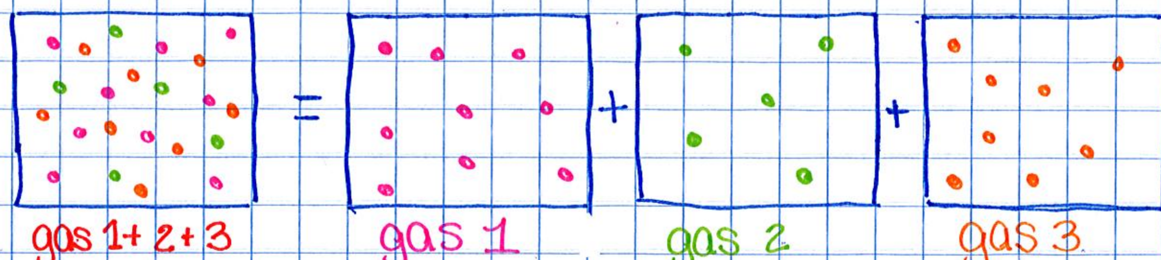
7. Dalton's Law of Partial Pressures
(when you have a mixture of gases)

The total pressure of a mixture of gases equals the sum of the pressures that each would exert if it were present alone.



P_{TOT} = 22.0 atm P_1 = 9.0 atm P_1 = 5.0 atm P_3 = 8.0 atm

$$P_{TOT} = P_1 + P_2 + P_3 + \ldots$$

- mole Fraction, χ_1

$$\chi_1 = \frac{n_1}{n_{TOT}}$$

$$P_1 = \chi_1 P_{TOT}$$

Ex (15) From data gathered by Voyager 1, scientists have estimated the composition of the atmosphere of the moon, Titan. The total pressure on the surface to Titan is 1220 torr. The atmosphere consists of 82 mol percent N_2, 12 mol percent Ar, and 6.0 mol percent CH_4. Calculate the partial pressure of each gas

P_{N_2} = .82(1220 torr) = 1000.4 torr

P_{Ar} = .12(1220 torr) = 146.4 torr

P_{CH_4} = .06(1220 torr) = 73.2 torr

Ex (16) A mixture containing .477 mol Hg (g), .280 mol N_2(g), and .110 mol Ar (g), is contained in a 7.00L vessel at 25°C.

(A) Calculate the partial pressure of each gas.

(B) Calculate the total pressure of the mixture.

(A) P = ?
V = 7.00L
n = .477 mol
R = .08206 $\frac{L\,atm}{mol\,K}$
T = 25°C = 298

$PV = nRT$

$P(7.00L) = (.477mol)(.08206\frac{L\,atm}{mol\,K})(298K)$

$P_{Hg} = 1.67\,atm$

$P_{N_2}(7.00L) = (.280mol)(.08206\frac{L\,atm}{mol\,K})(298K)$

$P_{N_2} = .978\,atm$

$P_{Ar}(7.00L) = (.110mol)(.08206\frac{L\,atm}{mol\,K})(298K)$

$P_{Ar} = .384\,atm$

(B) P_{TOT} =

1.67 atm
+ .978 atm
.384 atm

3.032 atm

Ex (17) At an underwater depth of 250 ft, the pressure is 8.38 atm. What should the mole percent of oxygen be in the diving gas for the partial pressure of oxygen in the mixture to be .21 atm, the same as in air at 1 atm?

