The Many Faces of Chemistry:
A Hands-on Program

An Educational Demonstration Package

Prepared by the

National Chemistry Week Committee

of the

Cleveland Section of the American Chemical Society

for

National Chemistry Week 2007

Overview

Chemistry has many faces; Cleveland covers all the bases!

Perform experiments related to people and companies from northeast Ohio who have contributed to the history of chemistry and science.

Join us for an hour of hands-on experiments and demonstrations to celebrate National Chemistry Week and do tests to identify acids and bases with color-changing wonders, build a bubbling volcano, make paint out of milk, and more.

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Acknowledgments

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 2007, the Cleveland Section volunteers will perform over fifty demonstrations at libraries, schools, and other public sites. Continuing our relationship that started in 2001, the Cleveland Section will also be providing hands-on training and (at least) 40 sets of materials for Cleveland-area teachers, at the Cleveland Regional Council of Science Teachers' Fall Conference, so that they can conduct additional programs in their own classrooms.

Our NCW efforts reach many children each year because of various sponsors who have donated money, materials, and/or services to the Cleveland Section specifically for National Chemistry Week. We are especially grateful for a third year in a row to the Martha Holden Jennings Foundation for a significant financial grant this year of $2500. We also thank John Carroll University, the Cuyahoga County Public Libraries, NASA Glenn Research Center, LD Carlson, Graftech, and other anonymous sponsors for their numerous contributions and support.

Last and most important, we thank all the volunteers who donate their time and expertise. This library/school program and other NCW events are the result of the hard work of many dedicated and talented volunteers. It all starts with our local section NCW Planning Committee. The Committee develops a theme for the program; recommends, tests, and reviews activities & experiments; writes a script; collects supplies and materials; prepares the kits; recruits sponsors and volunteers; contacts libraries and schools; and schedules shows. This Committee, as well as the rest of the Section's NCW activities, was overseen by the Cleveland Section's NCW coordinator for 2007 Kat Wollyung. Committee members include Lois Kuhns, Marcia Schiele, Bob Fowler, Shermila Singham, Cassandra Corrao, Vince Opaskar, Mark Waner, Don Boos, Dan Tyson, John Pendery, and Rich Pachuta, who were later joined by Betty Dabrowski and our distant friend Paula Fox. A special thanks to Rita Haag for helping us ensure our experiments met the Ohio education standards. Additional credit and thanks is given to the many GAK (Grand Assembly of Kits) Day volunteers (including local university students) who donated their time beforehand or gave up a Saturday in September to help count, measure, and assemble all of the necessary materials for our demonstration kits. A final thank-you goes out to the dozens of dedicated chemical professionals who lead the presentations and activities in schools, libraries, and other public locations; without them there would be no Cleveland Section NCW program.

How Experiment Write-ups are Organized

The materials and set-up of the demonstrations are located in the introduction section of this packet. Then, each experiment write-up is presented as follows:

- Background Information for Demonstrators
- Demonstration Instructions
- Experiment Conclusions
- Additional Information If Needed – You obviously do not need to cover all of this material with your students. Some is only for your adult/parent audience. Pick out what you are comfortable explaining.

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: Many 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 student's hands-on work are nearly simultaneous. You lead 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. In a few cases, only the demonstrator will perform the experiment. You are encouraged to get student helpers for the demonstrator-only experiments.

The NCW Committee offers a "Dress Rehearsal" to show the entire program to the demonstrators in advance of their own program performances; however attendance is not mandatory. This script provides enough detail for a competent adult to be able to perform the presentation. The Cleveland ACS and NCW Committee do not require background checks on its volunteers nor requires formal educational/teaching experience from all of its volunteers.

MAKE SURE TO FOLLOW ALL DIRECTIONS IN EXPERIMENTS

Some experiments may have special safety concerns due to the materials being used. Any safety concerns are listed in the section for that experiment, including where to obtain an MSDS.

For information about the American Chemical Society's NCW safety guidelines, visit www.acs.org/portal/Chemistry?PID=acsdisplay.html&DOC=ncw%5Csafetyguidelines.html

Demonstration Check-Off List

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

Activities To Do Well Before the Day of the Demonstration	**Completed ?**
Read through this packet to familiarize yourself with the experiments and verify that you have all the items as listed in the kit contents.	❑
Please check your kits upon receiving them. Vials and bottles containing solutions may have shifted during storage and transportation. Check for leakage; correct situations. Store vials and bottles in an upright position as much as possible.	❑
Please do not store kits in an overly warm area (such as in a car on a hot day). The kit contains many vials and bottles containing solutions that may leak under pressure created by higher temperatures.	❑
Contact us with any questions: Kat Wollyung katkat@neo.rr.com , Bob Fowler fowler@EN.com or Marcia Schiele marschiele@sbcglobal.net	❑
Collect the materials you need to bring with you to the demonstration. The materials list is on page 8. The librarian may be able to provide some of the items, but you need to call to verify that – do not assume they have anything.	❑
If you wish to add other experiments or demos into your program, please contact the head children's librarian through your local librarian ahead of time to get approval. Be careful and think "safety first". Neither the NCW Committee nor the Cleveland ACS approves of any experiments added to your program, and you are responsible for your own actions.	❑
You may wish to ask a friend to be your assistant. Having someone available to help set-up the room before the program and collect trash as the program progresses can help keep supplies organized. That person can also assist if multiple students need assistance or have questions about the experiments.	❑
Read over the experiments a few times and become familiar with them. Our program is designed for one-hour, but this assumes you are familiar with the program and are not strictly relying on reading the script step by step on site.	❑
Continued next page…	

Contact the children's librarian: ❈ Verify that they limit registration to 30 children ❈ Ask the room to be arranged with 6 student tables with 5 chairs each and an additional front table for the demonstrator ❈ Ask for all the tables to be covered with newspapers and for extra paper towels for each table. Otherwise take newspaper and do this during setup. ❈ Ask about availability of demonstration materials from list of page 8 (ex. paper towels, newspaper, extension cord, scissors) ❈ Ask if the librarian is available at the start of the program to greet the students and to make nametags. ❈ Make sure that the room is available before and after the program for set up and clean up. **Set-up may take up to an hour** on your own. Ask the librarian if someone is available to help with set-up to cut down this time. ❈ Offer that a librarian is welcome and encouraged to stay for the entire program. (They might even offer to be an assistant if given the opportunity.)	❑

Activity To Do AT LEAST ONE DAY BEFORE the Demonstration	**Completed?**
Review the script in its entirety and be familiar with all the experiments.	❑
Gather all the items needed for your presentation as provided in the materials list starting on page 8. Do NOT assume your librarian will supply any materials unless agreed upon in advance, and even then, call and verify they remembered your requests. Do NOT assume you can easily obtain water in the library; at some sites, faucets are close to the sink bottom and allow little room for filling bottles or cups easily.	❑

Activities To Do When You Get To The Library	**Completed?**
NOTE: Arrive approximately 1 hour before demo time to allow for set-up depending on how quickly you think you can perform the steps listed in the Experimental Setup section beginning on page 12. Do NOT assume that a librarian will be present to help you set up for the experiments.	❑
Introduce yourself to the children's librarian.	❑
Ask the librarian how many students are pre-registered (designed for 30). If the librarian has time to assist during your room set-up, ask him/her to write the first names on the bottom of the 'name tags' for Experiment 1.	❑

Confirm that the tables and chairs are set up properly.	❑
Confirm that all tables are covered in newspaper and have paper towels.	❑
Obtain those supplies from list on page 8 if provided by library.	❑
Complete Demonstration Set-Up for all demonstrations: see Experimental Set-Up: "Activities to Do On-Site Prior to Demonstration" starting on page 12. *Note: This set-up is estimated to take 45-60 minutes.*	❑
Set-up note! If you follow the script as originally written, there are many cups and other items on the tables. Depending on the size of your tables, and the activity level of your students, you may choose to distribute fewer items originally, and distribute other items throughout the program	❑
Set-up note! There are caustic and irritating materials in this year's program. Do not open bottles or bags until necessary. Wear gloves and goggles when told.	❑
You may wish to set up an 'Entrance' area table to allow space for beginning-of-program activities: goggle distribution and 'face making' (see Expt. #1, page 15)	❑
You may wish to set up an 'Exit' area table to allow space for end-of-program activities: goggle return and literature distribution.	❑

Activities To Do At the Start of The Demonstration	**Timing**
Hand out goggles and help adjust to the correct fit (if necessary).	4 min
Assess number of students per table and adjust to 3 - 5 per table. Record the number of students and adults on the provided Demo Feedback form. Do not allow any child to sit alone at a table as some experiments require two people to perform.	-

Activities To Do During The Demonstration	**Timing**
Complete the Opening Session Introduction	3-5 min.
Perform demonstrations ❋ Welcome and Experiment 1: Phenolphthalein Faces	5 min.
❋ Experiment 2: Traffic Light	5 min.
❋ Experiment 3: CO_2 Volcano	8 min.
❋ Experiment 4: Smucker's® Jelly Indicator	5 min.

