Chemistry Around the Clock

An Educational Demonstration Package

Prepared by the

Cleveland Section

of the

American Chemical Society

National Chemistry Week 1999

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Acknowledgements

The National Chemistry Week (NCW) programs of the Cleveland Section ACS began in 1994 with an idea to put together a scripted program that could be performed at any local school or library. This idea has expanded to become the centerpiece of Cleveland Section's NCW activities, which has received national recognition from the American Chemical Society. In 1999, the Cleveland Section will perform fifty demonstrations.

A local section Organizing Committee coordinates this library/school hands-on demonstration program. This Committee develops a theme for the program; recommends, tests, and reviews activities and experiments; writes a script; collects supplies and materials; recruits sponsors and volunteers; contacts libraries and schools; and schedules individual shows. The Committee (as well as the rest of the Section's NCW activities) is overseen by the Cleveland Section's NCW coordinators, Betty Dabrowski and Paula Fox. Committee members include Shermila Singham, Lois Kuhns, Helen Mayer, Ann Ebner, Marcia Schiele, Rich Pachuta, Fen Lewis, Kat Wollyung, and David W. Ball.

The foundation of this program has been the script, written so that the it can be performed easily at any school or library. This year's script, written by Helen Mayer, is based on the well-organized format set in past years by Susie Rolland and Mike Setter.

Our NCW efforts reach farther this year because of various sponsors who have donated money, materials, or services to the Cleveland Section specifically for National Chemistry Week. We are grateful to NASA Glenn Research Center for their contributions and support.

Last and most important, thanks to all the volunteers who donate their time and expertise. Without the dozens of dedicated chemical professionals to lead these activities, there would be no Cleveland Section NCW program.

Overview

This year's National Chemistry Week demonstrations fit the theme that chemistry is with us all day, everyday. The theme is illustrated with examples taken throughout a child's day. The demonstrator will be provided with a paper-plate "clock" which will mark time as the day moves on.

Through the demonstrations, the students will learn:

- how yeast works
- how toothpaste works
- properties of rubber
- how to make milk paint
- how to use iodine to test for starch
- how to make handwarmers
- what hard water is
- the concept of surface tension
- how carbon dioxide extinguishes flames

How Experiment Write-ups are Organized

The experimental write-ups are organized slightly differently this year than in the past. The materials and set-up of the demonstrations is located in the introduction section of this packet. Then, each experiment write-up is presented as follows:

- Background and Set-Up Information for Demonstrators
- Demonstration Instructions
- Experiment Conclusions & Answers
- Additional Information If Needed

New This Year

- The demonstrator's kit is totally disposable.

Demonstrator's Guide

Presentation Overview

This section describes the basic presentation technique used during the demonstrations. This is a guideline only as the technique may vary for some experiments. Make sure you follow the instructions given in each experiment.

1. Introduce experiment.
2. Do your demonstration piece.

   Note: *Most experiments require you to perform the experiment to show the students what to do on their own.*

3. Have the students do their experiment.

   Note: *For some experiments your demonstration and the students hands-on work are nearly simultaneous. You are leading them as they perform the experiment.*

4. Some experiments will be done by all students. For others, there will be one experiment that will be shared by all students at the table.

MAKE SURE TO FOLLOW ALL DIRECTIONS IN EXPERIMENTS

- The yeast experiment requires you to start it early in the program and finish it during the 5 pm Dinner experiment. Do not forget to return to this experiment before the program ends.
- Some experiments have special safety concerns due to the materials being used. These are listed in the section for that experiment.

Demonstration Check-Off List

The next few pages list suggested activities to complete for the program.

Activities To Do Before You Go To The Demonstration	✓ When Complete
Read through this packet to familiarize yourself with the experiments	❑
Collect the materials you need to bring with you to the demonstration. The materials list is on page 12.	❑
Contact the children's librarian: ➢ Ask the room to be arranged with 6 tables around a front table ➢ Ask to have 5 chairs around each of the 6 tables ➢ Ask for all the tables to be covered with newspapers ➢ Ask for extra paper towels for each table	❑

Activities To Do When You Get To The Library	✓ When Complete
Introduce yourself to the children's librarian	❑
Ask the librarian how many students are pre-registered	❑
Confirm that there are 6 student tables and 1 demonstrator's table	❑
Confirm that all tables are covered in newspaper and have paper towels	❑
Set out the individual items for each experiment on the students' tables and the demonstrator's table	❑
Complete Demonstration Pre-Work Set-Up for all demonstrations: *Note: This set-up is estimated to take 30-40 minutes.*	❑
Set out the literature (1-page hand-out on experiments to do at home and *WonderScience*)	❑

