Chemistry—It's Elemental!
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 2009

Overview

This year we've developed a fun program for the students based on the Periodic Table. The students have been told to expect that they're going to be solving a mystery. Each experiment features one or more elements which, when coupled with their location in the Periodic Table, give rise to clues which solve the mystery.

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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 2009, 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 students 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 fifth year in a row to the Martha Holden Jennings Foundation for a significant financial grant this year of $3000 and the Cleveland Section for its continuing support. We also thank Dr. Mark Waner and the John Carroll University, the Cuyahoga County Public Libraries, NASA Glenn Research Center, 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 co-coordinators for 2009, Kat Wollyung and Bob Fowler. Committee members include David Ball, Don Boos, Betty Dabrowski, Natalie Karsti, Lois Kuhns, Vince Opaskar, Margaret Pafford, Marcia Schiele, Shermila Singham and Mark Waner. 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.

This Year

On this 140th anniversary of the creation of the Periodic Table, from this year's theme "Chemistry—It's Elemental!" we created a program around a "mystery" story line based on the Periodic Table. In your kits you'll find a copy of the Periodic Table with certain elements blanked out. The "mystery" is that someone has stolen the elements—where did they go and what is their identity? Our student detectives will help find them and where they're located on the Periodic Table. Students will then be able to solve a Mystery Message (hand-out provided) using what they learned about the Periodic Table during the program. The Mystery Message puzzle can be started during the program and completed by the students with their parents at home. After all, "It's Element(ary)", my dear chemist.

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:

- Experiment Purpose & General Methodology
- Introduce the Experiment
- Performance Details
- Conclusions
- Additional Information if Needed: Technical Information
- Any additional information for the teachers who receive this kit

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. The program this year consists of 8 parts:
    a. Sign-up. Note that, since we're "empowering" each student as a "chemistry detective" during sign-in, sign-in this year is an integral part of the overall program.
    b. A presentator-only demonstration of how to rip an Al can
    c. Six experiments
        i. *Note: For some experiments your demonstration and the student's hands-on work are nearly simultaneous. You will lead them as they perform the experiment.*
        ii. Some experiments will be done by all students. For others, there will be one experiment that will be shared by all or some of the students at the table. In one case only the demonstrator will perform the experiment. You are encouraged to get student helpers for the demonstrator-only experiments.

2. Introduce each experiment. The first experiment is actually a presenter-only demonstration of can ripping while the remaining 6 involve hand-on for the students.

Note: Many of the other experiments require you to perform the experiment along with the students in order to show the students what to do on their own.

3. Have the students do their experiments (Exps. 1-6), some of which they will perform individually and some of which they will perform in a group.

Note: For some experiments your demonstration and the student's hands-on work are nearly simultaneous. You will lead them as they perform the experiment.

4. At end of each experiment (including the Demonstration) announce to the students the element(s) that was (were) involved in the experiment. These will be found in the "Conclusion" section of each experiment, and they are the solution to the mystery of the identity of the elements. In each case tell the students what each element's(s') symbol and atomic number are. (The symbols are shown on the bottom of the blanked-out Table.) Then ask them to find the element's (s') atomic number and enter each symbol where its atomic number is found. In this way they'll complete the Periodic Table and solve the mystery of the elements identity.

5. ***Make sure that you've revealed all of the elements and atomic numbers to the students by the end of the session even if you haven't completed all of the experiments. In this case they can complete the Table at home.***

6. At the end of the day they'll have a completed Periodic Table. They'll be able to take this with them and complete the Mystery Message on the take-home sheet.

The NCW Committee will offer a "Dress Rehearsal" on Saturday, Oct. 3, 2009 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: Bob Fowler at fowler@en.com or Kat Wollyung at katwollyung@mac.com.	❑
Collect the materials you need to bring with you to the demonstration. This materials list is on page 11. 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 demonstrations into your program, you must contact the Head Childrens' 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.	❑
It is strongly recommended that you ask a friend and/or contact the children's librarian well in advance and request a student assistant or librarian to be your assistant. This year the children will be given "Chemistry Detective" badges and ID card onto which they'll copy their fingerprints. 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.	❑
At least a week in advance contact the children's librarian who is helping you to coordinate your program:	❑

➢ Verify that they limit registration to 30 students. ➢ Ask the room to be arranged with 6 student tables with 5 chairs each, an additional front table for the demonstrator and a sign-in table with 2 or 3 chairs. ➢ Ask for all the experiment 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 11 (ex. paper towels, newspaper, extension cord, scissors) ➢ Ask if the librarian and/or an assistant will be available to (1) assist with the setup, (2) greet the students, sign them in, assist with assignment of badges and printing of fingerprints and help distribute goggles and (3) assist with the program. ➢ Make sure that the room is available before and after the program for set up and clean up. **Set-up will take <u>at least</u> 1.5 hours** on your own. When you call the librarian, **<u>make sure that the room will be available and that you can access to it 1.5 hours before the start time</u>**. If the librarian and/or that friend/student assistant is available to help with set-up, this will cut down the time. ➢ Offer that a librarian and/or student assistant 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 11. 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.	❑

How You Can Help Yourself This Year

There are two optional (but highly recommended) steps you can take to help yourself this year:

1. Since the setup time is at least 90 minutes this year, bring an assistant and also ask the librarian is he/she and/or an assistant can be available to assist. Make sure that you can the librarian in advance with this request. Also make sure that the room will be available 90 before the presentation and that you'll have access to it. (Sometimes the room is scheduled for something else or the library is closed 90 minutes before your presentation is scheduled.)

2. Perform as much of the Setup at home before the presentation. In particular we recommend that you:
   - **Fill in a detective badge** as a sample to put on the sign-in table: write your name, date of program ("licensing" date) and use carbon paper to make your thumbprint [there's a space for grade level, for the kids, too].
   - Eliminate part of the set-up for **Exp. 2** by putting the **vinegar in the 31 vials**, at home, any time before your program. (Refers to step #1 under Experimental Set-up for Exp. 2. This would also eliminate the need for the cups and the 1st step for the kids.). **Close vials tightly**, **keep upright** (can bundle several vials with rubber bands).
   - Eliminate part of the set-up for **Exp. 4** by filling the **7 vials with iodine**. (Refers to step #3 under Experimental Set-up for Exp 4.) Again, <u>close vials tightly</u>, keep upright (can bundle with rubber bands.)

Also recommended to do IN ADVANCE:

- Download copies of the script for your helpers: **csuohio.edu/sciences/dept/cleveland_acs/NCW/**

- Ask the librarian how many kids have signed up. You may not need to set up all 30 places. However, allow for some extras.

Activities To Do When You Get To The Library	Completed?
NOTE: <u>Arrive at least 1-1/2 hour before demo time</u> to allow for introductions and set-up depending on how quickly you think you can perform the steps listed in the Experimental Setup section beginning on page 15. Do NOT assume that a librarian will be present to help you set up for the experiments.	❑
Introduce yourself to the Childrens' librarian.	❑
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 the list on page 11 if provided by library.	❑
Ask the Childrens' Librarian or an assistant to take pictures during the demonstration (subject to parents'/guardians' having given permission).	❑
Complete Demonstration Set-Up for all demonstrations: see Experimental Set-Up: "Activities to Do On-Site Prior to Demonstration" starting on page 15. *Note: This set-up is estimated to take at least 90 minutes depending upon the number of people involved.*	❑
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. If so, then perhaps keep the remaining experiments' material at your demonstrator's table and distribute these items throughout the program.	❑
Set-up note! There are few solutions which are irritating to the skin in this year's program: silver nitrate solution, 3% hydrogen peroxide solution, copper sulfate solution and iodine solution. For the corresponding MSDS sheets please see our website at http://www.csuohio.edu/sciences/dept/cleveland_acs/NCW/ .	❑
You may wish to set up an 'Entrance' area table to allow space for sign-in activities (see page 19).	❑
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**
Ask each student to sign in. Ask the parent/guardian for permission to photograph the children and obtain their signatures to this effect. (If that permission is not obtained, make sure that that student is positioned in such a way in the room that they won't be included in the photographs. Give each student a "Chemistry Detective" badge and ID card, a copy of the Mystery Message puzzle and a pencil. Using the carbon paper, create each student's thumbprint on their ID cards.	4 min
Hand out goggles and help adjust to the correct fit (if necessary).	-
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 student to sit alone at a table as some experiments require two people to perform.	-

Activities To Do Once You Get Home	**Completed?**
Provide feedback about your program to Bob Fowler at fowler@en.com and Kat Wollyung at katwollyung@mac.com with the following information: (1) attendance, (2) specific experiment comments/recommendations, (3) other comments as per the kit-enclosed feedback form. This information may be useful to other demonstrators who have not yet performed their 2009 presentation.	❑
Smile! You have just shared your joy of science and chemistry with children, possibly inspiring them to become great scientists, chemists, biologists, …...	☺.