❋ Experiment 5: Milk-paint	7-8 min.
❋ Experiment 6: Super-absorbents - Sodium Polyacrylate	5 min.
❋ Experiment 7: Isolation of Aluminum Metal	7-8 min.
❋ Experiment 8: Create a Flashlight	4 min.
❋ Experiment 9: Polymers	7-8 min.
Complete the Closing Session information.	1-2 min.
Collect goggles & hand out literature.	1 min.
Note: Times are approximate. Be familiar with the experiments before you arrive so you do not waste time 'reading' the script. You may choose to omit an experiment so that your program does not run over time, or change an experiment from hands-on to a demonstration. <u>Plan ahead</u> to determine which experiment you might skip over or abbreviate.	*Total Time: ~ 60 min*

Activities To Do Immediately After The Demonstration	Completed?
Clean up as indicated in the **Clean Up** section (page 41).	❑
Give the reusable items and the feedback form in the mailing envelope(s) along with the box of 32 goggles to the librarian for return to Fairview Park Regional via interlibrary mail. *(Those outside of the CCPL network can return items to your nearest CCPL branch for return to Fairview Park. See <u>www.cuyahogalibrary.org</u> for branch listings.)* Please return all materials within two weeks of NCW.	❑
Give any leftover literature and the "You Can Be a Chemist" book to the librarian *(CCPL library kits only).*	❑

Activities To Do Once You Get Home	Completed?
Leave a message for Kat Wollyung at katkat@neo.rr.com with the following information: (1) attendance, (2) specific experiment comments/recommendations, (3) other comments.	❑

Supplies Required for Demonstration

Items for Demonstrator to Provide (or to request in advance from the librarian)

scissors

1 large garbage bag for solid waste collection

1 bucket for liquid waste collection (optional if sink is within the demo room)

1 roll paper towels (if none at site)

2 gallons of water, approximately (Note: It may be difficult to transport water from library restrooms with shallow sinks or fountains with low spigots, so do NOT plan to use this method to obtain water unless you have investigated the water availability at your site.

4 cups warm water (take an insulated container of warm/hot water and add cool water just prior to the program until it reaches the desired temperature) (for Expt. #4)

newspaper for covering 7 long tables with a few layers of paper (if none at site)

1 large measuring cup or half-gallon pitcher or other container with a spout for adding water to various cup/bottles in experiments

1/4 cup measuring cup with markings for ounces

1 shiny new penny

Optional:
Apron
1 or 2 cup Pyrex measuring cup or 250-400mL Pyrex beaker
funnel
bottle of vinegar to quickly neutralize any spills (sodium hydroxide preparation)
a handheld mirror to show the students their own chemistry faces – have fun with a washable marker and write 'A Face in Chemistry…' around the edge

<u>Notice</u>: If you will be performing multiple demonstrations on the same day, you will need to sanitize the goggles between demonstrations. You will also need:

small quantity of household bleach

wash bin or bucket

rags, old towels, or cotton paper towels for drying (soft so as not to scratch the goggles)

Items Provided in Each Demonstration Kit:

Note: Items needed for each demonstration that are to be provided by the demonstrator are listed in italics below the kit items for convenience/reference

General:

1 box containing kit contents
30 copies *Celebrating Chemistry* newspapers (if available from ACS)
30 copies each of 'Book List" and "Experiments to do at Home"
30 copies each of our 'Faces and Places Activity Page' with a Puzzle and Places to Visit
1 copy of "You Can Be a Chemist" book as a gift to the library
5 (or so) copies of a Photo Permission Form
1 NCW balloon
1-2 envelope(s) for returning supplies (addressed to Fairview Park Library) *(library kits only)*
1 Program Feedback Form to be completed by demonstrator after the program
2 envelopes for mailing the feedback form and reusable supplies to the NCW coordinator
1 box of goggles (30 child & 2 adult size, addressed to be returned to Fairview Park Library) *(library kits only)*
NOTE: The return envelope will contain much of the paperwork for your program. It was placed within the envelope to help prevent folding and wrinkling in storage/transport. Distribute it as instructed below.

Opening Session / Experiment 1: Phenolphthalein Faces

30 1/6 pieces of white paper
1 full piece of white paper (note, this may be in the literature envelope)
1 50mL vial or bottle containing a solution of 1% phenolphthalein/isopropyl alcohol
1 cup marked "P" for the phenolphthalein solution (typically plastic cocktail type)
3 sharpened pencils
3 cotton swabs
1 small spray bottle containing Windex® Original (or home-made ammonia solution)

Experiment 2: Traffic Light

1 water bottle (16 to 20 oz) containing 3 grams of dextrose
1 vial of indigo carmine indicator (1% m/v in water/alcohol mixture)
1 vial containing 5 grams of sodium hydroxide pellets or flakes (**CAUSTIC!**)
1 piece of Parafilm™
2 pairs of polyethylene gloves for setup and cleanup
250 ml (or 1 cup) of tap water

Experiment 3: CO_2 Volcano

7 Styrofoam bowls
7 35 mm film containers
7 Styrofoam plates
7 snack size zip-lock bags of vermiculite **(IRRITANT!)**
7 snack size ziplock bags of citric acid and baking soda (marked CA/BS)
7 3 oz. cups marked "W" for water (or a larger cup with a line marking 2 oz volume)
pair of scissors
water (~14 oz)

Experiment 4: Smucker's® Jelly Indicator

7 packages of grape jelly
~~7 snack-size zipper-lock bags containing about 1/2 teaspoon baking soda (marked 'B')~~
1 bottle of ammonia solution with 7 cups or 7 small vials of ammonia solution
7 plastic 3-oz cups marked "V" for vinegar
1 water bottle filled with 100-150 mL vinegar (note 30mL=1oz)
7 plastic spoons
7 clear plastic cocktail cups
7 1/4-sheets of white paper
4 cups warm (not hot!) water (supplied by the demonstrator)
paper towels (supplied by the demonstrator)

Experiment 5: Milk Paint

7 zipper close snack-size bags containing 1/4 c dry milk (labeled 'M')
7 plastic cocktail cups (9 or 10 oz)
7 plastic spoons
7 5-oz cups marked "P' for paint
7 craft sticks
31 cotton swabs
31 quarter-sheets of DAY GLO paper
About 2.5 cups water
Scissors

Experiment 6: Super-absorbents – Sodium Polyacrylate

1 double-bagged sandwich-size Ziplock bag, marked "SA" containing ~1-2 teaspoons sodium polyacrylate
2 Styrofoam cups
2 clear plastic cups, 9-10 oz cocktail size
1 sandwich-size zipper-close plastic bag
3 salt packets
1 sharpened pencil (from Expt 1)
About 4.5 cups water

Experiment 7: Isolation of Aluminum Metal

7 50-mL vials each containing 2 grams Copper (II) sulfate pentahydrate ($CuSO_4{\cdot}5H_2O$) and a pinch of salt. **(TOXIC!)**
7 3-oz. plastic cups labeled "Cu" for copper
7 2" squares of aluminum foil
7 wooden stirring sticks
1 pair of polyethylene gloves
tap water
tablespoon
1 shiny new penny

Experiment 8: Create a Flashlight

7 AAA batteries
7 pieces of Tygon tubing (1", 3/8" ID) with one 1.2V flashlight bulb inserted into one end
7 strips of 2C/24 AWG coated Cu wire (5" each)
7 strips of Al foil (1/2" x 1")

Experiment 9: Polymers

14 3-oz plastic cups (7 marked "S" for starch and 7 marked "B" for boron compound
21 5-oz plastic cups (7 each marked "1", "2" and "3")
7 9-oz plastic cups (cocktail size)
7 plastic teaspoons
21 wooden sticks,
7 bags containing 12g cornstarch (marked "C")
1 bottle with Elmer's glue
1 bottle with laundry starch
1 50-ml vial with borax solution
paper towels
1 gal jug with "rinse" water.

Closing:

Set out the items for the students to take as they exit the program:
Celebrating Chemistry activity newspapers
Things-to-do at home take-home sheets
Set out the book to be donated to the library: "You Can Be a Chemist"

Activities to Do On-site Prior to Demonstration

General:

- ❋ Verify room setup (6 student tables with 5 chairs each, one demonstrator table, all covered with newspaper, each with paper towels, etc.)
- ❋ Obtain any supplies requested from librarian (see page 8)
- ❋ Place Photo Permission Forms on the demonstrator table. IF photos are taken during your presentation for NCW/ACS use (on website for event descriptions) you MUST obtain a photo permission form for each and every person in the photo. Do NOT take photos of anyone who requests else wise.

