

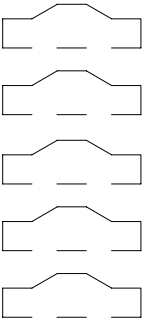
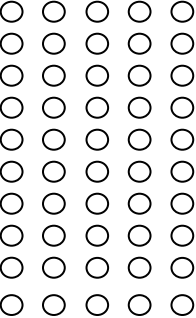
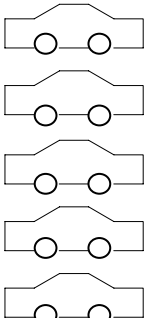
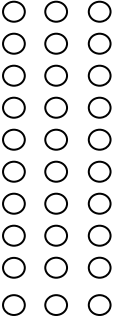
Stoichiometry: LIMITING REACTANT

Limiting Reactant (LR) – the reacting substance in the chemical reaction that limits the amount of product that can be formed; the reaction will stop once all of this substance is consumed.

Excess Reactant (XS) – the reacting substance in the chemical reaction that remains when the reaction stops once the limiting reactant (the other reacting substance) is completely consumed. This excess reactant is left over because there is nothing else to react with.

Example:



| | | | | | | |
|---|---|--|---|---|---|--|
| 1 CAR BODY | + | 4 TIRES | = | 1 CAR | + | 0 SPARE TIRES |
|  | + |  | → |  | + |  |
| 5 CAR BODIES { LIMITING REACTANT } | + | 50 TIRES { EXCESS REACTANT } | = | 5 CARS ↓ { 5 CAR BODIES + 20 TIRES } | + | 30 SPARE TIRES { AMOUNT OF EXCESS } |

Regardless of the number of tires there are, if you only have 5 car bodies, then you can only build 5 cars. This is the same case with chemistry. If you only have a certain amount of 1 reacting substance available for a chemical reaction, then the reaction must end when that specific reacting substance is consumed even if you still have some of the other reacting substance(s) left.

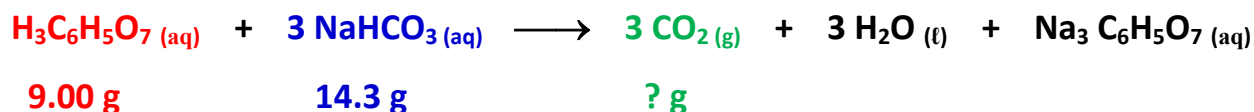
Sample Limiting Reactant Problem & Calculation:

A 9.00 g sample of $\text{H}_3\text{C}_6\text{H}_5\text{O}_7$, citric acid in lemon juice reacts with 14.3 g of baking soda, NaHCO_3 . **A) How many grams of carbon dioxide will be produced**, which is called the theoretical yield? **B) What substance is the limiting reactant?** **C) What substance is in excess?** **D) How many grams of the excess reactant is left over (remaining) after the reaction stops?**

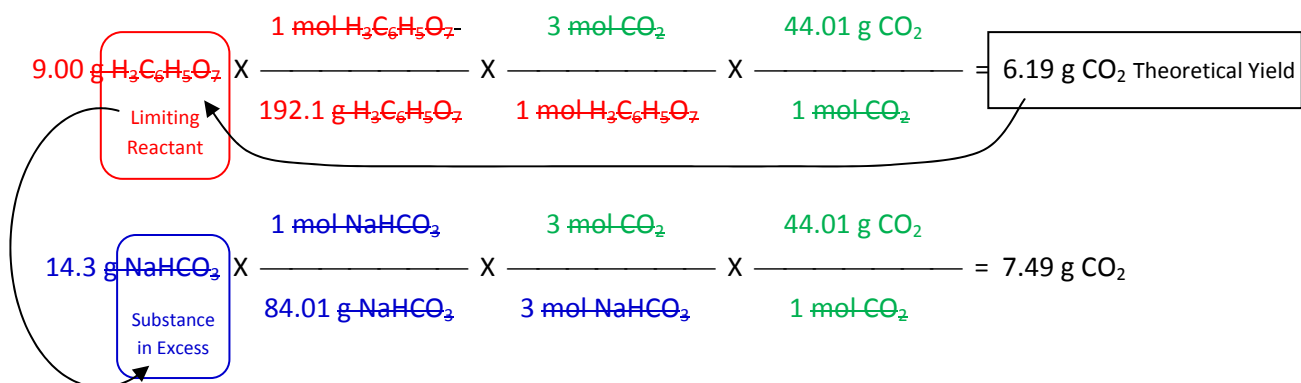
STEP 1: is to write and balance the chemical equation for this reaction.



STEP 2: is to list the given information from the question underneath the appropriate substances to gain a better idea of what we are calculating.



STEP 3: is to use stoichiometry to calculate how much product is produced by each one of the reactants.



STEP 4: is to analyze the above result that you setup and calculated to actually answer questions asked above including **A) the amount of product produced, theoretical yield, B) limiting reactant, and C) the substance in excess.**

- A)** The amount of product, CO_2 produced from this reaction is 6.19 grams, the smaller amount that you calculated from the two calculations above. This answer is also called the theoretical yield.
- B)** The reacting substance that produces the smaller amount of product (the theoretical yield), in this case $\text{H}_3\text{C}_6\text{H}_5\text{O}_7$, citric acid is the limiting reactant.
- C)** The other reacting substance in this reaction, baking soda, NaHCO_3 , is the substance in excess.

STEP 5: is to determine how many grams of the excess reactant is left over after the reaction stops by calculating the amount of excess that actually reacted with the limiting reactant, citric acid ($\text{H}_3\text{C}_6\text{H}_5\text{O}_7$). Then, we will take that calculated amount of reacted excess substance, and subtract it from the original amount of the excess substance.

$$\begin{array}{ccccccc}
 & & 1 \text{ mol } \text{H}_3\text{C}_6\text{H}_5\text{O}_7 & 3 \text{ mol } \text{NaHCO}_3 & 84.01 \text{ g } \text{NaHCO}_3 & & \\
 9.00 \text{ g } \text{H}_3\text{C}_6\text{H}_5\text{O}_7 & \times & \frac{\quad}{192.1 \text{ g } \text{H}_3\text{C}_6\text{H}_5\text{O}_7} & \times & \frac{\quad}{1 \text{ mol } \text{H}_3\text{C}_6\text{H}_5\text{O}_7} & \times & \frac{\quad}{1 \text{ mol } \text{NaHCO}_3} = 11.8 \text{ g } \text{NaHCO}_3 \\
 \text{Limiting Reactant} & & & & & &
 \end{array}$$

Original sample of excess substance – reacted amount of excess substance = amount of excess remaining

$$14.3 \text{ g } \text{NaHCO}_3 - 11.8 \text{ g } \text{NaHCO}_3 = 2.50 \text{ g } \text{NaHCO}_3 \text{ excess remaining}$$

D) 2.50 g NaHCO_3 excess is remaining after the reaction stops

We have come to the end of this problem!