Activities To Do During The Demonstration	**Timing**
Perform demonstrations ➢ Fingerprinting	2 min
➢ Demonstration: **Al Can Ripper**	10 min.
➢ Experiment 1: **Magnetism Test**	8 min.
➢ Experiment 2: **Cu Plating**	8 min.
➢ Experiment 3: **Silver Deposition**	10 min.
➢ Experiment 4: **Starch Test using I_2**	5 min.
➢ Experiment 5: **H_2O_2 Decomposition**	7-8 min.
➢ Experiment 6: **The Fate of $CaCO_3$**	5-6 min.
➢ Completion of Experiments 2 and 3.	1 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. Remember: if you do omit an experiment (or don't complete one) make sure you tell the students which elements were involved so they can complete their Periodic Table . <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 44).	❑
Complete the Feedback Form.	❑
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 Julia Boxler via interlibrary mail. *(Those outside of the CCPL network can return items to your nearest CCPL branch for return to Julia Boxler-YTH. See <u>www.cuyahogalibrary.org</u> for branch listings.)* Please return all materials within two weeks of NCW.	❑
Give any leftover literature to the librarian *(CCPL library kits only)*.	❑

Supplies Required for Demonstration

Items for Demonstrator to Provide (or to request in advance from the librarian—do not assume that the library will have these materials)

1. *newspaper for covering 7 long tables with a few layers of paper (if none at site)*
2. *1 large garbage bag for solid waste collection*
3. *1 bucket for liquid waste collection (optional if sink is within the demo room)*
4. *1 2-cup measuring cup, small pitcher or other container with a spout for adding water to various cup/bottles in experiments*
5. *1 pair of scissors*
6. *1 tablespoon and 1 teaspoon*
7. *1 roll of paper towels (several of the experiments have paper towels included, but it's a good idea to have extra).*
8. *1.5 cups (≈ 350 mL) of hot tap water. (Note: the libraries may or may not have a microwave for warming the water.) It's suggested that you bring a thermos containing at least 2 cups of hot tap water.*
9. *It's a good idea to bring a gallon of water (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.)*

Optional: IF you care to take pictures, bring a digital camera for taking photos. Make sure students' parents have given their permission for the children to be photographed on the ACS form and that the students and adults to be photographed are all wearing goggles. You might want to assign the photography chores to an assistant during the demonstration.

Note: If you will be performing multiple demonstrations on the same day, you will need to sanitize the goggles between demonstrations. You will also need:

1. small quantity of household bleach
2. wash bin or bucket
3. old towels or cotton paper towels for drying (soft so as not to scratch the goggles)

…OR…

4. individual sanitizer wipes (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. 1 kit box containing materials for Sign-up, the Demonstration and six Experiments:
    a. 30 copies Celebrating Chemistry newspapers (if available from ACS)
    b. 30 copies each of "Book & Website List", "Experiments to do at Home" or other handouts
    c. 1 Program Feedback Form (designed for either teacher programs or library programs)
    d. 1-2 envelopes for returning the Feedback Form and reusable supplies to the NCW via interlibrary mail (addressed to Julia Boxler - YTH) (library kits only)
    e. 1 copy of the ACS photo permission form.
    f. 1 bottle of white vinegar (for Experiments 2 and 6)

NOTE: Initially, the return envelope will contain much of the paperwork for your program. This was done to help prevent folding and wrinkling in storage/transport.

2. 1 box of goggles (30 student & 2 adult size, addressed for return to Julia Boxler - YTH) (*library kits only*)

Materials by Experiment

Sign-In & Fingerprinting

1. 31 pencils (golf sized—to be used for sign-in and for completing the Periodic Table)
2. 31 pieces of carbon paper (about 3" x 1 ")
3. 31 "Chemistry Detective" badge/ID Forms handouts
4. 30 copies of the Mystery Message Puzzle
5. 31 wipe-ups for removing carbon from fingers.

Demonstration: Al Can Ripper (Group Demonstration)

1. 31 ¼ sheet of paper
2. 2 aluminum cans treated prior to demonstration
3. 31 copies of the Periodic Table (with several elements blanked out)
4. 1 copy of the complete Periodic Table

Experiment 1: Magnetism Test (Individual Experiment)

1. 31 pieces of copper foil (1/2" x ½ ") in a plastic bag marked "C"
2. 31 pieces of zirconium foil (1/2 "x ½ ") in a plastic bag marked "Z"
3. 31 paper clips (**SAVE:** these will be used in Experiment 2 to plate on)
4. 31 magnet pieces 1"x1"

Experiment 2: Cu Plating (Individual Experiment)

1. 6 rolls + 10 single pennies
2. 1 bottle of vinegar (for this experiment and Experiment 6)
3. 31 packets of salt
4. 1 water/pop bottle containing blue 1% copper sulfate solution
5. 32 beral pipets
6. 31 3 oz plastic-coated paper cups
7. 7 3-oz. plastic cups labeled "C"
8. 31 empty 50-mL self standing vials
9. 31 paper towels

Experiment 3: Silver Deposition (Group Experiment)

1. 7 strips of copper foil, 1/2" x 3"
2. 7 50-mL vials containing 40 ml of $AgNO_3$ solution each
3. 7 small magnifying glasses
4. 1 pair disposable plastic gloves
5. 7 paper towels

Experiment 4: Starch Test using I_2 (Individual Experiment)

1. 1 sandwich bag marked "F" containing flour
2. 1 sandwich bag marked "R" containing puffed rice
3. 1 sandwich bag marked "S" containing sugar
4. 1 sandwich bag marked "P" containing potato flakes
5. 2 50-mL vials each containing 40 mL of iodine solution
6. 31 paper plates marked into four quadrants (F, R, S, P)
7. 8 beral pipets
8. 7 pairs disposable plastic gloves
9. 7 empty 10 mL self-standing vials labeled "I"

Continued next page

Experiment 5: H_2O_2 Decomposition (Individual Experiment)

1. 7 packets of commercial dry yeast.
2. 1 empty beral pipet
3. 1 beral pipet filled with food coloring.
4. 32 plastic teaspoons
5. 1 pint bottle of 3% H_2O_2.
6. 1 10-mL vial marked "D" with 4 mL of dish detergent.
7. 7 3-oz. paper cups labeled "Y"
8. 31 3-oz plastic cups labeled "P"
9. 7 unlabeled 10-oz plastic cups
10. 31 paper towels

Experiment 6: The Fate of $CaCO_3$ (Individual Experiment)

1. 1 baggie containing 2 50-mL vials marked "A" containing alginate
2. 1 baggie marked "T" containing 31 Tums™ tablets pieces
3. 1 baggie marked "C" containing at least 31 chalk pieces
4. 1 baggie marked "ES" containing at least 31 egg shell pieces
5. 1 baggie marked "L" containing at least 31 limestone pieces
6. 31 beral pipets
7. 7 3 oz. plastic cups marked "A"
8. 7 3 oz. plastic cups marked "V"
9. 31 paper towels
10. 31 pieces of paper marked "T", "C", "ES" and "L".
11. 31 pieces of waxed paper to cover these
12. 1 baggie containing wax paper and paper charts
13. Vinegar (from Exp. 2)

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 11)
- On the sign-in table place the ACS Photo Permission form, the "Chemistry Detective" badges/"ID" forms and the small pencils. IF photos are taken during your presentation for NCW/ACS use (on Cleveland NCW ACS website and/or for submission to National ACS for awards or annual reports) 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. Also, everyone in any photo must be wearing goggles. Give each student a "Chemistry Detective" badges/"ID" form and a pencil to take to their places and tell them to notice the example completed from (yours) that's lying there.

Sign-In

On the sign-in table, lay out the following:

- 30 "Chemistry Detective" badge/ID cards. Put your completed "Chemistry Detective" badge/ID card next to the stack so the students can see your example.