Opening Session and Experiment 1: Phenol Face

- ➢ Pour some of the phenolphthalein solution into the cup. You can pour more later as needed.
- ➢ Set up a "welcome, sign-in" table. Put out the 30 small pieces of paper, the pencils, and cup of phenolphthalein solution on the table. Put the cotton swabs in the cup.
- ➢ Draw your "face" on the large sheet of paper with a pencil. (This large piece may be located in the overall literature envelope.) Using a cotton swab, dot the cheeks with phenolphthalein solution. Write your name underneath. Set your artwork on the "welcome, sign-in" table as an example for the students.

Experiment 2: Traffic Light

- ➢ IMPORTANT: Prepare the traffic light at least 30 minutes before the demonstration.
- ➢ Add 250 ml (1cup) of tap water to the water bottle and shake until the dextrose dissolves.
- ➢ **WEARING YOUR GOGGLES and gloves CAREFULLY** add the contents of the vial containing the sodium hydroxide (NaOH) to the bottle and **IMMEDIATELY** swirl until the pellets dissolve. <u>There is a great deal of heat evolved that may distort the plastic bottle if it is not stirred immediately after the addition of the Sodium Hydroxide.</u>

  CAUTION: sodium hydroxide is **CAUSTIC**. If any of the solid or solution gets on your hands, wash thoroughly immediately; remove contaminated clothing. See Appendix for more information.

  Alternatively, you may pour the dextrose solution into a beaker or 2 cup Pyrex (heat resistant glass) container and stir in the sodium hydroxide. Pour contents carefully back into the bottle, preferably using a funnel, when all the pellets have dissolved.

  If any material has spilled onto the outside of the bottle, be sure to wipe it off very well with wet paper towels, and handle the bottle later with gloves as a precaution. If a leak or spill does occur, dilute it with water and the vinegar you may have brought from home. Rinse off your gloves with water and discard in the trash.
- ➢ Cap loosely and set aside where it will not be knocked over; allow to cool to room temperature.

- Add the entire vial of indicator to the solution and swirl carefully. Then cap the bottle tightly and use the Parafilm to seal the bottle. The solution will gradually turn yellow.
- Set the bottle on the demonstrator's table and keep the other gloves aside for clean-up later.

Experiment 3: CO_2 Volcano

- Break up any lumps in citric acid / baking soda in baggies (marked CA/BS)
- If needed, insert a film container into the hole in each bowl. (Turn bowls upside down and insert the film containers, bottom first into the hole.)
- Put the upside down bowls into the Styrofoam plates. Put one assembly on each table.
- Cut one bottom corner off of each bag of citric acid/baking soda and each bag of vermiculite (the cut section should be about 3/4 in. so that each bag can easily be poured into the film canister later). You MAY CHOOSE to leave the bags intact to prevent spillage from the bags by overactive students. If so, you will need to walk around and cut them later.
- Onto each table place a cup, a bag of vermiculite, and a bag of citric acid / baking soda CA/BS.
- Add 2 oz of water to each 3 oz plastic cup (or fill the cup supplied up to the marked line).

Experiment 4: Smucker's® Jelly Indicator

- Adjust the temperature of the water you brought in your insulated container so it is just warm, or obtain ~4 cups of warm water from the library rest room. Warm water helps the jelly dissolve faster. Do NOT distribute the water at this time; distribute the water during the experiment so that it stays warm longer.
- Distribute the vinegar equally among the 7 cups marked vinegar. Keep cups on the demonstrator's table and cover each with one of the sheets of paper to reduce the odor.
- Place 1 cup, 1 spoon, 1 paper towel, 1 package of grape jelly, ~~and 1 bag of baking soda (labeled 'B'~~ on each of the students' tables and on the demonstrator's table.
- Distribute the ammonia between the student tables using the cups or vials provided.

Experiment 5: Milk Paint

- Fill the plastic cocktail cups labeled 'w' 1/2 to 2/3 full with water. Set one cup on each of the students' tables and one on the demonstrator's table.
- Set out a plastic spoon on each of the students' tables and on the demonstrator's table. You may wish to put the spoon directly into the water cup.
- Set out 1 paper cup, 1 craft stick, 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 spoon, one cotton swab, and one half-sheet of paper on the demonstrator's table.
- Set out one plastic bag containing the milk (marked "M") on each of the students' tables and one on the demonstrator's table.

Experiment 6: Super-absorbents – Sodium Polyacrylate

- Place the two Styrofoam cups, the salt packets, and the empty zipper-close sandwich bags on the demonstrator's table.
- Add about half of the bag marked "SA" containing sodium polyacrylate to one Styrofoam cup. (You mark it #2 if desired; otherwise simply look into the cups during the experiment to verify that the first (#1) is empty and the second (#2) contains the material)
- Close the 'SA' bag containing sodium polyacrylate and place on the demonstrator's table.
- Fill the clear plastic cups about half full with water.

Experiment 7: Isolation of Aluminum Metal

- Place one square of aluminum foil, one stirring stick, and one closed vial (containing the blue copper (II) sulfate pentahydrate and salt) onto each student table and one on the demonstrator's table. CHECK ALL VIALS FOR LEAKS and clean up or discard and adjust your program as needed. Safety first!
- To each of the cups labeled "Cu" add about one ounce (2 tablespoons) tap water and set on each of the student tables and place on the demonstrator's table. [This will fill the vial to about the 30ml mark.]

Experiment 8: Create a Flashlight

- Lay the flashlight components out – one set (small plastic bag) per table

Experiment 9: Polymers

- Empty the entire contents of the 7 baggies marked "C" for cornstarch into the 7 5oz cups marked "1" and add 1 wooden stick to the cup.
- Place 4 teaspoons (20ml) of glue into 7 5-oz cups marked "2" and add 1 wooden stick
- Place 5 teaspoons (25ml) of glue into 7 5-oz cups marked "3" and add 1 wooden stick Measure 3 teaspoons (15ml) of liquid starch into 7 3-oz cups marked "S."
- Measure 1 teaspoon (5ml) of the borax solution into 7 3-oz cups marked "B"
- Fill the 7 cocktail cups 2/3 full with water and place one teaspoon in this water cup.
- Keep the glue, starch and borax solutions and water cups on the demonstrator's table until just before the experiment is performed with the students.

Closing Session - You may wish to set up an 'Exit' area to allow space for end-of-program activities: goggle return, literature distribution.

Greet the Students (and Parents) Upon Their Arrival and Distribute Face/Name-tags and Goggles

Do the following:

- As the students enter the room, show them your own face drawing. If you or the librarian had time during set-up to write the pre-registered students' names on the nametags, hand them out as the students enter. Have them draw their face on one of the small sheets of paper with a pencil and dot their cheeks with phenolphthalein solution using the cotton swabs.
- Have the students take their "Name Tag" faces to their seats at the tables and place them on the table in front of them. Tell them we will soon demonstrate the colorful faces of chemistry in the Cleveland area.
- Hand out and adjust students' goggles (alternately, do this at the start of the program; however doing this before the program saves time).
- Ask each student to take a seat at a table (no more than 5 students per table) and to PLEASE not touch any of the materials before the program begins. Some experiments may be ruined if they do.

Opening Discussion

Do the following:

- Introduce yourself as a chemist or chemist/science teacher (or state your interests in chemistry), and 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-scientists know about chemistry and how it has improved our everyday life.)*

What is Chemistry and Chemicals?

Do the following:

- Explain that chemistry involves the study of everything around them.
- Ask volunteers to name some chemicals. Then ask more volunteers to name something that isn't a chemical.

> ***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?

- *Note: This should last no more than 1 minute. Remember to leave the physical chemistry lecture and the "big" chemistry words at home!*
- Ask the participants to tell you what a chemist does, what a chemist looks like.
- Tell them BRIEFLY and in simple terms what you do as a chemist and/or scientist.
- 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 and Distribute Goggles

Do the following:

- Tell the students that various items have been gathered for them on their table.
- Most of the items can be found around the house, but they should NOT touch anything until instructed to do so. *Never taste or smell anything, as if they were in a laboratory!*
- Tell the students that even though most of our items are relatively harmless today, we will still be good chemists and take the safety precaution of protecting our eyes with our goggles. Put on a pair of the adult-sized goggles. If you have an assistant, ask them to do the same.
- Help the students put on their goggles. Adjust the straps as necessary. (Note: These goggles are sanitized each year and prior to each demonstration.)

