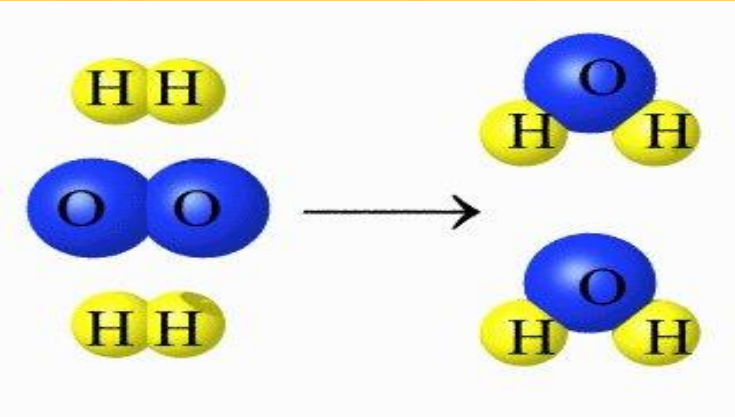
Basic Concepts In Chemistry



How Many Cookies Can I Make?

- **You can make cookies until you run out of one of the ingredients**
- **Once this family runs out of sugar, they will stop making cookies (at least any cookies you would want to eat)**

How Many Cookies Can I Make?

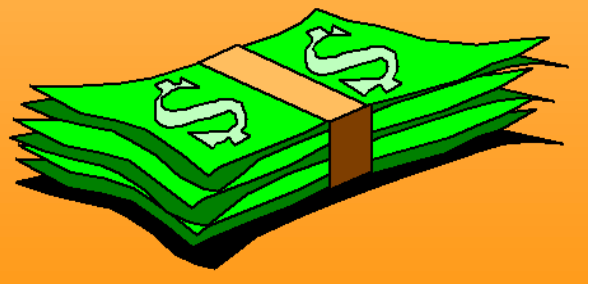
- In this example the sugar would be the limiting reactant, because it will limit the amount of cookies you can make

Limiting Reactants

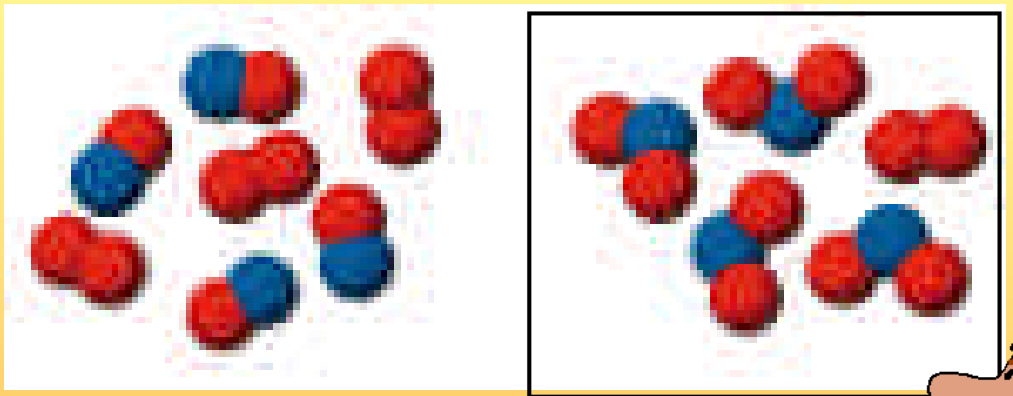
The limiting reactant is the reactant present in the smallest stoichiometric amount

Reactions Involving a LIMITING REACTANT

- In a given reaction, there is not enough of one reagent to use up the other reagent completely.
- The reagent in short supply **LIMITS** the quantity of product that can be formed.



