PokeChem

An Educational Demonstration Package

Prepared by the

Cleveland Section

of the

American Chemical Society

National Chemistry Week 2000

Overview

You've heard of Pokemon™, now learn about the exciting universe of PokeChem and the real power of chemistry! This year's demonstrations illustrate the mysterious characteristics of matter and energy. Each experiment is introduced with its own PokeChem character, followed by a demonstration, and then an explanation of the strengths and weaknesses of that chemistry principle.

The students will learn about the wonders of Hydrophobic, Crystallize, Refraction, Polarized, Indicator, Gelatinous, Magnetism, and Pressurize characters as they explore the science behind these concepts.

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Acknowledgements

The National Chemistry Week (NCW) programs of the Cleveland Section ACS began in 1994 with an idea to put together a scripted program that could be performed at any local school or library. This idea has expanded to become the centerpiece of Cleveland Section's NCW activities, which has received national recognition from the American Chemical Society. In 2000, the Cleveland Section will perform sixty demonstrations.

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

The foundation of this program has been the script, written so that it can be performed easily at any school or library. Helen Mayer wrote this year's script.

One Saturday in October is devoted to measuring and distributing all the supplies that make up the demonstration kits. The day is known to all involved as GAK Day (Grand Assembly of Kits). We recognize all the unnamed but important GAK Day volunteers.

Our NCW efforts reach farther this year because of various sponsors who have donated money, materials, or services to the Cleveland Section specifically for National Chemistry Week. We are grateful to NASA Glenn Research Center, Welch's, John Carroll University, Cuyahoga Community College, and UCAR Carbon Company for their contributions and support.

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

Demonstrator's Guide

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

Presentation Overview

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

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

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

3. Have the students do their experiment.

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

4. All students will do some experiments. 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.

MAKE SURE TO FOLLOW ALL DIRECTIONS IN EXPERIMENTS

- Some experiments have special safety concerns due to the materials being used. Any safety concerns are listed in the section for that experiment.

Demonstration Check-Off List

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

Activities To Do Before the Day of the Demonstration	✓ When Complete
Read through this packet to familiarize yourself with the experiments	❑
Collect the materials you need to bring with you to the demonstration. The materials list is on page 6.	❑
Two days before the presentation, prepare the Ghost Crystals (see Experiment 3 Part II in the Activities to Do On Site Before the Demonstration section).	❑
Contact the children's librarian: ➢ Ask the room to be arranged with 6 tables around a front table ➢ Ask to have 5 chairs around each of the 6 tables ➢ Ask for all the tables to be covered with newspapers and for extra paper towels for each table. ➢ Make sure there is a source of hot water available ➢ Check to see if the room is available before and after the program for set up and clean up.	❑

Activities To Do When You Get To The Library	✓ When Complete
Introduce yourself to the children's librarian	❑
Ask the librarian how many students are pre-registered	❑
Confirm that the tables and chairs are set up properly	❑
Confirm that all tables are covered in newspaper and have paper towels	❑
Set out the individual items for each experiment on the students' tables and the demonstrator's table	❑
Complete Demonstration Set-Up for all demonstrations: *Note: This set-up is estimated to take 45-60 minutes.*	❑
Set out the literature (Experiments To do at Home, Book List and *Get Cooking with Chemistry* magazine)	❑

Activities To Do During The Demonstration	Timing
Welcome the students and parents as they enter the room	-
Assess number of students per table and adjust to 3 - 5 per table. Record the number of students and adults.	-
Complete the Opening Session introduction	2 min.
Perform demonstrations	*Total Time: 55 min.*
➢ Experiment 1: Hydrophobic	5 min.
➢ Experiment 2: Crystallize	10 min.
➢ Experiment 3: Refraction	9 min.
➢ Experiment 4: Polarized	5 min.
➢ Experiment 5: Indicator	10 min.
➢ Experiment 6: Gelatinous	5 min.
➢ Experiment 7: Magnetism	5 min.
➢ Experiment 8: Pressurize	5 min.
Complete the Closing Session information and hand out literature	1 min.

