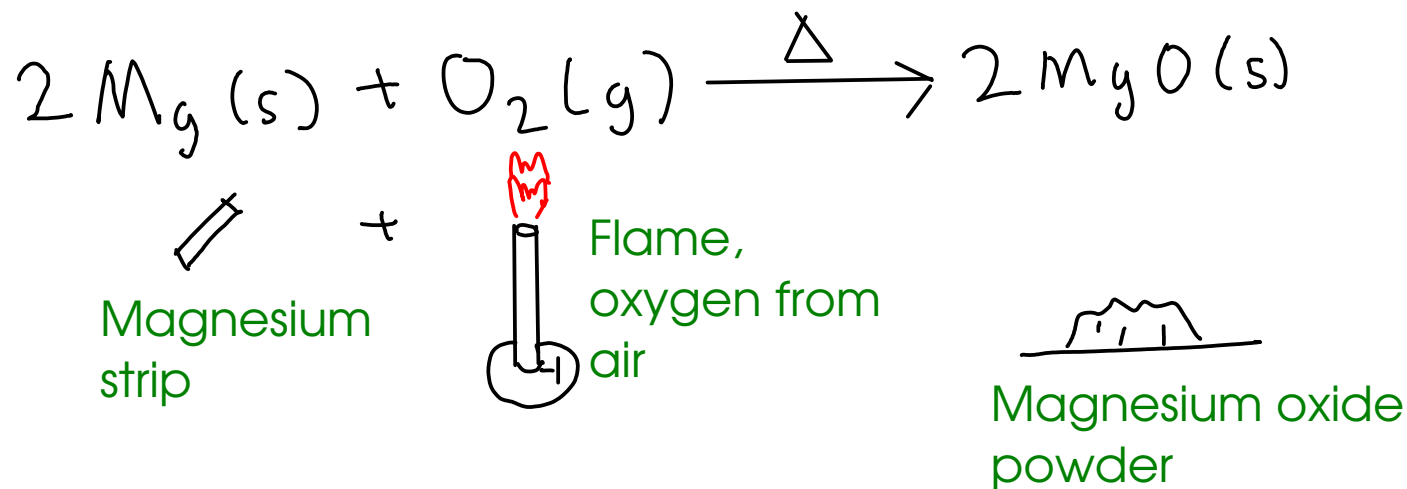


## CONCEPT OF LIMITING REACTANT

- When does a chemical reaction STOP?



- When does this reaction stop? When burned in open air, this reaction stops when all the MAGNESIUM STRIP is gone. We say that the magnesium is LIMITING.

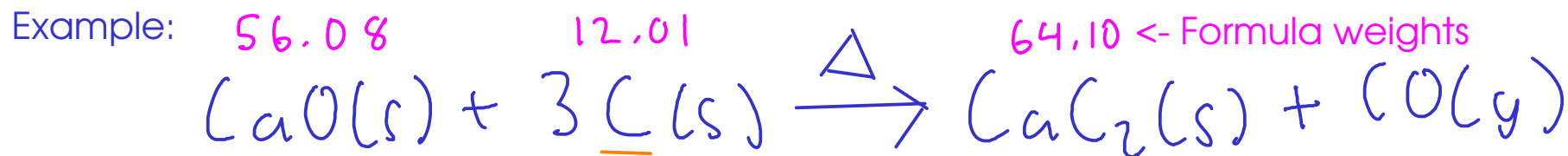
- This reaction is controlled by the amount of available magnesium

- At the end of a chemical reaction, the LIMITING REACTANT will be completely consumed, but there may be amount of OTHER reactants remaining. We do chemical calculations in part to minimize these "leftovers".

These are often called "excess" reactants, or reactants present "in excess"

## LIMITING REACTANT CALCULATIONS

- To find the limiting reactant, calculate how much product would be produced from ALL given reactants. Whichever produces the SMALLEST amount of product is the limiting reactant, and the smallest amount of product is the actual amount of product produced.



If you start with 100. g of each reactant, how much calcium carbide would be produced?

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$$\text{CaO: } 56.08 \text{ g CaO} = \text{mol CaO} \quad | \quad \text{mol CaO} = \text{mol CaC}_2 \quad | \quad 64.10 \text{ g CaC}_2 = \text{mol CaC}_2$$

$$100. \text{ g CaO} \times \frac{\text{mol CaO}}{56.08 \text{ g CaO}} \times \frac{\text{mol CaC}_2}{\text{mol CaO}} \times \frac{64.10 \text{ g CaC}_2}{\text{mol CaC}_2} = \boxed{114 \text{ g CaC}_2}$$

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$$\text{C: } 12.01 \text{ g C} = \text{mol C} \quad | \quad 3 \text{ mol C} = \text{mol CaC}_2 \quad | \quad 64.10 \text{ g CaC}_2 = \text{mol CaC}_2$$

$$100. \text{ g C} \times \frac{\text{mol C}}{12.01 \text{ g C}} \times \frac{\text{mol CaC}_2}{3 \text{ mol C}} \times \frac{64.10 \text{ g CaC}_2}{\text{mol CaC}_2} = 178 \text{ g CaC}_2$$


---

114 grams of calcium carbide should be produced. Calcium oxide runs out when the reaction has made 114 g of calcium carbide, so no further product can be made.

We say that calcium oxide is "limiting" in this reaction, and carbon is present "in excess".

