

## Announcements – Lecture XXIII – Wednesday, June 26<sup>th</sup>

EXAM III: FRI, JUN 28<sup>th</sup>, IN CLASS  
3 OR 4 questions taken from:  
LAB ONLS, 3.4, 4.2, 4.5, 5.5, 5.6



## Stoichiometry – The Essentials

SOLIDS and pure liquids :

$$\# \text{ mol} = \frac{\text{Mass in grams}}{\text{Molar Mass}}$$

Aqueous solutions :

$$\# \text{ mol} = M \times V(L)$$

$$M = \frac{\# \text{ mol}}{V(L)}$$

Gases :

$$\# \text{ mol} = \frac{PV}{RT}$$

$$PV = nRT$$



## LO\_3.4 Solution Concentration

In the laboratory you dissolve 16.0 g of calcium nitrate in a volumetric flask and add water to a total volume of 500 mL.

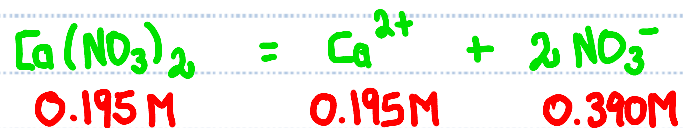
What is the concentration of the calcium cation? **0.195M**

What is the concentration of the nitrate anion? **0.390M**

$$\text{Ca(NO}_3)_2 : 40.08 + 2(14.01) + 6(16.00) = 164.1 \text{ g}\cdot\text{mol}^{-1}$$

16.0g  
500 mL

$$M = \frac{\# \text{ mol Ca(NO}_3)_2}{V(L)}$$
$$\frac{16.0 \text{ g Ca(NO}_3)_2}{164.1 \text{ g}} \cdot \frac{1 \text{ mol}}{164.1 \text{ g}} = 0.0975 \text{ mol}$$
$$= \frac{0.0975}{0.5} = 0.195 \text{ M}$$



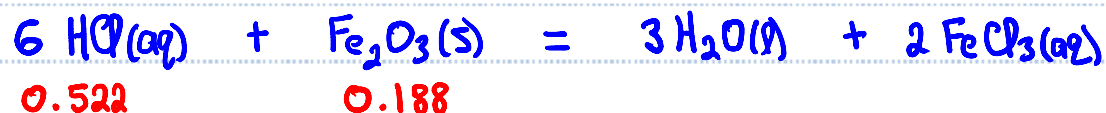
## LO\_4.2 Limiting Reagent

Hydrochloric acid (aq) + iron(III) oxide (s) = water (l) + iron(III) chloride (aq)

When 0.522 moles of hydrochloric acid are mixed with 0.188 moles of iron(III) oxide

Determine the formula for the limiting reagent and what is the maximum amount of water in moles that can be produced:

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$$\frac{0.522 \text{ mol HCl}}{6 \text{ HCl}} \times \frac{3 \text{ H}_2\text{O}}{1} = 0.261 \text{ mol H}_2\text{O} \quad *$$

$$\frac{0.188 \text{ mol Fe}_2\text{O}_3}{1 \text{ Fe}_2\text{O}_3} \times \frac{3 \text{ H}_2\text{O}}{1} = 0.564 \text{ mol H}_2\text{O}$$

Limiting reagent : HCl  
0.261 mol H<sub>2</sub>O = maximum amount

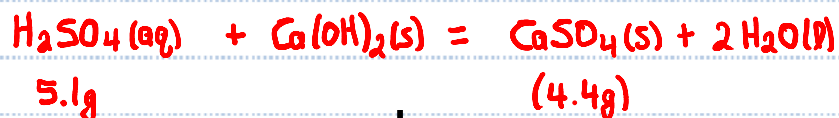
## LO\_4.5 Percent Yield

For the following reaction, 5.1g of sulfuric acid are mixed with excess calcium hydroxide. The reaction yields 4.4g of calcium sulfate