Activities To Do Immediately After The Demonstration	✓ When Complete
Clean up as indicated in the Cleaning up section	❑
Give any left-over literature to the librarian	❑
Give envelope with materials to be returned to librarian so that it can be returned by interlibrary mail	❑

Supplies Required for Demonstration

Experiment 1: Hydrophobic (Magic Sand)

1 bag containing magic sand
1 bag containing regular sand
14 clear plastic cups marked water
7 clear plastic cups marked magic sand
7 clear plastic cups marked sand
7 plastic spoons
1 coffee filter (for clean up)

Experiment 2: Crystallize (Paint with Epsom Salt)

1 bottle containing 14 teaspoons Epsom salt
7 plastic cups marked Epsom
31 pieces of black construction paper
31 cotton swabs
_ cup hot water (provided by the demonstrator)
measuring tablespoon or graduated cylinder (provided by the demonstrator)

Experiment 3: Refraction

Part I: Disappearing Glass Rods

2 clear plastic cups with straight sides
2 vials containing 2 oz Wesson oil each
1 Pyrex glass rod
1 straw
paper towels (supplied by the demonstrator)
optional—coin (supplied by the demonstrator)
optional—paper from the Crystallize experiment

Part II: Ghost Crystals

1 bag marked Ghost containing Ghost Crystals
1 quart jar
tap or distilled water; distilled water is preferred (provided by demonstrator)
1 large spoon to fit into the quart jar (provided by demonstrator)

Experiment 4: Polarized

14 polarizing filters
7 squares of clear acetate covered in criss-cross strips of transparent tape
Optional--empty container from an audiocassette (provided by demonstrator)

Experiment 5: Indicator (Grape Jelly)

7 packages of grape jelly
7 snack-size zipper-lock bags containing about _ teaspoon baking soda
2 vials containing 50 ml vinegar each
7 plastic cups marked vinegar
7 plastic spoons
7 clear plastic cocktail cups
7 sheets of white paper
4 cups warm (not hot!) water (supplied by the demonstrator)
paper towels (supplied by the demonstrator)

Experiment 6: Gelatinous (Diaper Polymer)

1 sandwich-size ziplock bag, marked "Gelatinous" containing ~1-2 teaspoons sodium polyacrylate
3 styrofoam cups, marked "1", "2", and "3"
2 clear plastic cups
3 sandwich-size zipper close plastic bags
3 salt packets

Experiment 7: Magnetism

15 ceramic ring magnets
7 metal washers
7 thin wooden dowels
pencil (supplied by demonstrator)

Experiment 8: Pressurize (Marshmallow in Syringe)

7 plastic syringes about 30ml in size with a cap (no needles)
40 mini-marshmallows
Optional—Sharpies pens for drawing smiley faces (provided by demonstrator)

Overall

30 copies *Get Cooking with Chemistry* magazines
30 copies each of Book List and Experiments To Do at Home
Set of instructions

Items for the Demonstrator to Provide

1 gallon jug for waste water collection
1 gallon jug of water (if none available at site), plus hot water (1/2 cup) and warm water
1 roll of paper towels (if none available at site)
2 or 3 Sharpie-type pens and 1 pencil (for labeling)
1 large garbage bag (for waste collection)
measuring tablespoon or graduated cylinder
1 large spoon to fit into the quart jar

OPTIONAL—empty container from an audio cassette
OPTIONAL—one coin

Activities to Do On-Site Prior to Demonstration

Experiment 1: Hydrophobic

- Distribute the Magic Sand into the 7 cups marked magic sand.
- Distribute the regular sand into the 7 cups marked sand.
- Fill the 14 cups marked water about 2/3 full.
- Place one cup of Magic Sand, one cup of sand, two cups of water and 1 plastic spoon at each table.
- Reserve the coffee filter for cleaning up.

Experiment 2: Crystallize

- Add 5 tablespoons (75ml) of hot water to the bottle containing the Epsom salt; shake well until dissolved. Divide the solution equally between the 7 cups marked "Epsom". Place one cup on each of the students' tables and one on the demonstrator's table.
- Place 5 sheets of black construction paper and 5 cotton swabs on each of the students' tables. Place one sheet of black paper and one cotton swab on the demonstrator's table.

Experiment 3: Refraction

Part I: Disappearing Glass Rods

- Pour Wesson oil into one of the cups. Pour water into the other cup to the same level as the oil. Place both cups on the demonstrator's table.
- Place the glass rod, the straw and the paper towels on the demonstrator's table.
- Optional experiment—place the coin and the paper from the Crystallize experiment on the demonstrator's table. Have extra water available.

Part II: Ghost Crystals.

- Two days before the presentation fill the quart jar with distilled water (Note: tap water is acceptable but does not work as well as distilled). Save a few crystals for the demonstration at the presentation, and add the remainder of the "Ghost Crystals" to the jar. Cover the jar with plastic wrap and place in refrigerator. Putting the jar in the refrigerator eliminates the air bubbles that appear within the crystals. The jar will be nearly filled with the crystals after they absorb the water.
- After removing the jar from the refrigerator, break any air bubbles with a pin.

- On the day of the presentation, place the quart jar and the bag containing the remaining crystals on the demonstrator's table.

Experiment 4: Polarized

- Place a pair of polarizing filters and one tape square on each of the students' tables and on the demonstrator's table. Place the empty audiocassette container (optional) on the demonstrator's table.

