stoichiometry

1) **stoichiometry** relates the amount of one substance to another during a chemical reaction

- use the **mole ratio** to relate the 2 substances to each other

$$\frac{\text{moles of substance B (the unknown from the balanced equation)}}{\text{moles of substance A (the given substance from the balanced equation)}}$$

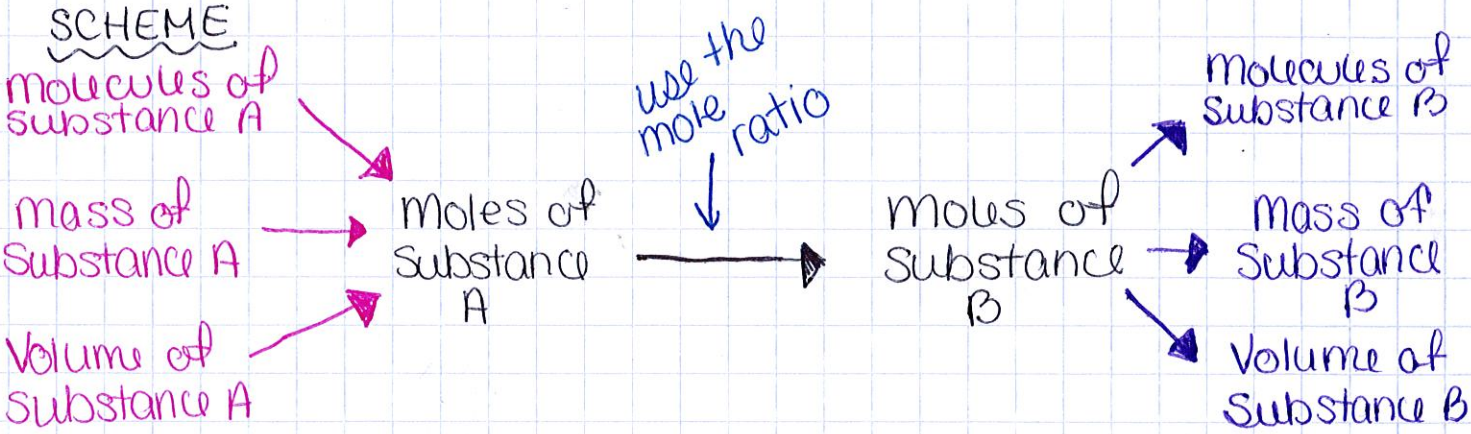
- In reality, we can't measure moles directly. So we measure

mass (g) or volume (L) or molecules (if gas)

& then convert those to moles BEFORE using the **mole ratio**.

- Also, since moles can be abstract, we usually convert back to mass, volume, or molecules at the end, AFTER using the mole ratio.

SCHEME



Ex) 1) $4\,BaCO_3 + Y_2(CO_3)_3 + 6\,CuCO_3 \rightarrow 2\,YBa_2Cu_3O_7 + 13\,CO_2 + 3\,O_2$

How many grams of $CuCO_3$ (B) are needed to fully react with 0.104 g of $BaCO_3$ (given A)?

$$\frac{.104\text{ g } BaCO_3}{197\text{ g/mol}} = 5.279\times10^{-4}\text{ mol } BaCO_3 \left(\frac{6\text{ mol } CuCO_3}{4\text{ mol } BaCO_3}\right)$$

$1(137) + 1(12) + 3(16) = 197$ g/mol

$$= 7.918\times10^{-4}\text{ mol } CuCO_3\,(124\text{ g/mol})$$

$1(64) + 1(12) + 3(16) = 124$

$= 0.098$ g $CuCO_3$

2) $2\,SO_2(g) + O_2(g) + 2\,H_2O(l) \rightarrow 2\,H_2SO_4(aq)$ (A → B)

What mass of sulfuric acid is produced from the reaction of 99.3 L of sulfur dioxide gas with excess oxygen gas and water at STP?

$$\frac{99.3\text{ L } SO_2}{22.4\text{ L/mol}}\left(\frac{2\text{ mol } H_2SO_4}{2\text{ mol } SO_2}\right)(98\text{ g/mol}) = 434\text{ g } H_2SO_4$$

3) $Cr_2O_3 + 2\,Al \rightarrow 2\,Cr + Al_2O_3$

How many atoms of chromium are produced from the reaction of 6.38×10^{23} formula units of chromium (III) oxide?

$$\frac{6.38\times10^{23}\text{ fu } Cr_2O_3}{6.02\times10^{23}\text{ fu/mol}}\left(\frac{2\text{ mol } Cr}{1\text{ mol } Cr_2O_3}\right)\left(6.02\times10^{23}\ \frac{\text{atoms } Cr}{\text{mol}}\right) = 1.28\times10^{24}\text{ atoms Cr}$$

2) Limiting Reactants

A) Limiting reactant controls, or limits, how much product can be made during a chemical reaction
- you run out of this reactant 1ST, so the reaction stops
- In a stoichiometry problem, it produces the least amount of product.

B) Excess reactant is present in more than sufficient quantity to have the reaction complete.

C) Theoretical yield is the amount of product the limiting reactant can create.

D) Actual yield is the amount of product made when the reaction is done in reality

E) $\%\text{yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100$

Ex) 1) $Cr_2O_3 + 2\,Al \rightarrow 2\,Cr + Al_2O_3$

If 18.7g of chromium (III) oxide reacts with 8.1g of aluminum...

152/48 — 102/54

A) Determine the theoretical yield of aluminum oxide.

LR

$$\frac{18.7\text{g } Cr_2O_3}{152\text{ g/mol}} = .123026315\text{ mol } Cr_2O_3 \left(\frac{1\text{ mol } Al_2O_3}{1\text{ mol } Cr_2O_3}\right) = .123026315\text{ mol } Al_2O_3 \left(\frac{102\text{ g}}{1\text{ mol}}\right)$$

$12.5\text{ g } Al_2O_3$

ER

$$\frac{8.1\text{g } Al}{27\text{ g/mol}} = .3\text{ mol } Al \left(\frac{1\text{ mol } Al_2O_3}{2\text{ mol } Al}\right) = .15\text{ mol } Al_2O_3 \left(\frac{102\text{ g}}{1\text{ mol}}\right)$$

$15.3\text{ g } Al_2O_3$

B) In the lab, 10.8g of aluminum oxide was produced. What is the percent yield for this process?

$$\%\text{ yield} = \frac{10.8\text{g}}{12.5\text{g}} \times 100 = 86.4\%$$

59) $Al(OH)_3 + 3HCl \rightarrow AlCl_3 + 3H_2O$

b) Find g HCl to react w/ .500g $Al(OH)_3$

$$.500\,g\,Al(OH)_3 \left(\frac{3\,mol\,HCl}{1\,mol\,Al(OH)_3}\right) 37\,g/mol = .712\,g\,HCl$$

64c) $2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$

d = .692 g/mL ? g

1.00 gal

$d = \frac{m}{V}$

$m = d \cdot V$

3.7854 L

V = 3785.4 mL

$m = .692\,\frac{g}{mL}(3785.4\,mL)$

$$m = 2619.5\,g\,C_8H_{18} \left(\frac{25\,mol\,O_2}{2\,mol\,C_8H_{18}}\right) 32\,g/mol = 9191.2\,g\,O_2$$