

# **Lab Specialist Annual Professional Development Training**

Coordinated by the Safety and Health Department  
United Federation of Teachers  
A Union of Professionals  
52 Broadway – New York, NY 10004



Green Chemistry Agenda  
Wednesday, January 27, 2016  
UFT Headquarters  
5 – Broadway – 19<sup>th</sup> Floor  
Rooms B/C

Agenda

1. Welcome
2. Principles of Green Chemistry
3. The Need for Green Chemistry Alternatives
4. Biomimicry – Imitating Nature
5. Steps to plan for a Green Chemistry Pilot
6. Laboratories that Align to NYSED Regent Chemistry
7. Laboratory Activities – rewritten to Align to CCLS/NGSS
8. Inventory Checklist – First Step in the Schools
9. Department of Environmental Conservation –Removal of Excess/Unwanted/Unneeded Chemicals
10. Supplies/Equipment – ShopDOE and Amazon.com
11. Preparation of Labs and Demonstrations in Green Chemistry
12. Questions & Answers



# Catalysts and Oxygen

Modified from the activity written by: Beryl Chisholm and Veronica O’Riordan at the 2008 Solutions in Green Chemistry Workshop

**Replacement lab:** this lab replaces  $\text{MnO}_2$  Manganese Dioxide catalytic reaction.

**Goal:** To demonstrate the effect of a catalyst on a chemical

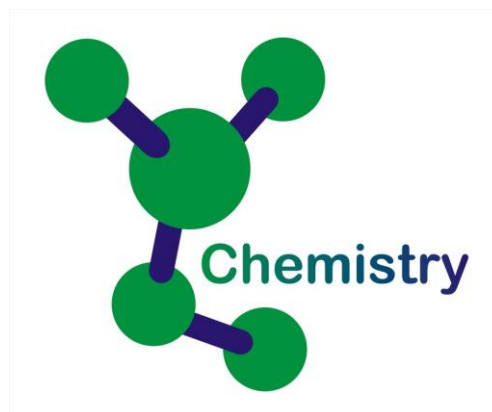
**Objectives:** Students will...

- explain the concept of a catalyst and reaction rates
- understand how a catalyst can improve the efficiency of a process
- recognize that a chemical reaction involves reactants and products which may differ from each other
- recognize that the products of the reaction will be benign
- practice safe laboratory procedures

**Time:** 1 x 45 – 60 mins class period

**Materials:**

- 1 x 250 ml beaker
- tap water
- thermometer (capable to reading  $60^\circ\text{C}$ )
- hot plate
- 2 x test tube (25 x 100 mm size works best)
- 10 ml graduated cylinder
- Green food coloring
- Biodegradable liquid dish detergent (7<sup>th</sup> generation works well)
- 3% hydrogen peroxide ( $\text{H}_2\text{O}_2$ )
- vitamin C tablets (equal to 3.40 grams of crushed vitamin C)
- mortar and pestle



**Procedure:**

- Introduce the lesson as an inquiry/investigation into chemical reactions.
- Discuss what the students expect from a chemical reaction.
- Ask the students to get into lab groups of 2 – 3

## Catalysts and Oxygen

### Student lab sheet

**Materials:** gather the following materials

- 1 x 250 ml beaker
- tap water
- thermometer (capable to reading 60°C)
- hot plate
- 2 x test tube (25 x 100 mm size works best)
- 10 ml graduated cylinder
- Green food colouring
- Biodegradable liquid dish detergent (7<sup>th</sup> generation works well)
- 3% hydrogen peroxide ( $\text{H}_2\text{O}_2$ )
- vitamin C tablets (equal to 3.40 grams of crushed vitamin C)
- mortar and pestle