Fingerprinting

At each student's place, put the following:

- 1 pencils
- 31 small pieces of carbon paper
- 30 copies of the Mystery Message puzzle
- 31 wipe-ups

Demonstration: Al Can Ripper (Group Demonstration)

- Place two aluminum cans on the demonstrator's table. This experiment requires only one can but a second is included in the event one has ripped in transport.
- Place the ¼ sheets of paper on the newspaper for each student and the demonstrator.
- Place 1 copy of the Periodic Table (with several elements blanked out) at each student's place
- Place 1 copy of the complete Periodic Table on the demonstrator's table

<u>Experiment 1: Magnetism Test</u> (Individual Experiment)

At each student's place put the following:

1. 1 piece of copper foil
2. 1 piece zirconium foil
3. 1 piece of magnet material
4. 1 paper clip (also to be used in Experiment 2)

<u>Experiment 2: Cu Plating</u> (Individual Experiment)

At the demonstrator's table do the following:

1. Put 20 mL of vinegar (1 tablespoon and 1 teaspoon full) into each of 31 3-oz plastic-coated paper cups before the program starts. Keep these on the demonstrator's table until ready to do the experiment to reduce odors at the students' tables. Put a sheet of paper over the cups to keep the odor minimized. Keep the remainder of the vinegar for Experiment 6.
2. Using one of the beral pipets, put about 30 mL of the copper sulfate solution from the water/pop bottle into each of the 7 3-oz cups marked "C". Keep this on the demonstrator's table until you begin the experiment.

At each student's place and at the demonstrator's table put the following:

1. 1 beral pipet
2. 1 salt packet
3. 10 pennies
4. 1 empty 50 mL self standing vial
5. 1 paper towel

<u>Experiment 3: Silver Deposition</u> (Group Experiment)

At the Demonstrator's table (only) place the following:

1. 1 pair disposable plastic gloves

At each table (including the demonstrator's) place the following:

1. 1 strip of copper foil, 1/2" x 3"
2. 1 small magnifying glass
3. 1 paper towel
4. 1 50 mL vial containing 40 mL of $AgNO_3$ solution

Experiment 4: Starch Test using I_2 (Individual Experiment)

First, at the demonstrator's table, put/do the following:

1. 7 empty 10 mL vials labeled "I"
2. 1 beral pipet
3. Using the beral pipet, fill each of the 7 10-mL vials with 10 mL of iodine solution from your stock of 2 50-mL vials
4. Re-cap each 10 mL vial.
5. 1 paper plate marked with four quadrants marked "F", "R", "P" and "S"
6. From the four sandwich baggies marked "F", "R", "P" and "S", place a small amount (~1/4 tsp) of each substance on the paper plates in the appropriate locations. You *might* want to **carefully** stack these completed plates up for later ease of distributiuon.

Then at each table (including the demonstrator's) put the following:

1. 1 10 mL vial filled with iodine solution
2. 1 beral pipet
3. 1 pair disposable plastic gloves

Experiment 5: H_2O_2 Decomposition (Individual Experiment)

Do the following at the demonstrator's table:

1. Put 2 teaspoons of the 3% H_2O_2 into each of 31 3oz. plastic cups labeled "P" and KEEP AT THE DEMONSTRATOR'S TABLE UNTIL YOU BEGIN THE EXPERIMENT.
2. Using a disposable pipet, add 1-2 drops of detergent from the vial marked "D" to each of the cups labeled "P" containing the peroxide solution.
3. Holding the pipet containing the food coloring vertical and upside down, carefully snip off the tip with your scissors. Now carefully add 2-3 drops of food coloring to each of the cups labeled "P" containing the peroxide/soap solution.
4. Place 50 ml (≈1/4 cup) of hot water into 7 10-oz plastic cups. *Note: if possible you might want to wait until just before this experiment is demonstrated to have an assistant pour the hot water from your thermos or from a recently-microwaved source.*
5. Empty one package of yeast into each of 7 paper cups labeled "Y".

At each student's place and at the demonstrator's table put the following:

1. 1 plastic teaspoon.
2. 1 paper towel.

At each table put the following:

1. 1 paper cup labeled "Y" containing the yeast
2. 1 unlabeled 10 oz. plastic cup with the hot (soon to be warm) water.

Experiment 6: The Fate of $CaCO_3$ (Individual Experiment)

At the demonstrator's table (only) place the following:

1. 2 50 mL vial marked "A" containing alginate solution
2. 2 beral pipets

Do the following at the demonstrator's table: DO NOT PLACE THESE ON THE STUDENT TABLE UNTIL YOU ARE READY FOR THE EXPERIMENT

1. Add approximately 30 ml of vinegar (2 tablespoons) from the bottle of vinegar to each of 7 3-oz. plastic cup marked "V".
2. Distribute the alginate solution from the 50 mL vials marked "A" equally to each of 7 3 oz. plastic cup marked "A"

At each student's place and at the demonstrator's table put the following:

- 1 piece of 3 2/3" x 8" paper with 4 sections marked "T", "C", "L" and "ES".
  - Cover each piece of paper with a similar sized piece of wax paper
- 1/4 Tums^{TM} table in the sector marked "T".
- 1 piece of chalk in the sector marked "C".
- Egg shell pieces in the sector marked "ES" (divvy up the egg shell pieces supplied evenly).
- 1 piece of limestone in the sector marked "L".
- 1 beral pipet.
- 1 paper towel.

Closing Session

- Set out the literature for students to pick up at the END of the program
  - Celebrating Chemistry activity newspapers
  - Multiple stacks of the various take-home sheets
- Set up an area for goggle drop-off

Sign-In

Greet the Students (and Parents) Upon Their Arrival and Distribute Goggles

As part of the Sign-In process, do the following:

- Ask the parents/guardian to give or withhold their permission for the student to be photographed via the ACS consent form. Don't forget to obtain their signatures either way.
- Hand out and adjust students' goggles. Help the students put on their goggles. Adjust the straps as necessary. (Note: These goggles are sanitized each year and prior to each demonstration.)
- Give each student their "Chemistry Detective" badges/ID cards, a pencil and a piece of carbon paper for them to take with them.
- Ask the parents/guardians to take their students to a seat at a table (no more than 5 students per table) and fill out their ID cards. Ask each student to PLEASE not touch any of the materials before the program begins. Some experiments may be ruined if they do. (*Note*: You might want some librarian assistance with this: IF you plan to take photos and some of the parents have denied permission, you'll need to put all of the children who aren't going to be photographed at a separate table.)

Fingerprinting

Purpose & General Methodology

- Students will use carbon paper to create their own fingerprint and pencil graphite to sign a "Detective ID Form"

Introduction

Once you enter the demonstration room, tell the students the following:

- Since everyone's fingerprints are different, fingerprints are often used to identify people. When someone becomes a detective, they have to register their fingerprint so that they won't be confused with others. Since you will be detectives trying to solve a mystery in a few minutes, we must first register your fingerprints on special "Detective Registration Papers". The material that will be used to register your fingerprint is the "lead" from a piece of carbon paper.
- The "lead" found in pencils is actually called graphite and is made up of the element carbon. Carbon is an element that can be found in lots of things, including your body, diamonds, all living things and of course pencils!
- The carbon atoms in graphite are bonded together in such a way that allows graphite to be very soft. This is why it rubs off on paper when you write with a pencil! You may also have noticed that graphite smears easily.

- The carbon on carbon paper is another form of the element called carbon black. In this experiment, carbon paper will be used to "copy" your thumbprint onto your detective ID to make it "official".

Ask the students to do the following:

- Press your thumb onto the back of the carbon paper and then press section of the "Detective ID Form" labeled "Fingerprint" as hard as possible in order to ensure that an accurate fingerprint is obtained.
- Using the golf pencil, write the other information on the "Detective ID Form": Last Name, First Name, Grade and Licensing Date (the day of the library program).
- Clean your hands after creating the fingerprint with the wipe-ups provided.

Conclusions

- The bonds between carbon atoms in the graphite and amorphous carbon are weak, so it is easy for the graphite to rub off on paper and other surfaces when smeared. This is why the graphite was so easy to transfer from the paper to your thumb and from your thumb to the "Detective Registration Paper". This same characteristic of graphite can also explain why it can be used in pencils to write on paper. The bonds are broken when the graphite rubs against the paper, leaving some of the carbon behind.

