Jerel Ray Perez	**Anderson High School**	**Pre-AP Chemistry**	**90 minutes**
Objective **Having conceptualized the idea of stoichiometry students will use this lesson to both reinforce the mathematical skills needed to write chemical equations and introduce limiting reagents**			
Warm up **In the space shuttle program, the CO_2 that the crew exhales was removed from the air by a reaction within canisters of lithium hydroxide. On average, each astronaut exhales about 20.0 mol of CO_2 daily. How many grams of water will be produced?** **$CO_2(g)$ + LiOH(s) ------> $Li_2CO_3(aq)$ + H_2O**		Materials Needed Teacher White board, dry erase markers, copy of Hydrogen Boom Lab, Stoichiometry Quiz, solution of hydrochloric acid, zinc metal powder	Students Pencils or pens, calculator, Periodic Table with Polyatomic Ions Chart, materials listed on lab

ENGAGE/HOOK/INTRODUCTION				
Pacing	**Level of Thinking** (Bloom's Taxonomy)	**Description of Demonstration: Combustion of hydrogen gas.** **Objective: Students will visualize the procedure for the lab and the chemical reaction.**		**Probing Questions**
10-15 min.	Knowledge	Teacher Do: Explain the process of extracting CO_2 from the air in a closed environment. Say: Describe the lab that students will conduct by going over the procedure. Explain that the process will be broken into two parts and they will take a quiz while the reaction is taking place. The quiz covers calculating stoichiometric equations.	Students Do: Observe while instructions and safety precautions are given by instructor. Say: Participate in answering questions and use guided steps to explain answers.	1. How does the reaction create an added opportunity to the astronauts? 2. What is the chemical reaction used to form hydrogen gas in the lab? 3. What is the chemical reaction for the combustion of hydrogen?

		Do: Demonstrate with a prefilled balloon of hydrogen gas that the result of their experiment will produce a volatile component and must be treated with care. Allow students to understand that the balloon will float because the gas is lighter than air. Tape the balloon to the edge of the table. Light a long match, step back and ignite the balloon. There will be a loud boom and the formation of water vapor.		

§112.35. Chemistry

(2) Scientific processes. The student uses scientific methods and equipment during laboratory and field investigations

(C) know scientific theories are based on natural and physical phenomena and are capable of being tested by multiple independent researchers.

(E) plan and implement descriptive, comparative, and experimental investigations, including asking questions, formulating testable hypotheses, and selecting equipment and technology

EVALUATE/ASSESS/CHECK FOR UNDERSTANDING:	Ask probing questions

Extend/Elaborate (Lab)				
Pacing	**Level of Thinking** (Bloom's Taxonomy)	**Description of Activity: Production of hydrogen gas.** **Objective: Students will conceptualize the idea of limiting reagents in chemical reactions while practicing safe laboratory techniques.**		**Probing Questions**
45 min.	Application Knowledge comprehension	Teacher Do: Put students into small groups and have them take their place at an assigned lab station. Walk them step-by-step through the procedure being sure to check for understanding and support their misconceptions with valid data. Do: Put students into small groups. Have them perform the procedure until they reach a point where they await the completion of their reaction. Students should then take their seats. Allow them a few minutes to review for the quiz.	Students Do: Conduct the Hydrogen Boom lab in groups and record all information onto their lab. Create a data table for their results and observations. Answer as many analysis questions as possible prior to the quiz.	1. Why should students inflate the balloon once before conducting the experiment? 2. What safety equipment should be used? 3. How could chemists speed up this reaction?

§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

Assessment: Stoichiometry Quiz				
Pacing	**Level of Thinking** (Bloom's Taxonomy)	**Description of Activity: While the reaction in their experiment is taking place students will receive a short assessment on their knowledge of stoichiometric equations**		**Probing Questions**
25 min.	Knowledge comprehension Assessment	Teacher Do: Ask students to put away all materials except for a periodic table, pencil and calculator. Do: Pass out quizzes and give students ample time to complete the quiz.	Students Do: Quietly take the quiz Do: When complete they may return to their lab stations and continue working on their report.	1. Did the balloon inflate to the expected volume?

§112.35. Chemistry (c) Knowledge and skills.

