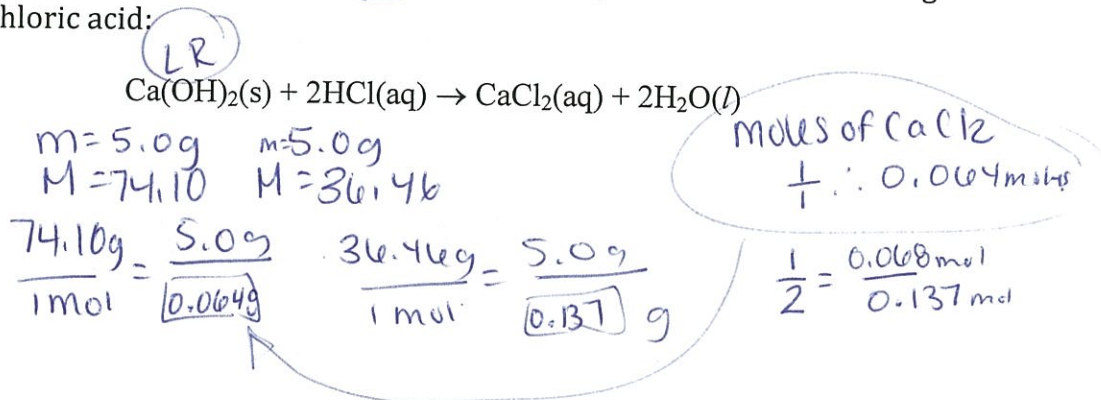# Chemical Analysis – Applications of Stoichiometry
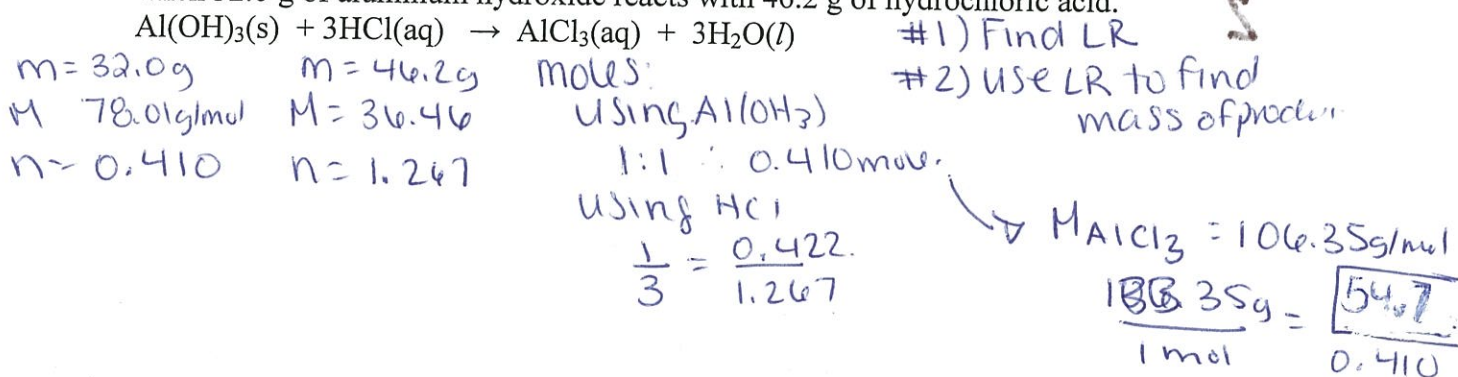
Unit Exam: _tomorrow_ (Chapter 8)