Additional Information If Needed: Technical Background

A typical piece of carbon paper consists of a sheet of paper that has been impregnated with carbon. Its coating is made up of several materials, the most important of which is carbon black. Carbon black is a very fine, spherical, amorphous form of carbon that is not as crystalline as graphite. Mostly carbon, it also contains small amounts of oxygen, hydrogen, and sulfur. The carbon black adheres to the paper with the help of various waxes. Familiar one-time black carbon paper (the kind used for credit card receipts, for example) is coated with a mixture commonly composed of paraffin wax (33%), mineral oil (25%), carbon black (15%), china clay or kaolin (12%), montan wax (8%), carnauba wax (6%), and methyl violet or gentian violet (1%). Less common one-time blue carbon paper is commonly coated with a mixture composed of iron blue (21%), paraffin wax (20%), petrolatum (20%), mineral oil (15%), carnauba wax (10%), china clay (10%), and montan wax (4%).

Any additional information for the teachers who receive this kit

None.

Opening Discussion

Introduce the Items on the Tables

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 some of our items today can stain clothes or hands if we're not careful, so we be good chemists and take the safety precaution of protecting our eyes with our goggles. Mention to mom and dad that the chemicals can be washed off with soap and water if any hands get stained.
- Put on a pair of the adult-sized goggles. If you have an assistant, ask them to do the same.

Do the following:

- Introduce yourself as a chemist or chemist/science teacher/engineer (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.)*
- The theme of National Chemistry Week this year is "Chemistry—It's Elemental". Ask "Why do you think we chose this theme for this year?" *A*: This year chemists around the world are celebrating the 140th anniversary of this creation of the Periodic Table. Explain that chemistry involves the study of everything around them. That's why we celebrate it every year with programs like this.
- Tell the students that by the end of the session they'll have enough information to solve the mystery of the missing elements by adding them to their Periodic Table that contains the blanks. Tell them that f all of the experiments aren't completed in time, you'll let them know the identity of the missing elements. Then tell them that they will able to solve the Mystery Puzzle at home using their completed Periodic Table.

Introduce Today's Presentation:

Tell the students the following:

- The Periodic Table was created by Dimitri Mendeleev. He was the first to present the elements known at the time into a useful tool for study and experimentation. The periodic table is simply a way to organize all the elements (117+) so that chemists can keep all of the information about elements organized in their mind! The elements are the basis of the entire universe and of life on Earth. The elements are an important part of everyday life. They compose the graphite in pencils, the tungsten in light bulbs, neon lights, copper for cooling applications, the sodium in table salt—the list literally never ends! So we hope today that you will help us investigate and appreciate the discovery and use of elements in our lives.
- But we have a mystery on our hands! Someone has stolen some of the elements from Mr. Mendeleev's table, and we don't know which ones they were.
- With your help we're going to find out what's missing.
- We've created some chemistry experiments whose results will reveal the missing elements to us.
- You were given a copy of the Periodic Table which shows where the missing elements go.
- Using what you learn during the program about the elements on the periodic table, you will be able to
    - Complete the puzzle of the Periodic Table's elements
    - Solve the Mystery Puzzle that you were given at home.

Now you can begin the formal part of the program…

Demonstration

Experiment Purpose & General Methodology

- Introduce the concept of an element by tearing up a piece of paper and continuing the concept until the mental paper can be torn no more yet still retains its unique chemical properties.
- Briefly explain the difference between chemical and physical properties.
- Introduce the Periodic Table and the crime to be solved.
- Show the power of chemistry by tearing apart an aluminum can with a minimum amount of effort.
- Introduce the first element—**aluminum.**

Introduce the Experiment

Tell the students the following:

- Today we will be exploring the simplest forms of chemicals which are called elements.
- Ask the students if they can define an element? (Their responses will vary.)
- Tell them that they will perform an experiment to try to mentally picture an element.
- Have each of the students pick up the ¼ sheet of paper in front of them as you do the same.
- Ask them to tear their paper in half while you demonstrate this. Tell them it is not necessary to do it exactly for our purposes today. This paper is going to represent a pure element.
- Now take one of the halves and tear it in half, Do this again and again until you can no longer tear it up. (this will require about 12 tears which should be about a square millimeter)
- Now explain that if you can think of this last piece of paper and continue to tear it in half mentally another 20 times they would have a piece of paper that is the size of an atom.
- A single atom is called an element. There are currently 117 elements some of which still need to be confirmed. Each element has a set of chemical properties that no other element has.
- The properties of a substance are those characteristics that are used to identify or describe it. When we say that water is "wet", or that silver is "shiny", we are describing materials in terms of their properties. Properties can be divided into the categories of physical properties and chemical properties. **Physical properties** are readily observable, like; color, size, luster, density or smell.
- **Chemical properties** are only observable during a chemical reaction. A chemical property lets us know how an element will react with other elements. There is **always a change that takes place**. For example, you might not know if sulfur is combustible unless you tried to burn it, then it would turn from a yellow solid into a very unpleasant smelling gas.
- This year we are celebrating the 140th anniversary of the Periodic Table. Pick up your copy of the periodic table as you say this.
- Ask the students to also pick up their table.
- EXCLAIM!! OH MY GOODNESS! SOMEONE HAS STOLEN SOME OF THE ELEMENTS FROM MY TABLE. Ask the students if there are any blank spaces on their tables. (There are!).

- Well, students I guess we will have to solve this mystery today and place the missing elements back into the table where they belong. Ask if they are willing to help you do this.
- Tell the students that this Periodic Table is an arrangement portraying the **elements** in terms of similarities and differences in chemical properties. In the table, the elements are arranged in rows in increasing order of **atomic number**, running from left to right across the table. Point out to the students that the numbers are in numerical order from left to right and increase as they go from the top of the table to the bottom.

Perform the following for the students

- Tell the students that it looks like the culprit who stole the elements left some hints at the bottom of the table—the names and symbols of the missing elements. The **symbols** are shorthand for the element names just like abbreviations are for some words. A good example is the abbreviations we use for the states (e.g. Ohio = OH).
- Tell them to get out their chemical detective badges and let's solve this crime! Shall we put the elements back into their proper places?
- Carefully pick up the treated aluminum can from the demonstrators desk by the base or top.
- Ask the students if they know what element this can is made from? (Students should reply **aluminum**).
- Ask the students if they think you can tear the can in half just like you did the paper. (Responses will vary).
- Hold the can carefully in both hands near the middle and give a strong twist. Pretend that you are using every once of strength you have to do this. The can should tear in half to the amazement of the students.
- **CAUTION: torn cans have sharp edges.**

Conclusions

Tell the students the following:

- Tell the students that you used one of the chemical properties of aluminum to perform that demonstration and will examine a similar reaction in another experiment later.
- Do the demonstration a second time if the other can is still whole.
- Now refer to the hint sheet and let's determine where this element belongs on your Periodic Table. Let the students examine the clues and determine that this is aluminum.
- Ask the students for the correct symbol of the element **Aluminum** (**Al**) and this is what they should write in the space under the box with the number 13 in it. Just as 'M' is the thirteenth letter of the alphabet, aluminum is the 13^{th} element in the periodic table.

EXPERIMENT CONCLUDES THAT THE ELEMENT IDENTIFIED IS:

- Aluminum (Al) Atomic Number 13

Additional Information If Needed: Technical Background

Aluminum cans are lined with plastic to prevent the liquids from reacting with the metal. Each can was scored on the inside of the can near the middle with a sharp file to break the coating and expose the aluminum for the reaction that will occur. About 5 grams of copper(II) sulfate pentahydrate (or copper chloride) were added to the can. The can was filled with hot tap water to a level above the scored ring. The contents were swirled several times over about a 10 minute period. At this time the copper solution could be poured into the drain and flushed with lots of water. The copper ions from the solution oxidize the aluminum metal to aluminum ions. When the reaction is complete, as evidenced by a brownish ring where it was scored, the only thing holding the can together is the paint!

REACTION: $3\ Cu^{+2}\ (aq) + 2\ Al\ (s) \rightarrow 2\ Al^{+3}\ (aq) + 3\ Cu\ (s)$

SAFETY PRECAUTIONS:

Do not leave the cans with the solutions in them in an area where they may be mistaken for soda.

Copper (II) sulfate (or copper (II) chloride) solution is toxic both by ingestions and inhalation.