Experiment 5: Indicator

- Warm 4 cups of water. Warm water helps the jelly dissolve faster. Distribute the water during the experiment so that it stays warm longer.
- Separate the 2 vials of vinegar equally into the 7 cups marked vinegar. Place one cup on each of the students' tables and on the demonstrator's table.
- Place 1 cup, 1 spoon, 1 piece of paper, 1 paper towel, 1 package of grape jelly, and 1 bag of baking soda on each of the students' tables and on the demonstrator's table.

Experiment 6: Gelatinous

- Place the three styrofoam cups, the salt packets, and the empty zipper-close sandwich bags on the demonstrator's table.
- Add about half of the bag marked "Gelatinous" containing sodium polyacrylate to the cup marked "3".
- Close the bag containing sodium polyacrylate and place on the demonstrator's table.
- Fill the clear plastic cups about half full with water.

Experiment 7: Magnetism

- Place two ring magnets, one washer, and one thin dowel on each of the students' tables.
- Place one washer and one dowel on the demonstrator's table.
- Using a pencil, place small marks on the demonstrator's set of magnets in order to identify the poles. Place two magnets with one pole up and the other with the pole down on the demonstrator's table.

Experiment 8: Pressurize

- Place one syringe with cap on each of the students' tables and one on the demonstrator's table.
- Place 5 marshmallows on each of the students' tables and one on the demonstrator's table.

Optional: You may wish to provide a marking pen for each table so that the students can draw a smiley face on the marshmallow before the experiment.

Opening Discussion

Introductions

Do the following:

- Introduce yourself as a chemist, 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-chemists know about chemistry and how it has improved our everyday life.)*

What is Chemistry and Chemicals?

Do the following:

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

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

What Do Chemists Do?

- Ask the participants to tell you what a chemist does, what a chemist looks like.
- Tell them BRIEFLY and in simple terms what you do as a chemist.

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

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

Introduce the Items on the Tables

Do the following:

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

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

Experiment 1: HYDROPHOBIC (Magic Sand)

Experiment Summary

- The students will compare and contrast different types of sand and learn that some substances attract each other and some repel each other.
- This experiment will by done by each table and should take 5 minutes to complete.

Introduce the Experiment

Tell the students the following:

- Show the students the picture of the PokeChem character called Hydrophobic. Ask them what they think Hydrophobic means. Hint: Ask them to define "phobic" (fear of). They may know other phobias, like claustrophobic or arachnophobic (fear of spiders). Tell them "hydro" means water as in fire hydrant.
- Ask the students what the word "hydrophilic" would mean. Hint: they should remember hydro from the above discussion. "Philic" means "love of". A PokeChem character with hydrophilic characteristics would like water and getting wet!

Perform the Experiment as a Demonstration, then Simultaneously with the Students

Do the following:

- Pour the regular sand into one of the cups marked water.
- Take the spoon and remove some of the sand to show that it is still wet.
- Decant the water into the cup marked sand to show that the rest of the sand is still wet.
- Pour a small amount of the Magic Sand into the other cup marked water. Show how it floats on top if only a little is put in. Pour all of the Magic Sand into the cup and show how it makes shapes and will keep those shapes.
- Take the spoon and remove some of the sand to show that it is still dry.
- Decant the water into the cup marked magic sand to show that the rest of the sand is still dry.

Conclusions

Tell the students the following:

- Regular sand gets wet because it has hydrophilic portions on its surfaces that are attracted to water. Magic sand is regular sand that has been treated with another chemical that hates water [hydrophobic]. That is why the sand can be in water and still feel dry.
- Ask the students what other hydrophilic materials they encounter in everyday life [answers can be sponges, clothes, etc.]
- Ask the students what other hydrophobic materials they encounter in everyday life [answers can be raincoat, wax on car, oil, etc.]
- Tell the students that a PokeChem character called Hydrophobic would have strengths that could include the following: not slowed down by water, can go through water that other characters would not be able to go through, does not get wet in water, and not scared of getting splashed with water. The Hydrophobic character could have the following weaknesses: cannot hide in water because will stay near the surface.