### Lab Procedure:

1. Look at the students' data sheet and make sure you are clear about what information you need to collect as you are performing the experiment.
2. Fill the 250 ml beaker halfway with tap water. Place thermometer inside beaker.
3. Place beaker on hot plate, and heat the water so that it maintains a temperature of 60°C.
4. Measure 10 ml of 3%  $\text{H}_2\text{O}_2$  using the 10 ml graduated cylinder. Transfer the  $\text{H}_2\text{O}_2$  to one test tube. Label test tube "Test tube A".
5. Add 2 drops of food coloring to test tube A. Mix well.
6. Add 2 drops of biodegradable liquid dish detergent to test tube A. Mix well.
7. Measure 10 ml of 3%  $\text{H}_2\text{O}_2$  using the 10 ml graduated cylinder. Transfer the  $\text{H}_2\text{O}_2$  to one test tube. Label test tube "Test tube B".
8. Add 2 drops of food coloring to test tube B. Mix well.
9. Add 2 drops of biodegradable liquid dish detergent to test tube B. Mix well.
10. Using the mortar and pestle, crush enough vitamin C tablets to obtain 3.40 grams of it.
11. Add the 3.40 grams of crushed vitamin C into test tube B.
12. Place both test tubes into the water beaker (do not get any water into the test tubes).
13. Fill data in table in 2 minute intervals, starting at 0 minutes (before test tubes are placed into water bath).
14. Allow test tubes to sit in water bath for 10 minutes.
15. Remove test tubes and allow to cool in a test tube rack.
16. Turn off hot plate and clean area up.

**Student Data:**

Time (min)	Water bath temperature (°C)	Test Tube	Bubble formation in liquid visible Y/N	Foam formation Y/N	Color of liquid
0		A			
		B			
2		A			
		B			
4		A			
		B			
6		A			
		B			
8		A			
		B			
10		A			
		B			

### Questions:

1. A chemical reaction is....
2. The chemical equation for the reactions in both test tubes is:

What are the reactant(s)?

What are the product(s)?

Name the type of chemical reaction that occurs.

Write a balanced equation for the reaction.

3. Which test tube had a catalyst? How do you know?
4. Name the catalyst used in this experiment.
5. What is the role of the catalyst?
6. How does using a catalyst improve the efficiency of a process?
7. Identify the hazards and the necessary safety procedures for this experiment.



## Teacher Answer Key

Data:

Time (min)	Water bath temperature (°C)	Test Tube	Bubble formation in liquid visible Y/N	Foam formation Y/N	Color of liquid
0	60	A	N	N	Dark green
		B	N	N	Dark green
2	60	A	N	N	Dark green
		B	Y	N	Dark green
4	60	A	N	N	Dark green
		B	Y	Y	Dark green
6	60	A	N	N	Dark green
		B	Y	Y	Lightening of color should be observed by 5 minutes
8	60	A	N	N	Lighter shade of green
		B	Y	Y	Lighter shade of green
10	60	A	N	N	Lighter shade of green
		B	Y	Y	Lighter shade of green

### Questions:

8. A chemical reaction is....

A reaction in which a new substance is formed.

9. The chemical equation for the reactions in both test tubes is:



What are the reactant(s)?  $\text{H}_2\text{O}_2$

What are the product(s)?  $\text{H}_2\text{O}$  and  $\text{O}_2$

Name the type of chemical reaction that occurs. Decomposition

Write a balanced equation for the reaction.  $2 \text{H}_2\text{O}_2 \rightarrow 2 \text{H}_2\text{O} + \text{O}_2$

10. Which test tube had a catalyst? How do you know?

Test tube B had the catalyst. The decomposition of  $\text{H}_2\text{O}_2$  occurred much faster in test tube B than in test tube A because of the presence of the catalyst.

11. Name the catalyst used in this experiment.

Vitamin C

12. What is the role of the catalyst?

Increase the rate of the reaction, does not get consumed, lowers activation energy.

13. How does using a catalyst improve the efficiency of a process?

Since using a catalyst can speed up a reaction, it can save time and energy (i.e. heat input) in a chemical process, especially when working on larger scales.

14. Identify the hazards and the necessary safety procedures for this experiment.

#### Hazards:

- 3%  $\text{H}_2\text{O}_2$  is used
  - May cause skin and eye irritation
  - Do not ingest
- Heat input
  - Hot plate may cause burns

#### Safety procedures:

- Wear safety glasses and gloves (in case spattering of 3%  $\text{H}_2\text{O}_2$  occurs)
- Do not ingest any chemicals
- Do not touch hot plate when its heat is on

*Side note: Although vitamin C is ingested as a daily supplement, ingesting 3.4 grams worth may cause harm.*

## Preparation of Oxygen

### Description

Oxygen is prepared through the action of solid manganese dioxide on a solution of 6% aqueous hydrogen peroxide.

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### Hazards

Aqueous hydrogen peroxide is a strong oxidizing agent and is toxic. Aerosols of manganese dioxide are toxic. Burning splints may cause injury.

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### Precautions

- Handle the hydrogen peroxide with caution. Wipe up spills immediately. Do not ingest the hydrogen peroxide.
- Do not squeeze the dry pipet filled with manganese dioxide (an aerosol might form).
- Use caution with matches and splints.