Introduce Today's Presentation:

Tell the students the following:

- This year's theme for National Chemistry Week is "The Many Faces of Chemistry"
- When we hear the word "chemical" in the news, it is often in a story about a 'dangerous' chemical spill, or how a chemical has been found to be harmful to our health. But this isn't always the case! Chemistry can be good for us and important to things in our daily lives!
- Can you name any famous Clevelanders, or Ohioans? (TV, sports, industry)
- Our schoolbooks often mention famous Chemists and sometimes it may seem that they are all from foreign places, but there have been some important and famous Cleveland scientists whose inventions we see every day! When we drive around town, do our homework, or paint our home, there may be a famous Ohio or Cleveland scientist or business behind it.
- Throughout out experiments today, we will be discussing some of the contributions to chemistry made by more local faces in chemistry.
- We will try to use the scientific method to guide us in our investigation of various items associated with chemists and chemical companies in NE Ohio. We will make observations, form a hypothesis (a guess as to how or why something works), use experiments to test our hypothesis, and then evaluate the results of the experiment to accept or reject the hypothesis.

Opening Session and Experiment 1: Phenol Faces

Experiment Purpose & General Methodology

- Students will learn that phenolphthalein is an acid-base indicator that is colorless in neutral or acidic solutions (as in this alcohol solution) and bright pink in basic solution such as the aqueous ammonia found in Windex®.
- In summary, students will spray their drawn faces with Windex® and observe the color change (to pink in the cheeks). As the ammonia evaporates, the pink color will fade and disappear, as the solution is no longer basic.
- Each student will make a color-changing face as a table nametag.
- The experiment should take a total of 5 minutes to complete.

Introduce the Experiment

Tell the students the following:

- There are many Clevelanders who became famous for their inventions in chemistry. You, too, may be a famous "face" one day. We'll show how chemistry can "work magic" and change your face from plain to bright.
- We used a pencil to draw our faces.
- Ask: Does anyone know what is in a pencil?
- It is NOT lead. It is graphite and clay. Graphite is soft, slippery carbon (like a very pure piece of coal) (think of soot which leaves your hands black if you touch it). Graftech is a Cleveland-area company; its world headquarters are in Parma. It uses graphite to make all kinds of things; it's the U.S.'s largest maker of graphite electrodes (for furnaces). Now you understand why we drew faces with pencils containing graphite – it's our Cleveland connection!
- We painted the cheeks of our drawing with phenolphthalein which is a chemical called an indicator. In this case, our indicator has one color in acids (like lemons and fruits) and another color in bases (like cleaning products). The powder is dissolved in rubbing alcohol.
- We are going to spray our pictures' cheeks with Windex® which is a base. It is a window cleaner that you may use at home. Anyone know what is in original Windex®? What makes it smell like that?
- It is ammonia. A Cleveland inventor, Garrett Morgan, had two great inventions – one of which relates to this smelly gas and another we will investigate later in the program. Garrett Morgan created a safety helmet, also known as a 'gas mask' to keep people from breathing smoke and ammonia. He patented this "Breathing Device" in 1914, and used it to save people from a gas-filled tunnel beneath Lake Erie after the Cleveland Waterworks explosion on July 25, 1916.

Perform Experiment Simultaneously with the Students

Do the following:

- When everyone is seated, and your introductions are completed, hold up your drawn face and spray with Windex®. The cheeks will turn bright pink.
- Go around the room and spray everyone's face picture. If there is little ventilation, consider asking the students to wait till the end of the program, when you can spray their pictures outside

Conclusions

Tell the students the following:

- This experiment was an example of how chemistry can work to detect and identify various things. Color changes like those of our indicator can tell if something is acidic (like food) or basic (like household cleaners, such as Windex®.
- Cleveland chemical companies are important to artists like us, because of the graphite (pencil) connection. We also learned that a famous Clevelander produced a safety helmet that was used to help rescue people that were breathing fumes. The fumes we had here were no more than what you'd breathe if you were cleaning windows; nonetheless, it is best to use all "fumy" or "smelly" cleaners in a well-ventilated area (with a lot of fresh moving air).
- *If you brought a hand-held mirror from home and if it is easy to quickly walk around your room…*Tell the students they will now see some REAL faces in chemistry, and walk around with your mirror.
- **NOTE: YOU MAY want to occasionally walk around the room with your mirror throughout the program congratulating students on being a face in chemistry and science.**

Additional Information If Needed: Technical Background

- Phenolphthalein used to be found in Exlax®.
- Standard Oil scientists in Linden, New Jersey in 1920, when trying to invent useful things from gasoline by-products, ended up making isopropyl alcohol, or rubbing alcohol. So, rubbing alcohol was the first chemical made from oil, sold as a commercial product.
- Websites:
    - GrafTech http://www.graftech.com/GrafTech/Home/Default.htm
    - http://en.wikipedia.org/wiki/Pencil
    - http://www.jcu.edu/chemistry/NAOSMM/2007/FamousPeople.html

Experiment 2: Traffic Light

Experiment Purpose & General Methodology

- The color of a solution changes from yellow to red to green as a result of changing levels of oxygen in the solution. This oxidation/reduction reaction resembles a traffic light.
- This experiment **represents** the contribution of Garrett A. Morgan to Cleveland history. The traffic light itself is not the result of chemical reactions.
- This experiment is a demonstration and will run ~5 minutes.

Introduce the Experiment

Tell the students the following:

- Garrett A. Morgan was an important African American Clevelander who invented two very important devices that keep us safe. In the last experiment, we mentioned his invention of the safety helmet or gas mask. The one he invented in 1923 keeps us safe in traffic. Does anyone know what this invention might be? (Answer: students may give a variety of answers such as brakes, stop signs, and horns, but do not tell them that it was the traffic light until the demonstration is complete.)
- Well, to give you a hint we have a demonstration to show you.

Perform Experiment as a Demonstration

Do the following:

- This is a demonstration only. **Students should NOT handle this bottle.**
- What is the color of the solution in this bottle? (Answer: yellow)
- I am going to slowly swirl this bottle once or twice. What is the color now? (Answer: red) (Note: Do not shake or invert the bottle; prevent leaks as much as possible.)
- Okay, now I am going to swirl it some more, and what is the color now? (Answer: green)
- Set the bottle down on the demonstrator's desk so that the students may see it. The color will slowly fade to red, orange and back to yellow. You could repeat this demo several times if you wish, just don't swirl too vigorously.
- What do you think Garrett A. Morgan's invention was now? (Answer: they all should guess it to be a traffic light!)

Conclusions

- Garrett A. Morgan sold his invention to the General Electric Company. The actual traffic light works on electricity rather than chemistry but we wanted to include this demonstration to honor this great local inventor.
- The chemistry used in this demonstration relies on indigo carmine which is an indicator that changes color with different amounts of oxygen. When we swirled the bottle it turns green when more oxygen is dissolved in the water. It turns back to yellow when less oxygen is available. The red color is an in-between stage for this indicator.

Additional Information if Needed: Technical Information.

- This is a REDOX (reduction/oxidation) demonstration using indigo carmine which reacts with oxygen to produce red, yellow, and green solutions. The demonstration can be done several times.
- Indigo carmine undergoes a reversible reduction.
- Shaking the flask brings more oxygen into the solution, provoking the formation of the oxidized (green) form. The indigo carmine will eventually undergo reduction again to its reduced (yellow) form when the oxygen concentration drops due to a reaction with the dextrose. The intermediate color is due to formation of a red semiquinone intermediate.
- From: http://www.jcu.edu/chemistry/naosmm/2007/FamousPeople.html

Experiment 3: CO_2 Volcano

Experiment Purpose & General Methodology

- When water is added to a mixture of citric acid and baking soda, CO_2 is generated. The CO_2 generated forces the vermiculite out of the film container and over the bottom of the bowl simulating the lava flow from a volcano.
- This experiment demonstrates a classic acid/base reaction producing CO_2 gas.
- The experiment will take ~8 minutes and be performed at each table.

Introduce the Experiment

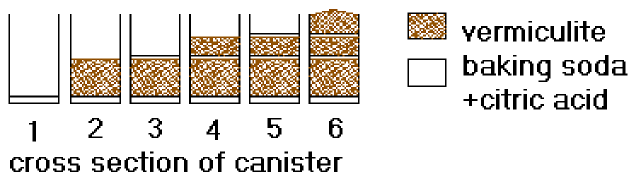
Tell the students the following:

- Ask the students if they ever go to the bakery or buy bakery products at the grocery store?
- Which bakeries do they go to or what brands do they like from the grocery? (answers may vary)
- Haw many bakeries are in Ohio? (answer: lots!)
- Some of the famous bakeries in the Cleveland area are Aladdin's, Corbo's, Davis, Nickles and Orlando Bakeries. Some of your parents will remember fondly the Hough Bakeries, which was the place to go for birthday cakes. Each of these began in an effort to bring their family recipes to the masses or fill a need in their communities. There are hundreds of little bakeries in our area and everyone has their favorites.
- Ask the students what they most like at a bakery. (answers will vary)
- Ask the students to describe the texture of bread and cake.
- Ask them what made all the holes in the texture.
- Tell them that bubbles of carbon dioxide in the dough made the holes.
- Tell them that in cake the carbon dioxide comes from adding an acid to baking soda.
- Tell them we are going to make carbon dioxide and use it to simulate a volcano which will show the action that goes on in the cake baking process.
- The acid we will use is citric acid, a solid mild acid found in fruit.

