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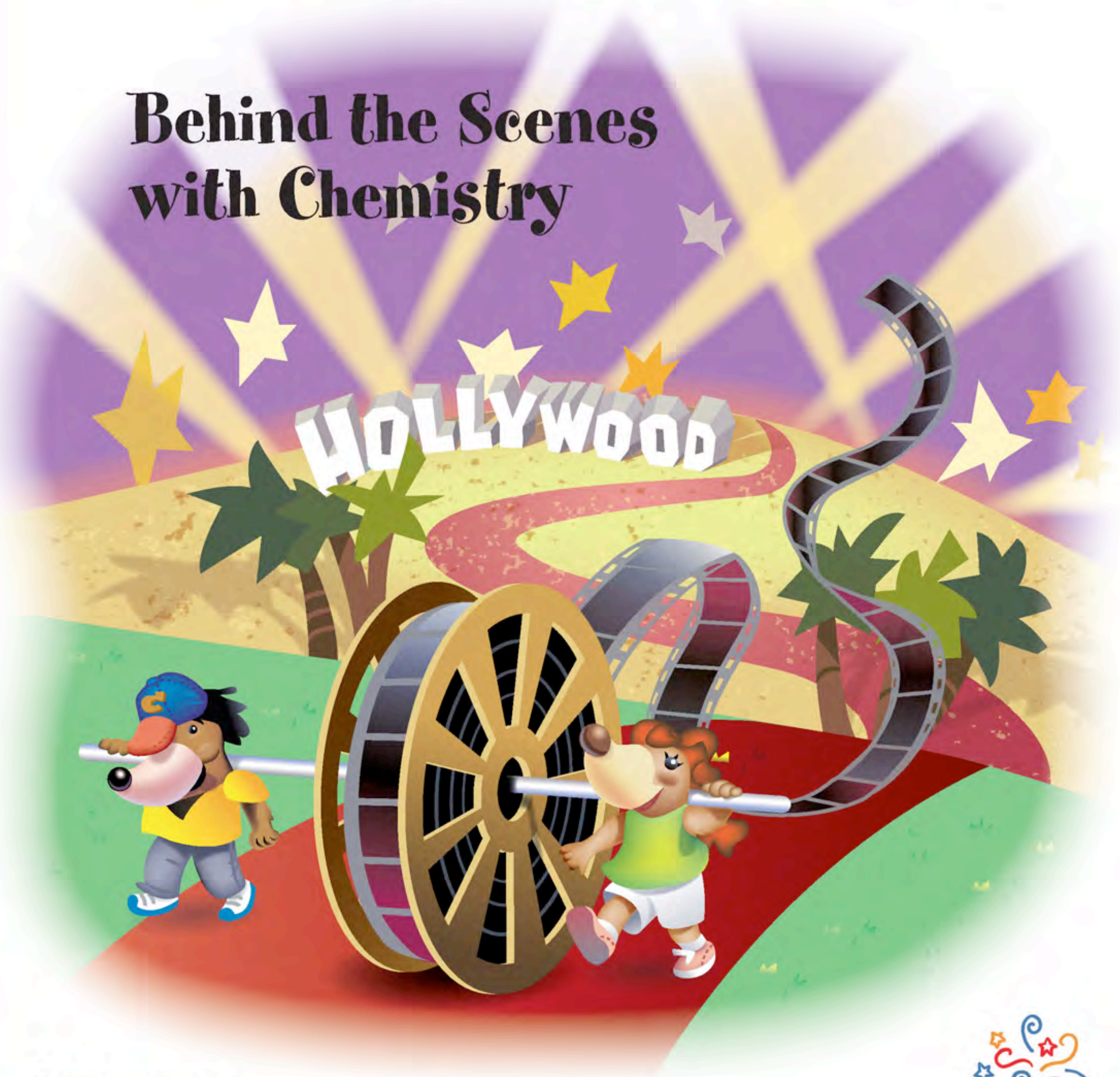
National Chemistry Week — American Chemical Society

