

Predicting Chemical Reactions

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Subject: Chemistry

Grade Level: High School

Standards: Next Generation Science Standards (www.nextgenscience.org)

HS-PS1-7 Use mathematical representations of phenomena to support claims that atoms, and therefore mass, are conserved during a chemical reaction.

Schedule: 1-Hour long class

CCMR Lending Library Connected Activities:



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<u>Objectives:</u> Students will learn about chemical reactions and what the signs are for them. They will prove the Law of Conservation of Mass. Knowing how to balancing reactions Identifying the limiting reactant	<u>Vocabulary:</u> Limiting reactant Stoichiometry Molar mass Concentration pH scale
<u>Students Will:</u> - Understand chemical reactions and the law of conservation of mass. - Prove that mass is conserved in chemical reactions. - Identify the signs of a chemical reaction and the limiting reactant. - Learn how to use a scale to measure mass. - Be able to compare the mass of a system before and after chemical reactions. - Be able to balance a chemical reaction. - Understand the pH scale.	<u>Materials:</u> For Each Group (1-3 students) ___ Narrow mouth bottle ___ 4 pieces of chalk ___ Electronic Balance scale For Class ___ Bottle of vinegar* ___ pH paper Teacher Will Need to Provide ___ Goggles ___ A sink to drain the bottles and rinse out the bottles with tap water. ___ Outlets for the scales. * We might not be able to ship all the vinegar needed. You might need to purchase some on your own.
Safety	When reacting the vinegar and chalk in the bottle with the cap screwed on, there will be pressure building up in the bottle. When opening the bottle, slowly unscrew the cap. Goggles should be worn!



Science Content for the Teacher:

Chemical reactions are important in our daily lives. From cars burning gasoline to batteries in our phones, chemical reactions are everywhere. Even our bodies are constantly performing chemical reactions to keep us alive. Being able to predict chemical reactions is an important skill for scientists. For example, NASA engineers need to know exactly how much fuel a rocket will use for it to reach orbit without using too much or too little. Additionally, when alcohol is distilled, understanding the difference between methanol and ethanol can either lead to blindness/death or a consumable drink.

This activity is designed for students with a basic understanding of balancing reactions and stoichiometry. They will learn to apply this knowledge to a real chemical reaction, vinegar and chalk. This lab is also good for introducing concepts such as limiting reactant and pH. When chalk and vinegar are mixed to react, CO_2 is released as a gas, decreasing the mass of the system. This change in mass can be detected with a scale and predicted using the knowledge of the starting reactants. Chalk will also change the pH of the vinegar and the change in pH can also be predicted with some understanding of the pH scale.

Classroom Procedure:

Notes on the Google presentation:

The presentation is designed to be flexible for each teacher's needs. Modification of the slide deck before the class is expected.

The iodine clock reaction demo can be shown at the beginning of the presentation. We recommend showing this demo when introducing the "importance of predicting chemical reactions." This demo is recommended for three students in front of the class. See the detailed explanation at the end of the document.

We recommend that students start the lab after introducing how to balance equations. Ask the students what happens when chalk and vinegar are mixed together. What are the products? How would you balance this reaction? Following lab protocol steps 1-5 will help to give a clue for the students to identify the products. The reaction also needs to be started early on in the class or a noticeable change in mass may not be observed. The reaction takes 30-45 mins.

The students may not be able to correctly predict the products so the presentation is designed to explain the correct answer. While the reaction is taking place, continue to explain limiting reactants, mass lost, and change in pH. The full presentation is designed for a 1 – 1.5 hour class. At the end of the



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presentation measure the change in mass and pH to check and see if the change in mass is correct.

Prep work for the lab:

Make sure the scales are plugged in or running on batteries. Prep all materials for the groups laid out on the table before the class starts. A few big bottle of vinegar may be placed in the middle of the room for students to fill up their narrow mouth bottles. A waste bucket or sink should be available to empty out the bottles. Also fresh water (tap water) should be available for students to clean out their bottles.

Assessment:

Where the students able to meet the objectives of the lab? Did they successfully predict the change in mass and pH?

Were the students able to answer the discussion questions at the end of the lab?

Extra Activities:

An extra demo could be done by the teacher. Place a candle on a scale and measure the weight at the beginning of class. Light it and let it burn during the class, out of the students' reach. Then measure the weight with the scale at the end of class. Mass is not conserved because the combustion reaction emits carbon dioxide, which slowly decreases the mass of the candle. Try to predict the change in mass of the candle!

Iodine Clock Reaction:

The iodine clock reaction is also a very interesting reaction demo that could be performed.

Materials for Demonstration:

- Potassium iodate solution, KIO_3 , 0.1 M, 175 mL
- Beakers or containers, 100- and 500-mL, 3 each
- Sodium meta-bisulfite solution, $\text{Na}_2\text{S}_2\text{O}_5$, 0.2 M, 30 mL
- Graduated cylinders (preferably 100 mL and 250 mL)
- Starch solution, 90 mL
- Stirring rods, 3
- Water, distilled, deionized, or even bottled water, 600 mL



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Preparing the solutions:

1. Measure 3.75 grams of potassium iodate and dissolved in water to make a 175 mL solution.
2. Measure 1.33 grams of potassium meta-bisulfate and dissolved in water to make a 30 mL solution.
3. Mix a few grams of starch in 90 mL of water to make the starch solution.
4. Label three 500-mL beakers 1, 2, and 3. Using a 100- and/or 250-mL graduated cylinder, respectively, measure and add the following amounts of 0.1 M potassium iodate solution and distilled water to each beaker. These are Solution A for each experiment.

Experiment	KIO ₃ , 0.1 M	Water
1	50 mL	150 mL
2	100 mL	100 mL
3	25 mL	175 mL

5. Using a graduated cylinder for each solution, measure and add 10 mL of 0.2 M sodium meta-bisulfite solution, 30 mL of starch solution, and 40 mL of distilled water to each 100-mL beaker. These are Solution B for each experiment. Stir each solution.

Demo protocol:

Ask three students to volunteer for the demo. At the front of the class ask them to hold one solution A container and one solution B container. Then at the same time ask them to pour solution B into the container holding solution A. You can either provide a stir rod or have them gently swirl the containers to mix the solutions. The solutions will change color from experiment 1 (~5 sec), 2 (~10sec), and then 3 (~30 sec).

The point of this demo is to show one of the many signs of a chemical reaction, color change. It is also a good way to show that a chemical reaction can be controlled and made predictable.

Some recommended precautions: Providing safety glasses to demo participants helps to promote a safety culture among students. Although the solutions are not harmful, try to avoid skin contact or spilling on clothes (will stain). Clean out demo containers immediately after use because the iodine dye will stain the containers.



See the following link:

<http://www.rsc.org/learn-chemistry/resource/res00000744/iodine-clock-reaction?cmpid=CMP00005152>

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