Perform Experiment as a Demonstration, then Simultaneously with the Students

Do the following, leading the students:

- Have the students each share in doing the tasks in this experiment.
- Demonstrator diagram:



- Note to the students that the bag of citric acid/baking soda (marked CA/BS) and the bag of vermiculite are (or will now be) cut at one corner and that we will pour the contents of each bag out of the bag through that hole, using it like a funnel. Be careful in picking up the bag.
- Using the cut corner of the bag of the citric acid/baking soda as a funnel, put one-half of the citric acid/baking soda into the bottom of the film canister.
- Next, place half of the vermiculite on top of the citric acid in the canister. **Do not press or pack-down between steps.**
- Add 1/2 of the remaining citric acid/baking soda on top of the Vermiculite.
- Fill 1/2 of the remaining space with vermiculite
- Add the rest of the citric acid/baking soda
- Fill the film container with vermiculite. **Do not press or pack the vermiculite!!**
- Are we ready? Pour the water at a moderate rate over the vermiculite.
- Stand back and watch!

Conclusions

Tell the students the following:

- Here the CO_2 is generated in a mass to force out the vermiculite. If it were a fine powder uniformly mixed in sticky cake dough it would make numerous small bubbles in the dough.
- Ask the students how they think this chemical reaction relates to their experience with the texture of cakes.
- Ask if anyone has every eaten a cake where the cook forgot the baking soda.
- Ask what they think a cake would taste like if it did not have all those air holes?

Additional Information If Needed: Technical Background

- The chemical reaction for citric acid and baking soda is shown below:

  $HC_6H_7O_7$ (s) + $NaHCO_3$ (s) ----water---> $HC_6H_7O_7$ (aq) + $NaHCO_3$ (aq)

  $HC_6H_7O_7$ (aq) + $NaHCO_3$ (aq) ----> $NaC_6H_7O_7$(aq) + CO_2 (g) + H_2O (l)

- Aladdin's Bakery was founded in 1970 by two brothers to make pita bread. These "pocket" breads are found in most grocery stores. www.alladinbaking.com.
- Corbo's Bakery is in Cleveland's Little Italy and has been there for four generations. It is a specialized Italian bakery. www.corbos.com
- Nickles Bakery was established in 1909 and found on most grocery stores shelves. www.nicklesbakery.com Nickles bakery began in 1909 as the Navarre, Ohio Bakery where he settled. While this is not northeast Ohio, he brought out many other bakeries in our area.
- Orlando Bakery has been in Cleveland since 1904 when part of the family left Italy and established this well-known operation whose product is found on most grocery shelves. www.orlandobaking.com
- Davis Bakery and Delicatessen was a Cleveland Height landmark for over 50 years. The owners have expanded their operations across the city.
- The old Hough bakery recipes are still used at Archie's Lakeshore Bakery. He was the baker at Hough before it closed. 14906 Lakeshore Boulevard, Cleveland, Ohio.

Experiment 4: Smucker's® Jelly Indicator

Experiment Purpose & General Methodology

- The students will learn about the use of indicators to tell between acids and bases. In this experiment, grape jelly is used as the indicator.
- Each table will share one experimental setup. This experiment will take 10 minutes.

Introduce the Experiment

Tell the students the following:

- Have you ever seen fruits or vegetables change color before your very eyes? (some may answer yes. If so, ask them to explain.)
- Have you ever done an experiment in school with red cabbage? (answers may vary)
- Have any of you ever used color-changing markers? (most will have)
- Well today we are going to look at one particular food, grape jelly, that changes color when they are in contact with an acid or a base.
- Explain to the students that an acid is a chemical that has a sour taste and sharp smell. Examples of acids include orange juice and vinegar.
- A base is a chemical that is bitter tasting and slippery to the touch. Common examples of bases include soap, ammonia, and baking soda.
- Does anyone know of a local company who produces grape jelly? (Answer: Smucker's—they should all know this one!)
- Smucker's is our neighbor in Orville, Ohio. This company has a pretty neat story of how it got started.
- Who knows the name of the person who went around the country planting apple trees? (answer: Johnny Appleseed).
- It was from the fruit of one of these trees that Jerome Monroe Smucker first pressed cider at a mill he opened in 1897; then he produced apple butter and the rest is the history of Northeast Ohio!
- Today we are going to investigate the use of Smucker's grape jelly as an indicator of acids and bases.

Perform the Experiment Simultaneously with the Students

Do the following, leading the students:

- Add one packet of the jelly to the cup.
- Add about a half-cup of warm water to the cup on each table. Note: this should be done during the experiment so that the water is kept as warm as possible. Also note that the jelly does not have to be completely dissolved for the experiment to work.
- Distribute one cup of vinegar (marked "V") and piece of paper to each table, setting the vinegar cup on top of the water paper. Tell the students that this white background allows the color changes to be more easily seen.
- Ask the students what color the solution is. [Answer: Reddish-purple].
- Clean off the spoon with the paper towel. ~~Add about half of the baking soda from the bag (marked "B")~~ add half of the ammonia (1/2 tsp) to the cup and stir gently. Note that the color changes to gray-blue. If the color change is not dramatic, add more of the ammonia.
- Clean off the spoon with the paper towel. Add vinegar by the half-teaspoonfuls with stirring until the color turns back to reddish-purple. [This should take about 3-4 teaspoons]. Note that the solution bubbles.
- If time and supplies permits, the addition of ~~baking soda~~ ammonia and vinegar can be repeated for another set of color changes.

Conclusions

Tell the students the following:

- The bubbles they saw during the experiment were due to carbon dioxide evolved during the chemical reaction between the ~~baking soda~~ ammonia and the vinegar.
- The color change was due to the presence of a chemical in the grape jelly that acted as an indictor. An indicator changes color when a solution is changed from acidic to basic.
- Tell the students, If you like color-changing indicators and want to do more, you can visit our website where there is a contest to enter and receive a prize too. Search under 'NCW' and Cleveland and you'll find us.
- You can try this same experiment at home with other household acids and bases with parent supervision.

Additional Information If Needed: Technical Background

- Smucker's website: http://www.smuckers.com
- In the early 19th century, John Chapman, or "Johnny Appleseed," wandered the Ohio countryside, sowing apple seeds and securing a place in American history.
- It was from the fruit of Johnny Appleseed's trees that Orrville, Ohio resident Jerome Monroe Smucker first pressed cider at a mill he opened in 1897. Later, he also prepared apple butter, which he sold from the back of a horse-drawn wagon. Each crock bore a hand-signed seal as his personal guarantee of quality.
- Before long, J.M. Smucker's name became well known in its own right, as residents throughout the region – and eventually the nation – came to associate the Smucker's name with wholesome, high-quality fruit products.
- Much like Johnny Appleseed's trees, The J.M. Smucker Company has strong roots that have allowed it to grow and prosper over the last 100 years. Today, their products can be found in homes and restaurants throughout the world.
- Travel through the decades along their timeline to see how Smucker's has become the market leader of fruit spreads, ice cream toppings, health and natural foods beverages, and natural peanut butter in North America.
- The J.M. Smucker Company, Strawberry Lane, Orrville, Ohio 44667, (330) 684-3838.
- The chemical reaction that occurs is

~~NaHCO3~~	$NH_4OH(aq)$	+ $HC_2H_3O_2$ (aq) -------->	CO_2	+ ~~Na~~ NH_4	$C_2H_3O_2(aq)$	+ H_2O
~~Baking soda~~	Ammonia	vinegar	gas	ions		water
	Basic	acidic				

Experiment 5: 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.
- Various pigments can be used in paper as well as fabric, plastic etc. to give it special qualities.
- The experiment should take 8 minutes to complete and is done per table.

Introduce the Experiment

Tell the students the following:

- What material is common to art class, the walls of your home and the exterior of your car?

(Answer: paint).

- Chemistry is an important part of art and the paint industry.
- Chemicals also 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.
- Our paper is rather special too. What do you notice about the paper? (Answer: very bright)
- This paper is made by DayGlo Corporation in Cleveland which is the world's largest manufacturer of daylight fluorescent pigments and products. They began in Cleveland over 60 years ago. When you think of Glow-in –the-Dark, think DayGlo!
- Paints have become a very big industry for Cleveland. Does anyone know the name of the two really big companies here? (Sherwin Williams and Glidden paints)
- Sherwin Williams and Glidden paints began their paint business in the 1870's, over 125 years ago. Both companies began and stayed in Cleveland.
- Many people before the 1820's used paint. But what did they use to make paint? (Answer: milk!)
- Let's make some today the old fashioned way

Perform Experiment as a Simultaneously with the Students

Do the following:

- Add the dried milk from the bag marked "M" to the 5 oz plastic cup.
- Add four teaspoons of water to the milk in the 3-oz paper cup and mix with the craft stick. If it is too thick, add a bit more of water and stir until it is the consistency of poster paint.
- *Note: Remind the students that the spoon is for the water and the craft stick is for stirring.*
- Using the cotton swabs, paint a picture on the paper. Then put the paper aside to dry.

