Chemistry 20
Unit 4- Stoichiometry Unit (Quantitative Relationships)

KEY

Outcome 1 – Quantitative Relationships with balanced chemical reactions

Students will explain how balanced chemical equations indicate the quantitative relationships between reactants and products involved in chemical changes.

Specific Outcomes met in Outcome 1

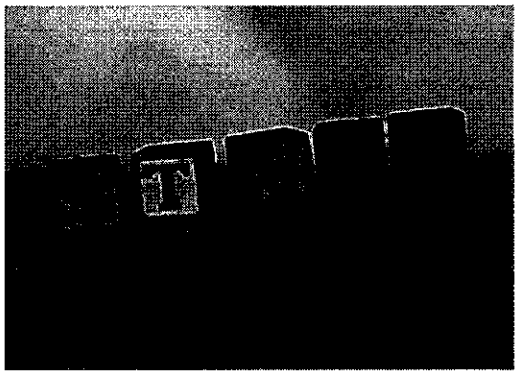
Students will:

20–D1.1k - predict the product(s) of a chemical reaction based upon the reaction type
20–D1.2k - recall the balancing of chemical equations in terms of atoms, molecules and moles
20–D1.3k - contrast quantitative and qualitative analysis
20–D1.5k - calculate the quantities of reactants and/or products involved in chemical reactions, using gravimetric, solution or gas stoichiometry.

20–D2.3k - define theoretical yields and actual yields
20–D2.4k - explain the discrepancy between theoretical and actual yields

Lessons in which the above Specific Outcomes will be embedded

*Lesson 1 – Stoichiometric ratios
*Lesson 2 – Gravimetric Stoichiometry
*Lesson 3 – Gas Stoichiometry
*Lesson 4 – Solution Stoichiometry



Chemistry 20 – **Stoichiometry Unit** ***Date:***

Outcome 1 **– Quantitative Relationships with balanced chemical reactions**

Lesson 1: Stoichiometric ratios

I can... describe the molar ratio in balanced chemical reactions.

I can... write balanced chemical reactions.

I can...describe the unit of measurement used for reactions of solids, aqueous solutions and gases.

To help me learn this I will:
1. Do the pages 1-3 in the work booklet
2. Do the examples below
3. See Mr. Gray if I am having trouble

Examples:

1. Hydrochloric acid is produced in the stomach to aid in the breakdown and digestion of food. Excess stomach acid, however, can irritate the lower esophagus causing heartburn. Milk of magnesia, a suspension of $Mg(OH)_{2(s)}$ in water, can usually provide effective relief from heartburn pain.

a) Write a balanced equation for the chemical reaction of milk of magnesia with excess stomach acid.

$2HCl_{(aq)} + Mg(OH)_{2(s)} \rightarrow 2H_2O_{(l)} + MgCl_{2(aq)}$

b) How many moles of stomach acid are neutralized for every mole of magnesium hydroxide in milk of magnesia?

2 moles of HCl : 1 mol of $Mg(OH)_2$

Chemistry 20 – **Stoichiometry Unit** ***Date:***

Outcome 1 **– Quantitative relationships with balanced chemical reactions**

Lesson 2: Gravimetric Stoichiometry

I can... write a balanced chemical equation.

I can... use the molar ratio and then the m=nM formula to determine the mass of the wanted species.

I can...determine the % yield on an experiment that I preform.

I can... determine % error to decide if an experiment was valid.

To help me learn this I will:
1. Read pgs. 286-293
2. Do # 6-10 on page 293
3. Do pages4&5 of the work booklet
4. Do the examples below
5. See Mr. Gray if I am having trouble

Examples:

1. In a double replacement reaction, $KOH_{(aq)}$ reacts with excess $Sn(NO_3)_{2\,(aq)}$ to produce a precipitate. If the mass of the precipitate is 2.57g, what mass of $KOH_{(aq)}$ was present in the original $KOH_{(aq)}$ solution?

