CHEMICAL CALCULATIONS WITH THE GAS LAWS

$FW_{NaHCO_3} = 84.007\ g/mol$

$$H_2SO_4(aq) + 2NaHCO_3(s) \rightarrow 2H_2O(l) + 2CO_2(g) + Na_2SO_4(aq)$$

Given 25.0 g of sodium bicarbonate and sufficient sulfuric acid, what volume of carbon dioxide gas would be produced at 25.0 C and 0.950 atm pressure?

1 - Convert 25.0 g sodium bicarbonate to moles sodium bicarbonate. Use FORMULA WEIGHT.
2 - Convert moles sodium bicarbonate to moles carbon dioxide. Use CHEMICAL EQUATION.
3 - Convert moles carbon dioxide to volume. Use IDEAL GAS LAW.

① $84.007\ g\ NaHCO_3 = 1\ mol\ NaHCO_3$ ① $2\ mol\ NaHCO_3 = 2\ mol\ CO_2$

$$25.0\ g\ NaHCO_3 \times \frac{1\ mol\ NaHCO_3}{84.007\ g\ NaHCO_3}\ (①) \times \frac{2\ mol\ CO_2}{2\ mol\ NaHCO_3}\ (②) = 0.297599248\ mol\ CO_2$$

③ $PV = nRT$

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

$n = 0.297599248\ mol\ CO_2$ $\quad P = 0.950\ atm$

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

$T = 25.0°C = 298.2\ K$

$$V = \frac{(0.297599248\ mol\ CO_2)\left(0.08206\ \frac{L \cdot atm}{mol \cdot K}\right)(298.2\ K)}{(0.950\ atm)} = 7.67\ L$$

at 25.0°C, 0.950 atm

What volume would the gas in the last example problem have at STP?

STP: "Standard Temperature and Pressure" (0 C and 1 atm)

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$P_1 = 0.950\ atm$ $\quad$ $P_2 = 1\ atm$

$V_1 = 7.67\ L$ $\quad$ $V_2 = ?$

$T_1 = 298.2\ K$ $\quad$ $T_2 = 273.15\ K$

$$\frac{(0.950\ atm)(7.67\ L)}{(298.2\ K)} = \frac{(1\ atm)(V_2)}{(273.15\ K)}$$

$$6.67\ L \text{ at STP} = V_2$$

You could also calculate the volume at STP using the ideal gas equation. In the previous problem, we had calculated the moles of gas! (You will get the same answer as the calculation above...)

$2\ NH_4NO_3(s) \longrightarrow 2\ N_2(g) + O_2(g) + 4\ H_2O(g)$

At 300.°C, ammonium nitrate violently decomposes to produce nitrogen gas, oxygen gas, and water vapor. What is the total volume of gas that would be produced at 1.00 atm by the decomposition of 15.0 grams of ammonium nitrate?

To simplify the calculation, we will calculate the TOTAL MOLES OF GAS instead of treating the different gas molecules separately!

$F_w\ NH_4NO_3 = 80.052\ g/mol$