Behind the Scenes with Chemistry



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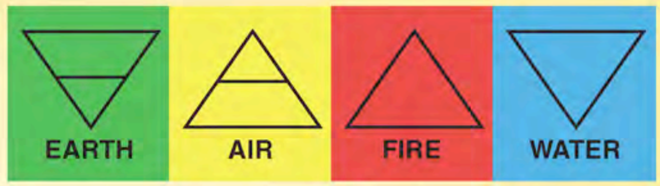
National Chemistry Week

Behind the Scenes with Chemistry

By Analice Sowell

Have you ever walked out of a movie theater or seen a television show and thought, "Wow, those were great special effects"? Some believe that these special effects come from magic. In reality, it is not magic, but some serious science that can explain the most simple to the most complex special effects used in movies and television shows today! Special effects coordinators on movie sets use principles of chemistry every day to set up colored flames, explosions, and snow … even in the middle of the summer! Make-up artists use special flexible plastic to make masks and costumes that can be attached to a person's skin in order to change the actor into his or her character. But, special effects are not the only place chemistry is found on a TV or movie set. From the film used to record the show, the lighting they use to light the set, the materials used to build the set, even the food they eat during the day: chemistry is everywhere!

Chemistry began long before motion pictures were developed, though. Back in the 5th century, B.C.E., the Greek philosopher Empedocles proposed that everything was made of four fundamental elements: earth, air, fire, and water. Even later, in the time of Plato and Aristotle and until the Middle Ages, people thought that all matter was a combination of the four fundamental elements in different ratios. In the Middle Ages, early chemists, known as alchemists, discovered modern elements such as mercury and gold. But, they still believed that these modern elements were some combination of the original four elements proposed by the Greeks.



And, as a result, they also thought that this meant that they could make gold out of other things by simply changing the ratio of the four fundamental elements. In the 1700s, scientists discovered more elements by conducting controlled experiments. As a result, the focus of chemistry changed from being that of magic and mystery to that of experiments and research. Today, all the elements known to man are displayed on the Periodic Table, which was organized by Demitri Mendeleev in the late 1800s. It is these same elements that are found on the Periodic Table that give us the foundations for the chemical reactions necessary to create special effects in movies and television.

This year's National Chemistry Week edition of *Celebrating Chemistry* focuses on the theme "Behind the Scenes with Chemistry." Over the next few pages, you will find articles on the chemistry behind common special effects in movies and on television. You will also find out some of the chemistry secrets behind the special effects in popular books. Visit **www.acs.org/ncw** for additional articles and activities. So, get ready: Lights! Camera! It's National Chemistry Week!

Analice Sowell is a chemistry instructor and coach of the Science Bowl and Science Olympiad teams at Memphis University School in Memphis, TN. She is a former research chemist and past secretary and chair of the Memphis ACS Local Section.

The Adventures of Meg A. Mole, Future Chemist

One of my favorite recent books is *ReAction! Chemistry in the Movies* (2009) by Mark Griep and Marjorie Mikasen. To go behind the scenes with this author, I traveled to Nebraska to meet Mark Griep, Associate Professor at the University of Nebraska–Lincoln. Dr. Griep researches antibiotics, which is a kind of medicine that can be used to cure infections.

When I first arrived at the lab of Dr. Griep, I could not wait to talk to him about his book, *ReAction! Chemistry in the Movies.* I told him my favorite part in his book was when he discussed *Harry Potter and the Chamber of Secrets* (2002). "The second year at Hogwarts begins with a lesson from Prof. Sprout in the greenhouse. While the students learn how to re-pot human-shaped mandrake plants, Hermione Granger explains that mandrake extract is used to cure petrification. This information soon becomes important when the students discover that someone or something has petrified the Muggle-borns and the cat Mrs. Norris!" Dr. Griep really liked this scene because they remembered to be safe and used earmuffs to protect their hearing. He also told me that "many real plants have chemicals in them with medicinal properties. It turns out that mandrakes really exist although they are just plants and don't really scream when you pull them out of the ground. On the other hand, when you squeeze out their juice, it contains two chemicals that affect humans. One of them is an anti-seasickness molecule called scopolamine. The other molecule causes your pupils to open wide and is called atropine."

