



## GAS STOICHIOMETRY!

Name

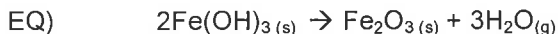
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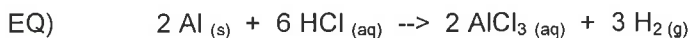
**STP CONDITIONS**

1) Solid iron (III) hydroxide decomposes to produce iron (III) oxide and water vapor. If 0.75 L of water vapor are produced at STP, how many grams of iron (III) hydroxide were used?



$$\text{Stoich) } 0.75\text{L H}_2\text{O} \left( \frac{1\text{mol H}_2\text{O}}{22.4\text{L}} \right) \left( \frac{2\text{mol Fe(OH)}_3}{3\text{mol H}_2\text{O}} \right) \left( \frac{106.88\text{g}}{1\text{mol Fe(OH)}_3} \right) = \boxed{2.4\text{g Fe(OH)}_3}$$

2) Assume that 13.5 grams of solid aluminum react with HCl according to the following balanced equation at STP:

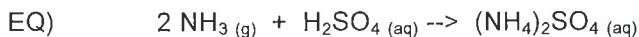


How many liters of H<sub>2</sub> gas could you ideally produce?

$$13.5\text{g Al} \left( \frac{1\text{mol Al}}{26.98\text{g}} \right) \left( \frac{3\text{mol H}_2}{2\text{mol Al}} \right) \left( \frac{22.4\text{L}}{1\text{mol H}_2} \right) = \boxed{16.8\text{L H}_2}$$

**NON-STP CONDITIONS (use PV=nRT either before or after stoichiometry)**

3) Ammonium sulfate, an important fertilizer, can be prepared by the reaction of ammonia with sulfuric acid according to the following balanced equation:



Calculate the volume of NH<sub>3</sub> (in liters) needed at 20°C and 25.0 atm to react with 150. g of H<sub>2</sub>SO<sub>4</sub>. (hint: find moles of NH<sub>3</sub> needed then put in PV=nRT)

$$150.\text{g H}_2\text{SO}_4 \left( \frac{1\text{mol H}_2\text{SO}_4}{98.08\text{g}} \right) \left( \frac{2\text{mol NH}_3}{1\text{mol H}_2\text{SO}_4} \right) = \boxed{3.06\text{mol NH}_3}$$

$$V = \frac{nRT}{P} = \frac{(3.06\text{mol}) \left( 0.0821 \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}} \right) (293\text{K})}{(25.0\text{atm})}$$

$$\boxed{V = 2.94\text{L NH}_3}$$

4) If 45.0 L of natural gas, which is essentially methane ( $\text{CH}_4$ ), undergoes complete combustion at 0.961 atm and 20.°C, how many grams of  $\text{CO}_2$  product is formed?



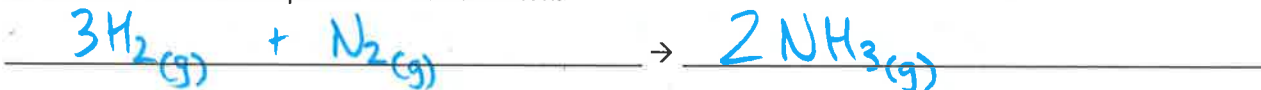
Math:  $n = \frac{PV}{RT}$

$$n = \frac{(0.961 \text{ atm})(45.0 \text{ L})}{(0.0821 \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}})(293 \text{ K})}$$

$$n = 1.80 \text{ mol CH}_4 \left( \frac{1 \text{ mol CO}_2}{1 \text{ mol CH}_4} \right) \left( \frac{44.01 \text{ g}}{1 \text{ mol CO}_2} \right) = \boxed{79.1 \text{ g CO}_2}$$

5) Fritz Haber, a German chemist, discovered a way to synthesize ammonia gas ( $\text{NH}_3$ ) by combining hydrogen ( $\text{H}_2$ ) and nitrogen gases ( $\text{N}_2$ ) at extremely high temperatures and pressures.

a. Write the balanced equation for this reaction.



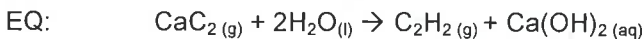
b. If 100. g of nitrogen combines with excess hydrogen at 550.°C and 250. atm, what volume (Liters) of ammonia gas is produced?

$$100. \text{ g N}_2 \left( \frac{1 \text{ mol N}_2}{28.02 \text{ g}} \right) \left( \frac{2 \text{ mol NH}_3}{1 \text{ mol N}_2} \right) = \boxed{7.14 \text{ mol NH}_3}$$

$$V = \frac{nRT}{P} = \frac{(7.14 \text{ mol})(0.0821 \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}})(823 \text{ K})}{250. \text{ atm}}$$

$$V = \boxed{1.93 \text{ L NH}_3}$$

6) A 3.25 gram sample of solid calcium carbide ( $\text{CaC}_2$ ) reacts with water to produce acetylene gas ( $\text{C}_2\text{H}_2$ ) and aqueous calcium hydroxide. If the acetylene was collected at 17°C and 0.9737 atm, how many Liters of  $\text{C}_2\text{H}_2$  were produced?



Math:  $3.25 \text{ g CaC}_2 \left( \frac{1 \text{ mol CaC}_2}{64.10 \text{ g}} \right) \left( \frac{1 \text{ mol C}_2\text{H}_2}{1 \text{ mol CaC}_2} \right) = 0.0507 \text{ mol C}_2\text{H}_2$

$$V = \frac{nRT}{P} = \frac{(0.0507 \text{ mol})(0.0821 \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}})(290. \text{ K})}{0.9737 \text{ atm}} = \boxed{1.24 \text{ L}}$$