## PERCENT YIELD

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

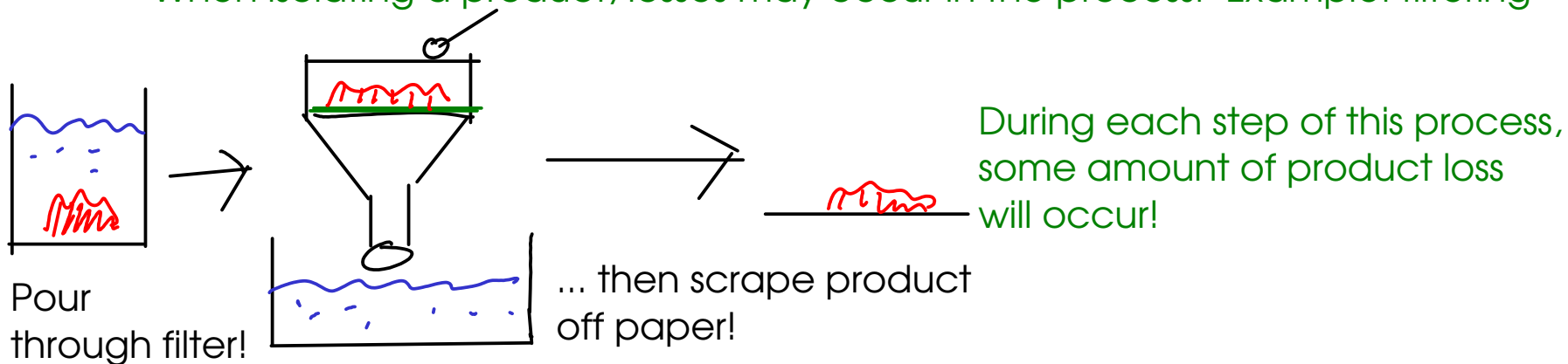
① SIDE REACTIONS:



... 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



### ③ EQUILIBRIUM

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

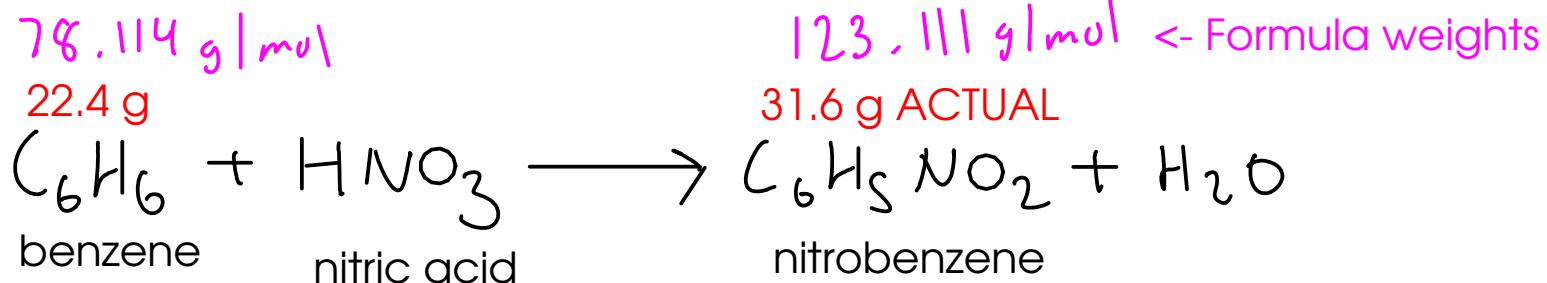
- All of these factors cause a chemical reaction to produce LESS product than calculated. For many reactions, this difference isn't significant. But for others, we need to report the PERCENT YIELD.

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

↙ Determined EXPERIMENTALLY!

↑ 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!



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?

To find PERCENT YIELD, we need to know what the THEORETICAL YIELD is! Calculate the expected amount of nitrobenzene we could make from 22.4 grams of benzene.

$$78.114 \text{ g C}_6\text{H}_6 = \text{mol C}_6\text{H}_6 \quad \text{mol C}_6\text{H}_5\text{NO}_2 = \text{mol C}_6\text{H}_6$$

$$123.111 \text{ g C}_6\text{H}_5\text{NO}_2 = \text{mol C}_6\text{H}_5\text{NO}_2$$

$$22.4 \text{ g C}_6\text{H}_6 \times \frac{\text{mol C}_6\text{H}_6}{78.114 \text{ g C}_6\text{H}_6} \times \frac{\text{mol C}_6\text{H}_5\text{NO}_2}{\text{mol C}_6\text{H}_6} \times \frac{123.111 \text{ g C}_6\text{H}_5\text{NO}_2}{\text{mol C}_6\text{H}_5\text{NO}_2} =$$

$$= 35.3 \text{ g C}_6\text{H}_5\text{NO}_2 \quad \text{This is the THEORETICAL YIELD of nitrobenzene,}$$

$$\% \text{ yield} = \frac{\text{ACTUAL YIELD}}{\text{THEORETICAL YIELD}} \times 100\% = \frac{31.6 \text{ g}}{35.3 \text{ g}} \times 100\% = \boxed{89.5\%}$$

## Electrolytes and Ionic Theory

- electrolytes: substances that dissolve in water to form charge-carrying solutions

\* Electrolytes form ions in solution - (ions that are mobile are able to carry charge!). These IONS can undergo certain kinds of chemistry!

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### IONIC THEORY

- the idea that certain compounds DISSOCIATE in water to form free IONS

What kind of compounds?

- Soluble ionic compounds
- Acids (strong AND weak)
- Bases (strong AND weak)

The ions formed may interact with each other to form NEW compounds!

Strong vs weak?

- If an electrolyte COMPLETELY IONIZES in water, it's said to be STRONG
- If an electrolyte only PARTIALLY IONIZES in water, it's said to be WEAK
- Both kinds of electrolyte undergo similar kinds of chemistry.