Activities To Do During The Demonstration	**Timing**
Welcome the students and parents as they enter the room	**-**
Assess number of students per table and adjust to 3 - 5 per table *Note: If you have extra tables, keep them empty.*	**-**
Complete the Opening Session introduction	2 min.
Perform demonstrations ➢ 7 am: Starting the Bread Machine (Yeast)	*Total Time: 60 min.* 5 min.
➢ 8 am: Brushing Your Teeth (Toothpaste)	10 min.
➢ 9 am: On the School Bus (Rubber)	6 min.
➢ 10 am: Art Class (Milk Paint)	6 min.
➢ 12 noon: Lunch (Starch and Iodine)	10 min.
➢ 2 pm: Science Class (Handwarmers)	5 min.
➢ 5 pm: Dinner (Yeast Revisited)	2 min.
➢ 6 pm: Washing Up (Hard Water)	5 min.
➢ 7 pm: Birthday Party (Water on Penny plus Candle)	10 min.
Complete the Closing Session information and hand out literature to take home	1 min.

Activities To Do Immediately After The Demonstration	✔ When Complete
Transfer all liquids to the 1 gallon waste jug	❑
Transfer all solids to the garbage bag	❑
Remove newspapers from the tables and put in the garbage bag	❑
Give any left over literature to the librarian	❑

Activities To Do Once You Get Home	✔ When Complete
Pour waste liquid from 1 gallon jug down the drain	❑
Put garbage bag in the trash	❑

Note: ***All materials are typical household products. They can be safely disposed of in the manner indicated above.***

Contents of Demonstrator's Kit

Contents of Kit Key

Normal type: Provided per kit

Italics: Provided by demonstrator

Opening Session

Paper plate clock

7am: Starting the Bread Machine (Yeast)

Note: The kit contains an extra set of consumable materials for a practice run.

2 snack-size zipper bags labeled "Yeast" containing 1 tablespoon dry yeast

2 sugar packets

2 balloons

1 plastic bottle, 12-20 oz.

1 8 oz plastic cup

1/2 cup warm (not boiling) water

8 am: Brushing Your Teeth (Toothpaste)

1 plastic bag marked "$CaCO_3$ + $NaHCO_3$" with 1/2 c $CaCO_3$ & 1 tsp $NaHCO_3$

1 vial marked "water + glycerin + peroxide" with 15 ml H_2O, 5 ml glycerin, and 2 ml H_2O_2

1 roll of pennies (Tip: make sure at least 30 pennies are relatively dirty. Substitute clean pennies with dirty ones)

7 craft sticks

7 small paper cups (3 oz)

7 small plastic cups

1 beral pipette

35 cotton swabs

paper towels (provided by library)

water (for cleanup of pennies and hands)

9 am: On the School Bus (Rubber)

1 vial marked "latex + water" containing 2 parts latex to one part water

1 vial marked "vinegar"

2 film canisters

1 8-oz plastic cups

10 toothpicks
35 paper towels

10 am: Art Class (Milk Paint)

7 zipper close snack-size bags labeled "milk" containing 1/4 c dry milk
7 plastic cocktail cups labeled "water"
14 plastic spoons
2 sealed pipettes containing food coloring
31 3-oz paper cups
31 craft sticks
31 cotton swabs
31 half-sheets of paper
water
scissors

12 noon: Lunch (Starch and Iodine)

Part I: Pizza

7 dessert size paper plates
7 single-cracker packets
7 ketchup packets
7 parmesan cheese packets
7 sugar packets
notebook paper from Milk Paint experiment
1 sealed pipet containing iodine solution
scissors

Part II: Starch and Vitamin C

1 bottle marked "starch" containing of 2% starch solution
1 vial marked "vitamin C" containing 1% vitamin C solution
7 medium sized plastic cups
7 small paper cups
1 sealed pipette containing iodine solution
7 craft sticks
7 beral pipettes
scissors

2 pm: Science Class (Handwarmers)

7 zipper-close snack size plastic bags marked "iron" containing 4 teaspoons iron powder

7 zipper-close snack size plastic bags marked "salt" containing 1 teaspoon table salt

7 zipper-close sandwich size plastic bags marked "vermiculite" containing 4 tsp vermiculite

1 plastic cocktail cups labeled "water" (from the Milk Paint Experiment)

1 plastic spoon (from the Milk Paint Experiment)

5 pm: Dinner (Yeast Revisted)

materials from 7 am Yeast experiment

6 pm Washing Up (Hard Water)

14 vials containing distilled water

7 zipper-close snack size plastic bags marked "soap" containing 2 pea-sized pieces of Ivory soap

7 zipper-close snack size plastic bags marked "Epsom salt" containing 1/8-1/4 tsp salt

7 salt packets

7 pm: Birthday Party (Water on Penny plus Candle)

Part I: Water on Penny

clean pennies (from Toothpaste experiment)

glass of water (from Milk Paint experiment)

vial containing soap, water, and table salt (from Hard Water experiment)

31 beral pipettes

Part II: Candle on Birthday Cake

Note: The kit contains an extra set of consumable materials for a practice run.