Additional Information If Needed: Technical Background

- Regular sand is mostly silicon dioxide that is formed in grains. The surface of the grains contains polar OH groups that are easily attracted to the polar OH bond of water. Therefore, beach sand is hydrophilic or water-loving.
- Water wets or adheres to beach sand and flows freely between the grains. Sand is denser than water and sinks. Sand mixed with a lot of water acts more like a fluid than a solid. The sand/water mixture slides, slumps, and resists construction attempts.
- The special sand used in this experiment is commercially known as Magic Sand™, Astro Sand™, or Mystic Sand™. The instructions suggest putting water in a large glass bowl and sprinkling in a small amount of magic sand. Instead of sinking, like beach sand, the magic sand will float and form a "sand raft". By sprinkling more and more magic sand onto the sand raft, the raft can be made to plunge to the bottom. The magic sand does not appear to be wet but to be surrounded by a silvery layer looking like plastic film. This silvery layer is the curved surface of a large air bubble that surrounds the magic sand.
- Magic sand is ordinary beach sand treated with the vapors of trimethylhydroxysilane, $(CH_3)_3SiOH$, the active ingredient in ScotchGuard™. When the grains of sand are exposed to the trimethylhydroxysilane, a chemical reaction takes place forming water and the bonding of the trimethysilane compound to the silica particles. Following this treatment, the exterior of the sand grains contain methyl groups that are insoluble in water or hydrophobic. The Magic Sand is very attracted to nonpolar molecules such as oil and will appear "wet" with the oil.

Experiment 2: Crystallize (Painting with Epsom Salt)

Experiment Purpose & General Methodology

- The students will learn about crystal formation while drawing pictures with Epsom salt.
- The experiment will be done by each student and should take about 10 minutes.

Introduce the Experiment

Tell the students the following:

- Show the students the picture of the PokeChem character named Crystallize. Ask the students what they think Crystallize means [answer: to solidify from a liquid].
- Tell the students that when water evaporates from some solutions (like sugar and water), solid crystals form. Today, we will be working with a water and Epsom salt solution. Epsom salts can be found around the house and are often used for foot baths. We will paint a picture with the salt solution, wait for it to dry, and see what happens.

Perform Experiment Simultaneously with the Students

Do the following:

- Soak one end of the cotton swab in the Epsom salt solution in the cup. Drop the end of the swab on the paper and draw. Dip the swab frequently into the solution to keep it wet. Note: The solution should be visible in "pools" on the paper if you would like to grow "needle-like" crystals. If the solution is rubbed on the paper, the crystals will appear smaller and very sparkly.
- Let the solution dry for about 10 minutes. Crystals should start forming in about 10 or so minutes, depending on the temperature of the room.
- Remember to come back to this experiment at the end of the program

Conclusions (can be done immediately or at the end of the program)

Tell the students the following:

- Crystals are solids that have repeating patterns of molecules connected together. The shapes of crystals are due to the pattern of the particles that make up the crystals.
- Crystals can "evolve" from solutions, which are a mixture of a liquid and at least one other chemical dissolved in the liquid. In our case today, we are using Epsom salt and water. Each salt molecule that be thought of as a "building block." When the water evaporated, the

building blocks came together to make an organized structure (like building with Legos™, where you are limited to how the pieces can come together). As the water evaporates, the crystals form and become evident.

- Strengths of the PokeChem Crystallize character include growing larger with time, as any of you who have make rock candy can attest to. If you have never made rock candy, we will give you a handout at the end of this session that will tell you how. Crystals also have the advantage of having a definite shape. Some crystals (like diamonds) are hard and resist heat.
- Weaknesses of the Crystallize character may include sometimes being able to be dissolved in liquid (like sugar). Some crystals (like sugar) are also very soft, and do not resist heat well.

Additional Information If Needed: Technical Background

- Epsom salts are magnesium sulfate heptahydrate, $MgSO_4 \bullet 7H_2O$. These water-soluble salts are found as white needle-shaped crystals. Epsom salts were first obtained from a mineral spring in England. They are also found in the mineral epsomite.
- Crystals can be small (as in salt or sugar) or large (as in single-crystal silicon which can be grown to a diameter of 6 inches and is used as the precursor of semiconductor boards).
- Crystals are commonly believed to be sparkling and "invisible." But actually, some crystals are transparent (clear as glass), some are translucent (clear enough to let light through), and some are opaque (dark or light-absorbing). The thicker the crystal, the more opaque it looks. Most crystals are transparent when cut into thin films.
- Our experiment today actually uses the concept of a "super-saturated" solution. Hot water was used for the experiment so that more salt could be dissolved in it than normal. As this super-saturated solution cooled, the remaining water could not hold all the salts, so they "undissolved" and grew into larger particles that formed crystals. Crystals grow fastest in a super-saturated solution because the individual ions are more likely to encounter each other and start building up a crystal structure.
- There are seven types of crystal lattice systems: cubic, hexagonal, tetragonal, trigonal, orthohombic, monoclinic, and triclinic. Crystals can be divided into four classifications due to bonding structure: (1) covalently bonded, like diamonds, that are strong and have very high melting points, (2) metallic crystals that have high melting points, (3) ionically bonded, like sodium chloride, that are hard and have fairly high melting points, and (4) molecularly bonded (hydrogen or van der Waals) that are softer and have lower melting points, like sugar.