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### Procedure

1. Squeeze the bulb on a thin-stemmed polyethylene transfer pipet. Place the tip in some fine mesh manganese dioxide. Release and thereby withdraw a sample of the solid into the pipet bulb. Wipe the pipet tip with a paper towel.
2. Fill a 100-mm test tube with water.
3. Place 200 mL of water in a 250-mL beaker. Cover the filled test tube with the first fingertip. Invert. Immerse under the surface of the water in the beaker.
4. Place 20 mL of 6% aqueous hydrogen peroxide in a 50-mL beaker. Slowly squeeze the bulb on the pipet containing the solid manganese dioxide taking care not to discharge any solid. Bend the stem, and withdraw 2 mL of the hydrogen peroxide solution.

5. Bend the stem of the pipet. Immerse the tip under the lip of the filled test tube. Fill the test tube with gas.
6. Hold the tube under the water surface. Stopper the tube.
7. Support the gas-filled test tube in a small beaker. Light a splint, and blow out the flames. Remove the stopper, and insert the glowing splint into the test tube. Note any evidence for reaction.

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## Handout Makeup

Name \_\_\_\_\_ Class \_\_\_\_\_

Teacher \_\_\_\_\_

### *DoChem 056 Preparation of Oxygen*

1. Write an overall balanced chemical equation for the  $\text{H}_2\text{O}_2$  decomposition.  $\text{MnO}_2$  is a catalyst.
2. Air contains oxygen. Why did the wood splint burn more brightly in the oxygen tube than in air?

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## Teachers Guide

### Purpose

To prepare a sample of oxygen (dioxygen) in the laboratory.

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## Materials

(for 10 students working in pairs)

- 5 250-mL beakers
- tap water
- 50 mL 6% aqueous hydrogen peroxide (from drug store near hair care products)
- 1 g manganese dioxide powder

- 5 thin-stemmed polyethylene transfer pipet
- 5 13- x 100-mm test tube and suitable stopper
- 5-10 50-mL beaker
- 5 splint
- matches
- paper towels
- 50 mL 5%  $\text{NaHSO}_3$

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### Lab Hints

- When the dioxygen forms in the pipet, a slurry of manganese dioxide is often expelled from the stem. While not particularly attractive, this does not alter the outcome of the experiment.



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### Time

Teacher preparation: 10 minutes

Class Time: 30-40 minutes

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### Disposal

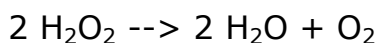
1. Blow out the splint; discard with ordinary trash when cooled. Dilute the hydrogen peroxide with 20 volumes of water, and discard at the sink.
2. Treat any solid manganese dioxide by covering with 20 volumes of tap water. Add sufficient 5% aqueous sodium bisulfite to dissolve the solid. Acidify very slightly if necessary to dissolve. Discard the resulting solution at the sink.

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## Background

- Aqueous solutions of hydrogen peroxide are unstable. They decompose to form water and dioxygen according to the chemical equation:



- Stabilizers are added to the commercially available material to slow this reaction. Caps on peroxide bottles should have some mechanism for releasing gas pressure that results from the decomposition.
- Many substances serve as catalysts for the decomposition of hydrogen peroxide. Solid manganese dioxide is such a catalyst.

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## Makeup Ans.

1.  $2 \text{H}_2\text{O}_2 \rightarrow 2 \text{H}_2\text{O} + \text{O}_2$
2. Air is only 20% oxygen and the tube contained 100% oxygen. The rate of reaction is much faster (5 times) in the higher concentration of oxygen.

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## Key Words

- |             |                         |
|-------------|-------------------------|
| • redox     | • oxygen                |
| • oxidation | • dioxygen              |
| • reduction | • decomposition         |
| • catalyst  | • displacement of water |
| • gas       |                         |