$P_{O_2} = .21\,atm$
$X_{O_2} = ?$
$P_{TOT} = 8.38\,atm$

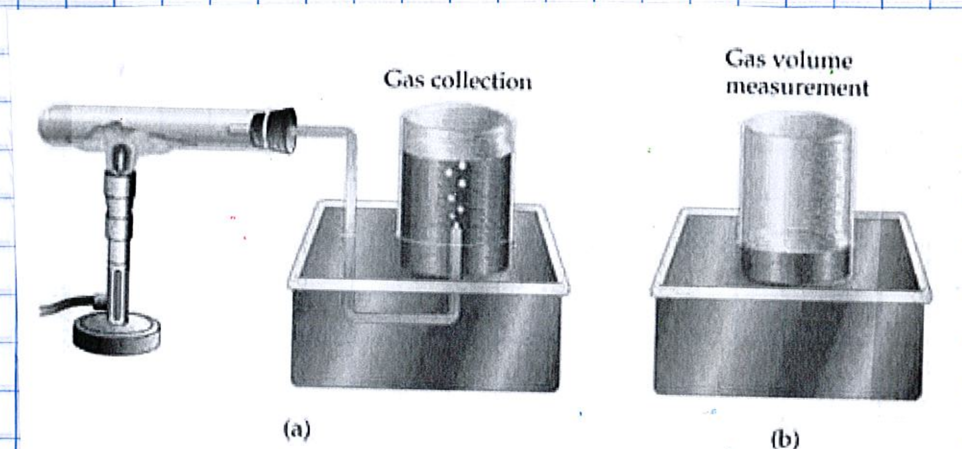
$P_1 = X_1 P_{TOT}$

$.21\,atm = X_{O_2}(8.38\,atm)$

$.025 = X_{O_2}$

8. Collecting Gases over water

- An experiment often encountered involves determining the #moles of gas collected from a chemical reaction. Sometimes the gas is collected over water.



The volume of gas collected is measured by raising/lowering the bottle until the H_2O levels inside & outside the bottles are the same.

$$P_{TOT} = P_{gas} + P_{H_2O}$$ ← water vapor

P_{H_2O} @ various temps. is found in Appendix B (p. 1111)

Ex (18) A sample of potassium chlorate is partially decomposed, producing O_2 gas, which is collected. The volume of gas collected is .250 L at 26°C and 765 torr total pressure.
(A) How many moles of O_2 gas are collected
(B) How many grams of $KClO_3$ are decomposed?

$$2\,KClO_3(s) \rightarrow 2\,KCl(s) + 3\,O_2(g)$$

(A) 1st

$$P_{TOT} = P_{O_2} + P_{H_2O}$$
$$765\text{ torr} = P_{O_2} + 25.21\text{ torr}$$
$$739.79\text{ torr} = P_{O_2}$$

2nd $PV = nRT$

$$(739.79\text{ torr})(.250L) = n_{O_2}\left(62.36\,\frac{L\,torr}{mol\,K}\right)(299\,K)$$

$$\boxed{9.92\times10^{-3}\text{ mol} = n_{O_2}}$$

(B) $$9.92\times10^{-3}\text{ mol }O_2\left(\frac{2\text{ mol }KClO_3}{3\text{ mol }O_2}\right)\left(\frac{122.5\text{ g }KClO_3}{1\text{ mol }KClO_3}\right) = \boxed{.810\text{ g }KClO_3}$$

Ex (19) Ammonium nitrite, NH_4NO_2, decomposes upon heating to form $N_2(g)$:

$$NH_4NO_2(s) \rightarrow N_2(g) + 2\,H_2O(l)$$

When a sample of NH_4NO_2 is decomposed in a test tube, 511 mL of $N_2(g)$ is collected over water at 26°C and 745 torr total pressure. How many grams of NH_4NO_2 were decomposed?

$$P_{Tot} = P_{N_2} + P_{H_2O}$$

$$745\text{ torr} = P_{N_2} + 25.21\text{ torr}$$

$$719.79\text{ torr} = P_{N_2}$$

$P_{N_2} = 719.79$ torr
$V = 511$ mL $= .511$ L
$n = ?$
$R = 62.36$ L torr/mol K
$T = 26°C = 299$ K

$PV = nRT$

$$(719.79\text{ torr})(.511\text{ L}) = n_{N_2}(62.36\text{ L torr/mol K})(299\text{ K})$$

$$.0197\text{ mol} = n_{N_2}$$

$$.0197\text{ mol } N_2 \left(\frac{1\text{ mol } NH_4NO_2}{1\text{ mol } N_2}\right)\left(\frac{64\text{ g } NH_4NO_2}{1\text{ mol } NH_4NO_2}\right) = \boxed{1.26\text{ g } NH_4NO_2}$$

HW - p 429-431

46, 48, 52, 54, 56, 60, 62, 66, 68, 70

Due: Mon., 10/3