Experiment 3: Refraction

Experiment Purpose & General Methodology

- The students will learn the concept of refraction by comparing what objects look like in water and oil. Through the use of "ghost crystals," the students will discover what happens when two substances have the same index of refraction.
- The demonstrator will do both parts of this experiment. This experiment will take 9 minutes.

Part I: Disappearing Glass Rods

Introduce the Experiment

Tell the students the following:

- Show the students the PokeChem character called Refraction. We will be doing an experiment that will illustrate the concept of refraction.

Perform Experiment as a Demonstration

The demonstrator should do the following:

- Ask the students what they expect to see when the straw is placed into the cup with water.
- Place the straw at a 45° angle in the cup with water (resting on the side of the cup). Ask the students to describe what they observe. Hint: have them look at the straw at the surface of the liquid. [Answer: the straw should look bent at the surface of the liquid.]
- Dry off straw with paper towel.
- Ask the students what they expect to see when the straw is put into the cup with the Wesson oil.
- Place the straw in the cup with the oil. Ask the students to describe what they observe. [Answer: the straw should look bent at the surface of the liquid.]
- Repeat the experiment, this time using the Pyrex glass rod instead of the straw. [Answer: the glass rod should look bent at the surface of the water and will disappear in the oil].
- Optional Experiment—fill the water cup above to the top with water. Place the coin under the cup. Have the students come to the demonstrator's table to look down at the cup with the water and the coin under it. Ask them if they think you can make the coin disappear using only a piece of paper. Place the piece of paper over the top of the cup. Have the students look into the cup to see if the coin is still visible. [Conclusion for this experiment—the light bouncing off the coin was bent in such a way that it could not come out of the side of the cup.

It would have been visible only from the top of the cup. Thus it "disappears" when the paper is placed over the cup.]

Conclusions

Tell the students the following:

- Everyone is familiar with rays of light (from a lamp or from the sun), but does everyone realize that light travels at a measurable speed? Think about what would happen when light travels from one material to another, as in from air to water. Imagine what would happen if you were walking on solid ground towards a lake, and then started to wade in the water. The water would slow you down, and you would find yourself changing direction.
- The same happens when light travels through different substances. As a ray of light travels from air to water, it bends as it moves from one material to another. This bending is called refraction. Each material has a certain level of bending associated with it called index of refraction. The index of refraction will predict the bending of light in that material.
- The indices of refraction of the straw, air, and water are different, so the straw appears to bend when placed in water. The same is true for the glass rod, air, and water as well as the straw, air, and oil.
- The indices of refraction of the oil and the glass rod are the same. The speed of light does not change as it enters the object so no refraction takes place. We cannot see the object.
- The strengths of Refraction are its ability to bend light as it hits different materials.
- The weaknesses of Refraction are if the indices of refraction of two materials are the same, no bending will take place.

Part II: Ghost Crystals

Introduce the Experiment

Tell the students the following:

- Tell the students that, based on the previous experiment, sometimes our eyes play tricks on us. We will do one more experiment where things are not what they seem.

Perform Experiment as a Demonstration

The demonstrator should do the following:

- Show the students the glass container. Ask them what is in the container. They will probably reply water or some other clear liquid (this is why it is important to have all air bubbles removed).

- Dip the spoon or your hand into the container and lift up the crystals. The students will be amazed! Return the crystals to the container, and watch them "disappear."
- Tell the students that the crystals, known as Ghost Crystals, are made from a polymer. A polymer is a large molecule that is made from many smaller, similar units. For example, the plastic bags used in many of our experiments today are made from a polymer. This particular polymer is able to absorb about 600 times its weight in water. As a result of this much water absorption, the polymer and water have the same index of refraction.
- Pass around the bag containing the original crystals. Show the students how small the original crystal is.
- Show the students how easy it is to break one of the wet crystals. (If you wish, pass one around.)

Conclusions

Tell the students the following:

- The major strength of a PokeChem character based on Ghost Crystals is its ability to disappear in water.
- A weakness of the Ghost Crystals is they can be easily crushed when wet.

Additional Information If Needed: Technical Background

- Eyeglasses, microscopes and telescopes all use the principle of refraction to focus light rays to make objects look clearer or larger.
- Index of refraction is the measure of the amount of refraction. It is the ratio of the wavelength of light in a vacuum to that in a substance.
- Ghost Crystals are made from polyacrylamide. These polyacrylamide crystals can be reused several times if they are placed in distilled water. Polyacrylamide crystals can be added to potted plants during vacations so the roots of the plant receive water while you are gone.