Conclusions

Tell the students 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 and the milk is the binder.
- 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, non-yellowing 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.

- Web sites: http://www.jcu.edu/chemistry/naosmm/2007/FamousPeople.html

  DayGlo Corporation: www.dayglo.com

  Sherwin Williams: http://www.sherwin-williams.com/ main web page

  Glidden paints: http://www.glidden.com/home/index.jsp main web page

  Francis Glidden: http://www.lkwdpl.org/lore/lore59.htm --Francis Glidden

Experiment 6: Super-absorbents – Sodium Polyacrylate

Experiment Purpose & General Methodology

- The students will learn that sodium polyacrylate changes form as it absorbs water.
- This experiment will be performed as a demonstration and should take 5 minutes.

Introduce the Experiment

Tell the students the following:

- Some of the most common consumer products rely on interesting chemicals to carry out their function.
- Polymers are very large molecules made up of many small molecules.
- The powder used in this experiment becomes a gel upon absorbing water (nearly 800 times its weight).
- While it absorbs water quite well, it does not absorb salt water very well.

Perform Experiment Simultaneously with the Students

Do the following:

- Hold up the clear cup with water. Ask the students to observe what is in the cup. Using those observations ask the students to make a guess as to what might be in the cup.
- Pour the water from one of the clear plastic cups into the first Styrofoam cup. Ask the students: "Where is the water now?" (You should get a resounding "Cup #1" answer.)
- Acknowledge that they are correct and then pour the water from the first Styrofoam cup into the second cup (containing the sodium polyacrylate). Now ask them where the water is. ("Cup #2") Again, ask the students if they are sure. (Of course, they will be.)
- Make sure you pause a little here while you are talking to the students to make sure that the sodium polyacrylate absorbs all of the water. A little stirring with the eraser end of the pencil might help.
- Again, ask them: "Are you really sure?" and turn the second cup upside down! (Nothing should come out and the students should be amazed!) Ask the students where the water went? (Ask for a few ideas but don't spend too much time.)
- Let the students know that the second cup had sodium polyacrylate in it when you started!
- Next, show the students the doubled plastic bag with the dry sodium polyacrylate, marked 'SA". Explain that this is how the powder looks when it is "dry". Then add water (from the second clear cup) into the plastic bag, re-seal both bags and allow the students to see how the powder changes into a gel. Then pass the gel around for everyone to feel through the plastic

bag. THE STUDENTS SHOULD NOT OPEN THE PLASTIC BAG TO TOUCH THE GEL - SODIUM POLYACRYLATE ABSORBS WATER AND IF THE STUDENTS GET ANY IN THEIR EYES OR MOUTHS IT WOULD BE VERY IRRITATING!

- Tell the students that this polymer works best with pure water. It does not absorb water with dissolved salts nearly as well.
- Pick up a packet of salt and ask, "Where do we find salt?" (Answers may vary)
- "Does anyone know of local companies that mine salt?" (Answers may vary)
- "Where do we use salt?" (food, roads in winter, ice cream making in summer, preservative, water softening, agriculture, maintain body electrolytes, etc)
- "Why is salt so helpful for these?" (Answer: when dissolved it forms ions)
- If they have not already guessed, Morton Salt in Fairport Harbor and Cargill on Whiskey Island in downtown Cleveland both mine salt from under Lake Erie. The salt from here is usually used for road salt but can be re-crystallized into the salt you find in your kitchen and in these salt packets.
- Add the packets of salt into second Styrofoam cup containing the gel. Stir it a bit with the pencil.
- While holding the second cup over the first clear plastic cup, poke a hole in the bottom of the cup using the point of the pencil. Water should begin to drip/pour out the bottom as the gel releases it.

Conclusions

Tell the students the following:

- You see that salt has a pretty amazing property. It dissolves in water and is capable of breaking apart some substances.
- The properties of the polymer we used were also impressive. We will explore polymers later in this program.

Additional Information If Needed: Technical Background

- Information about Morton Salt and Cargill may be found at www.mortonsalt.com and

  http://www.cargilldeicing.com/about/dc_dt_prod_clev.pdf
- Morton Salt dates back to 1848. The company introduced the country to the slogan "When it rains, it pours™". It also introduced us to one of the most recognizable icons in the world – the Morton Umbrella Girl.

- In 1959 Morton developed what was, at the time, the world's deepest and most modern salt mine in Fairport, Ohio.
- In 1961 The International Salt Company established the Cleveland salt mine now operated by Cargill.
- Sodium polyacrylate is a super-absorbent polymer, sometimes sold as "waterlock". It is used in some diapers, potting soils (to help retain moisture), and airplane fuel line filters (to prevent water from entering the engine lines).
- It is also used to make a gel that can be sprayed on the outside of homes threatened by nearby forest/brush fires. Water is very good at absorbing heat without changing temperature much (we say it has a high specific heat). The gel can absorb the heat of the nearby fire, protecting the house from absorbing too much heat and catching on fire itself.
- Sodium polyacrylate works by osmosis. There is a high sodium ion concentration on the inside of the polymer (which forms a permeable membrane around the sodium). When water is added to the polymer, osmosis occurs, and the polymer absorbs water in order to balance the level of sodium ions in solution both inside and outside the polymer. This results in a swollen, gelatinous polymer.
- Sodium polyacrylate can absorb up to 800 times its weight of deionized water. It will absorb less tap water (only about 400 times its weight) due to the presence of dissolved ions.
- When table salt is added to the sodium polyacrylate, there is a higher concentration of sodium ions outside the polymer. Osmosis occurs again, releasing water in order to equalize the concentrations.

Experiment 7: Isolation of Aluminum Metal

Experiment Purpose & General Methodology

- This experiment demonstrates a general practice of metal extraction from its ores; in other words, getting metal directly from a rock.
- A few pieces of aluminum foil are placed into a vial containing a copper sulfate solution. The aluminum is oxidized, reducing the copper ions in solution to a pile of copper metal on the bottom of the vial.
- The students will use one sample per table; the demonstrator will use one sample. The experiment should take ~8 minutes.

Introduce the Experiment

Tell the students the following:

- Pick up the vial of copper(II) sulfate pentahydrate ($CuSO_4 \cdot 5H_2O$) and the cup of water marked "Cu".
- Have the students find their own vials and "Cu" cups.
- Open your vial and pour the water into the vial. Recap the vial.
- Have the students repeat your actions and recap their vials. **Be sure the cap is on correctly before shaking!!! The demonstrator should check each vial before the students shake them.**
- Tell the students that the first step to obtain metal from its ore is to put it into solution.
- Have the students shake their vials vigorously. Do the same with your vial.
- Tell the students that it will take a little time for the water to dissolve the ore.

  Note: It will take about a minute or two to dissolve the copper(II) sulfate pentahydrate. Keep shaking the vial to speed dissolution.

REMEMBER - COPPER(II) SULFATE IS TOXIC.
DO NOT LET STUDENTS SPILL THE SOLUTION.

Note: If there is a spill, clean it up with paper towels. The U.S. recommended Daily Allowance for copper (as Cu^{2+}) is 4 mg. To exceed that, the students would need to ingest 0.5 ml of this solution.

- While the students dissolve the crystals ask them if they notice anything special about the solution in their vials. (Answer: it is becoming blue and the crystals are dissolving).
- Explain that this solution is made of copper ions a salt form of copper rather than the pure element form as found on the outside of a penny or copper wiring.
- We are going to use a very special pure element to create the pure copper from its ions.
- Does anyone recognize the silvery square of metal in front of them? (Should be lots of yeses.)
- Does anyone know the name of this pure chemical element? (answer: aluminum)
- How many of you know that aluminum is the most common metal on the planet Earth?
- In 1886, Charles M. Hull, who had just graduated from Oberlin College a few months before found an easy and very inexpensive way to produce pure Aluminum from its ore.
- At one point aluminum was so valuable that it was worth more than gold!
- It is too difficult for us to create pure aluminum today so we are going to use aluminum to produce pure copper.

Perform Experiment Simultaneously with the Students

Do the following:

- Pick up your vial of copper (II) sulfate solution.
- Have the students do the same.
- Pick up the pieces of aluminum foil and have the student pick up theirs.
- Have one of the students tear the foil into about eight smaller pieces while you do the same.
- Open your vial and drop the aluminum pieces into it.
- Have them use the wooden stick to push the pieces under the surface of the solution.
- Recap the vials. AGAIN, DOUBLE CHECK that that the caps are tight!
- Show the students the reaction occurring and warn them of the temperature rise of the vial.
- Have the students repeat your action.