(11) Science concepts. The student understands the energy changes that occur in chemical reactions. The student is expected to:

(A) understand energy and its forms, including kinetic, potential, chemical, and thermal energies;

(B) understand the law of conservation of energy and the processes of heat transfer

(9) Science concepts. The student understands the principles of ideal gas behavior, kinetic molecular theory, and the conditions that influence the behavior of gases. The student is expected to:

(A) describe and calculate the relations between volume, pressure, number of moles, and temperature for an ideal gas as described by Boyle's law, Charles' law, Avogadro's law, Dalton's law of partial pressure, and the ideal gas law;

(B) perform stoichiometric calculations, including determination of mass and volume relationships between reactants and products for reactions involving gases

(8) Science concepts. The student can quantify the changes that occur during chemical reactions.

(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.

Closure	Homework
Discuss the relevance of limiting reagents. Have students predict how this concept will be included in the next lesson. Time permitting, give students a sample reaction and ask them to define which reactant is the limiting reagent before the next class.	Complete lab report

Name_____ Date_____ Per_____

Quiz: Reaction Stoichiometry

1. How much iron would you isolate by reacting 7.9 g of iron (III) acetate with excess sodium?

2. How many grams of zinc would you need to react with hydrochloric acid to produce 1 L of H_2 gas?

3. How many grams of silver chromate will precipitate from the reaction of 100.0 mL of 0.200 M silver nitrate with excess potassium chromate? (chromate = CrO_4^{2-})

Name: Period: Date:

Hydrogen Boom Lab

The purpose of this experiment is to illustrate the concept of a limiting reagent in chemical reactions. Chemists will combine quantities of solid zinc metal and hydrochloric acid in order to produce an expected amount of hydrogen gas. Understanding of the chemical reaction along with stoichiometric calculations will predict the amount of gas produced.

Materials needed:

medium size graduated cylinder	electronic balance	250mL Erlenmyer flask
rubber balloon	zinc metal	hydrochloric acid
long match	calculator	Periodic Table

Pre-lab Questions:

1. Write and balance the chemical equation for the reaction of zinc with hydrochloric acid. Predict all products and give states of matter.

2. Molarity is a unit for measuring moles in a solution, typically in moles per liter (mol/1L) and designated with *M*. A 3 molar solution of sodium hydroxide (3*M* NaOH) contains 3 moles of NaOH in one liter of water (3 mol NaOH/1L H_2O). Knowing that 1 mole of any gas at STP is 22.4 liters, calculate the volume of hydrochloric acid needed to produce 750mL of hydrogen gas. Show all work including units.

3. What is the mass of zinc needed to produce 750mL of hydrogen gas?

Procedure

1. Gather all materials for the lab including safety gear.
2. Your group will be given an amount of zinc to use. All groups will have a slightly different mass.
3. Measure out your zinc to the nearest tenth of a gram.
4. Inflate the balloon once and release the air. This is to release the initial tension of the rubber.
5. In a 250mL Erlenmeyer flask add 100mL of hydrochloric acid.
6. Add the zinc to the inside of the balloon with a dry funnel.
7. Stretch the balloon end over the opening of the flask without dropping the zinc into the flask.
8. Predict how the addition of the metal to the acid will affect the overall weight of the system.
9. Lift up on the balloon and shake the zinc into the flask.
10. Record your observations.

Data Table

Create a data table for all measurements taken (weights of samples used, moles, formula mass, mole ratios, and observations versus time).

Analysis

Each group used a slightly different mass of zinc and hydrochloric acid. Compare your results with others. Do the results make sense in terms of the amount of chemicals used? Produced? Be specific

Theoretically the same experiment could be conducted with a 0.1 molar solution of acid (0.1 *M* HCl) and completed with two samples of zinc. Zinc A is 1.2 grams and Zinc B is 0.6 grams. One balloon would be twice the size as the other when the reaction is complete. Why? Use words and calculations to justify your answer.

If a third experiment is conducted with 2.4 grams of zinc is used, then the balloon would have the same volume as Zinc A. Why? Of the hydrochloric acid and zinc, which one is the limiting reagent? Explain.

Ask the instructor to supervise as you combust the hydrogen gas produced. Based on your results, what volume of water vapor did you form? Show calculations.