Gas Stoichiometry & Dalton's Law of Partial Pressure

Gas Stoichiometry

- $2C_4H_{10} + 13O_2 \rightarrow 8\ CO_2 + 10\ H_2O$

- Just like a mole to mole ratio, you can now have a liter to liter ratio

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?
- You cannot use straight stoichiometry, but you can go from L of one thing to L of another any time

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?
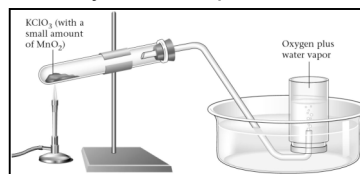
Example

What would be the total pressure?

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 $KClO_3$ 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?

Kinetic Molecular Theory of Gases

1. Gases consist of large numbers of molecules that are in continuous motion
2. The volume of all the molecules of a gas are negligible compared to the total volume in which the gas is contained
3. Attractive and repulsive forces between gases are negligible

Kinetic Molecular Theory of Gases

4. Energy can be transferred between molecules during collisions, but the average kinetic energy of the molecules does not change with time as long as the temperature remains constant (collisions are perfectly elastic)
5. The average kinetic energy of the molecules is proportional to the absolute temperature. At any given temperature the molecules of all gases have the same average kinetic energy