Excess and Limiting Reagents
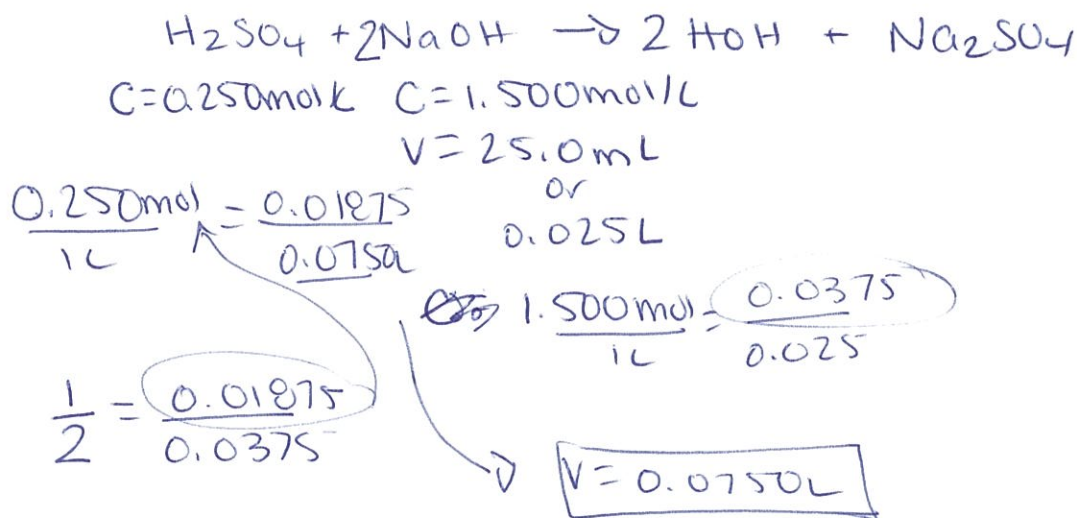
1. Determine the limiting reagent if 5.0 g of calcium hydroxide react with 5.0 g of hydrochloric acid:

(LR)

$$Ca(OH)_2(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + 2H_2O(l)$$

m = 5.0g   m = 5.0g
M = 74.10   M = 36.46

$$\frac{74.10g}{1 mol} = \frac{5.0g}{0.064g}$$ $$\frac{36.46g}{1 mol} = \frac{5.0g}{0.137} g$$

moles of CaCl₂
∴ 0.064 moles

$$\frac{1}{2} = \frac{0.068 mol}{0.137 mol}$$

2. From the following balanced equation, determine the mass of aluminum chloride formed when 32.0 g of aluminum hydroxide reacts with 46.2 g of hydrochloric acid.
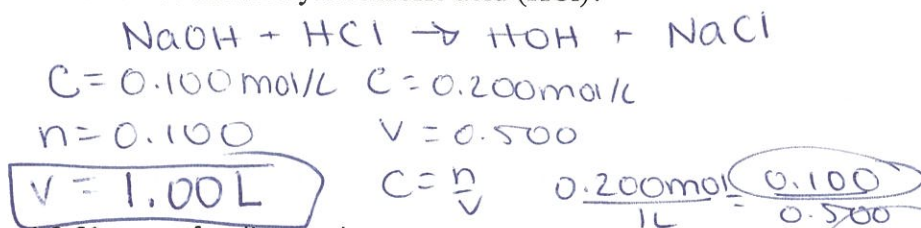
$$Al(OH)_3(s) + 3HCl(aq) \rightarrow AlCl_3(aq) + 3H_2O(l)$$

#1) Find LR
#2) use LR to find mass of product

m = 32.0g   m = 46.2g   moles:
M 78.0g/mol   M = 36.46   using Al(OH)₃
n ~ 0.410   n = 1.267   1:1 ∴ 0.410 mol.

using HCl
$$\frac{1}{3} = \frac{0.422}{1.267}$$

M AlCl₃ = 106.35g/mol

$$\frac{106.35g}{1 mol} = \frac{54.7}{0.410}$$

3. How many mL of 0.250 mol/L $H_2SO_{4(aq)}$ are required to react completely with 25.0 mL of 1.500 mol/L $NaOH_{(aq)}$?

$$H_2SO_4 + 2NaOH \rightarrow 2HOH + Na_2SO_4$$

C = 0.250mol/L   C = 1.500mol/L
V = 25.0mL
or
0.025L

$$\frac{0.250mol}{1L} = \frac{0.01875}{0.075a}$$

$$\frac{1.500mol}{1L} = \frac{0.0375}{0.025}$$

$$\frac{1}{2} = \frac{0.01875}{0.0375}$$

$$V = 0.0750L$$

Titrations

1. What volume of 0.100 mol/L aqueous sodium hydroxide (NaOH) is neutralized by 500 mL of 0.200 mol/L hydrochloric acid (HCl)?