Conclusions

Tell the students the following:

- The solid accumulating on the bottom of the vial is copper metal. It looks different from a penny because it is many little tiny balls joined together in filaments or threads.
- Normally you see metal as very large sheets or chunks.
- This difference in the way the copper has been formed causes the different appearance.

- If we removed the solid from the vial, melted it, and then cooled it, it would look as shiny as a new penny. The demonstrator should show their bright shiny penny at this time, if one was brought to the program.
- This is exactly what is done with metals made in this fashion.

Additional Information If Needed: Technical Background

- Back in 1886, Charles Hall in nearby Oberlin, Ohio, developed an inexpensive way to extract aluminum (considered an expensive and rare metal) from its ore. In 1997 the American Chemical Society, declares this discovery a "National Historical Chemical Landmark"
- The traditional 10^{th} anniversary gift is aluminum!
- The shiny and dull sides of Aluminum foil are simply a result of the manufacturing process.
- Henri Sainte-Claire Deville of France substituted potassium with less expensive sodium in 1854 and was able to create enough aluminum for display at the Paris Exposition of 1855. Billed as "silver from clay," aluminum bars were shown alongside France's crown jewels. The juxtaposition was fitting: rubies, emeralds and sapphires consist mainly of crystalline aluminum oxide.
- In 1855, pure aluminum was valued at $115 per pound—more expensive than gold. Napoleon III proudly displayed aluminum cutlery at his state banquets, commissioned aluminum equipment for his military and even had an aluminum and gold baby rattle made for his son.

Experiment 8: Create a Flashlight

Experiment Purpose & General Methodology

- Assemble some of the components into a flashlight.
- Demonstrate how a flashlight works by competing the circuit through the battery.

Introduce the Experiment

Tell the students the following:

- Every chemical reaction has an energy change associated with it.
- Sometimes this energy is observed as heat (either heating or cooling) and sometimes as electrical energy.
- Electrical energy is generated (or consumed) when electrons released at a cathode (where an oxidation reaction is taking place) flow across an electrolyte to an anode (where a reduction reaction is taking place).
- A battery is a device which stores energy until needed.
- It consists of an anode (-, red.), a cathode (+, ox.) and a substance between them (electrolyte) which allows electrons to pass from the cathode to the anode.
- When an external resistance (such as a light bulb) is attached to the anode and cathode, electrons flow. This is known as an electrical current.
- In this way the battery converts the energy of chemical reactions at the anode and cathode into electricity which can be used to light a flashlight.
- While our earlier 'traffic light' was a chemical reaction, these real lights are electrical in nature.

Work with the Students to construct their flashlights.

Do the following, leading the students:

- Find the piece on tubing with a flashlight bulb inserted into one end. Our NCW volunteers did this for us to save time today.
- Wad the Al foil and place it into the opposite end of the tubing making sure that it's snug against the bottom of the bulb. If necessary, use the eraser end of a pencil to ensure good contact between the Al and the bulb. (This is done to ensure good electrical contact between the bulb and the + terminal of the battery.)

- Now force the + end of the battery into the open end of the Tygon tubing. Insert it sufficiently far to make certain that the battery's cathode is making good electrical contact with the foil wad and the bulb.
- Carefully wrap the exposed Cu end of the wire around the bulb's open thread. Twist the end of the wire reasonably tightly around itself near its insulation, again to ensure good electrical contact.
- If good electrical contact has been maintained, the bulb will light when the opposite end of the wire is touched to the batteries – terminal (anode).
- If the bulb doesn't light, check to make sure that the bulb-Al-top of battery connection is good.

Conclusions

Tell the students the following:

- By the connections they've just made, they have duplicated the way flashlights work.
- We can be thankful to Mr. Urry at Eveready's Parma Technical Center for the invention of alkaline batteries.

Additional Information If Needed: Technical Background

- Batteries were first invented in 1798.
- The first commercially available battery, a carbon-zinc battery known as Columbia, was manufactured in 1896 by the National Carbon Company. National Carbon eventually merged with Union Carbide and then became the Eveready Battery Company and is known today as Energizer.
- Conrad Hubert invented the flashlight in 1898. In this same year size D batteries (the kind used in larger flashlights) were invented.
- The first 9V battery (used in smoke detectors and garage door openers) was invented in 1956
- Modern alkaline batteries were invented in 1959 by Lewis Urry at Energizer's Parma Technical Center on Snow Road. The first prototype alkaline cell, hand-built by Urry, is at the Smithsonian National Museum of History in Washington, DC.
- Silver oxide miniature batteries (used in hearing aids and watches) were introduced in 1960.
- The size AA lithium battery was introduced in 1992, and titanium-powered batteries debuted in the early 2000's.
- http://en.wikipedia.org/wiki/Lewis_Urry
- http://www.energizer.com/learning/historyofflashlights.asp

Experiment 9: Polymers

Experiment Purpose & General Methodology

- Different Polymers can be made from similar materials.
- Mixtures are different than chemical reactions.
- This experiment will be done per table, and will take 8 minutes.

Introduce the Experiment

Tell the students the following:

- Distribute the cups to each table while you talk about polymers.
- Ask the students "Does anyone know the difference between a mixture and a polymer?"(Answer: you can separate out the original materials in a mixture but in a polymer a chemical reaction occurs and the properties are different than the original materials)
- There are many types of polymers. Ask the students if they can name some. (Examples of polymers are balloons, paint, lunch bags, clothing, etc.)
- Some are very important (automobile tires), some can be funny (flubber/slime). Many polymers come from oil.
- Charles Goodyear is known for inventing vulcanized rubber in 1839 – a chemical process involving high heat and addition to sulfur to the rubber to make it more durable and harder. Harvey Firestone developed the precursor the modern tire in Akron, Ohio. Today Firestone Rubber Company and Goodyear Tire are well known North East Ohio companies.
- Polymers can be made from simple chemicals called monomers, "mono" meaning "one." The prefix "poly" means many so lots and lots of monomers make up a polymer.
- We will investigate a mixture and two similar polymers and see how they are different.

Perform Experiment Simultaneously with the Students

Do the following, leading the students:

- Hold up cup "1" and let the students know you have placed 12 g of cornstarch into it.
- Ask the students to find the cup marked "1".
- Simultaneously with the students stir the contents while adding in 2 teaspoons of water. One student can stir while another adds the water.
- Ask them to observe what happens when it is stirred. (it is rather thick)
- Have then poke at it. What happens? (it is stiff)

- Ask the students, "Does it look like the material is sticking together? (yes)
- Ask them if they think it is a polymer?
- Ask if they think it has reacted?
- While you demonstrate the technique ask the students to pick up the "dough" out of the reactor cup and roll it into a ball. (this may be a little sticky)
- Ask the students to giggle the ball or tap it with their hand. What happens?
- Try to stretch the product. Does it fall apart? Do you think the materials (starch and water) have reacted? This is an example of a "mixture". If it dries out, what will happen?
- Let's now look at two similar polymers and see what happens when they differ by only one chemical.
- Ask the students to locate the cup marked "2" while you hold it up. Tell them that this already has 4 teaspoons of white glue in it.
- Have them add the contents of the cup marked "S" for starch to the glue and stir it well. Let them know this is a pre-measured amount of liquid starch like you find in the grocery stores.
- Ask them to determine what kind of material is formed in this reaction?
- Do you think it has changed or "reacted"?
- Pour off any excess liquid in a previously used cup from another experiment.
- Demonstrate how to pick up the product and roll it into a ball and ask them to do the same.
- How would you say it is different from the first product?
- Try to stretch the product. What happens?
- Roll it up again and put it on the newspaper. Tap the table firmly. What happens?
- We will now compare this to a product of glue and a boron solution.
- Hold up cup "3" and ask them to do the same.
- Add 4 teaspoons of water and have them to the same. Stir the mixture.
- Now you and the students should add the contents of the cup marked "B" for boron which is 1 teaspoon of a 4% boron solution. Mix well.
- What is happening? How would you describe the material that is formed?
- Do you think it has changed or "reacted"? Pour off any excess liquid.
- Demonstrate how to pick up the product. Roll it into a ball. Try to stretch it. How does it differ from the first two experiments?
- Please use the paper towel in front of you to wipe your hands. You can wash them more thoroughly in the bathroom after the program.

Conclusions

Tell the students the following:

- Polymers come from "reactions" of different materials.
- Tell them that we have prepared 2 types of polymers but there are many types of polymers and they all have different properties.
- There are many uses of polymers.
- Mixtures and reactions are different. The experiment with the cornstarch was a mixture, but the other two were chemical reactions.