LIMITING REACTANTS



Reactants Products

$$2\ NO(g) + O_2(g) \rightarrow 2\ NO_2(g)$$

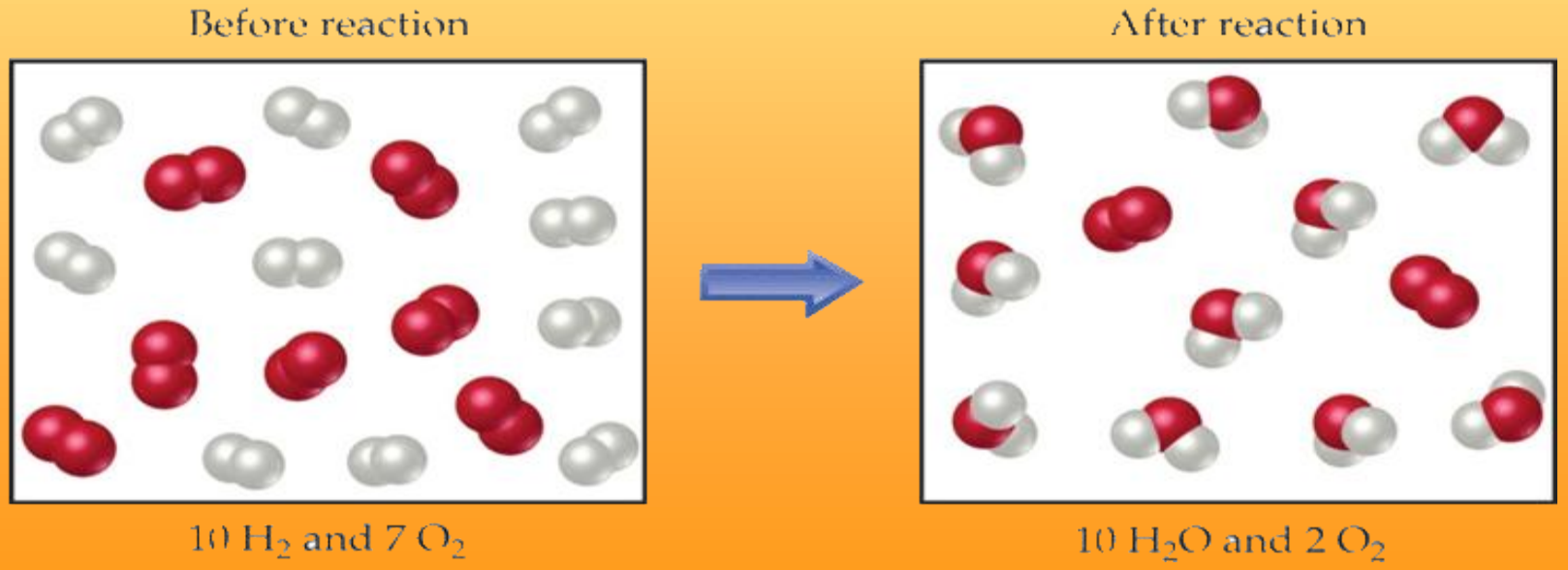
Limiting reactant =_____

Excess reactant =_____

Limiting Reactants

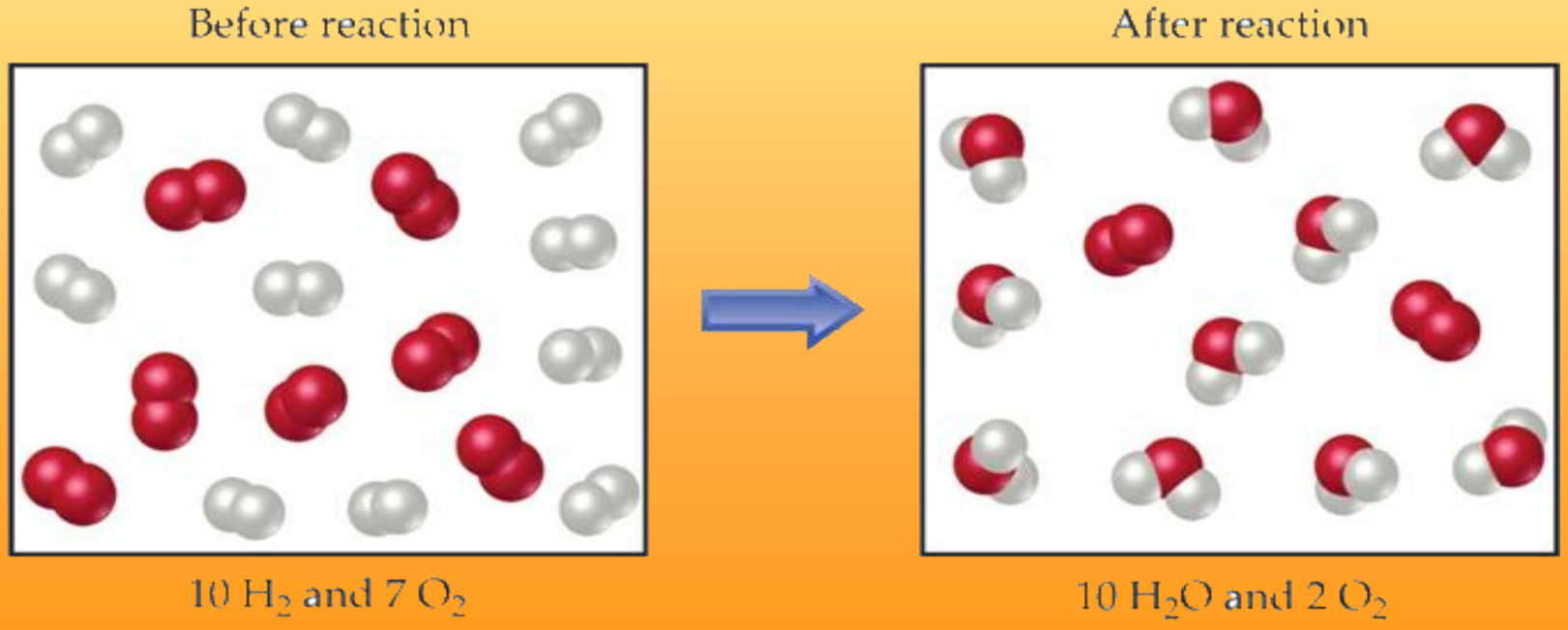
In other words, it's the reactant you'll run out of first