1 clear plastic cup, about the height of the candle, with mark for water height

2 Alka-Seltzer® tablet packets

2 relighting birthday candles

1 small piece of clay in a snack-size zipper close plastic bag

matches

water

Overall

1 gallon jug for waste water collection

1 plastic garbage bag for waste collection

1 roll of paper towels

30 copies *Wonder Science* magazines

5 copies *ChemMatters* magazines (to leave with the librarian)

1 large cardboard box

Set of instructions

Set of 1-page handouts

Items for the Demonstrator to Provide

1 gallon jug for waste water collection

1 gallon jug of water (if none available at site)

1 roll of paper towels (if none available at site)

2 or 3 Sharpie-type pens (for labeling)

1 large garbage bag (for waste collection)

1/2 cup warm (not boiling) water

matches

scissors (not your best pair)

Activities to Do On-Site Prior to Demonstration

7 am: Starting the Bread Machine (Yeast)

- Fill the plastic cup with 1/2 cup of very warm water. Set on the demonstrator's table.
- Set one bag labeled "yeast", one sugar packet, one balloon, and one plastic bottle on the demonstrator's table.

8 am: Brushing Your Teeth (Toothpaste)

- Distribute the powder in the bag marked "$CaCO_3$ + $NaHCO_3$" equally between seven small paper cups. Place one cup on each of the students' tables and one on the demonstrator's table.
- Mark seven plastic cups "toothpaste" with a Sharpie-type pen. Fill seven small clear plastic cups half full with water. Place one cup on each of the students' tables and one on the demonstrator's table.
- Place 5 dirty pennies on each of the students' tables (one for each student) and one on the demonstrator's table.
- Place 5 cotton swabs on each of the students' tables (one for each student) and one on the demonstrator's table.
- Place 1 craft stick on each of the students' tables and one on the demonstrator's table.
- Place the vial marked "water + glycerin + peroxide" and the beral pipette on the demonstrator's table.

9 am: On the School Bus (Rubber)

- Mark one film canister "vinegar" using a Sharpie-type pen and fill with vinegar from the vial marked vinegar. Mark one film canister "latex" using a Sharpie-type pen and fill with latex from the vial marked "latex and water." Place both film canisters on the demonstrator's table.
- Fill the 8-oz plastic cup with water and place on the demonstrator's table.
- Dampen 35 paper towels. Place 5 towels on each of the students' tables (one per student) and one on the demonstrator's table.
- Place the toothpicks on the demonstrator's table.

10 am: Art Class (Milk Paint)

- Mark the seven plastic cocktail cups "water" with a Sharpie-type marker. Fill the plastic cocktail cups about 2/3 full with water. Set one cup on each of the students' tables and one on the demonstrator's table.
- Set out two plastic spoons on each of the students' tables and two spoons on the demonstrator's table.

Note: one spoon is for the dry milk and the other spoon is for the water. You may wish to put the water spoon directly into the water cup.

- Set out 5 paper cups, 5 craft sticks, 5 cotton swabs, and 5 half-sheets of paper (one for each student) on each of the students' tables. Set one paper cup, one craft stick, one cotton swab, and one half-sheet of paper on the demonstrator's table.
- Set out one plastic bag containing the milk on each of the students' tables and one on the demonstrator's table.
- Set the pipettes containing the food color on the demonstrator's table. Set the scissors on the demonstrator's table.

12 noon: Lunch (Starch and Iodine)

Part I: Pizza

- Prepare the foods that represent the pizza by unwrapping and placing the cracker, ketchup, cheese, and sugar on the paper plate. Make one plate for each of the students' tables and one for the demonstrator's table.
- Place the sealed pipette containing the iodine solution on the demonstrator's table. Set the scissors on the demonstrator's table.

Part II: Starch and Vitamin C

- Mark 7 medium-sized plastic cups "starch" with a Sharpie-type pen. Distribute the starch solution evenly between the 7 cups. Place one cup on each of the students' tables and one on the demonstrator's table.
- Mark 7 small paper cups "vitamin C" with a Sharpie-type pen. Evenly divide the contents of the vial marked "vitamin C" into each of these cups. Place one cup on each of the students' tables and one on the demonstrator's table.
- Place one eyedropper and one craft stick on each of the students' tables and one on the demonstrator's table. Set the scissors on the demonstrator's table.

2 pm: Science Class (Handwarmers)

- Place one bag marked "iron," one bag marked "salt," and one bag marked "vermiculite" on each of the students' tables and one of each on the demonstrator's tables.

