Stoichiometry Lesson Plan

Jerel Ray Perez	**High School**	**Chemistry**	**90 minutes**
Objective			
Students will use their knowledge of chemical reactions as it applies to stoichiometry and predicting outcomes. This lesson will have students use their conceptual knowledge of chemical quantities and unit conversions in order to make precise calculations.			
Warm up		Materials Needed	
What is the molecular mass of propane?		Teacher	Students
Write a complete combustion reaction for propane.		Computer, projector, white board, dry erase markers, laptop	Pencils or pens, calculator, Periodic Table with Polyatomic Ions Chart, Stoichiometry notes and worksheet

ENGAGE/HOOK/INTRODUCTION				
Pacing	**Level of Thinking** (Bloom's Taxonomy)	**Description of Activity:** Decomposition of Sugar with Sulfuric Acid **Objective:** This demonstration has students visually conceive the idea of a volatile chemical reaction while practicing safe laboratory procedures.		**Probing Questions**
5-10 min.	Knowledge Analysis	Teacher says/does: Students are asked to gather near and observe around the sealed vent hood but do not interact with environment. Say: Ask for their understanding of decomposition reactions. Do: In the vent hood the teacher places 20 grams of sugar in a large glass container and slowly adds 20mL sulfuric acid. Step back and shut the vent hood glass window. A volatile reaction will occur that produces a lot of gas and heat.	Students say/do: Students should answer the first two probing questions before proceeding with the demonstration. Do: Students gather near a visible region of the vent hood but stay3-4 feet away from glass window.	1. What is a decomposition reaction? 2. What does a carbohydrate produce in a decomposition reaction? 3. What gas is being formed? 4. What is the black solid formed? 5. Was this an endothermic or exothermic reaction?
EVALUATE/ASSESS/CHECK FOR UNDERSTANDING:		Ask probing questions		

<table>
<tr><td colspan="5">Explain/Input/Instruction:</td></tr>
<tr><td>Pacing</td><td>Level of Thinking (Bloom's Taxonomy)</td><td colspan="2">Description of Activity: The teacher will give a Presi presentation via laptop onto the white board with the projector. The use of written equations on the whiteboard will be used enhance the learning process so students may show their predicted steps to solving the problems.
Objective: Students will demonstrate their understanding of stoichiometric calculations by identifying the step-by-step course of action required to predict quantities.</td><td>Probing Questions</td></tr>
<tr><td>20 min.</td><td>Knowledge
Comprehension</td><td>Teacher says/does: Ask students to refer to their notes sheet and take out an extra sheet of blank paper for calculations.
Do: Refer to each frame of the presentation while reviewing previous concepts, presenting new ideas to which they apply, and allow students the opportunity to solve two to three problems before proceeding.</td><td>Students say/do: Students will be given a number of mini-problem examples in order to reactivate prior knowledge.

Say: Students should be asked for every step in the equations and be asked to demonstrate their work.</td><td>1. What do you know about formula mass and the mole?
2. How do you identify mole ratios?
3. Why is this lesson significant?</td></tr>
<tr><td colspan="3">§112.35. Chemistry (c) Knowledge and skills.
(8) Science concepts. The student can quantify the changes that occur during chemical reactions. The student is expected to:
(A) define and use the concept of a mole;
(B) use the mole concept to calculate the number of atoms, ions, or molecules in a sample of material</td><td colspan="2">Independent/Group Practice:

Practice questions on note sheet</td></tr>
<tr><td colspan="2">EVALUATE/ASSESS/CHECK FOR UNDERSTANDING:</td><td colspan="3">Ask for participation; allow group practice and evaluate over groups.</td></tr>
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Assessment:

Pacing	Level of Thinking (Bloom's Taxonomy)	Description of Activity: Small Group Practice Objective: Students will demonstrate their understanding of stoichiometric calculations while modeling their procedure with their peers.		Probing Questions
10-15 min.	Knowledge Comprehension Application Evaluate	Teacher says/does: Do: Work the first one to two problems on the whiteboard with students suggesting steps to solve the problems. Do: Have students work in groups to solve the problems on the worksheet. Students should show their work. Do: Require students to complete the sheet within the period and submit it for review.	Students say/do: Students will be placed in groups to complete the worksheet. Do: Students will apply this new skill by both successfully completing the Stoichiometry worksheet and help their group members create their understanding of the concept.	1. What is the mole to mole ratio for each equation? 2. Determine the formula mass and weight of each compound.