1. What is the theoretical yield of calcium sulfate: 7.1 g

2. What is the percent yield of calcium sulfate: 62 %



$$\text{H}_2\text{SO}_4: 2(1.01) + 32.07 + 4(16.00) = 98.09 \text{ g} \cdot \text{mol}^{-1}$$

$$\frac{5.1 \text{ g H}_2\text{SO}_4}{98.09 \text{ g}} \times 1 \text{ mol} = 0.052 \text{ mol H}_2\text{SO}_4$$

$$\frac{0.052 \text{ mol H}_2\text{SO}_4}{1 \text{ H}_2\text{SO}_4} \times 1 \text{ CaSO}_4 = 0.052 \text{ mol CaSO}_4$$

$$\text{CaSO}_4: 40.08 + 32.07 + 4(16.00) = 136.15 \text{ g} \cdot \text{mol}^{-1}$$

$$\frac{0.052 \text{ mol CaSO}_4}{1 \text{ mol}} \times 136.15 \text{ g} = 7.1 \text{ g CaSO}_4$$

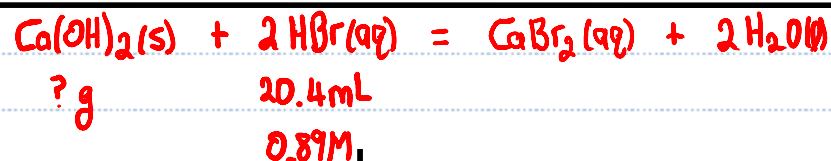
$$\left( \frac{4.4}{7.1} \right) 100 = 62\%$$

## LO\_5.5 Titrations

How many grams of solid calcium hydroxide are needed to exactly neutralize 20.4 mL of a 0.89M hydrobromic acid solution?

Assume the volume remains constant.

0.67 g



$$\# \text{mol HBr} = 0.89 \times 0.0204 = 0.018$$

$$\frac{0.018 \text{ mol HBr}}{2 \text{ HBr}} \left| \frac{1 \text{ Ca(OH)}_2}{1} \right. = 0.0091 \text{ mol Ca(OH)}_2$$

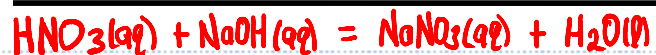
$$\text{Ca(OH)}_2: 40.08 + 2(16.00 + 1.01) = 74.1 \text{ g} \cdot \text{mol}^{-1}$$

$$\frac{0.0091 \text{ mol Ca(OH)}_2}{1 \text{ mol}} \left| \frac{74.1 \text{ g}}{1} \right. = 0.67 \text{ g}$$



## LO\_5.6 Titrations

34.4 mL of 1.74 M nitric acid is added to 44.1 mL of sodium hydroxide, the resulting solution is acidic. 23.8 mL of 0.630 M calcium hydroxide is required to reach neutrality. What is the molarity of the original sodium hydroxide solution?

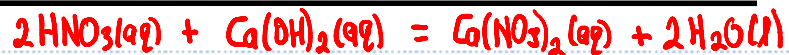


$$\begin{array}{l} 34.4 \text{ mL} \quad 44.1 \text{ mL} \\ 1.74 \text{ M} \end{array}$$

$$\# \text{ mol HNO}_3 \text{ added: } 1.74 \times 0.0344 = 0.0600 \text{ mol HNO}_3$$

$$\# \text{ mol Ca(OH)}_2 = 0.630 \times 0.0238 = 0.0150$$

$$\frac{0.0150 \text{ mol Ca(OH)}_2}{1 \text{ Ca(OH)}_2} \times \frac{2 \text{ HNO}_3}{1 \text{ Ca(OH)}_2} = 0.0300 \text{ mol HNO}_3$$



$$\begin{array}{l} 23.8 \text{ mL} \\ 0.630 \text{ M} \end{array}$$

$$0.0600 - 0.0300 = 0.0300 \text{ mol HNO}_3^*$$

\* amount that neutralized the 44.1 mL of NaOH

$$\frac{0.0300 \text{ mol HNO}_3}{1 \text{ HNO}_3} \times \frac{1 \text{ NaOH}}{1 \text{ HNO}_3} = 0.0300 \text{ mol NaOH}$$

$$M = \frac{\# \text{ mol NaOH}}{V(\text{L})}$$

$$= \frac{0.0300}{0.0441} = 0.680 \text{ M}$$