What made Dr. Griep want to become a chemist? He told me that when he was growing up, his "parents encouraged him to do well in all his classes" and also gave him a microscope set and a chemistry set! I then asked him what his favorite subjects were in school. He told me that "in grade school, I liked spelling and math. In high school, I liked math, history, and all the sciences."

When Dr. Griep is not researching new medicines or writing books about chemistry in the movies, he also likes to share his knowledge of chemistry with others. He said that "every year my colleagues and I put on a chemical show for high school students, and another one for the whole family."

I really enjoyed my trip to Nebraska to meet Dr. Griep. From now on, any time I watch a movie, I'll be watching for all the cool chemistry that he told me about … maybe all of you can too!

Personal Profile: Dr. Mark Griep

Favorite movie: One of my favorite family movies is *Flubber*, starring Robin Williams, because it has a lot of chemistry in it.

Birth date: July 22

Favorite hobby: I love to watch movies and then keep track when one of the characters says something chemical. I now have a list of 1200 movies that have chemistry in them.

Accomplishment you are proud of: I published a book about chemistry in the movies.

See Episode 2 of Meg's Interview at www.acs.org/ncw

Milli's Safety Tips Safety First!

ALWAYS:

- Work with an adult.
- Read and follow all directions for the activity.
- Read all warning labels on all materials being used.
- Use all materials carefully, following the directions given.
- Follow safety warnings or precautions, such as wearing gloves or tying back long hair.
- Be sure to clean up and dispose of materials properly when you are finished with an activity.
- Wash your hands well after every activity.

NEVER eat or drink while conducting an experiment, and be careful to keep all of the materials away from your mouth, nose, and eyes!

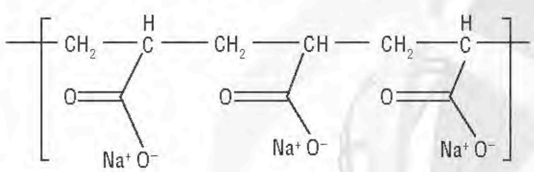
NEVER experiment on your own!

Special Effects Using Household Chemicals

By Christine Jaworek-Lopes

What would a movie be without special effects? These days, many special effects are created on a computer. However, you can make some special effects, like snow, and breaking glass, with supplies found in your home.

Movies and TV shows are often produced in areas very different from the climate that is shown. The makers of the movie might need to have a winter snow scene but it is the middle of summer and they are inside a studio. To solve this problem, they have to make fake snow. Hexylene glycol liquid is blown through an artificial snow machine for large snow scenes. In the following activity you will make and observe fake snow on a smaller scale using a different chemical. Four different types of fake snow will be made by combining different amounts of water with a polymer called sodium polyacrylate. A polymer is a long chain of molecules that are made of repeating units of the same arrangement of atoms. The sodium polyacrylate is a long chain composed of many repeats of the structure shown below. This polymer changes as water is added. See if you can find out how it changes.



SNOW DAY!

Materials:

1¼ teaspoons sodium polyacrylate, can be purchased online or in baby diapers
~8 tablespoons distilled water
Magnifying glass
5 small clear plastic plates
3 wooden stir sticks
3 plastic cups (5 ounce)
Measuring spoons (¼ teaspoon, 1 tablespoon)

SAFETY! *Be sure to wear eye protection when doing this activity. Wash hands thoroughly after handling the sodium polyacrylate.*

Procedures:

Plate A. Polymer Crystals

1. Measure ¼ teaspoon of sodium polyacrylate and pour onto a small clear plastic plate.
2. Touch the crystals, view with a magnifying glass, and record observations in the table "What did you see?".