$2KOH_{(aq)} + Sn(NO_3)_{2(aq)} \rightarrow Sn(OH)_{2(s)} + 2KNO_{3(aq)}$

$n = 0.0336mol$ ← $\times 2$ ← $m = 2.57g$

$M = 56.11g/mol$ $M = 152.73g/mol$

$m = nM$ $n = 0.0168mol$

$m = 1.89g$

Chemistry 20 – **Stoichiometry Unit** ***Date:***

Outcome 1 **– Quantitative Relationships with balanced chemical reactions**

Lesson 3 : Gas Stoichiometry

I can... use gas laws and molar volume to perform calculations (m=nM; PV=nRT; n=v/V)

To help me learn this I will:
1. Read pgs. 294-299
2. Do # 1-7 on page 299
3. Do the page 8&9 in the work booklet
4. Do the examples below
5. See Mr. Gray if I am having trouble

Examples:

1. In a combustion reaction, 150g of methanol ($CH_3OH_{(l)}$) are completely burned. What volume of $CO_2(g)$ at 95.0kPa and 20.0°C will be produced?

$2CH_3OH_{(l)} + 3O_{2(g)} \rightarrow 2CO_{2(g)} + 4H_2O_{(l)}$

$m = 150g$

$M = 32.05g/mol$

$n = 4.68mol$

$V = ?$

$n = 4.68mol$

$PV = nRT$

$(95.0kPa)(V) = (4.68mol)(8.31)(293k)$

$V = 120L$

Chemistry 20 – **Stoichiometry Unit** ***Date:***

Outcome 1 **– Quantitative Relationships with balanced chemical reactions**

Lesson 4 : Solution Stoichiometry

I can... use the concentration formula to determine the concentration of specific entities (c=n/v).

To help me learn this I will:
1. Read pgs. 300-303
2. Do # 1-6 on page 303
3. Do the page 6 &7 in the work booklet
4. Do the examples below
5. See Mr. Gray if I am having trouble

Examples:

1. In an experiment, 25.0 mL of 0.100mol/L sulfuric acid is neutralized completely with 10.0mL of potassium hydroxide solution. What is the concentration of the potassium hydroxide solution?

$H_2SO_{4(aq)} + 2KOH_{(aq)} \rightarrow K_2SO_{4(aq)} + 2H_2O_{(l)}$

$c = 0.100 mol/L$
$V = 0.0250 L$
$n = 0.00250 mol$

$\times 2$

$n = 0.00500 mol$
$V = 0.0100 L$
$c = \frac{n}{V} = \frac{0.00500 mol}{0.0100 L}$

$\boxed{c = 0.500 mol/L}$

Chemistry 20
Unit 4- Stoichiometry Unit (Quantitative Relationships)

Outcome 2 – Use stoichiometry to calculate and titrate

Students will use stoichiometry in quantitative analysis.

Specific Outcomes met in Outcome 2

Students will:

20–D2.1k - explain chemical principles (i.e., conservation of mass in a chemical change), using quantitative analysis
20–D2.2k - identify limiting and excess reagents in chemical reactions
20–D2.5k - draw and interpret titration curves, using data from titration experiments involving strong monoprotic acids and strong monoprotic bases
20–D2.6k - describe the function and choice of indicators in titrations
20–D2.7k - identify equivalence points on strong monoprotic acid–strong monoprotic base titration curves and differentiate between the indicator end point and the equivalence point.

20–D1.4k - write balanced ionic and net ionic equations, including identification of spectator ions, for reactions taking place in aqueous solutions

Lessons in which the above Specific Outcomes will be embedded

Lesson 5 – Limiting and Excess Reagents
Lesson 6 – Acid/Base Titrations
Lesson 7 – Net Ionic Reactions

***Chemistry 20 –* Stoichiometry Unit** **Date:**

***Outcome 2* – Use stoichiometry to calculate and titrate**

Lesson 5 : Limiting and Excess Reagents

I can... explain what the terms limiting reagent and excess reagent mean.

I can... calculate which reactant is the limiting reagent in a scenario.