DISPOSAL:

Copper (II) sulfate (or copper (II) chloride) solution may be rinsed down the drain with excess water. IF you are doing many cans, collect the waste solution and dispose of the solution according to your facilities rules.

Any additional information for the teachers who receive this kit

MSDS sheets are available at our website:
http://www.csuohio.edu/sciences/dept/cleveland_acs/NCW/.

Experiment 1: Magnetism Test

Experiment Purpose & General Methodology

- Students will learn the physical properties of metals.
- Students will determine which metal is magnetic and which is not based on a series of simple experiments.
- The experiment will require about 5 minutes and is to be performed by the group at each table.

Introduce the Experiment

- Ask the students to find the magnet in front of them.
- Ask the students what the other three objects are? (metals)
- Ask the students if they could name a few of the physical properties of metals. (responses will vary)
- Tell the students that scientists classify metals based on these characteristics:
  - Color, Luster (shininess), conductivity of electricity, malleability (bendable), ductility (ability to be pulled into a wire) and magnetic properties are some of the physical properties of metals. State of matter is a pretty good indicator because most metals are solids, although mercury is a metal and it is a liquid at room temperature

Performance Details:

Do the following, leading the students:

- Today we are going to try to determine the identity of three of our missing elements using a magnet.
- Ask what is attracted to a magnet? (Responses will vary but they should indicate that some metals are attracted to the magnet.)
- Ask if all metals are attracted to a magnet. (They are not—iron, cobalt and nickel are.)
- Let's see if we can identify one of the elements based upon its magnetic properties.
- Ask the students to put the colored piece of metal next to the magnet. Did it stick to the magnet or not? (It does not)
- Ask if anyone knows what this element is based upon its unique color? (copper)
- Now ask the students to pick up the other square piece of metal and bend it. Does it make a strange sound? (yes) Does it stick to the magnet? (no)
- Now ask the students to pick up the paper clips and see if it sticks to the magnet. (It does.)
- Ask the students if they know what metal makes up the paper clip? Some may say steel.
- Ask if they know what the major element is in steel? (iron)
- Hold up the paper clip and the zirconium foil and tell the students that one of these is zirconium and one is iron. Ask them if they can identify which is which.
- Congratulate them when they figure out that the iron is in the paper clip.

Conclusions

Tell the students the following:

- Now let us look at our periodic table and fill in these three missing elements.
- What is the symbol for the element copper? (Cu) Tell them that the atomic number of copper is 29 and to place the symbol Cu in that empty space on the Periodic table.
- What is the symbol for the element zirconium? (Zr) Zirconium is element number 40, so let us all write that into our table.
- Lastly, what is the symbol for iron? (Fe) Iron is element number 26 so let us all write that into the table as well.
- Tell the students that this element's symbol does not start with the letter "I" as they might expect because it is an ancient element and was named by the Romans as "Ferrum" which begins with "Fe."
- Many other elements have symbols that do not match their American spellings because of the languages of the peoples who discovered them. This would be a fun thing to research when you get home today.

EXPERIMENT CONCLUDES THAT THE ELEMENTS IDENTIFIED ARE:

- Copper (Cu) Atomic Number 29
- Iron (Fe) Atomic Number 26
- Zirconium Atomic Number 40

Additional Information If Needed: Technical Background

http://www.scifun.org/
The following is from: http://www.sciencespot.net/Pages/kdzchem2.html

Iron: **Name Origin:** From the Latin word *ferrum* (iron)

Copper
Name Origin: From the Latin word *cyprium (or cuprum)*, after the island of Cyprus

Zirconium: **Name Origin:** zircon (mineral)

Any additional information for the teachers who receive this kit
See the following web site for purchasing information:

http://www.chem4kids.com/files/elem_pertable.html
http://www.chemteam.info/Matter/Matter.html

Experiment 2: Cu Plating

Experiment Purpose & General Methodology

- Salt, Sodium Chloride, (particularly the chloride) causes the "cleaning" of the pennies to speed up. (Catalyst). The corrosive nature of chloride speeds up the removal of surface dirt.
- Acid dissolves the "dirt" (copper oxide) off the pennies AND dissolves some copper metal off the pennies. Blue copper acetate will form slowly. In this experiment, the acetic acid solution will be spiked with copper sulfate to demonstrate the point.
- The blue copper solution deposits the dissolved copper onto the steel paper clip "automatically" in a process known as immersion plating. Eventually, a colorless solution results and the red-brown copper deposit is observed on the paper clip.
- The experiment will require about 7 minutes and is to be performed by each student.

Introduce the Experiment

Tell the students the following:

Three chemical reactions (changes) take place in this experiment. We are going to clean dirty pennies with vinegar (acetic acid), then dissolve one metal (copper off pennies) with weak acid (vinegar). Then the copper in solution will be changed back into a solid or metallic state. At the same time the steel paper clip will be dissolving into the acid. Elements or atoms are "recycled".

Performance Details:

Do the following, leading the students:

1. Tell the students to pick out one of the brightest of their 10 copper pennies and save it for a color reference. (Tell the students that this penny will also be used in subsequent experiments.)
2. Distribute the 31 3-oz plastic coated paper cups of vinegar to each student. Tell the students to ***very carefully*** pinch the lip of the 3 oz. cups to form a pouring spout. Then just as carefully slowly pour the vinegar from the cups into the 50-mL vials at each student's place. Carefully hold the vial at an angle and slide the remaining 9 pennies into the vial containing the vinegar. Be careful not to splash any vinegar during the loading. Close the vial tightly. Swirl the vial and note if the pennies are "cleaning" up and getting "brighter". (Very little if any change can be seen; the acid only slowly cleans the "dirt" (oxide) layer off the "dirty" pennies.)
3. Open the vial and carefully add the salt from the salt packet into the vial with the pennies.
4. Demonstrate how the students should swirl their vial to dissolve the salt. Tell them that pennies develop a dark color over time as the copper on the surface very, very slowly reacts with oxygen in the air to form a new compound called copper oxide, which is dark in color.
5. Tell them that salt is a combination of two elements forming the compound "sodium chloride". You may want to point to Na and Cl on your periodic table for effect. While the acid can clean off the copper oxide layer, the chloride dissolved in the acid speeds up the cleaning or dissolution of the copper oxide outer "dirty" layer. When the oxide layer

is stripped off the dirty pennies, the bright copper metal can now also be attacked by the acetic acid in the vinegar. (The salt speeds up the action of the acid to dissolve the copper of the surface of the pennies.)

6. Tell them to think about the effect of salt on car rust and road deterioration in the winter. The very faint blue color is the copper in the acid solution. The blue color may not be obvious at first. Given enough time, the blue color develops. The copper and water give the blue color.
7. Observe the "cleaning". The copper oxides on the surface of the old pennies are gradually coming off and cupric ions are entering the solution. Given enough time and acidity, the solution would turn blue from the copper ions. In order to speed up the experiment (remember, this experiment is about electroplating) a lot more "predissolved" copper ions are going to be added to the tube.
8. Tell the students to locate the cup marked "C" on their table (1 cup per table). As this cup is passed from student to student, tell them to fill their pipets from this cup and gently squirt the contents (about 4-5 ml total of the 1% copper sulfate solution) into each of their 50 mL tubes. Note the nice light blue color. This is what it would look like if we were to add more acid and let the pennies sit for an extended period of time. (Which we cannot do. The rules state: No strong acids. And 2, we do not have the time.). Replace the cap, tighten and shake the tube gently. Set the tube down on the table.
9. Take the paper clip from the Magnetism Experiment and open its last branch so that only one loop remains and it forms an elongated "J" shape. The loop of the "J" will be used as a hook for suspending the paper clip from the edge of the open vial.
10. Tell them that when the paper clip made of iron is added to the copper solution a chemical reaction will occur (note that the dissolution of the oxide layer is a physical process). The iron now dissolves into the acid solution AND trades places with the copper in solution.
11. Remove the cap from the 50 mL vial and hang the steel paper clip into the vial. Carefully observe what happens (and it happens rather quickly with our fortified solution.) Some gas bubbles form on the paper clip. The paper clip turns dark at first and then brown. Pull the paper clip out after 5-10 seconds and note the color of the submerged area. Clean the smutty blackish material off with a paper towel. (This is a good second cleaning.)
12. Ask the students what the gas might be. Tell them it's hydrogen. The bubbles of hydrogen will be more visible over a longer immersion time. (The hydrogen comes from the vinegar's free acid protons.)
13. Place the paper clip back into the solution for 30 seconds, 60 seconds, and note the condition of the new surface on the paper clip. The paper clip has an immersion coating of copper metal. Given enough time it will look just like the reference penny in terms of color. It will look black at the start because the deposit is so thin and the surface of the paper clip is somewhat rough. As the deposit builds up thickness, the copper color is evident. (The copper continues to "pile up" on the paper clip as the reduced metal. It is copper metal (solid) that is seen on the paper clip surface. It is not shiny bright gold-brown because it is very thin (only several atoms of thickness at first). The surface roughness of the paper clip cannot give the shininess we would expect at first. Enough thickness will show the copper color, given enough ions in solution and time for reduction on the surface.)