(in this case, the H_2)



Limiting Reactants

In the example below, the O_2 would be the excess reagent



LIMITING REACTANTS

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React solid Zn with 0.100 mol HCl (aq)

$Zn + 2\ HCl \rightarrow ZnCl_2 + H_2$

	Rxn 1	Rxn 2	Rxn 3
mass Zn (g)	7.00	3.27	1.31

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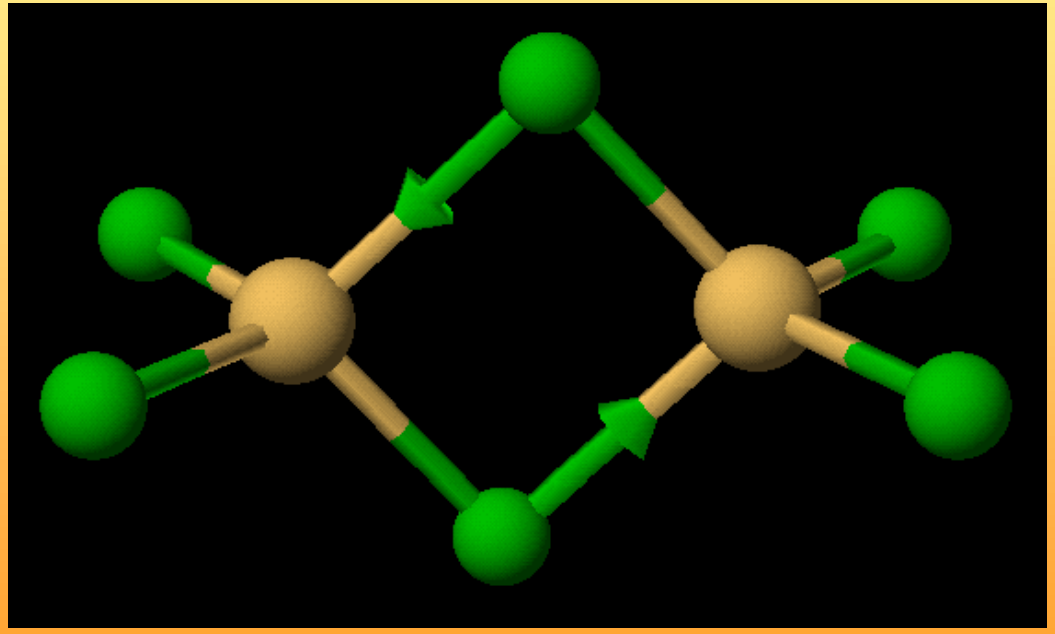
$Zn + 2\ HCl \rightarrow ZnCl_2 + H_2$