Plate B

1. Measure ¼ teaspoon of sodium polyacrylate and pour onto a small clear plastic plate.
2. Pour 1 teaspoon of deionized water onto the sodium polyacrylate (do not stir).
3. Touch the mixture, view with magnifying glass, and record observations.

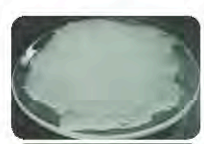
Plate C

1. Measure ¼ teaspoon of sodium polyacrylate and pour into a small clear plastic cup.
2. Pour 4 teaspoons of deionized water onto the sodium polyacrylate and stir with a wooden craft stick.
3. Pour onto a clear plastic plate to more easily observe.
4. Touch the mixture, view with magnifying glass, and record observations.

Plate D

1. Measure ¼ teaspoon of sodium polyacrylate and pour into a small clear plastic cup.
2. Pour 2 tablespoons of deionized water onto the sodium polyacrylate and stir with a wooden craft stick.
3. Pour onto a clear plastic plate to more easily observe.
4. Touch the mixture, view with magnifying glass, and record observations.

Plate E



1. Measure ¼ teaspoon of sodium polyacrylate and pour into a small clear plastic cup.
2. Pour 4 tablespoons of deionized water onto the sodium polyacrylate and stir with a wooden craft stick.
3. Pour onto a clear plastic plate to more easily observe.

Idaho State University Chemistry Club. (Front-left): Whitney Hess, Patrick Whitham, Jen Teixeira, (back) Joshua Pak, Jeff Hess, Aaron Wilkinson, Roy Malamakal, and Minh Nguyen (not shown)

Where's the Chemistry?

Sodium polyacrylate is a polymer that absorbs water really well. When water is added, the sodium polyacrylate traps the water, which makes the polymer expand. The polymer traps the water because it has negatively charged oxygen atoms (the O^- in the structure on page 4) and water is attracted to atoms and molecules that have a charge. As you add more water, the polymer looks even bigger and the texture changes, much like different types of snow. This water-loving polymer is found in diapers. Now you can also have a little fun with snow, even during the hot summer.

What did you see?

Amount of water added	What does the polymer look like?	What does the polymer feel like?	Can you pack the polymer?	Does the polymer look like it can hold more water?

SUGAR GLASS

Materials:

2 tablespoons of water
½ cup of light corn syrup
¼ teaspoon cream of tartar
1¾ cups granulated sugar
Candy thermometer
Deep sauce pan (1 qt)
Cooking spoon
Non-stick cooking spray
9" x 12" cookie sheet with edges
Spatula

⚠ CAUTION! HEALTH & SAFETY

Adult permission and supervision are required for this activity. Use caution when handling hot liquids. Be sure to wear eye protection when doing this activity. Do not attempt to break the glass with any body part!

Procedures:

1. Spray the cookie sheet with non-stick cooking spray.
2. In a sauce pan mix water, corn syrup, sugar, and cream of tartar on medium-high while stirring occasionally.
3. When the temperature reaches 300 °F, take the solution off the stove and pour onto the cookie sheet. It should be 1–2 cm thick.
4. When the solution starts to harden and while still a little warm, 5–8 minutes, depending upon the thickness, peel off the fake glass. The slower it is peeled off, the smoother the glass tends to be.
5. Place the glass on a hard surface and wait approximately 10 minutes so the glass may completely dry.
6. Break the glass by placing the cooled glass over a newspaper and hitting with a small hammer.

Sugar glass should be used soon after it's prepared. It is made of a lot of sugar, which is hygroscopic, meaning it will absorb water from its surroundings. If the sugar glass absorbs enough water, it will become too soft to serve its intended purpose of making a loud crashing noise when broken. (Recipe from **www.ehow.com/how_2078408_make-sugar-glass.html.**)

Christine Jaworek-Lopes is an Assistant Professor of Chemistry at Emmanuel College in Boston. She is actively involved in the ACS Northeastern Section and is a member of the Committee of Community Activities. The snow activity was developed by the Idaho State University Chemistry Club, which won the Chemvention 2009 competition.