- The demonstrator will use the water and the plastic spoon from the Milk Paint Experiment.

5 pm: Dinner (Yeast Revisted)

- This experiment was set up previously.

6 pm Washing Up (Hard Water)

- Place one vial marked "hard" and one vial marked "soft" on each of the students' tables and on the demonstrator's table.
- Place one bag marked "soap," one salt packet, and one bag marked "Epsom salt" on each of the students' tables and on the demonstrator's table.

7 pm: Birthday Party (Water on Penny plus Candle)

Part I: Water on Penny

- The clean penny, water, and soap solution are from previous experiments.
- Place 5 beral pipettes (one per student) on each of the students' tables and one on the demonstrator's table.

Part II: Candle on the Birthday Cake

- Place the candle in the cup using a small piece of clay to stand it upright. Fill the cup with water to the marked line. Place the cup/candle assembly on the demonstrator's table.
- Place the Alka-Seltzer® packets and the matches on the demonstrator's table.

Opening Discussion

Introductions

Do the following:

- Introduce yourself as a chemist.
- Introduce the American Chemical Society as the largest organization in the world devoted to a single profession.
- Introduce National Chemistry Week - what it is and why we do it.

(Hint: it is a nationwide event put on by volunteers like you to let non-chemists know about chemistry and how chemistry and chemists influence their lives.)

What is Chemistry and Chemicals?

Do the following:

- Explain that chemistry is the study of everything around them.
- Ask for volunteers to name some chemicals. Then ask more volunteers to name something that isn't a chemical.
- Remind students that chemistry is with us and all around us all day long.

Remember: everything around us is a "chemical".
Be very careful in correcting the students. Encourage their participation while explaining that anything they name really is a chemical.

What Do Chemists Do?

- Ask the participants to tell you what a chemist does, what a chemist looks like.

Note: *Be prepared for some strange and funny answers. Try not to laugh, cry, or get offended.*

- Tell them BRIEFLY and in simple terms what you do as a chemist.

Note: *This should last no more than 1 minute. Remember to leave the physical chemistry lecture and the "big" chemistry words at home!*

- Tell them that chemists use their knowledge to answer questions about the world around them. This is very exciting, as they will soon see.

Introduce the Items on the Tables

Do the following:

- Tell them not to touch anything until told to do so. Remind them never to taste or smell anything, as if they were in a laboratory.

Note: Some of the items in the demonstration are actual food items. Remind students throughout the demonstration not to eat anything!

- Tell them that they will learn that chemistry is indeed with them "around the clock". As we move the clock to a new time, we will do a new experiment.

7 am: Starting the Bread Machine (Yeast)

Experiment Purpose & General Methodology

- The students will learn that yeast gives off carbon dioxide to make baked goods "rise".
- This experiment will by done as a demonstration by the instructor.

Introduce the Experiment

Tell the students the following:

- Turn the clock to 7 am. It is time to get up and start the day!
- Tonight we would like fresh bread with our dinner. Does anyone have a bread machine at home, or have you ever helped a grown-up make bread? Discuss how much time it takes to make bread (usually ~3-4 hours).
- Bread is made from flour, sugar, and yeast. Yeast is what makes the bread rise. Today we will do an experiment that shows the action of yeast.

Perform the Experiment as a Demonstration

Do the following:

- Add the warm water to the bottle.
- Add the yeast and gently swirl the bottle for a few seconds.
- Add the sugar and swirl some more.
- Place the balloon over the neck of the bottle and let it sit on the demonstrator's table.
- Tell the students that the experiment takes time, and we will return to it at dinner time.

Note: This experiment takes about 10 minutes for the reaction to become noticeable. Occasionally swirl the bottle during this time.

8 am: Brushing Your Teeth (Toothpaste)

Experiment Purpose & General Methodology

- The students will learn about some of the chemicals contained in toothpaste and what they do.
- The students will simulate the action of toothpaste by cleaning a penny. Each student will do the experiment individually.

Introduce the Experiment

Tell the students the following:

- Turn the clock to 8 am.
- After breakfast, it is time to brush your teeth. After all, clean teeth are healthy teeth!
- There are several chemicals that are active ingredients in keeping your teeth healthy and white. Instead of cleaning teeth with these chemicals, we will demonstrate the effect by cleaning a dirty penny.
- Remind students that this is not real toothpaste, so do not taste it!

