A Safe Reaction

Chemical Demonstration

Introduction

All teachers know it is important to practice safety when working in the laboratory. Two reactions will be carried out during this demonstration. One experiment will display what happens when appropriate safety measures are taken in the lab, while the other will captivate students by displaying something slightly different.

Concepts

- Kinetics
- Catalyst
- Decomposition reaction

Background

Two reactions are conducted in order to demonstrate what can happen in a laboratory setting if proper safety precautions are not followed. The 100-mL graduated cylinder with 3% hydrogen peroxide will represent a safe classroom. The 100-mL graduated cylinder with 30% hydrogen peroxide will represent the consequences of forgetting or ignoring appropriate safety precautions.

Materials (for each demonstration)

Dishwashing liquid, 20 mL
Food coloring (optional)
Hydrogen peroxide, 3%, 20 mL
Hydrogen peroxide, 30%, 20 mL
Sodium iodide, 2 M, 10 mL
Graduated cylinder, 10-mL, 3
Graduated cylinder, borosilicate glass, 100-mL, 2
Plastic demonstration tray, several inches deep

Safety Precautions

Hydrogen peroxide, 30%, is a very strong oxidizing agent. Many substances will cause hydrogen peroxide to decompose into water and oxygen gas. It is very corrosive to skin, eyes, and the respiratory tract, and is a dangerous fire and explosion risk. Do not heat this 30% hydrogen peroxide. Hydrogen peroxide, 3%, is a weak oxidizing agent and is also a skin and eye irritant. Use only a borosilicate glass graduated cylinder for the reaction of 30% hydrogen peroxide—the reaction is very exothermic. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. Wash hands thoroughly with soap and water before leaving the laboratory. Follow all laboratory safety guidelines. Please review current Material Safety Data Sheets for additional safety, handling, and disposal information.

Preparation

The graduated cylinders should be set up in a large plastic tray in order to contain the products of the reactions.

Procedure

1. Place two 100-mL graduated cylinders in a large, plastic demonstration tray.
2. Add 20 mL of 3% hydrogen peroxide to the first cylinder. Mention to students this cylinder represents a safe lab.
3. Add 20 mL of 30% hydrogen peroxide to the second graduated cylinder, which represents the unsafe lab.
4. Measure 10 mL of dishwashing liquid into the 10-mL graduated cylinder and add it to the 100-mL graduated cylinder containing 3% hydrogen peroxide (safe lab).
5. Repeat step 4 to the graduated cylinder containing 30% hydrogen peroxide (unsafe lab). *Note:* The same 10-mL graduated cylinder can be used as in step 4.
6. Add food coloring to both solutions if desired.

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7. Obtain two clean 10-mL graduated cylinders.
8. Measure 5 mL of 2 M sodium iodide into each of the two 10-mL graduated cylinders.
9. Add 5 mL of the sodium iodide solution to the 100-mL cylinder containing the 3% hydrogen peroxide. This demonstration represents a safe classroom.
10. Allow students to predict what might happen in an "unsafe" lab if this reaction got a little "carried away."
11. Pour the second 5 mL of sodium iodide solution into the 100-mL graduated cylinder containing 30% hydrogen peroxide. Quickly stand back as steam and oxygen are quickly produced. This reaction demonstrates an unsafe classroom.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures, and review all federal, state and local regulations that may apply, before proceeding. The foam and solution left over in the cylinder and on the demonstration tray may be rinsed down the drain with excess water according to Flinn Suggested Disposal Method #26b.

Tips

- It is very important to conduct this experiment in a large demonstration tray. When the sodium iodide is added to the 30% hydrogen peroxide, the resultant foam will overflow the graduated cylinder.
- Addition of food coloring to the dishwashing liquid is completely optional. It will simply color the foam that is produced.
- Prove to students that oxygen is a product of this reaction. Light a wood splint or popsicle stick on fire. Allow it to burn for roughly three seconds and blow out lightly so the wood still glows orange. Immediately expose it to the edge of the foam bubbles and the wood splint should reignite. *Note:* This may require some practice.

Discussion

The decomposition of hydrogen peroxide is exothermic (produces heat), but the uncatalyzed reaction rate is quite slow. The role of a catalyst is also demonstrated—no reaction occurs until the sodium iodide solution is added, even in the case of 30% hydrogen peroxide. A catalyst is a substance that increases the reaction rate but is not consumed in the course of the reaction. In this case, the $I^-(aq)$ ions increase the decomposition rate of hydrogen peroxide. The decomposition of hydrogen peroxide produces steam and oxygen gas. The oxygen gas and water vapor cause the dishwashing liquid to foam.

$$2H_2O_2(aq) \xrightarrow{I^-(aq)} 2H_2O(l) + O_2(g) + \text{Energy}$$

The concentration of hydrogen peroxide will affect the reaction rate. The $I^-(aq)$ ion catalyst produces a more controlled, calm reaction when mixed with the 3% hydrogen peroxide than with the 30% hydrogen peroxide. The rate of the reaction increases as the concentration of reactants increases.

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12
Evidence, models, and explanation
Content Standards: Grades 5–8
Content Standard A: Science as Inquiry
Content Standard B: Physical Science, properties and changes of properties in matter
Content Standards: Grades 9–12
Content Standard A: Science as Inquiry
Content Standard B: Physical Science, chemical reactions

Answers to Worksheet Questions

1. Write the chemical equation for the decomposition of hydrogen peroxide.

$$2H_2O_2(aq) \xrightarrow{I^-(aq)} 2H_2O(l) + O_2(g) + \text{Energy}$$

2. What is a catalyst?

   A catalyst is a substance that increases the reaction rate but is not consumed in the course of the reaction.

3. Which chemical in this demonstration acts as the catalyst?

   The I^- ion from the sodium iodide solution acts as the catalyst in this demonstration.

4. Which product(s) in this reaction causes the dishwashing detergent to foam?

   The oxygen gas and water vapor cause the dishwashing liquid to foam.

5. Briefly describe how this demonstration showed the importance of 2–3 *specific* safety rules in your science safety contract (e.g., always read labels, do not carry out unauthorized experiments, etc.) Be specific!

Materials for *A Safe Reaction—Chemical Demonstration* are available from Flinn Scientific, Inc.

Catalog No.	Description
H0037	Hydrogen Peroxide, 30%, 100 mL
H0009	Hydrogen Peroxide, 3%, 473 mL
S0084	Sodium Iodide, 100 g
AP5429	Demonstration Tray

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.

Name: _____

A Safe Reaction Worksheet

Post-Lab Questions

1. Write the chemical equation for the decomposition of hydrogen peroxide.

2. What is a catalyst?

3. Which chemical in this demonstration acts as the catalyst?

4. What causes the dishwashing detergent to foam?

5. Briefly describe how this demonstration showed the importance of 2–3 *specific* safety rules in your science safety contract (e.g., always read labels, do not carry out unauthorized experiments, etc.) Be specific!