Lights, Camera, Action!

By Marilyn Duerst

A white or silvery (aluminum-coated) umbrella diffuser spreads out and softens light for a normal lighting effect.

Artificial light sources for movies can be as big as 50,000 watts (ordinary tungsten light bulbs are only 60 to 100 watts).

Fake snow can be made from soap flakes, confetti, or sodium polyacrylate, a super-absorbing polymer also used in baby diapers. Snow on buildings can be made of spray foams or starches.

A bodysuit filled with pockets of latex, polyfiber, or synthetic foam can visually add more than 100 pounds of body weight, making someone look larger than they are in real life.

Fake ground mist or fog can be made with powdered "dry ice" (solid carbon dioxide), which quickly sublimes into a gas, cooling any water vapor in the air, making a mist.

Early movies were actually strips of cellulose nitrate (over a mile long!), which sometimes caught on fire from the heat of the projection bulbs. Nowadays, film strips are made of the less flammable cellulose acetate or polyester material. Digital photography and computer animation have become very popular.

Ordinary makeup may contain powdered talc, silica, iron oxide pigment for reddish colors, or powdered charcoal for black, all mixed with oil or wax.

Highly trained makeup artists use far more than ordinary cosmetics: plastic or foam false noses, chins, hairpieces, or fake wounds may take hours to apply and to remove! To make an actor look older, liquid latex is applied to stretched skin. Once the latex dries, the skin is released to give the wrinkled effect.

Marilyn Duerst is on the Chemistry Faculty of the University of Wisconsin–River Falls and has been active in outreach for more than three decades.

Homework, Hogwarts Style

By Jane Snell Copes

When you sit down to start your homework, you probably get out pencils, paper, an eraser, and maybe a few art supplies. Nothing particularly magical about those items, is there? But if you were a Hogwarts student, you'd need quills, ink, and long rolls of parchment. You could use a spell-correcting quill or one enchanted to write what you dictate. You might use ink that changes color as you write!

So are those just impossible special effects made up by J. K. Rowling? Not entirely! It's true that the seven Harry Potter books and the movies to go with them are full of amazing characters who have incredible adventures. As good as the story is, though, I really love finding the science in the flash and bang of Harry's school world. My copies of the Potter books bristle with sticky-notes that remind me where to find recipes for making ancient paper or that color-changing ink.

I'm glad to provide a little Potions and Transfiguration lesson to teach you how to make some of Harry's school supplies. You won't need to visit Diagon Alley, but do make a shopping list for the grocery store before you start these projects. Good luck on your hex-ams!

SAFETY! *Be sure to wear eye protection when doing these activities. Be careful with hot liquids. Do not eat or drink any of the materials used in this activity.*

Ancient, Invisible, and Colored Inks

Let's make some special inks for your special papers. Ancient iron tannate ink is a modern recipe, but it's very similar to ink made from oak galls as early as the 1st century C.E. da Vinci and Bach wrote with iron-gall ink, and the Dead Sea Scrolls are written with this ink also. Go to **www.acs.org/ncw** for the Invisible Ink activity!

Ancient Iron Tannate Ink

Materials:

2 mugs, teacups, or small glass bowls
1 tea bag*
Boiling water and an adult helper
1 iron sulfate (ferrous sulfate) tablet**
A mortar and pestle or a small glass bottle
A measuring cup
A small storage container, like a pill bottle, with label

* Use black tea because herbal tea will not work.

** Ferrous sulfate tablets are an iron supplement that you can buy at a grocery or drug store.

Procedures:

1. Place a tea bag in a mug, tea cup, or small glass bowl. Add 2 tablespoons of boiling water to the bag to make a very strong tea. Remove the tea bag.
2. Label your storage container with your name, the date, and the contents: Iron Tannate Ink.
3. Some iron sulfate tablets come with a colored coating. If yours do, wash the colored coating off one tablet under running water. Dry the tablet. If there is no colored coating, go on to the next step.
4. Crush the tablet with a mortar and pestle or a glass bottle in the remaining mug, teacup, or glass bowl.
5. Add the iron tablet powder to the strong tea solution. You'll see the brown tea turn to black ink.
6. Carefully transfer your ancient ink to your storage container.
7. If your ink starts to grow mold, throw it away!