Perform Experiment Simultaneously with the Students

Do the following:

- Using the beral pipette, dispense about 2.5 ml (one squirt) of water into each plastic cup on each of the students' tables containing sodium bicarbonate and calcium carbonate. Do the same at the demonstrator's table.
- Stir the mixture with a craft stick until thick "toothpaste" forms. [If necessary, up to 1 ml more of water is required to make the paste thick enough to rub onto the penny].
- Have each student select one penny. Dip the cotton swab into the toothpaste and rub in on ONLY ONE HALF of the top of the penny as you count to 45 slowly. The students will need to hold the penny with one hand on the tabletop while they rub reasonably hard with the cotton swab. A second or third dab of toothpaste may be necessary to completely clean the surface.
- Rinse the penny in the cup of water and use the paper towels to dry it off. Compare the clean half of the penny to the dirty half.
- Let the students keep their penny.

Conclusions

Tell the students the following:

- Abrasives [a hard material that takes off a surface layer of a softer material] are necessary for removing plaque from our teeth. Calcium carbonate is being used today as our abrasive.
- Sodium bicarbonate (baking soda) is also in our mixture. Baking soda can be used as toothpaste, but it is not an abrasive. It does reduce the acids that erode the tooth surface.
- Glycerin was added to today's toothpaste. Glycerin helps retain the moisture in toothpaste so that the toothpaste does not dry out before you finish it.
- Hydrogen peroxide was added as a whitening agent.
- Several ingredients found in commercial toothpaste were not used in our toothpaste today. Fluoride is used to protect the enamel on teeth. Flavoring and sweeteners make the toothpaste taste good.

Additional Information If Needed: Technical Background

- Teeth are made from enamel that grinds food and protects the interior regions of the tooth. The enamel is largely hydroxyapatite, $Ca_{10}(PO_4)_6(OH)_2$.
- Despite its toughness, tooth enamel is susceptible to acids that come from a thin, adhesive polysaccharide film called plaque.
- Cavities are caused by bacteria in the mouth converts some of the sugars in our food into plaque, which attaches to the enamel and serves as home to still more bacteria. Some bacteria convert the plaque into an acid that erodes the calcium and the phosphate from the barrier that protects the tooth. When enough erosion has occurred, microorganisms can pass through the barrier and form cavities.
- The key to keeping teeth free of cavities lies in removing the accumulated plaque. This is more dependent on grinding it all away with a good dental abrasive than on a detergent that helps the toothpaste "foam." With daily removal of plaque, the calcium and phosphate normally present in saliva replace any that may have been removed. This process is called remineralization, which returns the enamel to its original strength. To be useful as a dental abrasive, the grinding agent must be harsh enough to remove accumulated plaque, yet not grind away the enamel itself.
- Calcium carbonate is the major ingredient in chalk and Tums. Calcium carbonate is also found in limestone, marble and seashells.

9 am: On the School Bus (Rubber)

Experiment Purpose & General Methodology

- The concept of rubber will be introduced by making a rubber band. Each student will perform the experiment.
- The students will do the experiment at the demonstrator's table.

Introduce the Experiment

Tell the students the following:

- Turn the clock to 9 am. It is time to go to school.
- Ask the students how they get to school. Hopefully the answers will include transportation like buses, cars, or bikes.
- Ask the students what the tires on buses or cars are make from. [answer: rubber].
- Ask the students why rubber is used for tires [answer: flexible, withstands pressure].
- Natural latex is harvested from milkweed, rubber plants, and rubber trees. To keep the latex from becoming rubbery, ammonia is added as a preservative.
- The students will use vinegar (an acid) to neutralize the ammonia (a base in the latex) which will cause the latex to solidify into rubber rather rapidly.

CAUTION: THE LIBRARIANS HAVE BEEN ADVISED TO ASK PARENTS ABOUT ANY LATEX ALLERGIES. THESE STUDENTS SHOULD BE IDENTIFIED AND NOT ALLOWED TO PARTICIPATE IN THIS EXPERIMENT.

Perform Experiment First as a Demonstration, Then Ask the Students to Line up to Do the Experiment

The demonstrator should do the following:

- Wipe a finger without any cuts on it (vinegar will make it sting) with the moistened towel.
- Dip a clean finger into the test tube marked "latex + water."
- Remove the finger and let the excess latex drip back into the tube.
- Dip the same finger into the test tube marked "vinegar." Move the finger up and down the tube twice.

- Dip the finger into the cup of water and move your finger around a few times to wash off the extra vinegar.
- Using a fingernail or toothpick, roll the latex off the finger by starting at the top nearest your palm and rolling it down and off the tip of your finger. Gently stretch your rubber band, but not too much.
- Wipe off your hands thoroughly with the moistened towel.

The demonstrator should ask the students to do the following:

- Wipe a finger without any cuts on it (vinegar will make it sting) with the moistened towel found on their table.
- Line up in a single file line at the demonstrator's table.
- Dip their fingers in the various solutions as explained above.
- Set the toothpicks at the end of the table for the students' use, if necessary.
- Ask the students to go back to their seats to play with their rubber band. Remind them to wipe off their hands thoroughly with the moistened paper towel.