§112.35. Chemistry (c) Knowledge and skills.
(8) Science concepts. The student can quantify the changes that occur during chemical reactions. The student is expected to:
(A) define and use the concept of a mole;
(B) use the mole concept to calculate the number of atoms, ions, or molecules in a sample of material;
(C) calculate percent composition and empirical and molecular formulas;
(D) use the law of conservation of mass to write and balance chemical equations; and
(E) perform stoichiometric calculations, including determination of mass relationships between reactants and products, calculation of limiting reagents, and percent yield.

Independent/Group Practice:

Practice questions on note sheet

EVALUATE/ASSESS/CHECK FOR UNDERSTANDING: Ask for participation

End of Part I

End of Part IExtend/Elaborate (Lab): TBA				
Pacing	**Level of Thinking** (Bloom's Taxonomy)	**Description of Activity: Chalk Lab** **Objective: Students will analytically determine how much chalk can be produced when mixing specific amounts of two chemicals**		**Probing Questions**
45 min.	Application Knowledge comprehension	Teacher says/does: Do: Prepare students for Chalk lab by instructing them to obtain specified glassware from the lab procedure and safety gear. Do: Put students into small groups. Have them perform the procedure and clean up the lab station. Allow them a few minutes to answer the questions at the bottom of the sheet. Pick up the papers to grade or go over in class.	Students say/do: Do: Follow the procedure which will walk them through making chalk through chemical mixture and gravity filtration. Students should write balanced equations for each addition of chemicals and predict products. Using their skills in stoichiometry they should predict the amount of calcium carbonate formed. Students will accurately mass their samples once all water has been evaporated after 24 hours.	1. Why do the chemicals need to be dissolved in water in order for the reaction to take place? 2. Why is it necessary to take accurate measurements during the entirety of the experiment?
§112.35. Chemistry (c) Knowledge and skills. (b) Introduction. (1) Chemistry. In Chemistry, students conduct laboratory and field investigations, use scientific methods during investigations, and make informed decisions using critical thinking and scientific problem solving.		(c) Knowledge and skills. (1) Scientific processes. The student, for at least 40% of instructional time, conducts laboratory and field investigations using safe, environmentally appropriate, and ethical practices. The student is expected to: (A) demonstrate safe practices during laboratory and field investigations		(F) collect data and make measurements with accuracy and precision; (G) express and manipulate chemical quantities using scientific conventions and mathematical procedures, including dimensional analysis, scientific notation, and significant figures;
EVALUATE/ASSESS/CHECK FOR UNDERSTANDING:		Probe for understanding; Students will submit a lab report from each group		

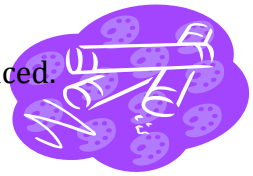
Closure	**Homework**
Exit ticket: Students will be given a note card and asked to write their name and an answer to each of the following questions- What do you know that is new to you? What do you think you do not understand completely?	Complete lab report showing all calculations

End of Part II

How much chalk can you make?

Calcium carbonate is an abundant chemical, and it is found in different forms. One type of calcium carbonate is chalk. (Not the blackboard chalk that you're used to!) Chalk is made for use as a gentle scouring powder. For that reason it is used in toothpaste.

Chalk is easy to make. You merely combine calcium chloride and sodium carbonate. In fact you can learn you can learn to make just the amount you want, and no more. Suppose you were given known amounts of calcium chloride and sodium carbonate. How much chalk could you make?



Purpose:

- To use stoichiometry to calculate the amount of chalk that should be produced.
- To use the actual and theoretical amounts to calculate the percent yielded.

PreLab Questions:

1. Balance the equation: ___$CaCl_2$ + ___Na_2CO_3 → ___$CaCO_3$ + ___NaCl

2. If you start the reaction with 2.5 grams of sodium carbonate, how much calcium carbonate in grams will you get?

3. If you start the reaction with 20 mL of a 1M solution or 0.02 moles of calcium chloride, how much calcium carbonate in grams will you get?

4. Now that you have performed the calculations in #2 and #3, which amount do you think is the one you will actually obtain in this lab? Why?

