Chapter 12-Stoichiometry

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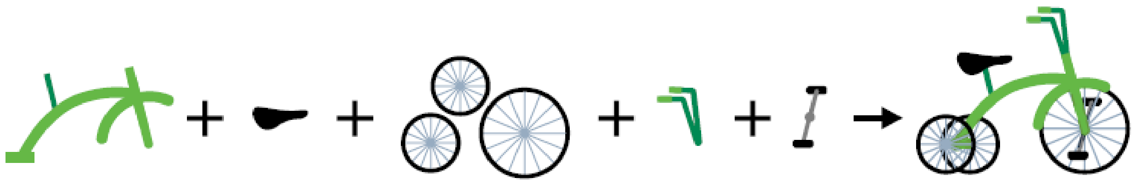
Section 12.1-The Arithmetic of Chemistry

- balanced chemical equations provide the 'recipes' for chemical reactions
- like baking recipes, it tells you how much you need and how much you get

EXAMPLE:

- each tricycle needs the material pictured below minimum to complete one unit



$$F + S + 3W + H + 2P \longrightarrow FSW_3HP_2$$

Questions:

1. How many complete tricycles could you make with 12 wheels?
2. How many seats would be needed?
3. How many pedals would be needed?

4. How many complete tricycles could be made if you had 17 wheels?
5. How many seats would be needed?
6. How many pedals would be needed?

7. How much of each material is needed to make 175 tricycles? Is anything left over?

Interpreting Chemical Equations

- balanced chemical equations can be interpreted a number of ways
  - > atoms, molecules, moles, mass or volume(if gases)

$N_2(g)$	+	$3H_2(g)$	→	$2NH_3(g)$
				
2 atoms N	+	6 atoms H	→	2 atoms N and 6 atoms H
1 molecule N_2	+	3 molecules H_2	→	2 molecules NH_3
10 molecules N_2	+	30 molecules H_2	→	20 molecules NH_3
$1 \times \left(6.02 \times 10^{23}\ \text{molecules}\ N_2\right)$	+	$3 \times \left(6.02 \times 10^{23}\ \text{molecules}\ H_2\right)$	→	$2 \times \left(6.02 \times 10^{23}\ \text{molecules}\ NH_3\right)$
1 mol N_2	+	3 mol H_2	→	2 mol NH_3
28 g N_2	+	3×2 g H_2	→	2×17 g NH_3
		34 g reactants	→	34 g products
Assume STP 22.4 L	+	22.4 L 22.4 L 22.4 L	→	22.4 L 22.4 L
22.4 L N_2		67.2 L H_2		44.8 L NH_3

Interpreting a Balanced Chemical Equation

Hydrogen sulfide, which smells like rotten eggs, is found in volcanic gases. The balanced equation for the burning of hydrogen sulfide is:

$$2H_2S(g) + 3O_2(g) \longrightarrow 2SO_2(g) + 2H_2O(g)$$

Interpret this equation in terms of

a. numbers of representative particles and moles.

The coefficients in a balanced chemical equation can be interpreted as atoms, particles or moles.

EXAMPLE:

$2H_2S$ can mean 2 molecules of H_2S or 2 moles of H_2S and so on

$2H_2S(g) + 3O_2(g) \longrightarrow 2SO_2(g) + 2H_2O(g)$

b. masses of reactants and products.

since the coefficients can be interpreted as # of moles, this balanced chemical equation tells us that 2 mol of H_2S and 3 mol of O_2 react to produce 2 mol of SO_2 and 2 mol of H_2O

Mass of Reactants

1 mol of H2S = 34.1g therefore 2 mol = 68.2g
1 mol of O2 = 32g therefore 3 mol = 96g

Total Mass is 68.2g + 96g = 164.2g

Mass of Products

1 mol of SO2 = 64.1g therefore 2 mol = 128.2g
1 mol of H2O = 18g therefore 2 mol = 36g

Total mass is 128.2g + 36g = 164.2g

Chemical Calculations

$N_2 + 3H_2 \longrightarrow 2NH_3$

1 mol of N_2 reacts with 3 mol of H_2 producing 2 mol of NH_3

Determine the masses in this reaction

28g N_2 + 6g H_2 $\longrightarrow$ 34g NH_3

Question?

What if only 0.5 mol of N2 were available?

$1N_2 + 3H_2 \longrightarrow 2NH_3$

$1N_2$	$3H_2$	$2NH_3$
↓	↓	↓
0.5	1.5	1.0

Therefore, only 1.5 mol of H_2 are used and it would only produce 1 mol of NH_3

28g N_2	+ 6g H_2	$\longrightarrow$ 34g NH_3
↓	↓	↓
14g	3g	17g

↑

1 mol H_2 = 2g
1.5 mol H_2 = 3g

'Typical' stoichiometric calculations will involve converting the moles of reactants or products into masses or volumes and vice versa.

These might include:

- *mole-mole calculations*
- *mass-mass calculations*
- *mole-volume@STP*
- *mass-volume@STP*
- *volume@STP-moles*
- *volume@STP-mass*

Generally speaking:

1. Balance the original equation
2. Convert masses or volumes to moles
3. 'rebalance' the equation using the 'new' mole values.
4. Convert the 'new' moles back into masses or volumes.

ALWAYS determine before starting

> ***what you are given***
> ***what you need to find***

Limiting Reagent and Percent Yield