273 K. What is the partial pressure of each gas?

Try this example

- What is the total pressure exerted by a mixture of 2.00 g of hydrogen gas ans 8.00 g of nitrogen gas at 273 K in a 10.0 L vessel?

Collecting Gases Over Water

- In chemistry it is often necessary to determine the number of moles of a gas generated in a chemical reaction.
- We do this by water displacement



Total Pressure

- $P_T = P_{gas} + P_{water\ vapor}$
- The pressure of the water vapor can be looked up in a chart in appendix B

Temperature, °C	Pressure, mmHg	Temperature, °C	Pressure, mmHg
0	4.6	27	26.7
5	6.5	28	28.3
10	9.2	29	30.0
11	9.8	30	31.8
12	10.5	35	42.2
13	11.2	40	55.3
14	12.0	45	71.9
15	12.8	50	92.5
16	13.6	55	118.0
17	14.5	60	149.4
18	15.5	65	187.5
19	16.5	70	233.7
20	17.5	75	289.1
21	18.7	80	355.1
22	19.8	85	433.6
23	21.1	90	525.8
24	22.4	95	633.9
25	23.8	100	760.0
26	25.2	105	906.1

Example

- A sample of KClO3 is partially decomposed producing oxygen gas that is collected over water. The total volume of gas that is collected is 0.250 L at 26°C and 765 torr (1atm = 760 torr)
- Question #1
- How many moles of oxygen were collected?

Example

Question # 2

- Calculate the number of grams of $KClO_3$ that were actually decomposed

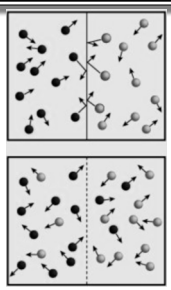
Another Example

- $NH_4NO_2 \rightarrow N_2 + 2H_2O$
- A sample of ammonium nitrite is decomposed and 511 ml of gas are collected over water at 26°C and 745 torr of total pressure. How many grams of ammonium nitrite were decomposed?

Another Example

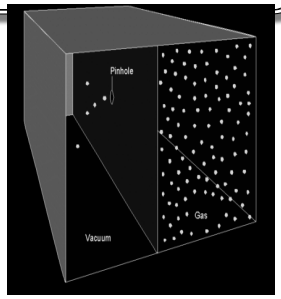
Diffusion

- Diffusion: describes the mixing of gases.
- The rate of diffusion is the rate of gas mixing.



Effusion

- Effusion: describes the passage of gas into an evacuated chamber.



Graham's Law of Effusion

- $\frac{\text{Rate of effusion for gas 1}}{\text{Rate of effusion for gas 2}} = \frac{\sqrt{M_2}}{\sqrt{M_1}}$
- Example:
- Calculate the effusion rates for hydrogen gas (H_2) and uranium hexafluoride (UF_6)