PROCEDURE:

Day 1 →

1. Obtain two beakers. One beaker will be "beaker 1" and the other will be "beaker 2."
2. Use a graduated cylinder to measure out 20 mL of 1 M calcium chloride, $CaCl_2$. Place this in beaker 1. (Hint: 20 mL of 1 M calcium chloride, $CaCl_2$, contains 0.02 moles of calcium chloride, $CaCl_2$)
3. Weigh out 2.5 grams of sodium carbonate, Na_2CO_3. Place this in beaker 2. Add 20 mL of distilled water to the beaker and stir until dissolved.
4. Mix/stir the sodium carbonate, Na_2CO_3, and the calcium chloride, $CaCl_2$ together. Set this beaker aside while you set up your funnel. Record your observations to describe the change that occurs when the two are mixed.
5. Your group should send one person to the analytical balance to obtain and weigh your filter paper. Record the weight of your filter paper.
6. Set up a funnel for filtering. The funnel should be set inside the Erlenmeyer flask. Now place the weighed filter paper into the funnel. Dampen it slightly with distilled water.
7. Pour the mixture into the filter. Add a little at a time. Each time fill the filter not more than half full. Do not spill any. The liquid that runs through the filter should be clear.
8. Once you have filtered all of the liquid and it has drained though, you will "wash" the solid. You will do this by adding about 5 mL of distilled water to the filter. If you have time, do this twice.

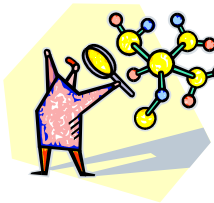
Day 2 →

9. Gently loosen the filter paper and set into the Petri dish given to you. Your sample will dry overnight.
10. After the sample has dried you will weigh it on the analytical balance.

OBSERVATIONS :

Day 1 →

Observation of the change that occurs when the sodium carbonate, Na_2CO_3, and the calcium chloride, $CaCl_2$ together are mixed:



Day 2 →

Observation of the **dry** product, calcium carbonate, $CaCO_3$:

DATA :

Data Table 1: Actual Data

Mass of filter paper (g): _____
Mass of filter paper + product (g): _____
Mass of product (g): _____

Data Table 2: Calculating % Yield

Mass of actual product (g):_____
Mass of predicted product (g): _____
% Yield = (Actual/Predicted) X 100= _____

QUESTIONS:

1. The reactant that is used up completely and stops the reactions from going forward is called the limiting reagent. Which chemical was the limiting reagent, calcium chloride or sodium carbonate? How did you know?

2. The reactant that is left over at the end or is the one that you had "extra" left over is called the excess reagent. Which chemical was the excess reagent, calcium chloride or sodium carbonate? How did you know?

3. In the data section you calculated a percent yield, which is a comparison of how much we made compared to how much we calculated we would make. Do you think that under normal laboratory conditions you will always get a 100% yield? Why or why not?

Stoichiometry Worksheet

1. Na_2SIO_3 (s) + 8 HF(aq) → H_2SiF_6 (aq) + 2 NaF(aq) + 3 H_2O (l)

a. How many moles of HF are needed to react with 0.300 mol of Na_2SiO_3?

b. How many grams of NaF form when 0.500 mol of HF reacts with excess Na_2SiO_3?

c. How many grams of Na_2SiO_3 can react with 0.800 g of HF?

2. $C_6H_{12}O_6$ (aq) → 2 C_2H_5OH (aq) + 2 CO_2 (g)

a. How many moles of CO_2 are produced when 0.400 mol of $C_6H_{12}O_6$ reacts in this fashion?

b. How many grams of $C_6H_{12}O_6$ are needed to form 7.50 g of C_2H_5OH?

c. How many grams of CO_2 form when 7.50 g of C_2H_5OH are produced?

3. Fe_2O_3 (s) + CO (g) → Fe(s) + CO_2 (g) (unbalanced!)

a. Calculate the number of grams of CO that can react with 0.150 kg of Fe_2O_3

b. Calculate the number of grams of Fe and the number of grams of CO_2 formed when 0.150 kg of Fe_2O_3 reacts

4. 2 NaOH (s) + CO_2 (g) → Na_2CO_3 (s) + H_2O (l)

a. Which reagent is the limiting reactant when 1.85 mol NaOH and 1.00 mol CO_2 are allowed to react?

b. How many moles of Na_2CO_3 can be produced?

5. C_6H_6 + Br_2 → C_6H_5Br + HBr

a. What is the theoretical yield of C_6H_5Br in this reaction when 30.0 g of C_6H_6 reacts with 65.0 g or Br_2?

b. If the actual yield of C_6H_5Br was 56.7 g, what is the percent yield?