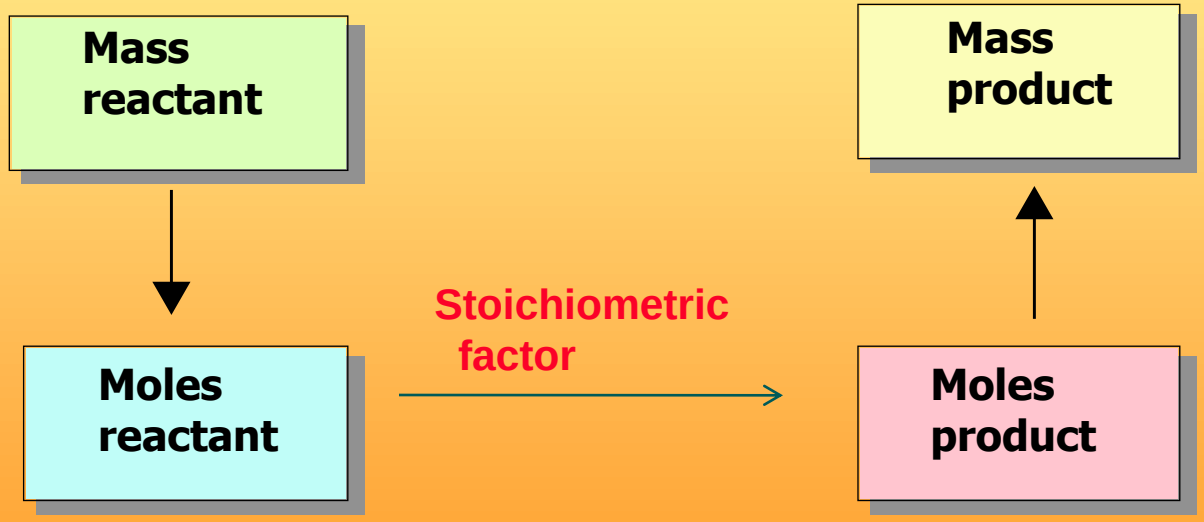
	Rxn 1	Rxn 2	Rxn 3
mass Zn (g)	7.00	3.27	1.31
mol Zn	0.107	0.050	0.020
mol HCl	0.100	0.100	0.100
mol HCl/mol Zn	0.93	2.00	5.00

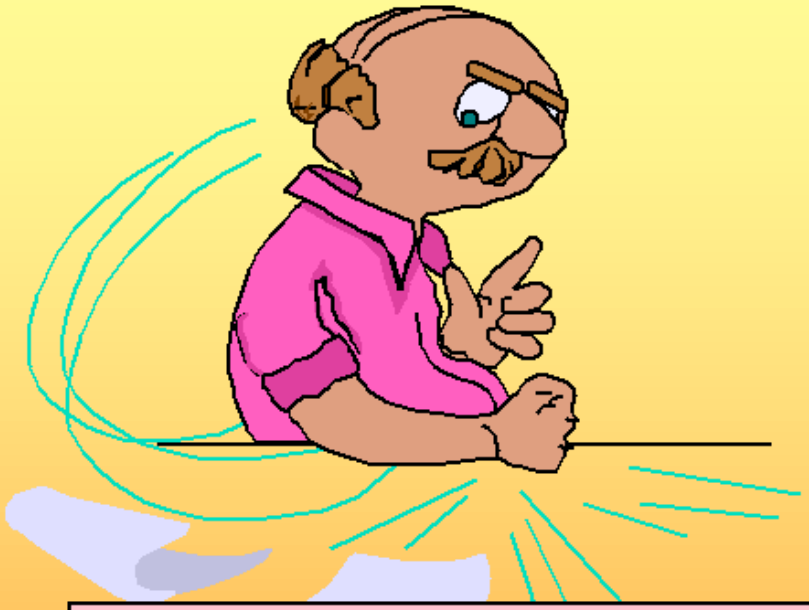
Reaction to be Studied

$$2\,Al + 3\,Cl_2 \longrightarrow Al_2Cl_6$$



PROBLEM: Mix 5.40 g of Al with 8.10 g of Cl_2. How many grams of Al_2Cl_6 can form?





Step 1 of LR problem: compare actual mole ratio of reactants to the oretical mole ratio

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$2\ Al + 3\ Cl_2 \rightarrow Al_2Cl_6$

Reactants must be in the mole ratio

$$\frac{\text{mol } Cl_2}{\text{mol Al}} > \frac{3}{2}$$

Deciding on the Limiting Reactant

$$2\,Al + 3\,Cl_2 \longrightarrow Al_2Cl_6$$

$$\frac{\text{mol } Cl_2}{\text{mol Al}} > \frac{3}{2}$$

then there is not enough Al to use up all the Cl_2, and the limiting reagent is Al

Step 2 of LR problem: Calculate moles of each reactant

We have 5.40 g of Al and 8.10 g of Cl_2

$$5.40\ \text{g Al} = \frac{1\ \text{mol}}{27.0\ \text{g}} = 0.200\ \text{mol Al}$$

$$8.10\ \text{g } Cl_2 = \frac{1\ \text{mol}}{70.9\ \text{g}} = 0.114\ \text{mol } Cl_2$$