Experiment 4: Polarized (Polarizing Filters)

Experiment Purpose & General Methodology

- The students will learn about polarized light by using polarizing filters.
- Each table will share a set of polarizing filters, but each student will participate in the experiment. This experiment will take 5 minutes to complete.

Introduce the Experiment

Tell the students the following:

- Show the students the picture of the PokeChem character named Polarized. This character has the ability to block light when working in a pair with another filter. However, certain transparent plastic objects will cause some light to leak through and will create beautiful colors.

Perform the Experiment Simultaneously with the Students

Do the following:

- Ask each student to look through a single polarizing filter. The degree of brightness of the light coming through the filter should be slightly diminished.
- Then ask them to add a second filter. Slowly rotate that filter, observing the changes in light coming through that pair of filters. At some point, they should observe that the light is almost totally blocked out. Give students a chance to try for themselves.
- Ask the students to place the tape square between the two filters. They should observe a stained glass effect. If they move the filters, it will look like a kaleidoscope.
- Optional—if you have brought the empty container from an audio cassette, place it between the two polarizers. You will be able to observe a rainbow or stained glass effect from the areas where there is a stress in the plastic.

Conclusions

Tell the students the following:

- Light is made up of waves of light going out in all directions. A polarizing filter always will let light waves traveling in the direction of the polarization of the filter to pass through and light travelling in the perpendicular direction to be stopped. If the filters are placed perpendicularly to each other, no light will be observed passing through the filters.

- Placing objects between the two polarizers often causes the light wave to undergo a partial turn, and the result is light leakage, usually in the form of colored light.
- The strength of the polarizers is that they can stop light.
- The weakness is that they require an additional friend to stop the light.

Additional Information If Needed: Technical Background

- The reason that the cheap transparent tape, plastic audiocassette cases or cellophane can be used to produce color displays is due to the stresses that have been placed upon the plastics in the formation of the products. In fact, during testing, plastic tensile test strips are not only stretched but also observed through polarizers to determine the weak points that are positions for possible product failure.

Experiment 5: Indicator (Grape Jelly)

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:

- Show the students the picture of the PokeChem character named Indictor. Tell them that this character has the power to change color depending on exposure to either an acid or 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 and baking soda.

Perform the Experiment Simultaneously with the Students

Do the following:

- Add one packet of the jelly to the cup.
- Add about _ 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.
- Place the cups onto the white piece of paper. 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 _ of the baking soda in the bag (or less) to the cup and stir gently. Note that the solution bubbles and the color changes to gray-blue.
- 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].
- If time permits, the addition of baking soda 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 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.
- The strength of an Indictor character is its ability to change colors. This acts as camouflage to help hide Indicator from its enemies.
- The weakness of Indictor is that the chemicals you add to get the color change must be acids or bases. If you add a neutral chemical, such as water, there will be no color change.

Experiment 6: GELATINOUS (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. This experiment should take 5 minutes.

Introduce the Experiment

Tell the students the following:

- Show the students the picture of the PokeChem character named "Gelatinous". "Gelatinous" means "having the consistency of gelatin or jelly."
- The Gelatinous character starts life as a powder and evolves into Gelatinous by absorbing water (nearly 800 times its weight) and changing its form, growing much bigger and able to defeat other water-containing opponents. Gelatinous however, also has a weakness - salt (or sodium chloride). When Gelatinous comes in contact with salt, it loses its new "stronger" form, and drowns in the water that once was its strength.

Perform the Experiment as a Demonstration

Do the following:

- Hold up the clear cup with water. Ask the students to identify what is in the cup (Answer - Water).
- Tell the students that the Gelatinous character is hiding in one of the cups and that they must watch closely in order to find out where it is.
- Pour the water from one of the clear plastic cups into the cup marked #1. Ask the students: "Where is the water now?" (You should get a resounding "Cup #1" answer.) Ask the students if they are sure. (They will be.)
- Acknowledge that they are correct and then pour the water from cup #1 into cup #2. Now ask them where the water is. ("Cup #2!") Again, ask the students if they are sure. (Of course, they will be.)
- Again, acknowledge that they are correct and then pour the water from cup #2 into cup #3 (containing the sodium polyacrylate). Again, ask the students where the water is. ("Cup #3!") Ask them if they are sure (they will probably be a little annoyed because your questions are too easy). 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.

- Again, ask them: "Are you really sure?" and turn the cup (#3) 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 Gelatinous was hiding out in cup #3!
- Next, show the students the plastic bag with the dry sodium polyacrylate. Explain that this is how Gelatinous looks when he is "dry". Then add water (from the second clear cup) into the plastic bag, re-seal, and allow the students to see how the powder changes into a gel. Then pass Gelatinous 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! If necessary, double-bag the gel with the extra zipper-close bags provided.
- Meanwhile, dump the gel from cup #3 into a plastic bag. If necessary, double-bag the gel with the extra zipper-close bags provided.
- Tell the students that Gelatinous has a weakness. Its weakness is salt. When Gelatinous comes in contact with salt, he gives off the water that made him big, then withers and drowns in the water.
- Add the packets of salt into the plastic bag of gel from cup #3, then seal well and pass around the room. As the students feel the plastic bag, the gel will turn into a liquid. Gelatinous will remain weak unless all of the salt can be washed off (not an easy task).