Caution: Making your own ink the old fashion way is a cool learning experience. Before you start, get permission and help from an adult. This ink is PERMANENT, which means it will NEVER come out of your clothes and will stain your skin for awhile. Once you get permission, wear old clothes or an apron and cover your working surface with newspaper. Ask your adult helper to handle the boiling water.

Why does it work?

Tea is brown because of soluble plant pigments called tannins. When tannin and iron come together in solution, they form a brown or black precipitate called iron tannate. The particles of iron tannate are very small, so they stay suspended in the liquid. This ink gets darker as it reacts with oxygen in the air, although it also seems to eat into paper after many years!

Special Papers

Harry and his schoolmates write their homework on long parchment scrolls, with assignments made in "inches of parchment" instead of by number of pages or words. Traditional parchment is made from sheepskin, calfskin, or goatskin. You can prepare some quickly "aged" paper that looks like parchment, by using a strong solution of ordinary black tea. Go to **www.acs.org/ncw** for the Ancient Paper activity.

You can make an excellent color-changing paper by soaking plain paper in purple cabbage juice. You can write on this paper with vinegar or baking soda solution when the paper is dry. Here's how:

Color-Changing Paper

Materials:

A strainer
Hot tap water
Purple cabbage
Plain white paper (8 ½" x 11")
A blender and an adult helper
A labeled storage container, quart-size
A big, flat pan (9" × 13" is a good size)
Newspapers or plastic sheet to cover work area
Vinegar, baking soda, lemon juice
Cotton swabs or wooden skewers

Procedures:

1. Cover your work area with newspapers or a plastic sheet.
2. Put 1/4 head of shredded purple cabbage into the blender.
3. Add half cup of water to the blender.
4. Blend the cabbage leaves and water until the cabbage is in small bits.
5. Strain the blended cabbage into the flat pan. Put the leftover cabbage bits in the trash.
6. Soak plain paper in purple cabbage juice. Hold each sheet of paper by a corner to let it drain into the pan. Let the paper dry on newspapers or plastic for about 24 hours.
7. Save some of your purple cabbage juice to use as a developer for invisible inks (see the activity at **www.acs.org/ncw**).
8. Cabbage indicator will keep in the refrigerator for a few days. Pour it down the drain after that time. The indicator may also be frozen in ice cube trays and kept in a plastic bag indefinitely.
9. Use cotton swabs or wooden skewers to write on your dry purple paper with vinegar, lemon juice, or baking soda solution (dissolve 1 teaspoon baking soda in a cup of water). What colors do you see? Record observations in the table below.

Why does it work?

Purple cabbage contains colored pigments that change their colors when they meet an acid or a base. Acids make purple cabbage juice turn pink. Bases make the juice turn blue or greenish.

Caution: Be sure you have an adult helper when you use the blender. Keep your hands OUT of the blender, and keep the lid ON when the blender is running. This paper needs about 24 hours to dry.

What did you see?

Acid = pink/red **Base = blue/green** **Neutral = purple**

Chemical	Color	Acid, Base, or Neutral
Vinegar		
Lemon or orange juice		
Baking soda mix		
Water		
Windex		

Quills, Magical and Otherwise

Even at Hogwarts, students aren't allowed to use magical quills to cheat on exams. Fred and George Weasley, however, do sell self-inking, smart-answer, and spell-checking quills at their store in London (*Harry Potter and the Order of the Phoenix*, chapter 6). Students love to buy sugar quills at Honeydukes sweet shop in Hogsmeade (*Harry Potter and the Prisoner of Azkaban*, chapter 5), because you can suck on them in classes while you appear to be thinking what to write. Rita Skeeter's acid-green Quick-Quotes Quill (*Harry Potter and the Goblet of Fire*, chapter 18) is an amazing device that automatically scribbles out what the reporter wants it to write.

