Calculations from Chemical Equations

Chapter 9

Stoichiometry

- Calculations involving chemical equations

- Chemical equations tell us exactly how much of one reactant will react (combine) with a second reactant and how much of the product we should expect.

$$2\ Al + 6\ HCl \rightarrow 2\ AlCl_3 + 3\ H_2$$

- 2 atom Al + 6 molecule HCl
- $\rightarrow$ 2 formula unit $AlCl_3$ + 3 molecule H_2

- 2 mol Al + 6 mol HCl
- $\rightarrow$ 2 mol $AlCl_3$ +3 mol H_2

- 2 (26.98 g) Al + 6 (36.46 g) HCl
- $\rightarrow$ 2 (133.3 g) $AlCl_3$ + 3 (2.016 g) H

$2\ Al + 6\ HCl \rightarrow 2\ AlCl_3 + 3\ H_2$

- How many molecules of HCl will react with 4 atoms of Al?
- How many atoms of Al are required to make 1 molecule of $AlCl_3$?
- How many moles of H_2 are made from 3 mole of HCl?
- If 4 moles of $AlCl_3$ are produced, how much H_2 is produced?
- How much HCl is required to react with 1 mole of Al?

$$CH_4 + 2\,O_2 \rightarrow CO_2 + 2H_2O$$

- How many moles of oxygen are required to react completely with 50.0 g CH_4?
- What mass of CH_4, in grams, is required to react with 96.0 g of O_2?
- Calculate the mass of CO_2 that can be produced by burning 6.0 moles of CH_4 in excess O_2?
- What mass of CH_4 produces 3.01×10^{23} water molecules when burned in excess oxygen?

- Smelling salts contain ammonium carbonate, which can decompose to form ammonia, which acts as a mild heart stimulant. Ammonium carbonate decomposes by the reaction

$$(NH_4)_2CO_3(s) \rightarrow 2\ NH_3(g) + CO_2(g) + H_2O(l)$$

- How many g of NH_3 will be formed from 0.500 g of $(NH_4)_2CO_3$?

- Calculate the number of moles of calcium chloride needed to react with excess silver nitrate to produce 6.60 g of silver chloride.
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- 1st - write the equation (a double displacement reaction)
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- 2nd -do stoichiometry

Reactions and Energy

- Reactions will often generate energy (heat) or produce (give off) energy. We can use stoichiometry to calculate energy consumption or production.

- Exothermic reaction -- A reaction that liberates heat.
- $C_6H_{12}O_6 \rightarrow 2\,C_2H_5OH + 2\,CO_2 + \text{heat}$

- Endothermic reaction -- A reaction that absorbs heat.
- $CO_2 + \text{heat} \rightarrow C + O_2$

- Consider the combustion of methane (used in our bunsen burners)
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- $CH_4(g) + 2\ O_2(g) \rightarrow CO_2(g) + 2\ H_2O(l) + 890\ kJ$
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- Calculate the amount of heat produced when 1.00 g of methane is burned in excess oxygen.

- Copper(I)sulfide reacts upon heating in oxygen gas to produce copper metal and sulfur dioxide. How many grams of copper can be obtained from 500.0 g of cuprous sulfide using this process?

- If 382.6 g of copper were obtained from the reaction above, what would be the percent yield?

- What mass of sulfur dioxide would be produced from 500.0 grams of cuprous sulfide?

Percent Yield

- % Yield = (mass product/mass expected)*100(%)

- What could cause the yield to be < 100%?
- impurities in the sample
- incomplete reaction
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- What could cause the yield to be > 100%?
- unexpected reactions
- Impure product
- incorrect weighing etc.

Limiting reactant

- Chez Ronald is making Big Macs. The formula for a Big Mac is B_3M_2, and is made according to the following fast food formula.
- $2\ M + 3\ B \rightarrow B_3M_2$
- If Chez Ronald buys 28 meats and 36 buns how many Big Macs (B_3M_2) can he make?
- We only got 11 Big Macs - What is the percent yield?

- How much potassium chloride is produced from the reaction of 2.00 g potassium and 3.00 g chlorine gas? Which is the limiting reagent?

- We only recovered 3.66 g KCl. What is the percent yield?

- When solutions containing 4.28 g Na_2SO_4 and 7.16 g $BaCl_2$ are mixed, what mass of $BaSO_4$ is produced?

$$Mg_3N_2 + 6H_2O \rightarrow 3Mg(OH)_2 + 2NH_3$$

- How many moles of $Mg(OH)_2$ would be produced from the reaction of 0.10 mole of Mg_3N_2?
- How many moles of NH_3 would be produced from the reaction of 500 g of Mg_3N_2?
- How many molecules of water would be required to react with 3.64 g of Mg_3N_2?
- What is the maximum number of grams of $Mg(OH)_2$ that can be produced by the reaction of 10.0 g of Mg_3N_2 and 14.4 g of H_2O?
- What is the percent yield if 9.4 g of $Mg(OH)_2$ are produced?