14. We will return to this experiment later to see the progress of the Cu coating. At the end of the session, pat the paper clip dry **gently** with the paper towel to show the copper deposit on the paper clip.

Conclusions

Tell the students the following:

In this experiment we used copper (pennies) and iron (the paper clip). Hmmm—we've already discussed copper and iron in the previous experiment. So what's new with our clues here? Oh wait. I know. We have accomplices. Criminals have accomplices who help them out. Here ours were the salt and the water. They help the reactions occur. Remember that water is composed of hydrogen and oxygen and salt is Na and Cl.

Chloride from table salt speeds up dissolving metal. Acid will dissolve the metal oxide (copper) from pennies forming ions in solution—a blue material. The copper in solution is free to move around by itself. When the copper meets the steel paper clip, some of the iron in the paper clip dissolves (goes into the acid solution) and some of the copper goes out of solution and turns back into a solid on the surface of the paper clip.

Tell the students that now they will add three more missing elements to the Periodic Table.

Remind them that they have already added copper, element 29. Remind them that they have already added copper, element 29. In the last experiment they were observing the physical property of copper. In this experiment they were able to observe a chemical property of copper. We also found iron earlier while studying their physical property of magnetism.

What other elements have we added in this experiment? Ask them if they remember the elements <u>used or produced</u> in this experiment.

1. The first element was hydrogen. The bubbles that were formed on the surface of the paper clip were composed of hydrogen which came from the water. Ask then what the symbol for hydrogen is? (H). Tell them to place the capital letter "H" under the atomic number 1.
2. Another element was Chlorine in its ionic form which is called chloride. Ask them what the symbol is for Chlorine? (Cl) Ask them to place that symbol in the empty space at atomic number 17.
3. Lastly, there was sodium in its ionic form. Ask them what the symbol is for Sodium. (Na). Have them place this symbol in the empty space at atomic number 11 while you remind them that this is another element whose name does not match its symbol.

<u>EXPERIMENT CONCLUDES THAT THE ELEMENTS IDENTIFIED ARE:</u>

- Hydrogen (H) Atomic Number 1
- Chlorine (Cl) Atomic Number 17
- Sodium (Na) Atomic Number 11

Additional Information if Needed: Technical Information

Immersion copper "plating" is a chemical phenomenon. But it is a cool thing to watch, because it can occur so quickly. The EMF (electromotive force) series law of the metallic elements in solution can be boiled down to the old adage that more "noble" elements can displace less "noble" elements with no "outside" energy (electrical voltage from a battery or transformer). In this case, the more noble copper has a ½ cell voltage of +0.34 volts and the "base" metal iron (non noble) has a ½ cell voltage of –0.409 volts. The copper is reduced to a metallic state (from the oxidized state in the solution) and the iron converts (corrodes) from the solid metallic state into the dissolved oxidized state in the solution (rust).
The blue copper solution loses the dissolved copper onto the steel paper clip by electroless "electrodeposition". This spontaneous reaction will slow down when the copper builds up on the paper clip and the iron can no longer escape through the newly formed copper layer.

In the real world of industrial electroplating, this process is a nuisance. The actual bonding of the copper on the iron has very little strength and it would tend to slough off in time. It can be wiped off the paper clip with a paper towel or our fingers. The transfer of electrons to reduce the copper comes from the iron atoms on the surface of the paper clip. In an industrial setup, the electrons would come from the current of energized electrons from a transformer (rectifier) with a voltage more positive than the ½ cell voltage of the iron (which is –0.409 volts). That way, the iron is not changed and is merely a conductor of electricity that supplies electrons for the reduction of the copper ions. The result is a metallic bond between the iron base metal and the noble copper coating.

What we see here is what Allessandro Volta saw, hundreds of years ago. We know today that the chloride helps dissolve the copper off the pennies (oxidation) to turn the solution blue. The blue cupric ions, in turn can be reduced back to metal by being reduced by the steel paper clip. The steel paper clip is oxidized and the copper in solution returns to a solid (reduced).

Advanced information. A chrome bumper on a car actually has the base metal protected by electrolytic layers of 1. copper, 2. a layer of sulfur containing nickel metal, 3. a layer of "microporous" nickel and 4. and thin 10-20 millionths of an inch of chromium metal. This layered sandwich of metals will give long service in corrosive atmospheres. There is no such thing as a one layer deposit of chrome except in "hard" chrome deposits found in, for example, earth movers' hydraulic rods.

Any additional information for the teachers who receive this kit
The name **hydrogen** is from the Greek words **hydro** and **genes**, which together mean "water forming."
The name Chlorine is from the Greek word for greenish yellow, **chloros**
The name **Sodium** comes from the English word **soda** and from the Medieval Latin word **sodanum**, which means "headache remedy." Sodium's chemical symbol comes from the Latin word for sodium carbonate, **natrium**.
Reactions involved:

$$Cu^{+2} + Fe^0 \rightarrow Fe^{+2} + Cu^0$$

$$2\ H_2O \rightarrow 2H_2\uparrow + O_2$$

Experiment 3: Silver Deposition

Experiment Purpose & General Methodology

- The experiment will be conducted as a group experiment (1 per table).
- Students will observe the deposition of silver from solution onto the copper foil.
- The experiment will require about 5 minutes and is to be performed by the group at each table.

Introduce the Experiment

Tell the students the following:

- Metals such as gold, silver, chromium and copper are expensive.
- Many items in use around our homes are made of cheaper materials with a thin layer of the expensive metal applied on the surface. This is known as "plating".
- Examples of this are gold plating on watches and chrome plating on automobile bumpers.
- Today we're going to watch this plating process take place as we "plate" a piece of copper foil with silver.

Performance Details:

Do the following:

- Wearing the plastic gloves, the demonstrator should go to each table in turn, open the 50 mL vial containing the $AgNO_3$ solution and deposit the Cu foil into the vial. Recap the vial and wipe it off with a paper towel. Tell the students the solution can stain and **DO NOT ALLOW THE STUDENTS TO HANDLE THE VIAL.** (Have the students come up one by one and observe the Ag crystal growth with the magnifying glass.
- Place the vial in the center of the table for observation.
- Using the magnifying glass, the students should take turns observing the deposition.

Conclusions

Tell the students the following:

- The element involved in this experiment is silver.
- Ask the Students to find the symbol for Silver. (Ag)
- Tell the students to place this symbol in the empty space for atomic number 47.
- The students should have been able to see the silver depositing on the copper foil as time proceeded.
- Some plating is done to use an inexpensive metal to protect an expensive one on the inside; here the plating could be used to cover an inexpensive metal with an expensive one. We like gold and silver jewelry, but these metals are soft and expensive; by plating silver onto another metal, we can produce harder items that don't break but make them look silver and very nice. Even some of the world's money is made of a strong, long-lasting metal and plated with the more expensive metal.

<u>EXPERIMENT CONCLUDES THAT THE ELEMENTS IDENTIFIED ARE:</u>

- Silver (Ag) Atomic Number 47

Additional Information If Needed: Technical Background

- Exercise care when handling silver nitrate. Like all silver salts, silver nitrate can stain skin and cause burns.
- The reaction involved in this experiment as silver from solution is deposited on the copper foil is the following:

  $2AgNO_3 + Cu^0 \rightarrow 2Ag^0 + Cu(NO_3)_2$.