Optional Clean-Up Experiment

- Dispose the water in the cup into the drain.
- Pour the latex into the cup. Add the vinegar. Stir quickly with a craft stick. Now you have your own bouncy rubber ball.

Additional Information If Needed: Technical Background

- Milkweed and rubber trees produce natural latex. When these plants are injured or cut, sap runs out and eventually thickens into a naturally rubbery substance that acts as a bandage to the plant by covering and protecting the injury.
- Latex is a polymer dispersed in water that contains gums, resins, tannins, alkaloids, proteins, starches, sugars, and oils. It is usually white, but in a few plants it may be yellow, orange, or red. Latex is now also produced synthetically.
- Rubber is a natural or synthetic substance characterized by elasticity, water repellence, and electrical resistance. Natural rubber is obtained from latex. Synthetic rubbers are produced from unsaturated hydrocarbons.
- Uncured rubber is used for cements, for adhesive tapes, and for crepe rubber used in insulating blankets and footwear. Cured rubber is used for tires, conveyor belts, and hoses.

10 am: Art Class (Milk Paint)

Experiment Purpose & General Methodology

- The students will learn to make their own paint using milk. Each student will make their own paint and paint their own picture.

Introduce the Experiment

Tell the students the following:

- Turn the clock to 10 am. It is time for art class.
- Chemistry is an important part of art class. Chemicals make the colors we use as well as the different types of materials (paints, crayons, and paper) that make our creations beautiful.
- Today, we will be making our own paint, using an old-fashioned method and milk as the primary ingredient.

Perform the Experiment Simultaneously with the Students

Do the following:

- Add one heaping teaspoon of dry milk and one teaspoon of water to the 3-oz paper cup and mix with the craft stick.

Note: Remind the students that one spoon is for the dry milk and the other spoon is for the water.

- Cut open the sealed pipette containing the food coloring using scissors. Add one or two drops of food coloring to each student's paint, and ask them to continue mixing.
- Using the cotton swab, paint a picture on the paper. Put the paper aside to dry.

Conclusions

Do the following:

- All paints consist of the same basic ingredients:
  - a carrier or solvent which allows the paint to be applied but then evaporates to leave a solid film behind,
  - a binder which forms a dry film, and
  - a coloring material.
- In our paint, water is the solvent, the milk is the binder, and the food coloring gives it color.

- The students may keep their masterpieces to take home.

Additional Information If Needed: Technical Background

- In the past, people used available products to make paint, such as milk. If milk is mixed with oil, it can be used to paint the outside of houses and barns. Barns are traditionally red because farmers used blood leftover from the slaughter of animals to make red paint.
- Composition of other paints that the students use in art class:
  - Binding dry powdered pigments with gum arabic produces watercolor paints. The resulting paint can be dissolved in water.
  - Acrylic paints are emulsions of pigments, water, and clear, nonyellowing acrylic resins. The advantage of acrylic paints is they dry quickly, and do not darken in color with time.
  - Oil paint contains pigment ground in oil that dries on evaporation with air. The pigment must be insoluble and chemically inert. The oil is usually linseed.

12 noon: Lunch (Starch and Iodine)

Experiment Purpose & General Methodology

- The students will learn to detect starches in a typical pizza lunch using iodine.
- The effect of vitamin C on the iodine-starch complex will be demonstrated.
- Each table will share one experimental setup.

Introduce the Experiment

Tell the students the following:

- Turn the clock to noon. It is lunchtime.
- Ask the students what their favorite lunch is. Pizza will most surely be mentioned.
- Ask the students what is in pizza. [Answers: dough that is made of flour, tomato sauce, etc.]
- Tell the students that foods are made from chemicals that give them energy and nutrients to grow. Starch is an important nutrient because it provides energy to move and grow.

Perform the Experiment Simultaneously with the Students

Part I - Starch in Pizza

Do the following:

- Ask the students to focus their attention on the plate with the food. Remind them that we are in chemistry lab, so nothing is to be eaten!
- The cracker represents dough, the ketchup represents tomato sauce, the parmesan is the cheese, and the sugar represents the juice or pop.
- Ask the students which of these foods have starch in them.
- Tell the students that iodine will tell us which foods have starch. The iodine will turn the food black-blue when starch is present.
- Cut open the sealed pipette containing the iodine with scissors. Go around the room and place a few drops of iodine on each food item on each table.

Conclusions on Starch in Pizza

- The cracker will turn black-blue because it has starch. The others do not have starch, so there will be no color change.

- The single units from which starch is made is represented in this experiment by sugar. Sugar does not react to the iodine test.
- *Optional Experiment*—Try a piece of notebook paper from the Milk Paint Experiment. It should turn black-blue because it contains cellulose.