To help me learn this I will:
1. Read pgs. 284 and 314-327
2. Do # 1-9 on page 327
3. Do page 10 &11 in the work booklet
4. Do the examples below
5. See Mr. Gray if I am having trouble

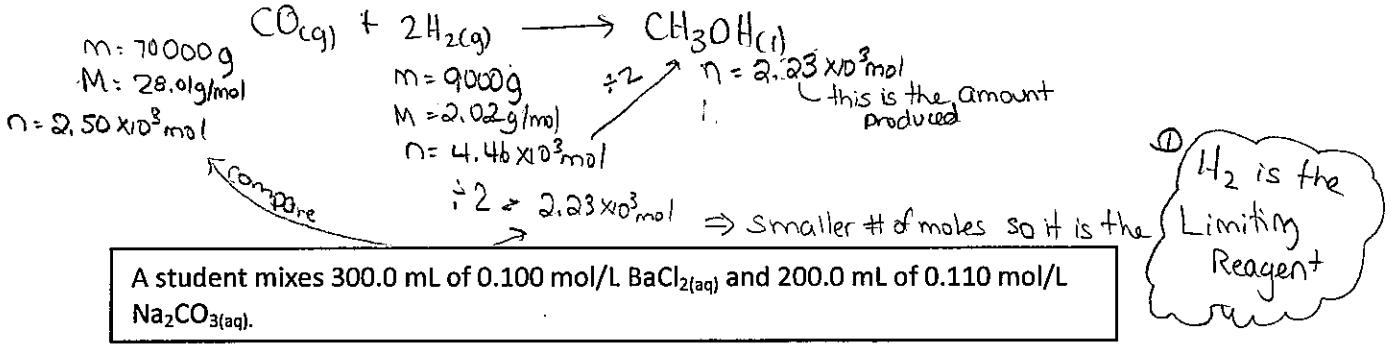
Examples:

1. Methyl hydrate ($CH_3OH_{(l)}$), commonly called gasoline antifreeze, is added to automobile gas tanks in winter to aid in the cleaner combustion of gasoline that has been contaminated by water condensation. The IUPAC name for methyl hydrate is methanol. It is produced by the chemical reaction

$$CO_{(g)} + 2H_{2(g)} \rightarrow CH_3OH_{(l)}$$

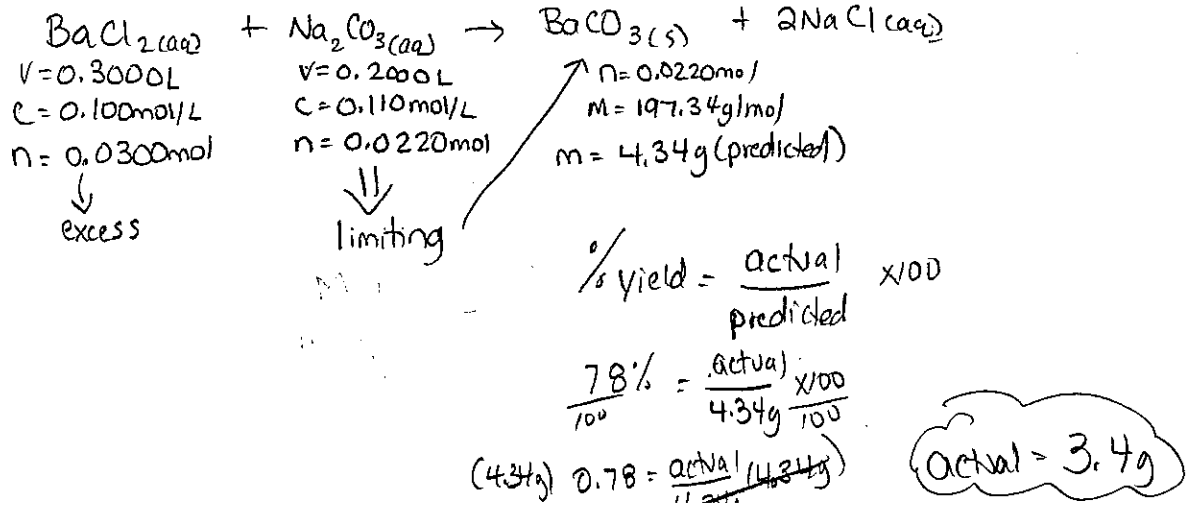
The reaction is carried out using 70.0kg of $CO_{(g)}$ in combination with 9.00kg of $H_{2.(g)}$.