Additional Information If Needed: Technical Background

- Sodium polyacrylate is a super-absorbent polymer. 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).
- 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: Magnetism (Floating Magnets)

Experiment Purpose & General Methodology

- The students will learn about magnetic properties by performing an experiment with magnets and a metal washer.
- Each table will share one experimental setup. This experiment will take 5 minutes.

Introduce the Experiment

Tell the students the following:

- Show the students the picture of the PokeChem character named Magnetism. Tell them that this character is stronger than iron, can be used to run a speeding train across a track, and help some butterflies navigate.
- Magnetism has the ability to distinguish between friends and enemies, as we shall soon see.
- NOTE: THE MAGNETS ARE VERY EASILY BROKEN IF DROPPED ON THE TABLE OR THE FLOOR. TELL THE STUDENTS TO BE CAREFUL WITH THEM.

Perform the Experiment as a Demonstration First, Then Have the Students Try

Do the following:

- Show the students your magnets. Ask them if they look the same. The students should agree. Tell the students that one of the magnets is a friend of Magnetism, and the other is the enemy.
- Hold the dowel in your hand and place one magnet on the dowel so that it sits at the base (on your hand).
- Tell the students that Magnetism likes to have friends around. Demonstrate by placing the magnet with the same pole up as the magnet on the bottom on the dowel so that the opposite poles are face to face and the magnets attract.
- Take the top magnet off, leaving the bottom magnet in place. Tell the students when Magnetism senses an enemy, he can use his powers to repel the enemy. Place the other magnetic, with the opposite pole up, on the dowel. The top magnet will "levitate" over the bottom magnet and amaze the students.
- Push down the top magnet to show the students that even when you try to force the two magnets together, they will repel each other.
- Ask the students to discover if their magnets are friends or enemies of Magnetism. [Optional: if you wish, place the magnets on the students' tables so that they all will either attract or repel each other when doing the experiment]

- After the students are done determining friend or enemy status, challenge the students to turn a friend into an enemy (or vice versa). If no one can tell you how to do this, show them that all they have to do is turn over the top magnet.
- Tell the students that opposite sides of magnets have different charges. Opposite charges attract each other, and like charges repel.
- Tell the students that Magnetism has a weakness. When there is other metal around, he loses his ability to repel his enemies.
- Now, hold the dowel in your hand and place one magnet on the dowel so that it sits at the base (like before). Then place the metal washer on top of the bottom magnet and show that regardless of the orientation of the top magnet, it will not repel.
- Let the students try.

Conclusions

Tell the students the following:

- The strengths of Magnetism are that two magnetic objects can repel, flip over, or grip together tightly. In this way, it can tell its friends from its enemies. Magnetism can attract Iron, a strong metal. In fact, with metal around, Magnetism can turn its enemies into friends.
- The weaknesses of Magnetism are that it has no power against materials that are not magnetic and when there is other metal around, it loses its ability to repel its enemies.

Additional Information If Needed: Technical Background

- Legend has it that a shepherd named Magnes noticed that his boot nails were attracted to certain rocks near Mt. Ida. The rocks (Fe_3O_4) are called "magnetite" after this shepherd.
- Scientists suspect that bacteria, birds, and butterflies have a magnetic sense of direction, aligning themselves with the earth's magnetic poles, just like the needles of a compass.
- Whenever a charged particle moves, there is an associated magnetic field. Atoms have charged electrons with magnetic moments. When the electrons pair up, the magnetic moments cancel. When the electrons do not pair up, the atom can indeed exhibit reaction to a strong magnetic force. The reaction is called "paramagnetism" and is disorganized and weak in most substances.
- The type of magnetism exhibited in this experiment is known as "ferromagnetism." For unknown reasons, some substances exhibit ferromagnetism rather than paramagnetism. In ferromagnetism, the electrons line up and act cooperatively, and the magnetic force can be significant. This is the case with iron. At least two factors can break ferromagnetism—high temperature and hammering. Both jostle the electrons and break up the strict alignment.

Experiment 8: Pressurize (Marshmallow in Syringe)

Experiment Purpose & General Methodology

- The students will learn about gas pressure by observing a marshmallow in a syringe.
- Each table will share one syringe but each student will do the experiment. This experiment should take about 5 minutes.