$$NaOH + HCl \rightarrow HOH + NaCl$$

$C = 0.100 \, mol/L \quad C = 0.200 \, mol/L$

$n = 0.100 \quad\quad\quad V = 0.500$

$\boxed{V = 1.00 \, L} \quad C = \dfrac{n}{V} \quad 0.200 \, mol \dfrac{0.100}{0.500}$

$\dfrac{}{1L}$

2. A 2.61 mass of sodium carbonate, $Na_2CO_{3(s)}$, was dissolved to make 200.0mL of solution. Samples (10.00mL) of this standard solution were then taken and titrated with the hydrochloric acid solution.

Trial	1	2	3	4
Final burette reading (mL)	15.3	25.9	38.8	15.4
Initial burette reading (mL)	2.2	15.3	25.9	1.1
Volume of $HCl_{(aq)}$ added	13.1	10.6	12.9	14.3

$$2HCl + Na_2CO_3 \rightarrow$$

$V = 13.00 \, mL \quad\quad m = 2.61$

or

$0.01300 \, L \quad\quad M = 105.99$

$\dfrac{105.99g}{1 mol} = \dfrac{2.61}{0.0246 \, mol}$

$C = ?$

$n = 0.00246$

$C = 0.123 \, mol/L$

$\boxed{C = 0.189 \, mol/L} \quad \dfrac{0.123 mol}{1L} = \dfrac{0.00123}{0.0100}$

3. A student conducts three trials to determine the concentration of barium hydroxide. The titrant used is a 0.250 mol/L hydrochloric acid solution. Each sample of barium hydroxide is 10.00 mL. Calculate the concentration of the barium hydroxide for each trial. What is the average concentration of barium hydroxide?

Trial #	1	2	3
Final volume HCl(aq) (mL)	37.32	24.56	11.78
Initial volume HCl(aq) (mL)	50.00	37.32	24.56

12.68 12.76 12.78

$V = 12.74 \, mL$

$$Ba(OH)_2 + HCl \rightarrow 2HOH + BaCl_2$$

$n = 0.003185 \quad V = 12.74 \, mL$

$V = 0.01000 \quad C = 0.250 \, mol/L$

$\boxed{C = 0.319 \, mol/L} \quad \dfrac{0.250 mol}{1L} = \dfrac{0.003185}{0.01274 \, L}$

pH Curves

1. Label the Equivalence point and buffering area.
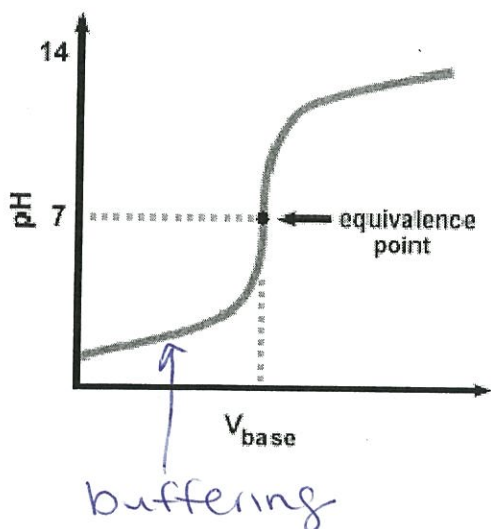
pH Range and Colour Change of Indicators

Indicator	pH Range	Colour Change
Methyl red	4.8–6.0	red–yellow
Bromothymol blue	6.0–7.6	yellow–green–blue
Phenol red	6.6–8.0	yellow–red
Phenolphthalein	8.2–10.0	colourless–pink

2. In a titration, an acid is the titrant that is in a burette. The titration goes past the equivalence point and the indicator colour is yellow. Referring only to the indicators listed in the table, what indicator was used?

   methylred.

4. A titration is to be carried out with the equivalence point coming at pH = 7.5. Referring only the indicators listed in the table, which one would be the best choice for this titration?

   Bromothymol blue