Announcements – Lecture XXIV – Wednesday, June 25th

1. **Exam III:** Friday, June 26th, In Class
   3 or 4 questions will be taken from Lab Owls:-
   3.4 , 4.2 , 4.5 , 5.5 , 5.6

Stoichiometry – The Essentials

Solids and pure liquids : $\#\,mol = \frac{\text{Mass in grams}}{\text{Molar Mass}}$

Aqueous solutions : $\#\,mol = M \times V(L)$

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

Gases : $\#\,mol = \frac{PV}{RT}$

$$PV = nRT$$

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 ? 0.390 M

$Ca(NO_3)_2$: $40.08 + 2(14.01) + 6(16.00) = 164.1\ g.mol^{-1}$

16.0 g

500 mL

$$M = \frac{\#\ mol\ Ca(NO_3)_2}{V(L)}$$

$$16.0\ g\ Ca(NO_3)_2 \left| \frac{1\ mol}{164.1\ g} \right. = 0.0975\ mol$$

$$= \frac{0.0975}{0.5} = 0.195\ M$$

$Ca(NO_3)_2 = Ca^{2+} + 2\ NO_3^-$

0.195 M 0.195M 0.390M

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:

$$\underset{0.522}{6\ HCl(aq)} + \underset{0.188}{Fe_2O_3(s)} = 3\ H_2O(l) + 2\ FeCl_3(aq)$$

$$0.522\ mol\ HCl \left| \frac{3\ H_2O}{6\ HCl} \right. = 0.261\ mol\ H_2O \quad *$$

$$0.188\ mol\ Fe_2O_3 \left| \frac{3\ H_2O}{1\ Fe_2O_3} \right. = 0.564\ mol\ H_2O$$

Limiting Reagent : HCl

0.261 mol H_2O = 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

Sulfuric acid (aq) + calcium hydroxide (s) = calcium sulfate (s) + water (l)

1. What is the theoretical yield of calcium sulfate: 7.1 g
2. What is the percent yield of calcium sulfate: 62 %

$H_2SO_4(aq) + Ca(OH)_2(s) = CaSO_4(s) + 2H_2O(l)$

5.1g (4.4g)

H_2SO_4: $2(1.01) + 32.07 + 4(16.00) = 98.09\ g.mol^{-1}$

$$5.1\ g\ H_2SO_4 \left| \frac{1\ mol}{98.09\ g} \right. = 0.052\ mol\ H_2SO_4$$

$$0.052\ mol\ H_2SO_4 \left| \frac{1\ CaSO_4}{1\ H_2SO_4} \right. = 0.052\ mol\ CaSO_4$$

$CaSO_4$: $40.08 + 32.07 + 4(16.00) = 136.15\ g.mol^{-1}$

$$0.052\ mol\ CaSO_4 \left| \frac{136.15\ g}{1\ mol} \right. = 7.1\ g\ CaSO_4$$

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

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

$Ca(OH)_2(s) + 2\,HBr(aq) = CaBr_2(aq) + 2\,H_2O(l)$

? g 20.4 mL 0.89M

#mol HBr = $0.89 \times 0.0204 = 0.018$

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

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

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

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?.

$HNO_3(aq) + NaOH(aq) = NaNO_3(aq) + H_2O(l)$

34.4 mL 44.1 mL

1.74 M

$2HNO_3(aq) + Ca(OH)_2(aq) = Ca(NO_3)_2(aq) + 2H_2O(l)$

23.8 mL

0.630 M

mol HNO_3 added: $1.74 \times 0.0344 = 0.0600$ mol HNO_3

mol $Ca(OH)_2 = 0.630 \times 0.0238 = 0.0150$

$$0.0150 \text{ mol } Ca(OH)_2 \left| \frac{2 \text{ } HNO_3}{1 \text{ } Ca(OH)_2} \right. = 0.0300 \text{ mol } HNO_3$$

$0.0600 - 0.0300 = 0.0300$ mol HNO_3*

* amount that neutralized the 44.1 mL of NaOH

$$0.0300 \text{ mol } HNO_3 \left| \frac{1 \text{ } NaOH}{1 \text{ } HNO_3} \right. = 0.0300 \text{ mol } NaOH$$

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

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