  The ΔE^0 for this reaction is positive (+0.337V) so its ΔG^0 is negative and the reaction as written is spontaneous.
- Because of the spontaneous nature of the reaction, silver is reduced on the copper surface via a process known as "electroless plating" since the application of a current is not involved.
- The earliest known application of this process was in 1742 by the Sheffield, England cutler Thomas Boulsover, who noted that the combination of fused silver and copper retained the ductility of both metals and acted as one when manipulated. The products from this process were known as "Sheffield Plate".

Any additional information for the teachers who receive this kit

The name silver comes from the Anglo-Saxon word **seolfor**. Silver's chemical symbol comes from the Latin word for silver, **argentum**.

Experiment 4: Starch Test using I_2

Experiment Purpose & General Methodology

- The purpose of the experiment is to use an iodine solution to determine which substances on the paper plate contain starch.
- The experiment will require about 7 minutes and is to be performed by each student.

Introduce the Experiment

Tell the students the following:

- Starch is the most important carbohydrate in the human diet. The major sources of starch intake worldwide are rice, wheat, maize (corn), potatoes and cassava. Widely used prepared foods containing starch are bread, pancakes, cereals, noodles, pasta, porridge and tortillas.
- Starch contains several elements including carbon, oxygen and hydrogen.
- We can find out which foods have starch in them by testing the food source with iodine. If starch is present in the food, it will turn blue when iodine is dropped on it.
- Let's see which of the food on our plate today contain starch.

Performance Details:

Do the following, leading the students:

- Have students identify the substances on their plate:
  - F → flour
  - S → sugar
  - R → puffed rice
  - P → potato flakes
- Tell the student to be very careful in the next step since iodine can easily stain their clothes.
- Ask the oldest or most careful student to please put on the plastic gloves and carefully open the small vial of iodine marked "I". Then, using the pipet, put 2 or 3 drops on each substance in each labeled area of each student's plates.
- The students should then note the color changes. For the substances containing starch, a purple color change will be observed. A drop of iodine on a white substance containing no starch will remain the color of the iodine solution (orange). From this the students will be able to identify which substances on their plate contain starch.

Conclusions

Tell the students the following:

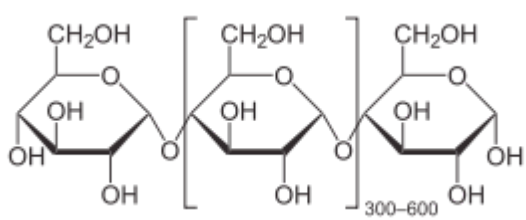
- Foods that are high in starch will produce a color change in the presence of iodine. Color changes should have been observed for the flour, puffed rice, and potato flakes. No color change should have been observed for the sugar.
- The iodine starch test is commonly used in the food industry and other biological applications. For example, in beer brewing, a negative starch test result confirms that all the starches in the beer have been converted to sugars, as expected.
- Ask the students to find the symbol for Iodine (I) at the bottom of the Periodic Table.
- Tell the students to place the letter I in the empty space under atomic number 53.

EXPERIMENT CONCLUDES THAT THE ELEMENT IDENTIFIED IS:

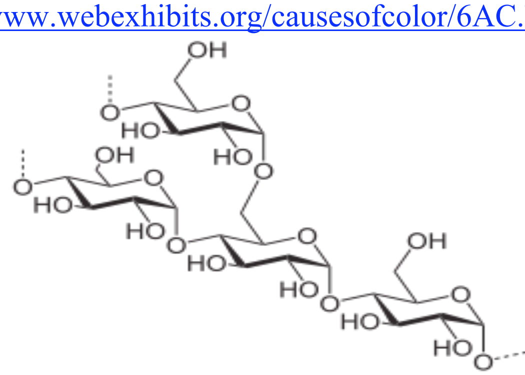
- Iodine (I) Atomic Number 53

Additional Information If Needed: Technical Background

- Plants store glucose as the polysaccharide starch. The cereal grains (wheat, rice, corn, oats, barley) as well as tubers such as potatoes are rich in starch. Starch can be separated into two fractions--amylose and amylopectin. Natural starches are mixtures of amylose (10-20%) and amylopectin (80-90%). The reaction between amylose (even though it is often present in lesser amounts) and iodine is said to account for the intense color change seen. Amylose molecules consist of single, mostly unbranched chains of glucose molecules, shaped like a spring. It is speculated that the iodine gets stuck in the coils of the beta amylose molecules. See http://www.webexhibits.org/causesofcolor/6AC.html



Structure of the amylose molecule.



Structure of the amylopectin molecule.

Any additional information for the teachers who receive this kit
The name for iodine comes from the Greek word for violet, **iodes**

Experiment 5: H_2O_2 Decomposition

Experiment Purpose & General Methodology

- The purpose of the experiment is to break hydrogen peroxide down into its parts and witness the release of oxygen in the form of bubbles.
- Water's formula is H_2O; hydrogen peroxide is H_2O_2 which shows only one more O or one more oxygen atom. Hydrogen peroxide is not a stable combination of water and oxygen. You can decompose, or break down, its molecules and see oxygen bubbles with the help of the laundry detergent.
- The experiment will require about 7 minutes and is to be performed by each student.

Introduce the Experiment

Tell the students the following as you distribute the cups containing the peroxide/detergent and food coloring mixture:

- Many chemicals are composed of combinations of elements.
- Hydrogen peroxide is commonly used around the house for cleaning but most commonly after you get a cut to disinfect the wounded area.
- Today's experiment will show that one of the elements making up hydrogen peroxide is oxygen.

Performance Details:

Do the following, leading the students:

- Have one student add the entire contents of the cup labeled "Y" (containing the yeast) to the large 10 oz. plastic cup of warm water. Have this student stir gently to mix.
- Tell the students that yeast is used to make bread and rolls but here it will act as a catalyst which is something that makes a slow reaction go very quickly.
- Have each student put 1 teaspoon of the yeast mixture from the large plastic cup into their 3 oz cup marked "P" into the large plastic cup containing the yeast and water. Ask them to do this carefully as their clothes may be ruined if they spill the solution. Tell the students to use the paper towel to wipe their hands if any of the solution gets on them.
- Tell each student that the solution in the cup labeled "P" contains hydrogen peroxide, soap and food coloring.
- Tell the students to stir the solution once and to immediately watch for the formation of bubbles (oxygen).
- Witness the surge of tiny soapy bubbles.
- See if you can feel the warmth from the exothermic (heat producing) reaction. (The bubbly mixture is safe to touch).

Conclusions

Tell the students the following:

- The decomposition of hydrogen peroxide shows the production of oxygen gas and helps us see the elements from which it's made.
- Ask the students to find oxygen's symbol at the bottom of the Periodic Table (O).
- Tell them to place the symbol in the empty space under atomic number 8.

EXPERIMENT CONCLUDES THAT THE ELEMENT IDENTIFIED IS:

- Oxygen (O) Atomic Number 8

Additional Information If Needed: Technical Background

Hydrogen peroxide molecules are very unstable and naturally decompose into water and oxygen gas. The chemical equation for the decomposition of hydrogen peroxide is:

$$2\ H_2O_2 \rightarrow 2H_2O + O_2$$

Hydrogen peroxide is a natural by-product of metabolism. All known animals which metabolise oxygen produce a natural enzyme called catalase which catalyses the decomposition of hydrogen peroxide into harmless water and oxygen gas. Yeast is a fungi which also produces the catalase enzyme. Adding yeast to hydrogen peroxide then rapidly increases (catalyses) the decomposition of hydrogen peroxide into water, oxygen gas and heat.

Any additional information for the teachers who receive this kit

The name oxygen comes from the Greek words **oxys** and **genes**, which together mean "acid forming."

Experiment 6: The Fate of $CaCO_3$

Experiment Purpose & General Methodology

- The students will determine which of several common substances give a reasonable proof of the presence of calcium carbonate.
- The students will make this determination by treating several test substances with acetic acid. Those which release CO_2 when treated with acetic acid likely contain carbonate ion.
- The presence of Calcium ion will be detected when it cross links with an alginate solution.
- The elements found in this experiment are Ca and C.
- The experiment will require about 7 minutes and is to be performed by each student.

