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 grams sodium bicarbonate to moles. Use FORMULA WEIGHT.
2 - Convert moles sodium bicarbonate to moles carbon dioxide gas. Use CHEMICAL EQUATION.
3 - Convert moles carbon dioxide gas to volume. Use IDEAL GAS EQUATION, PV=nRT

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

$$25.0\ g\ NaHCO_3 \times \frac{mol\ NaHCO_3}{84.007\ g\ NaHCO_3} \times \frac{2\ mol\ CO_2}{2\ mol\ NaHCO_3} = 0.2975942481\ mol\ CO_2$$

(1) (2)

(3) $PV = nRT$

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

$n = 0.2975942481\ mol\ CO_2$

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

$T = 25.0°C = 298.2\ K$

$P = 0.950\ atm$

$$V = \frac{(0.2975942481\ mol\ CO_2)(0.08206 \frac{L \cdot atm}{mol \cdot K})(298.2\ K)}{(0.950\ atm)}$$

$= 7.67\ L$ of CO_2 @ 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 $P_2 = 1$ atm

$V_1 = 7.67$ L $V_2 = ?$

$T_1 = 298.2$ K $T_2 = 0°C = 273.2$ K

$$\frac{(0.950\text{ atm})(7.67\text{ L})}{(298.2\text{ K})} = \frac{(1\text{ atm})(V_2)}{(273.2\text{ K})}$$

$V_2 =$ **6.67 L at STP**

Alternate solution. Since, we already knew the moles of gas, we can use PV=nRT...

$PV = nRT$

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

$n = 0.2975942481$ mol O_2 $P = 1$ atm

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

$T = 0°C = 273.2$ K

$$V = \frac{(0.2975942481\text{ mol }O_2)(0.08206\frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}})(273.2\text{ K})}{(1\text{ atm})}$$

$=$ **6.67 L at STP**