Additional Information If Needed: Technical Background

- The glue is polyvinyl acetate (PVA).
- The first co-polymer is a complex carbohydrate (starch).
- The second bridging material is a boron containing material, a borate, which forms boroxo bridges between the PVA units.
- The pH is neutral and the "products" can be handled. Handling is encouraged.
- The materials are innocuous to humans. (Not that anyone will ingest the materials.) pH is neutral in all cases.
- http://firestone.com/about/index_history.asp?id=history_main

Closing Session

Close Demonstration

- Remind the students that **they can take home** their face pictures and milk paint pictures to share our experiments with their family and friends.
- Remind the students to check our website for information on how to participate in our Chemistry and Poster Contests where each student receives a small token for entering and can win local and national prizes. They should also be able to find us by searching for the Cleveland NCW or Cleveland ACS. Our website address is http://www.csuohio.edu/cleveland_acs/NCW/ncw.htm
- Thank the students and parents for coming to this year's demonstration and learning about the chemistry brought to you by NE Ohio people and companies.
- Have students come up to the closing area to turn in their goggles, and pick up their take-home sheets & *Celebrating Chemistry* newspapers.

Clean up

After the students leave, clean up the room

- Empty the vials, spray bottles and film canisters, rinse them well with water, shake off as much water as possible, then place them on paper towels to start to dry while you clean up the rest of the room.
- Return items borrowed from the library. Give any leftover literature to the librarian. (You may save a copy for yourself though!)
- **NOTE SPECIAL TREATMENT**: Wear protective goggles and gloves and the apron you may have brought from home. Open the bottle carefully, and dispose of the Stop Light solution by pouring down the sink with copious amounts of water and then continue to rinse the sink with water for some time.
- Line the sink with several layers of paper towel. Aluminum Experiment: Wear goggles, your apron, and gloves to carefully pour the contents of the vials onto the towels. Carefully rinse the materials on the towel with slowly running water. Wrap up the solids in the wet towels and place back into the gallon baggie and dispose of it in the trash. Rinse all remaining solution down the drain with a 20-fold excess of water.
- Combine the rest of the water and other liquid-waste in a gallon jug or bucket. This liquid waste can be put down the sink safely with running water.
- Complete the Feedback Form.

- Collect items into plastic bags and place into the mailing envelope(s) marked "Fairview Park" to be returned to the NCW Committee for future programs via CCPL interlibrary mail. These include:
    - Completed Feedback Form,
    - dry (or damp) vials and film canisters in a zip lock bag (air pushed out and zipped closed), and
    - Windex bottles
    - Do not save extra paper and plastic cups. They are crushed in interlibrary mail.
- All solid waste can be collected in the large garbage bag and thrown into the regular trash. BUT PLEASE RECYCLE any of the CLEAN soda/water bottles.
- If you are performing another demonstration for this year's National Chemistry Week, sanitize the goggles between demonstrations with a dilute bleach solution as instructed in the written directions found on the inside cover of the goggle container. Be sure to dry them with soft cloth or soft paper towels to prevent scratching. Please stack them into their box without twisting or crushing!
- If you are finished performing your demonstration(s) for this year, place the used goggles into their box. Please stack them without twisting or crushing! (There is no need to clean them when you are through; our committee will clean them for the next year and/or for other programs.)
- Give the mailing envelope (containing saved supplies and feedback form) as well as the box of goggles to the children's librarian with instructions to put it them in the interlibrary mail to Fairview Park Library. (Or take to your nearest CCPL library, as instructed at the start of this script).

At home:

E-mail Kat at Katkat@neo.rr.com with feedback form info:

1. The number of students and adults at your program

2. Any comments you have to improve our programs in the future.

She needs this information to write the reports required by ACS National and industrial donators of supplies.

Finally:

Smile! You may have expanded or even sparked scientific interest in a child today!

THANK YOU for your participation in our program this year.

We hope you will join us next year too. Planning of experiments and contests starts in late April. You don't have to be a teacher or scientist to join our committee; all you need is a desire to share science with children. Development of ideas and refinement of experiments goes on throughout the summer, donation gathering and shopping is in late summer, and kit assembly (over 100 of them!) (needing a lot of volunteer hands) is on a Saturday in late September. It takes many, many volunteers to develop and put on all our programs. Even a little bit of help goes a long way. Contact us this year or next year if you (or a friend of yours) want to join in on the preparations!

Contact Kat, Cleveland section ACS, NCW Chair 2007 katkat@neo.rr.com

More info on our website: http://www.csuohio.edu/cleveland_acs/NCW/ncw.htm

Appendix

A. Material Safety Data Sheets

- An MSDS for NaOH pellets used in the Stop Light experiment is available at http://www.flinnsci.com/Documents/MSDS/S/SodHyd.pdf
- NaOH has a NFPA/HMIS label of 3,0,1 If handled or in eye, rinse thoroughly for minimum 15 minutes; seek medical attention. Discard contaminated clothing. If swallowed, do NOT induce vomiting; give large quantities of milk or water; seek medical attention immediately.
- An MSDS for the $CuSO_4$-$5H_2O$ is at http://www.sciencelab.com/page/S/PVAR/SLC3778 or www.tmc.co.kr/home/link/Microsoft%20Word%20-%201-2-2-2-15MSDS%20_copper%20sulfate%20Pentahydrate_.pdf
- $CuSO_4$-$5H_2O$ has a NFPA/HMIS label of 2,0,0. If handled or in eye, rinse thoroughly and seek medical treatment. If swallowed, induce vomiting and get medical treatment.
- You can obtain an MSDS from the ACS Cleveland section NCW Committee by going to our website at http://www.csuohio.edu/cleveland_acs/NCW/ncw.htm or contacting Kat Wollyung at katkat@neo.rr.com

B. Supply list for recreating these demos including item substitutions

Most of the materials in our script can be purchased form local General/Grocery, Craft (Pat Catans, Michaels), Outdoor/Building Supplies (Lowes, Home Depot), and Hardware stores.

Items required for each demonstration are listed in the "Required Supplies" section of this script, starting on Page 8. "Special" harder to find items are listed below.

Often the type and size of cups can be varied, but pay attention to if the cup needs to be clear (see-through not opaque) or needs to be sturdy (plastic not paper).

If you plan to scale-up or scale-down the experiment you may need to test the new procedure.

The few special items and their suppliers are listed here. For some experiments, alternative items are listed for some of the supplies. Using alternate items for acids and bases, or other changes to experiments, should also be tested for obtaining the desired result and for safety.

Experiment 1 –

http://avogadro.chem.iastate.edu/MSDS/phenolphthalein.htm (MSDS sheet)

http://membership.acs.org/c/ccs/pubs/CLIPS/JCE20010448.pdf (under typical conditions of use, over-exposure to phenolphthalein solution is unlikely; because it acts as a laxative, ingestion will result in purging)

http://www.chemistry.org/portal/resources/ACS/ACSContent/education/wande/resourcechem/acids_bases/ab05.pdf (For description of experiment) http://www.auspexscientific.com/phen.html (description of 1% in ethyl alcohol solution; colorless in presence of acidic solutions)

A home-made ammonia solution can be used in place of Windex

Experiment 2 –

The parafilm, dextrose, sodium hydroxide and indigo carmine are available from chemical supply houses such as Flinn Scientific. www.flinnsci.com

An extensive article on this reaction appeared in the February 1994 issue of the Journal of Chemical Education. This article gives dyes that can be used in place of Indigo Carmine.

Experiment 3 –

If only a few bowls need holes to be made you can mark the bottom with a ballpoint pen using the film canister as a template. Then cut the hole with an Exacto® knife.

If citric acid is not available, use baking soda alone and replace the water with vinegar.

Vermiculite is found in the garden departments of many stores. Baking soda is in all grocery stores. Citric acid was found at Drug Mart but should be available at winemaking stores.

Experiment 4 –

All materials for this lab are readily found in the grocery store.

Experiment 5 –

The DayGlo pigmented paper is available at office supply stores such as OfficeMax or Staples. All other material for this lab are readily found in the grocery store.

Experiment 6 –

Powdered sodium polyacrylate may be obtained from Flinn Scientific and other chemical supply houses. www.flinnsci.com

Experiment 7 –

Copper (II) sulfate pentahydrate ($CuSO_4 \cdot 5H_2O$) is available from garden supply or hardware stores as commercial "root killer". It is also available from chemical supply houses.

http://acswebcontent.acs.org/landmarks/landmarks/al/revolution.html is the story of the Commercialization of Aluminum as a National Historic Chemistry Landmark.

Experiment 8 –

The 1.2V flashbulbs are readily found in grocery stores, Radio Shack, outdoor supply stores.

Experiment 9 –

Borax is found in the laundry section of grocery stores. The boron compound used here is disodium octaborate tetra hydrate (Na2O.4B2O3.4H2O) which is 21% B in content. Borax from the grocery store is Na2O. 2B2O3.10H2O, which is about 11% B. Either will work.

General: http://www.jcu.edu/chemistry/naosmm/2007/FamousPeople.html