PERCENT YIELD

- Chemical reactions do not always go to completion! Things may happen that prevent the conversion of reactants to the desired/expected product!

1 SIDE REACTIONS:

$$C + O_2 \longrightarrow CO_2$$

This reaction occurs when there is a large amount of oxygen available

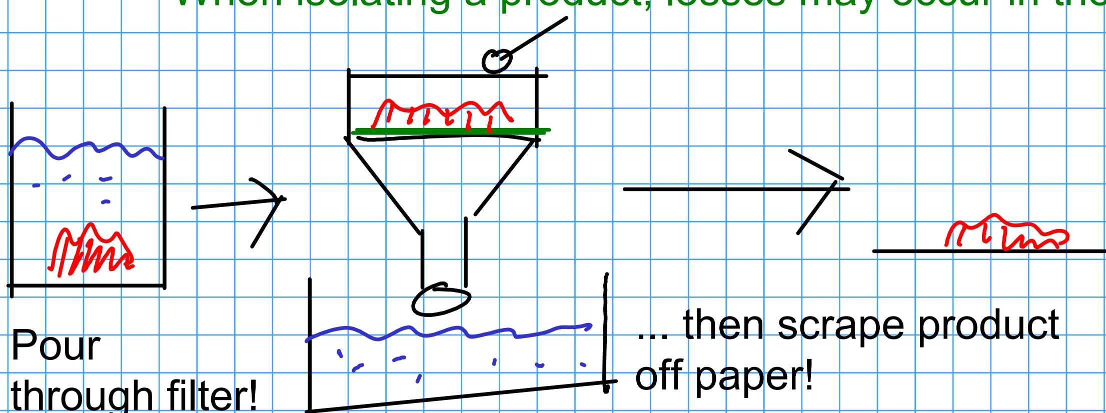
$$2C + O_2 \longrightarrow 2CO$$

... while this reaction is more favorable in low-oxygen environments!

... so in a low-oxygen environment, you may produce less carbon dioxide than expected!

2 TRANSFER AND OTHER LOSSES

- When isolating a product, losses may occur in the process. Example: filtering



Durning each step of this process, some amount of product loss will occur!

③ EQUILIBRIUM

- Reactions may reach an equilbrium between prodcuts and reactants. We'll talk more about this in CHM 111. The net results is that the reaction will appear to stop before all reactants have been consumed!

- All of these factors cause a chemical reaction to produce LESS product than calculated. For many reactions, this difference isn't significant. But for others, we need to report the PERCENT YIELD.

Determined EXPERIMENTALLY!

$$\text{PERCENT YIELD} = \frac{\text{ACTUAL YIELD}}{\text{THEORETICAL YIELD}} \times 100\%$$

Calculated based on the limiting reactant. (The chemical calculations you've done up to now have been theoretical yields!)

... the percent yield of a reaction can never be greater than 100% due to conservation of mass! If you determine that a percent yield is greater than 100%, then you've made a mistake somewhere - either in a calculation or in the experiment itself!

3,102, p120

$$\underset{\text{benzene}}{\overset{\substack{78.114\ g/mol \\ 22.4\ g}}{C_6H_6}} + \underset{\text{nitric acid}}{HNO_3} \longrightarrow \underset{\text{nitrobenzene}}{\overset{\substack{123.111\ g/mol \\ 31.6\ g\ \text{ACTUAL}}}{C_6H_5NO_2}} + H_2O$$

22.4 grams of benzene are reacted with excess nitric acid. If 31.6 grams of nitrobenzene are collected from the reaction, what is the percent yield?

1: Based on 22.4 g benzene, calculate the amount of nitrobenzene we would produce under ideal conditions - THERORETICAL YIELD!

$78.114\ g\ b = 1\ mol\ b \qquad 123.11\ g\ nb = 1\ mol\ nb$

$1\ mol\ b = 1\ mol\ nb$

$$22.4\ g\ b \times \frac{1\ mol\ b}{78.114\ g\ b} \times \frac{1\ mol\ nb}{1\ mol\ b} \times \frac{123.11\ g\ nb}{1\ mol\ nb} = 35.3\ g\ nb$$

theoretical yield of nitrobenzene

$$\frac{31.6\ g}{35.3\ g} \times 100\% = \boxed{89.5\%}$$

3.80, p 119

$$4\,C_3H_6 + 6\,NO \longrightarrow 4\,C_3H_3N + 6\,H_2O + N_2$$

42.081 g/mol (propylene) 53.064 g/mol (acrylonitrile)

Calculate how many grams of acrylonitrile could be obtained from 651 kg of propylene, assuming there is excess NO present.

42.081 g pr = 1 mol pr   53.069 g an = 1 mol an

4 mol pr = 4 mol an   Kg = 10^3 g

$$651 \cancel{kg} \cancel{pr} \times \frac{10^3 \cancel{g}}{\cancel{Kg}} \times \frac{1 \cancel{mol\ pr}}{42.081 \cancel{g\ pr}} \times \frac{4 \cancel{mol\ an}}{4 \cancel{mol\ pr}} \times \frac{53.069\ g\ an}{1 \cancel{mol}\ an} =$$

$$= 820986\ g\ an = \boxed{821000\ g\ an}$$

4.86, p 170

$$\underline{\underline{10}}\,\underset{151.90\text{ g/mol}}{FeSO_4} + \underline{\underline{2}}\,KMnO_4 + 8H_2SO_4 \rightarrow 5Fe_2(SO_4)_3 + 2MnSO_4 + K_2SO_4 + 8H_2O$$

How many mL of 0.250M potassium permanganate are needed to react with 3.36 g of iron(II) sulfate?

$151.90\text{ g } FeSO_4 = \text{mol } FeSO_4$ $\quad 10\text{ mol } FeSO_4 = 2\text{ mol } KMnO_4$

$0.250\text{ mol } KMnO_4 = 1\text{ L}$ $\quad \text{mL} = 10^{-3}\text{ L}$

$$3.36\text{ g } FeSO_4 \times \frac{\text{mol } FeSO_4}{151.90\text{ g } FeSO_4} \times \frac{2\text{ mol } KMnO_4}{10\text{ mol } FeSO_4} \times \frac{1\text{ L}}{0.250\text{ mol } KMnO_4}$$

$$= 0.0177\text{ L}$$

$$0.0177\text{ L} \times \frac{\text{mL}}{10^{-3}\text{ L}} = \boxed{17.7\text{ mL } KMnO_4 \text{ solution}}$$