Introduce the Experiment

- Calcium carbonate is a common substance found in rock in all parts of the world and is the main component of shells of marine organisms, snails, pearls, and eggshells.
- Have you ever been in a cave before? One of the most famous is Mammoth Cave in Kentucky. When you were in the cave did you notice the needlelike formations hanging from the ceiling or poking up from the floor? These are called stalactites (from the ceiling) or stalagmites. Did ever wonder how the caves and these needlelike shapes were formed?
- Many naturally-occurring rock deposits on earth are made of limestone. Over long periods of time acidic water sometimes dissolves large portions of these rock formations and creates caves.
- As the acidic water run down stalagmites or onto stalactites, some of the water evaporates and the dissolved minerals re-solidify. This process causes the formation of additional stalagmite or stalactite material, but they grow very, very slowly as time goes on.
- Limestone is composed primarily of calcium carbonate, and it forms carbon dioxide (a gas) when acids drop on it. So we know that at least the carbonate ion is present if we see bubbles forming when acids such as acetic acid are dropped on the sample.
- We will test 4 different materials for the presence of carbonate first and then calcium:
    - pieces of chalk in the spot marked "C"
    - a piece of a Tums™ tablet in the spot marked "T"
    - a piece of limestone in the spot marked "L"
    - some egg shells in the spot marked "ES"
- We will test for the presence of carbonates by placing a drop of vinegar on each sample.
- We will then look for the formation of bubbles (CO_2) on each sample.
- After we witness the formation of the bubbles for a minute or so, we'll treat each of the samples with a few drops of the alginate solution.
- After a minute or two, tell the students to find the gelatinous blobs of crosslinked calcium alginate that have formed. (The students may want to collect these and take them home with them.)

Performance Details:

Do the following, leading the students:

- Using the penny saved from Exp. 2, **carefully** crush the Tums™ tablet into something resembling a powder. (The closer the students come to a powder, the better the material will be attacked by vinegar.) Try to crush the chalk as well.
- Tell the students to locate the 3 oz. plastic cup marked "V" at their table. As this is passed from student to student, each student should fill the stem of their beral pipet with vinegar.
- Put several drops of vinegar on each of the test materials. Observe the results for about 1 minute.
- Now return any unused vinegar from the pipet back into the cup marked "V". Refill it completely with alginate solution from the cup marked "A" as this cup is located and passed around. Put about 10 drops of the alginate solution on each sample so it forms a circle about the size of a dime and wait for a minute or two.
- Tell the students to now search in each sample for a squishy blob. It's OK to touch this gooey stuff. (The best polymers will have been formed from those samples which gave the best results with the vinegar.)
- The students will enjoy playing with the polymers.
- Make sure that the students wipe their hands with the paper towels provided.

Conclusions

- Although it's not an absolutely definitive test, the carbonate ion is likely present in those samples which formed bubbles. The carbonate ion formed carbon dioxide gas. When two elements, such as carbon and oxygen, chemically combine they form what is known as a compound. There are millions of known compounds.
- What can we say about those samples which didn't form bubbles? (*Hint*: We can't necessarily say that they didn't contain $CaCO_3$ since something might be preventing the acid attacking the sample and forming bubbles [like the weak acid trying the attack the physically hard limestone samples]. So we can't jump to scientific conclusions without more proof.)
- The alginate solution reacted with the calcium ions to form a cross-linked polymer which became firmer with more time. It would be like each of you joining hands so that the entire room is connected. It is hard to move freely around the room just like the blob you formed.
- In this experiment we found the element calcium. Ask the students to find the symbol at the bottom of the Periodic Table for Calcium. (Ca). Tell them to place this symbol in the empty space under atomic number 20.
- We also found an element, carbon, that was part of a compound with oxygen. Ask the students to find the symbol for the element Carbon (C). Tell them to place this in the last empty space which should be atomic number 6.

EXPERIMENT CONCLUDES THAT THE ELEMENTS IDENTIFIED ARE:

- Carbon C Atomic Number 6
- Calcium (Ca) Atomic Number 20

Additional Information If Needed: Technical Background

- When treated with acids such as acetic acid, $CaCO_3$ releases carbon dioxide according to

  $$2\ H^+ + CaCO_3 \rightarrow CO_2 + H_2O + Ca^{2+}.$$

  Therefore, if $CaCO_3$ (or any carbonate ion) is present in the test materials, we would expect to see CO_2 evolution when the sample is treated with acetic acid. This CO_2 evolution gradually diminishes as more water is formed thereby diluting the acid.
- The acidic water which has transformed limestone formations into caves, stalactites and stalagmites is weak carbonic acid formed by the dissolution of CO_2. This is why it takes centuries to create these formations.
- Naturally occuring chalk is composed mostly of calcium carbonate with minor amounts of silt and clay. Modern blackboard chalk is generally made from the mineral gypsum (calcium sulfate), so it wouldn't be expected to generate CO_2.
- Tums™, limestone and the calcium supplements all contain $CaCO_3$. The physical hardness of the limestone prevents significant attack by the weak HAc, but the Ca supplement and the Tums™ tablets "fizz" vigorously. The egg shells are somehwere in between.
- Sodium alginate, a polysaccharide derived from brown seaweed, is a food additive commonly used as a thickening agent. $CaCO_3$ sample like the Tums™ tablet contains calcium ion in the form of the insoluble calcium carbonate. The calcium ion is released into solution by the action of the acetic acid in vinegar, producing carbon dioxide and water as a byproducts.
- One of the more interesting and useful properties of alginates is the ability to form gels by reaction with calcium salts. Under the proper conditions, sodium alginate will crosslink with calcium ions to form an instant gel which will become firmer over time. The egg shells, Tums™ tablets, chalk and limestone all contain calcium ion in the form of the insoluble calcium carbonate. The calcium ion is released into solution by the action of the acetic acid in vinegar, producing carbon dioxide and water as byproducts as well as calcium ion and the acetate ion. Diffusion of the calcium ion over time will change the character of the polymer becoming firmer over a ten minute period.

Any additional information for the teachers who receive this kit

The name for carbon comes from the Latin word for charcoal, **carbo**.

The name for calcium comes from the Latin word for lime, **calx**.

In the laboratory you could do a flame test with pure calcium carbonate or any calcium salt. Calcium has a charactistic orange-red color.

By adding vinegar to any carbonate, you could have the gas produced (carbon dioxide) bubble into a limewater (CaO (aq)) solution. If carbon dioxide is present then the solution will become cloudy as insoluble calcium carbonate precipitates.

Completion of Experiments 2 and 3.

At this point re-visit the results of Experiments 2 and 3 to see how the plating reactions are proceeding.

Closing Session

Close Demonstration

- Briefly explain to the students how to complete the Mystery Message puzzle. Encourage parent participation in helping the students complete the work at home. Mention that the answer to the puzzle can be found on the Cleveland American Chemical Society website (www.acs.org).
- Remind the students 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 cash prizes. They should also be able to find us by searching for the Cleveland American Chemical Society. Our website address is

  http://www.csuohio.edu/sciences/dept/cleveland_acs/NCW/index.htm
- Thank the students and parents for coming to this year's demonstration and learning about science and chemistry.
- 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 and 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!)
- 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 "Julia Boxler - YTH " to be returned to the NCW Committee for future programs via CCPL interlibrary mail. These include:
  - Completed Feedback Form,
  - dry (or damp) vials in a zip lock bag (air pushed out and zipped closed), and
  - 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 students' librarian with instructions to put it them in the interlibrary mail to Julia Boxler - YTH. (Or take to your nearest CCPL library, as instructed at the start of this script).

At home:
E-mail Bob Fowler fowler@en.com and Kat Wollyung at Katwollyung@mac.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.

We need 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 student 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 students. 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 Bob, Cleveland section ACS, NCW Chair 2009 at fowler@en.com.

More info on our website:
http://www.csuohio.edu/sciences/dept/cleveland_acs/NCW/index.htm

Appendix

A. Material Safety Data Sheets

MSDS' for all materials used in this year's program may be found at our web site at http://www.csuohio.edu/sciences/dept/cleveland_acs/NCW/.

B. Supply list for recreating these demos including item substitutions

Experiment 1 – Avery sheets of magnetic material can be purchased from Office Max.
Experiment 2 – The Cu foil used in Experiments 2 and 6 was purchased from http://basiccopper.com/5-mil-005-inch-t.html
Experiment 3 –
Experiment 4 – 237 mL bottles of 10% Iodine solution can be purchased on-line from CVS at (http://www.cvs.com/CVSApp/catalog/shop_product_detail.jsp?filterBy=&skuId=550756&productId=550756&navAction=push&navCount=6&no_new_crumb=true)
Experiment 5 –
Experiment 6 –