Hogwarts students and professors use all sorts of feathers to write with: owl, hawk, eagle, pheasant, and even phoenix and peacock feathers. Our word *pen* comes directly from the Latin word *penna*, which means feather. You can buy large turkey feathers at a craft store. Here's a simplified way to cut and use them with your special inks. (See Ancient Ink recipe at **www.acs.org/ncw**.)

Making Quills

1. Choose a feather with a sharp, pointed quill end, not a wide soft end.
2. Soak the quill end in warm water for 15 to 30 minutes.
3. Hold the feather so that its top curves back over your hand as you write. You're going to cut the tip of the quill diagonally with a small scissors, cutting from the underside of the quill.
   For more detailed instructions on quill cutting, visit the Quill Pen website (listed in references).
4. Dip the tip of the quill in ink and use a light touch on your paper. You'll have to re-dip the pen every few letters. Practice, practice, practice, and let your quill dry between uses.
5. You'll find it's much easier to write with rounded pen strokes rather than using abrupt changes of direction and spiky letters.

So dear students, when your letter inviting you to Hogwarts arrives, you'll already have some very important skills!

REFERENCES

Rowling, J. K. *Harry Potter and the Sorcerer's Stone, Scholastic*, 1997; *Harry Potter and the Chamber of Secrets, Scholastic*, 1998; *Harry Potter and the Prisoner of Azkaban, Scholastic*, 1999; *Harry Potter and the Goblet of Fire, Scholastic*, 2000; *Harry Potter and the Order of the Phoenix, Scholastic*, 2003.

A Wikipedia article on invisible ink: **http://en.wikipedia.org/wiki/Invisible_ink**.

Iron Gall ink: **www.knaw.nl/ecpa/ink/make_ink.html**.

HP Lexicon, quills: **www.hp-lexicon.org/magic/devices/devices-qhtml#quill**.

Jane Austen Society of Australia information on writing with a quill pen: **www.jasa.net.au/quillpen.htm**.

The Quill Pen website: **http://medievalwriting.50megs.com/tools/quill.htm**.

Jane Snell Copes is an inorganic chemist, inventor, teacher, writer, and business owner in Minnesota. Her job is having fun with science every single day. You can find Science Outside the Box on Facebook and become a fan!

Word Search

H	C	R	A	T	S	E	S	I	L	I	C	A	A	L
D	R	L	U	V	M	T	Z	S	I	O	H	L	A	A
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ACETATE	DRY	PIGMENT	POLYMER
ADHERE	ELEMENT	POLYACRYLATE	REACTION
ALCHEMY	HYGROSCOPIC	POLYESTER	SILICA
CELLULOSE	ICE	TALC	SODIUM
CHEMICAL	INDICATOR	TANNIN	STARCH
CHEMISTRY	MATTER	WATT	SUBLIMATION

Find the answers at **www.acs.org/ncw.**

Inspiring the Green Chemists of Tomorrow with Movies

By Jennifer Young

Have you seen any movies recently and become inspired to protect the planet? Some of the movies in the past year have shown us glimpses of nature, paradise, and how closely connected everything on Earth is. For example, in *Up*, we were flown to an ancient-looking jungle in South America, called Paradise Falls. This is a place that is a sort of lost world, almost untouched by humans and with strange, undiscovered plants and animals. In contrast, the movie *Earth* took us to the far reaches of our planet and showed the delicate and fragile balance of life on Earth, the fight for survival in nature, and animals that are near extinction because of humans. Then in *Avatar*, we traveled 150 years into the future to a far-away Earth-like planet called Pandora. In this paradise, we see what life can be like when creatures live in complete harmony and balance with the planet and are not harming it. In the movie, human scientists try to learn about this balance and interconnectedness and how humans and Earth could benefit from that knowledge. Movies give us a glimpse of what a perfect world can look like and a future where everything is healthy and in balance. How do we create a "green" future like that shown in the movies? How can we make a future on Earth, like in the movies, that has plenty of clean air, fresh water, safe energy, and healthy food for everyone—even more so than today?