Assuming the reaction goes to completion, identify the limiting reagent and the amount (in mol) of $CH_3OH_{(l)}$ produced in this situation?



2. A student mixes 300.0 mL of 0.100 mol/L $BaCl_{2(aq)}$ and 200.0 mL of 0.110 mol/L $Na_2CO_{3(aq)}$.

What mass of precipitate actually forms if the experimental yield is 78% of the predicted yield?



***Chemistry 20 –* Stoichiometry Unit** **Date:**

***Outcome 2* – Use stoichiometry to calculate and titrate**

Lesson 6 : Acid/Base Titrations

I can...explain the process of titrating, including how many trials must be preformed and why.

I can... explain what an endpoint is and what it means.

I can...use data to calculate the concentration of a reactant.

I can...use an acid/base pH curve to determine which indicator I should use in a titration.

To help me learn this I will:
1. Read pgs. 328-339
2. Do # 1-9 on page 329
3. Do the page 13 in the work booklet
4. Do the examples below
5. See Mr. Gray if I am having trouble

Examples:

1. A basic substance was titrated with HCL. The equivalence point occurred when the pH reached 3.5.

A Suitable indicator for this endpoint is (multiple choice)

a) Chlorophenol red
b) Bromothymol blue
c) Methyl orange
d) Thymol blue

2. A technician performed a titration to determine the concentration of 27.0 mL sample of $NaOH_{(aq)}$. A few drops of phenol red indicator were added to the base, which was then titrated with a 0.24 mol/L solution of $HCl_{(aq)}$ until the indicator changed colour from red to orange.

	Volume of Acid Used		
Final burette reading (mL)	25.8g	26.0g	25.6g
Initial burette reading (mL)	7.8g	8.1g	7.4g
	18.0 mL	17.9mL	18.2mL

[Acid] = 18.03mL

What is the concentration of the $NaOH_{(aq)}$ solution?

$NaOH(aq) + HCl(aq) \rightarrow H_2O(l) + NaCl(aq)$

V=0.027L
$n = 4.3 \times 10^{-3}$ mol

V=0.01803L
C=0.24mol/L
$n = 4.3 \times 10^{-3}$ mol

$C = \frac{n}{V}$

C= 0.16 mol/L

Chemistry 20 – **Stoichiometry Unit** ***Date:***

Outcome 2 – Use stoichiometry to calculate and titrate

Lesson 7 : Net Ionic Reactions

I can... explain what a spectator ion is.

I can... determine the net ionic reactions for ionic compounds.

To help me learn this I will:
1. Read pgs. 281- 284
2. Do # 10-14 on page 284
3. Do the examples below
4. See Mr. Gray if I am having trouble

Examples:

1. What is a spectator ion?
2. Ions that do not participate in the reaction. They do not change
3. Write the net ionic equation representing the reaction between calcium nitrate and sodium carbonate.

$$Ca(NO_3)_{2(aq)} + Na_2CO_{3(aq)} \longrightarrow CaCO_{3(s)} + 2NaNO_{3(aq)}$$

$$Ca^{2+}_{(aq)} + \cancel{2NO_3^{-1}_{(aq)}} + \cancel{2Na^{+1}_{(aq)}} + CO_3^{2-}{}_{(aq)} \rightarrow CaCO_{3(s)} + \cancel{2Na^{+}_{(aq)}} + \cancel{2NO_3^{-}{}_{(aq)}}$$

$$Ca^{2+}_{(aq)} + CO_3^{2-}{}_{(aq)} \rightarrow CaCO_{3(s)}$$

(spectator ions = $2NO_3^{-1}{}_{(aq)}$, $2Na^{+1}{}_{(aq)}$)