Introduce the Experiment

Tell the students the following:

- Show the students the picture of the Pressurize PokeChem character. Tell them that pressurize means to apply pressure. Ask them what they think pressure means [Some may answer "stress" due to the pressure their parents are under, but we are looking for an answer more like "the push of a gas on an object" like the push of air on the earth.]
- Ask the students if they have ever been up in the mountains. Perhaps several have had trouble breathing-—this was due to low air pressure. Air pressure is higher at sea level than in the mountains.
- A clever explanation of pressure is to have the students seated at their positions be normal atmospheric molecules. Have them move closer together—this illustrates what happens when the space available for them to move is reduced and the pressure is increased. Likewise, you could have them get as far away as possible from each other in order to illustrate the concept of lower pressure.
- Ask the students what is in a marshmallow. Hopefully, eventually they will get around to air.
- Tell the students they will learn about the power of pressure.

Perform the Experiment Simultaneously with the Students

Do the following:

- Show the students how the syringe works. Have one student at each table follow along with the syringe.
- Remove the cap, then pull air in and push it out of the container. Have the students feel the air coming out of the end of the syringe.
- Push all the air out of the syringe. Replace the cap. Pull on the plunger to show how difficult it is to remove. Tell the students they are creating low pressure inside the syringe.
- Remove the cap. Fill the syringe with air to the 30-ml mark. Replace the cap. Push on the plunger to feel the pressure needed to move the plunger.

- Remove the cap and the plunger from the syringe. Place one marshmallow (smiley face optional) inside the syringe. Replace the plunger and move it until it just touches the marshmallow. Replace the cap. Pull back the plunger. What happens to the marshmallow? [Answer: the marshmallow expands]. Move the plunger in and out a little to do it over again. Remove the cap and fill it with air, recap and move the plunger downward. What happens to the marshmallow? [Answer: the marshmallow shrinks to smaller than its normal size].
- Allow time for each student to explore the concept of pressure with their marshmallow.

Conclusions

Tell the students the following:

- The marshmallow expanded because the volume inside the syringe increased and the pressure inside the syringe decreased.
- A Pressurize character has the strength of being able to withstand great changes in the pressure around it and survive though it may change shape a bit.
- A Pressurize character has the weakness that it could be exploded or squished if the pressure was too high or too low.

Additional Information If Needed: Technical Background

- Marshmallows are as old as the pyramids. The Egyptians first discovered "althea" or "mallow root", a plant that grew in the marshes along the banks of the Nile. Eventually, "marsh" and "mallow root" became a single word—marshmallow. But it was the French in the mid-nineteenth century that began to sweeten and whip mallow root into a light and fluffy confection.
- Today's marshmallows do not contain mallow root. They consist of sugar, cornstarch, gelatin, and lots of air.
- Marshmallows formed from a gas in a solid, an example of one type of colloid. Similar colloids are whipped cream and shaving cream.
- Pressure is force per unit area.

Closing Session

Close Demonstration

- If you have not already done so, have the students look at the pictures they made in the Crystallize experiment. Conclude the experiment if you have not already done so.
- Remind the students that they can take home the picture they made.
- Hand out the Experiments to do at Home, the Book List, and the magazine entitled *Get Cooking with Chemistry*.

Clean up

After the students leave, clean up the room

- For experiment 1, pour off the water used in this experiment through the coffee filter so that any layers of fine sand particles on the surface of the water do not go down any sink drains. Optional: Place the reasonably dry sand into the plastic bag to take home or give to the librarians for their own use. To completely dry the sand, pour it onto several sheets of paper towels at home and allow to air dry. Store in a sturdy airtight container.
- For experiment 2, dispose of the solution down the drain. Dispose of all other items in the trash.
- For experiment 3, pour the water and oil down the drain. Place the Pyrex rod in the collection envelope. The ghost crystals can be thrown in the trash or recycled by taking them home and putting them in your potted plants to provide moisture to the roots while you are on vacation. Dispose of all other items in the trash.
- For experiment 4, place the polarizing filters and the tape squares in the collection envelope.
- For experiment 5, pour the vinegar down the drain. Dispose of all other solids in the trash.
- For experiment 6, dispose of the sealed bags containing the sodium polyacrylate in the trash (DO NOT pour down sink). Dispose of all other items in trash.
- For experiment 7, place the magnets back into the sealed bag and place in the collection envelope. Dispose of all other items in trash.
- For experiment 8, place the syringe into the collection envelope. Throw the marshmallows away.
- Seal the collection envelope containing the polarizing filters, magnets, Pyrex rod, the syringes, and the completed feedback sheet with attendance information. Give the envelope to the children's librarian with instructions to put it into interlibrary mail.