These are questions that green chemistry strives to find answers for. Green chemistry is a key to keeping the planet healthy and clean. What is green chemistry? Green chemistry means doing chemistry in a way that does not harm the environment and instead protects it. It means making products that we use every day, like soap, computers, and toys, in a way that does not pollute the planet or produce dangerous chemicals. And we can use green chemistry to make technologies to be able to provide clean drinking water to everyone on Earth.

Movies have made a big impact on my career decisions, too. When I was studying chemistry, I happened to watch some movies that really inspired me to become a green chemist. The classic Dr. Seuss story, *The Lorax*, taught me about the horrible consequences of cutting down too many trees (a new movie version is coming in 2012). Other movies made me want to help prevent the rainforests from disappearing, because at that time, the rainforests were shrinking so quickly that there was a real fear that they would all be destroyed. I really wanted to make a difference and do my part in protecting the planet with chemistry. I wanted to become a green chemist and prevent toxic products from being made, prevent pollution, and save our planet from further harm. This is what green chemistry is all about. Movies are giving us a wake-up call to do our part to protect the planet. Maybe you will be inspired by a movie too!

Jennifer Young is a polymer chemist and green chemist. She manages green chemistry programs on a daily basis in Washington, DC.

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What is the American Chemical Society?

The American Chemical Society (ACS) is the largest scientific organization in the world. ACS members are mostly chemists, chemical engineers, and other professionals who work in chemistry or chemistry-related jobs. The ACS has more than 161,000 members. Most ACS members live in the United States, but others live in different countries around the world. Members of the ACS share ideas with each other and learn about important discoveries in chemistry during meetings that the ACS holds around the United States several times a year, through the use of the ACS website, and through the journals the ACS publishes.

The members of the ACS carry out many programs that help the public learn about chemistry. One of these programs is Chemists Celebrate Earth Day, held annually on April 22. Another of these programs is National Chemistry Week, held annually the fourth week of October. ACS members celebrate by holding events in schools, shopping malls, science museums, libraries, and even train stations! Activities at these events include carrying out chemistry investigations and participating in contests and games. If you'd like more information about these programs, please contact us at **oca@acs.org**!

ACS Chemistry for Life™

Words to Know

Adhere: To stick or hold together.

Alchemy: This early forerunner of modern chemistry was based on untested goals, such as discovery of the panacea, finding the elixir for immortality, and changing base metals into gold and silver, a seemingly "magical" power.

Chemical reaction: The interaction of two or more chemical substances producing new substances with different properties from the original ones. When a chemical reaction takes place, you might see a color change or bubbles form. Other signs of chemical reactions are when you see light or feel heat after the chemicals are mixed together.

Chemistry: The study of matter and the changes it can undergo.

Element: Any of the more than 100 known chemical building blocks (92 occur naturally) that cannot be separated into simpler substances and that make up all matter. All of the known elements are listed on the periodic table.

Hygroscopic: Readily absorbing moisture, as from the atmosphere.

Matter: Anything that has both mass and volume (takes up space). Matter generally exists in one of three physical states: solid, liquid, or gas. All matter is made of elements.

Pigment: A substance used as coloring.

Polymer: Polymers are made of tiny chemical units that are hooked together to form very long chains. *Poly* means *many*, and *mer* means *part*. Together, the word *polymer* means *many parts*.

Starch: A long, stringy molecule of many sugars connected together that is found in some types of plants.

Sublimation: The process where a substance changes directly from the solid to the gaseous state without becoming liquid.

Watt: A unit that is used to measure power.

Knowledge Check-Up

1. What causes the changes in the fake snow properties?
2. How are fog scenes created?
3. What is film made of?
4. What are the brown pigments in tea called?
5. What are some green concepts expressed in recent films such as Avatar, Earth, and Up?