Part II – Effect of Vitamin C on the Iodine Test

Do the following:

- Cut open the sealed pipette containing the iodine solution with scissors. The demonstrator should go around the room adding a few drops of iodine to each cup marked starch. The solution should turn black-blue.
- Ask the students to add a few drops of the vitamin C solution to the starch solution. Stir after each addition. Ask them to count the number of drops it takes to remove the color from the solution.
- (Optional) The demonstrator can show that more iodine can be added so that the black-blue color returns. You may be able to go back and forth, but do not overtitrate!

Conclusions for the Effect of Vitamin C on the Iodine Test

Tell the students the following:

- When iodine is mixed with starch, a black-blue color is formed. If vitamin C is added, the vitamin C reacts preferentially with the iodine so the starch does not and the black-blue color is not formed.

Additional Information If Needed: Technical Background

- Starch is a polymer consisting of glucose monomers. It is found in rice, wheat, potatoes, grains, and cereals.
- The iodine test causes starch to react strongly with iodine to form the characteristic deep black-blue color. Other polysaccharides like cellulose also react with iodine to form color. Mono- and disaccharides (like the simple sugars) do not react with iodine.
- Vitamin C (ascorbic acid) is an interference for the iodine test.
- If you chewed your pizza dough or the cracker for about 5 minutes and spit it out, it would not turn black-blue with the iodine solution. Saliva has enzymes, some of which are amylases (specifically ptyalin) which break down starch into smaller sugar units. Sugar does not react to the iodine test.
- Iodine is sometimes used to disinfect cuts.

2 pm: Science Class (Handwarmers)

Experiment Purpose & General Methodology

- The students will mix several chemicals (iron powder, salt, water, and vermiculite) that will heat up.
- Each table will do one experiment.

Introduce the Experiment

Tell the students the following:

- Turn the clock to 2 pm. It is time for science class.
- Today we are going to learn about chemicals that heat up when they are mixed together. Mixing chemicals together to form another chemical is called a reaction. When you mix two chemicals together and the product produces heat, it is called an "exothermic reaction."

Perform the Experiment Simultaneously with the Students

Do the following:

- Ask the students to open the plastic bag marked "iron" and add the contents of the bag marked "salt." Close the bag and shake to mix.
- Open the bag marked "iron" and add the contents of the bag marked "vermiculite." Close the bag and shake to mix.
- Ask the students to open the bag marked "iron." The demonstrator should go around the room and add 1 teaspoon of water to each bag. [CAUTION: Do not use too much water or the experiment will not work.]
- Seal the bag, and work all the materials together with fingers. The bag should get noticeably warmer in a minute or two.
- After the mixture cools, the bag can be reopened and exposed to air, sealed again, and then mixed again. The material will warm up again.

Conclusions for the Handwarmer Experiment

Tell the students the following:

- The iron, salt, and the oxygen in the air and the water create chemical reaction. This reaction produces heat, so it is called an exothermic reaction.

- The iron and the oxygen are directly involved in the reaction that produces heat. The salt helps start the reaction and speeds it up.

Additional Information If Needed: Technical Background

- Iron powder works with this experiment. Iron filings do not work.
- The iron is oxidized when it comes into contact with the oxygen in the water and the air. Adding salt helps start the oxidation and speeds it up. Oxidation produces heat.
- Vermiculite is made from aluminum, magnesium, and iron. In this experiment, vermiculite is used for insulation because it holds in heat.

5 pm: Dinner (Revisit of Yeast Experiment)

Experiment Purpose & General Methodology

- We are concluding the yeast experiment started earlier in this demonstration.

Introduce the Experiment

Tell the students the following:

- Turn the clock to 5 pm. It is dinner time, and time to check on the bread we started earlier in the day.

Conclusions

Tell the students the following:

- Yeast in the package as we buy it in the store is dormant because it is cool and dry.
- When we add yeast to warm water, it comes to life (but do not look for movement, as it is on the microscopic level).
- Once yeast is active, it needs food for energy, just like any other living organism. We (and bakers) used sugar as the food.
- After yeast uses the food, it creates a gas as the byproduct. This gas is carbon dioxide, the same gas that we expel when we breathe out. It is the carbon dioxide gas from the yeast that caused the balloon to inflate AND it is what makes bread rise.
- In bread, the yeast creates millions of tiny bubbles of carbon dioxide in the dough before it is baked. That is why bread appears to have "holes" in it.

Additional Information If Needed: Technical Background

- Yeast is used in the production of baked goods, yogurt, beer, wine and vinegar.
- Yeasts are microscopic one-celled fungi that are important for their ability to ferment carbohydrates.