## GREEN LAB ALTERNATIVES



Unit #	Unit	Labs
1	Physical Nature of Matter	Sublimation Lab
1	Physical Nature of Matter	Determining P,V,T Lab
2	Atomic Concepts	Flame Test and Emission Spectra Lab
2	Atomic Concepts	Empirical Formula Lab
3	Nuclear Chemistry	Licorice Model for Half-Life
3	Nuclear Chemistry	Radon Gas Emissions PBL
4	Chemical Bonding	Reaction Lab - single/double/decomp/synthesis
4	Chemical Bonding	Exothermic/Endothermic Reactions Lab
5	Periodicity	
5	Periodicity	
6	Moles/Stoichiometry	Moles, Grams. Atoms, oh my! Lab
6	Moles/Stoichiometry	Moles of Rice Activity
7	Kinetics and Equilibrium	Equilibrium/Le Chatelier's Principle Lab
7	Kinetics and Equilibrium	Catalysts and Oxygen
8	Acids and Bases	Acids, Bases and pH Lab
8	Acids and Bases	
9	Oxidation & Reduction	Green(er) Redox Reaction Lab
9	Oxidation & Reduction	Enthalpy of Combustion
10	Carbon and Organic Chemistry	Recycling Polylactic Acid Lab
10	Carbon and Organic Chemistry	

# REGENTS CHEMISTRY

Unit of Study	Current Laboratory Activity	Green Chemistry Laboratory
Unit 1 – The Physical Nature of Matter	Gas Law Demonstration Iron and Sulfur Separation (heating with bunsen burner)	Chemical or Physical Reaction Lab Determining Pressure, Volume, Temperature Lab
Unit 2 – Atomic Concepts	Rainbow Demonstration (Alcohols are flammable)	Flame Test and Emission Spectra Lab Empirical Formula Lab
Unit 3 – Nuclear Chemistry	Microwave Activity	Exothermic/Endothermic Reactions Lab Licorice Model for Half-Life
Unit 4 – Chemical Bonding	Melting and recrystallization of naphthalene (toxic - flammable)	Reaction Lab (single, double, decomposition and synthesis)
Unit 5 – Periodicity	Burning Sulfur (the sulfur dioxide gas is toxic)	
Unit 6 – Moles/Stoichiometry	Composition of a Hydrate (copper sulfate penta-hydrate is a fungicide and an irritant)	Moles. Grams, Atoms, oh my! Lab Mole of Rice Activity Lab
Unit 7- Kinetics and Equilibrium	Iodine Clock (sulfuric acid is toxic and corrosive)	Equilibrium/la Chatelier's Principle Lab
Unit 8 – Acids and Bases	Titration (hydrochloric acid and sodium hydroxide are both corrosives and toxic)	Acids, Bases and pH Lab
Unit 9 – Oxidation/Reduction	Redox Reaction (Copper (II) Sulfate is an irritant)	Green(er) Redox Reaction Lab
Unit 10 – Carbon and Organic Chemistry	Esterification (Alcohols are flammable – sulfuric acid is corrosive)	Recycling Polylactic Acid lab



## **“GREEN” Glue**

Use common kitchen materials to make your own glue. Add vinegar to milk, separate the curds, and add baking soda and water. Glue!

### **Materials:**

1/4 cup hot water  
2T powdered dry milk

1 T vinegar  
1/2 tsp baking soda                      water

### **Procedure:**

1. Mix 1/4 cup hot tap water with 2 T powdered milk. Stir until dissolved.
2. Stir 1 T of vinegar into the mixture. The milk will begin to separate into solid curds and watery whey. Continue stirring until the milk is well-separated.
3. Pour the curds and whey into a coffee filter positioned over a cup. Slowly lift the filter, draining the whey. Keep the curd, which is in the filter.
4. Squeeze the filter to remove as much liquid as possible from the curd. Discard the whey (i.e., pour it down a drain) and return the curd to a cup.
5. Use a spoon to break the curd into small pieces.
6. Add 1 teaspoon hot water and 1/8 to 1/4 teaspoon baking soda to the chopped curd. Some foaming may occur (carbon dioxide gas from reaction of baking soda with vinegar).
7. Mix thoroughly until the glue becomes smooth and more liquid. If the mixture is too thick, add a bit more water. If the glue is too lumpy, add more baking soda.
8. The finished glue can vary in consistency from a thick liquid to a thick paste, depending on how much water has been added, how much curd was present, and how much baking soda was added.
9. Use your glue as you would any school paste. Have fun!
10. When not in use, cover your cup of glue with plastic wrap. Over time, its consistency will become smoother and clearer..
11. Unrefrigerated glue will 'spoil' after 24-48 hours. Discard the glue when it develops a spoiled milk smell.

### **Tips:**

1. The separation of curds and whey works best when the milk is warm or hot (which is why powdered milk is used).
2. If the separation doesn't work well, heat the milk or add a bit more vinegar. If it still doesn't work, start again with warmer water.
3. Clean dried glue by loosening/dissolving it in warm water and wiping it away. Glue will wash out of clothes and off surfaces.