Find mole ratio of reactants

$$2\ Al + 3\ Cl_2 \longrightarrow Al_2Cl_6$$

$$\frac{\text{mol } Cl_2}{\text{mol Al}} = \frac{0.114 \text{ mol}}{0.200 \text{ mol}} = 0.57$$

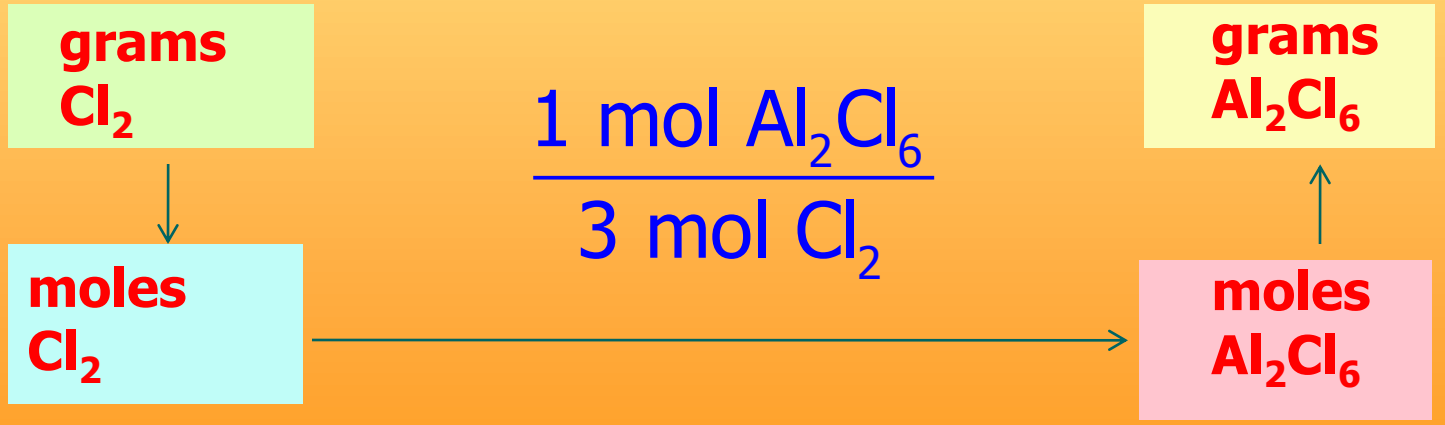
This should be 3/2 or 1.5/1 if reactants are present in the exact stoichiometric ratio.

Limiting reagent is Cl_2

Mix 5.40 g of Al with 8.10 g of Cl_2. What mass of Al_2Cl_6 can form?

$2\ Al + 3\ Cl_2 \rightarrow Al_2Cl_6$

Limiting reactant = Cl_2
Base all calcs. on Cl_2



CALCULATIONS: calculate mass of Al_2Cl_6 expected.

Step 1: Calculate moles of Al_2Cl_6 expected based on LR.

$$\text{mol } Cl_2 = \frac{1 \text{ mol } Al_2Cl_6}{3 \text{ mol } Cl_2} = 0.0380 \text{ mol } Al_2Cl_6$$

Step 2: Calculate mass of Al_2Cl_6 expected based on LR.

$$\text{mol } Al_2Cl_6 = \frac{266.4 \text{ g } Al_2Cl_6}{\text{mol}} = 10.1 \text{ g } Al_2Cl_6$$

How much of which reactant will remain when reaction is complete?

- Cl_2 was the limiting reactant. Therefore, Al was present in excess. But how much?
- First find how much Al was required.

- Then find how much Al is in excess.

Calculating Excess Al

$$2\,Al + 3\,Cl_2 \rightarrow \text{products}$$

0.200 mol

0.114 mol = LR

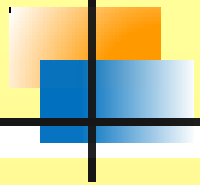
Calculating Excess Al

$$2\ Al + 3\ Cl_2 \rightarrow \text{products}$$

0.200 mol 0.114 mol = LR

$$\text{mol } Cl_2 = \frac{2 \text{ mol Al}}{3 \text{ mol } Cl_2} = 0.0760 \text{ mol Al req'd}$$

Excess Al = Al available - Al required
= 0.200 mol - 0.0760 mol
= 0.124 mol Al in excess



Thanks…