6 pm: Washing Up (Hard Water)

Experiment Purpose & General Methodology

- The students will learn the difference between "soft" and "hard" water.
- The students will learn why it is so difficult to wash up using hard water.
- This is an optional experiment. If you are running out of time, skip this experiment and go to the next one.
- Each table will do one experiment.

Introduce the Experiment

Tell the students the following:

- Turn the clock to 6 pm. Remind students that after dinner, we have to wash up because there will be a special surprise later tonight!
- Ask students if they have ever heard of hard or soft water. Which one is easier to use for washing up?

Perform the Experiment Simultaneously with the Students

Do the following:

- Add one small piece of soap (about the size of a pea) to the vial marked "hard" and the other piece of soap to the vial marked "soft." Shake to dissolve and make a head of soap bubbles.
- Add as little as possible (as little as a single crystal should work) Epsom salt to the vial marked "hard." Shake the vial. What happens? [Answer: The soap head formed should collapse immediately.]
- Add a few crystals of table salt to the vial marked "soft." Shake the vial. What happens? [Answer: The soap head should be unaffected.]

Conclusions

Tell the students the following:

- The vial that contains Epsom salt is hard water. It contains a chemical that makes foaming difficult.
- The table salt in the second test tube represents the salt in the body. Salt does not interfere with the foaming action of the soap, so it is easily washed away with "soft" water.

- Water softeners are popular in areas with hard water because they make bathing and washing clothes easier.

Additional Information If Needed: Technical Background

- The soap used must be Ivory; other brands tested did not work.
- Water hardness results from calcium, magnesium, and iron in water. These elements form stearate salts with mixed with soap (which is mainly sodium stearate and other sodium salts of fatty acids). These calcium, magnesium, and iron stearates are much less soluble in water than the sodium salt and precipitate upon mixing. The solid precipitates correspond to "soap scum" or bathtub ring.
- Many homes have water-softening devices that remove the dissolved metal ions; the most common type of water softener utilizes an ion-exchange resin that replaces Mg^{+2}, Ca^{+2}, and Fe^{+2} ions with Na^{+} ions. Laundry aid agents, such as Calgon, borax, and washing soda, are marketed to remove hard water cations by causing them to become part of larger soluble anions, or by precipitating them as carbonates, which are washed away with rinse water.
- Epsom salt is $MgSO_4 \cdot 7H_2O$.

7 pm: Birthday Party (Water on Penny and Candle)

Experiment Purpose & General Methodology

- The students will each play a "party game" in which they will see how much water can be placed on a penny.
- For the finale, the demonstrator will show how to blow out a relighting candle.

Introduce the Experiment

Tell the students the following:

- ➢ Turn the clock to 7 pm. It is time for a birthday party with friends.
- ➢ First we will play a party game to see who can put the most drops of water on a penny. Then, we will see how to blow out a relighting candle.

Perform the Experiment Simultaneously with the Students

Part I: Water on Penny

Do the following:

- ➢ Ask the students to place the clean penny from the Toothpaste experiment in front of them.
- ➢ Ask each student to fill a pipette with clean water.
- ➢ Carefully count the number of drops of water you can drip onto a penny before it spills off [it should take about 25-50 drops].
- ➢ Dry the penny with a paper towel and repeat the experiment using the soap and table salt solution used in the Hard Water experiment [it should take less than 5 drops].

Conclusions on the Water on Penny Experiment

- ➢ Ask the students if the soapy water had any effect on the number of drops they could get on a penny.
- ➢ The surface of water is held together by a strong force called "surface tension." You can image this force making water look like it has an elastic "skin" all over it. With pure water, the "skin" is strong, so you can pile up many drops of water on the penny without the water falling off.
- ➢ When soap is added to the water, it weakens the "skin" or the surface tension, so less drops off water can be piled on the penny.

Perform the Next Experiment as a Demonstration

Part II: Birthday Candle

- Light the candle and let it burn a few millimeters to be sure the "relighting" feature is working. Blow out the candle to show that it relights.
- Drop two Alka-Seltzer® tablets into the water. The candle will go out permanently.

  Note: Be sure there are no drafts in the room when you do this, or else the carbon dioxide will be blown out of the cup and the candle will relight anyway.
- The relighting candle needs oxygen to relight. The Alka-Seltzer® and water reaction produces carbon dioxide, which displaces the air and makes the candle distinguish permanently.

Additional Information If Needed: Technical Background

- Some insects, such as pond skaters, can walk on water without sinking because the surface tension of the water is strong enough to support them.

9 pm: Bedtime (Closing Session)

Close Demonstration

- Turn the clock to 9 pm. Time for bed!
- It has been a fun day, learning about chemistry around the clock.
- Remind the students that they can take home their penny and the picture they made in the milk paint experiment.
- Hand out the 1-page sheet containing instructions to do experiments at home and a book list. Also hand out *ChemMatters*.