Limiting Reactants

Limiting Reactant

- If it takes 500 bricks and 1000 boards to make a house, how many houses can you make from 1600 bricks and 2000 boards?
- 2 houses, there are enough bricks for 3.2 houses. but only boards for 2 with our plans (reaction).
- In this analogy, the boards would be the limiting reactant.
- We can't make another house without the boards.
- You may be able to make something else with the bricks, like a fire pit, but that would require a different set of plans (a different reaction).

Definition

- Limiting reactant- the reactant that determines the amount of product that can be produced because of the amount of that reactant present.
- Whichever reactant yields the LEAST amount of product is the limiting reactant. This will be completely used up in the reaction.
- After the reaction is complete, there will be product, and unused excess reactant.

$Fe + O_2 \rightarrow FeO$

- If you have 87 g of Fe and 130 g of O_2 how much iron (II) oxide can be produced?
- Balance it first, then do the problem like before for both iron and oxygen.

$2\ Fe + O_2 \rightarrow 2\ FeO$

- If you have 87 g of Fe and 130 g of O_2 how much iron (II) oxide can be produced?
- Balance it first, then do the problem like before for both iron and oxygen.

87 g Fe	1 mol Fe	2 mol FeO	71.85 g FeO	=110 g FeO
	55.85 g Fe	2 mol Fe	1 mol FeO	

130 g O_2	1 mol O_2	2 mol FeO	71.85 g FeO	~~=580 g FeO~~
	32 g O_2	1 mol O_2	1 mol FeO	

Why the answer is 110 g FeO

- We have enough oxygen to make 580 g FeO but enough iron to make 110 g, therefore we can only make 110 g.
- The rest of the oxygen is excess (leftovers)
- Iron is our limiting reactant
- We can't make more iron (II) oxide without more iron, regardless of how much oxygen we have.

Another Example

- $NH_3 + O_2 \rightarrow NO + H_2O$
- How much NO can be produced from 52 g of NH_3 and 79 g of O_2?

Another Example

- $4\ NH_3 + 5\ O_2 \rightarrow 4\ NO + 6\ H_2O$
- How much NO can be produced from 52 g of NH_3 and 79 g of O_2?

52 g NH_3	1 mol NH_3	4 mol NO	30.01 g NO	~~=92 g NO~~
	17.034 g NH_3	4 mol NH_3	1 mol NO	

79 g O_2	1 mol O_2	4 mol NO	30.01 g NO	=59 g NO
	32 g O_2	5 mol O_2	1 mol NO	

BCA Tables

- BCA or before change after tables are used for tabulating the amounts of everything present in a stoichiometry reaction.

Problem

- $N_2 + 3\ H_2 \rightarrow 2\ NH_3$
- If 33 g of nitrogen are reacted with 4.5 g of hydrogen, how much ammonia is produced, how much limiting reactant is left?

Convert to moles for BCA table

- 33 g N_2 x 1 mol/28.02 g = 1.17 mol N_2
- 4.5 g H_2 x 1 mol/2.016 = 2.23 mol H_2
- $N_2 + 3\ H_2 \rightarrow 2\ NH_3$
- B 1.17 mol 2.23 mol ---
- C
- A

Change

$N_2 + 3\ H_2 \rightarrow 2\ NH_3$

B 1.17 mol 2.23 mol ---

- Change will be based off moles of reaction. Which will be the moles of each component divided by the coefficient.
- 1.17mol N_2 /1 -1.17 mol reaction
- 2.23 mol H_2 /3 = .74 mol reaction
- Hydrogen is my limiting reactant, nitrogen is excess

Convert to moles for BCA table

- $N_2 + 3\ H_2 \rightarrow 2\ NH_3$ for .74 mol rxn
- B 1.17 mol 2.23 mol ---
- C -.74 mol -2.23 mol 1.49 mol
- A .43 mol ----- 1.49 mol
- Change is the change from the reaction, after is what is present afterwards.

Finish the problem

- $N_2 + 3\ H_2 \rightarrow 2\ NH_3$
- If 33 g of nitrogen are reacted with 4.5 g of hydrogen, how much ammonia is produced, how much limiting reactant is left?
- $N_2 + 3\ H_2 \rightarrow 2\ NH_3$ for .74 mol rxn
- B 1.17 mol 2.23 mol ---
- C -.74 mol -2.23 mol 1.49 mol
- A .43 mol ----- 1.49 mol
- We have moles of nitrogen and ammonia. This can be converted to other units if necessary.