EXPLORE! EXPERIENCE!

SCIENCE!

EXPERIMENT!

POP, BANG, FIZZ!

Prepare for a Truly Unforgettable Experience

Steve Spangler, science teacher and inventor and hands on science guru says the following, If we want to create unforgettable learning experiences, we must teach the learner how to do something truly amazing.

One of the secrets to achieving this goal is to make certain that our students are given the opportunity to do the activities themselves. That concept seems simple, but too many times we as teachers and adults end up doing the activity for the kids. Not that we shouldn't have fun. An enthusiastic, laughing adult who is thoroughly enjoying himself/herself while conducting or participating or guiding someone else through any kind of lesson is setting a far better example than the silent adult who likes to say "SHHHHH!" and gets upset when the children ask too many questions or get a little messy. Having fun is contagious - it's one of the best attributes of an amazing teacher.

Get the child up there, with sleeves rolled up and permission to talk and laugh and get wet or sticky or creative, and tell him he's going to do something LOUD and MESSY that might make the other kids duck and try to catch flying things, and the wonders that are our planet begin to unfold and make impressions on our students.

Lessons that demonstrate to ALL ages the love of learning are the best kind. And don't think that both the child and the adult don't notice that. When a child is so excited about what he has learned that day, that he can't wait to get home and share it with everyone around, that's genuine education that that child is going to remember.

Let's face it, science is already fun, but it also has to be relevant to the curriculum and to the real world. We have all been taught that a hands-on approach is better than the more traditional sit-and-listen lecture style, but is that true? "Just because kids are doing a hands-on activity doesn't mean they're learning," according to Steve Spangler. "We as teachers need to learn how to effectively use inquiry-based activities to teach our students how to better use the scientific method and to stimulate their problem-solving skills. The secret is engagement instead of simply involvement. Students want to be engaged and to be challenged to make their own discoveries.

For example, as a way of demonstrating the incredible power of air, instructor Doug Hodous vacuum-packed a willing teacher participant in a giant plastic bag.

"Once you're sealed in a bag from the neck down and the air is removed, you understand what it feels like to have 14.7 pounds of air pushing on every square inch of your body... and every kid in classroom wants to be vacuum-packed!"

There is a difference between guided inquiry and self-directed inquiry. When we teach, kids we give them guided inquiry, the steps to achieve a particular goal. Self-guiding is when a child can play and learn by making and doing. There are always times that guided instruction is necessary, but there is some wonderful learning that can take place when the teacher steps outside of that and we want to do both. By doing this, we'll make it one unforgettable week for our students, and ourselves.

Thanks for coming along on the adventure! We hope it will be a BLAST!

The included experiments, activities, and demonstrations were found at or inspired by www.stevespanglerscience.com and can be found in the hands on science library of experiments and are used with permission for private non-commercial and educational use only. Please go to the website and explore for even more fun hands on activities and amazing science products.

During all Activities, Demonstrations, and Experiments the following Standards will be covered:

K-2 Inq. 1 Use senses and simple tools to make observations

K-2 Inq. 2 Communicate interest in simple phenomena and plan for simple investigations

K-2 Inq. 3 Communicate understanding of simple data using age-appropriate vocabulary

K-2 Inq. 4 Collect, discuss, and communicate findings from a variety of investigations

3^{rd}-5^{th} Inq. 1 Identify specific investigations that could be used to answer a particular question and identify reasons for this choice.

3^{rd}-5^{th} Inq. 2 Identify tools needed to investigate specific questions

3^{rd}-5^{th} Inq. 3 Maintain a science notebook that includes observations, data, diagrams, and explanations.

3^{rd}-5^{th} Inq. 4 Analyze and communicate findings from multiple investigations of similar phenomena to reach a conclusion.

6^{th}-8^{th} Inq. 1 Design and conduct and open-ended scientific investigation to answer a question that includes a control and appropriate variables.

6^{th}-8^{th} Inq. 2 Identify tools and technologies needed to gather, organize, analyze, and interpret data collected from a moderately complex scientific investigation.

6^{th}-8^{th} Inq. 3 Use evidence from a dataset to determine cause and effect relationships that explain a phenomenon.

6^{th}-8^{th} Inq. 4 Review an experimental design to determine possible sources of bias or error, state alternative explanations, and identify questions for further investigation.

6^{th}-8^{th} Inq. 5 Design a method to explain the results of an investigation using descriptions, explanations, or models.

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Animals, Adaptations, and Habitats

Experiment: Ant Farm (AntWorks Habitat/Antworks Tunnel Vision)

Students will study the behavior of ants in a unique, self-contained environment. An ant farm is a great intro into several biological and behavioral concepts:

There is, of course, the study of insects and ant biology. Watching them dig tunnels is fascinating. And not in a lava-lamp kind of way, but in a logical, workhorse way: Ants are directed by very simple rules, but those simple rules can produce complex results, like the complexity of the ant community and the tunnel systems.

Also make notice of the group effort: Like Egyptian slaves laboring to build the Pyramids, or herds of animals fighting off predators, an ant farm is a great way to show how group effort and cooperation can accomplish more than a single individual ever could.

With Antworks, Its special gel is full of nutrients specially formulated for the needs of the ant (formulated by a certified ant nutritionist). Because the gel is clear, you can actually see the ants dig their tunnels in 3 dimensions. AntWorks includes a container with a special gel formulation, magnifying glass, 20 page booklet detailing fascinating ant facts and a special 'extreme magnification lens' with which you can even see hairs on the ants!

Examples of Correlating Standards:
Kinder 7.3.2 Record information about the care, feeding, and maintenance of a living thing
1st 7.3.2 Describe what plants and animals need in order to Gradeow and remain healthy
2nd 7.3.2 Design a model of a habitat for an organism in which all of its needs would be met.

3rd 7.3.3 Identify structures used by different plants and animals to meet their basic energy requirements.
3rd 7.4.1 Sequence diagrams that illustrate various stages in the development of an organism
3rd 7.4.2 Create a timeline to depict the changes that occur during an organisms' life cycle.
4th 7.5.1 Classify animals according to their physical adaptations for obtaining food, oxygen, and surviving within a particular environment.
4th 7.4.2 Study the life cycles of a variety of organisms and determine whether these processes illustrate complete or incomplete metamorphosis.

5th 7.5.2 Design a model to illustrate how an animal's physical characteristics enable it to survive in a particular environment.
5th 7.4.1 Explain how genetic information is transmitted from parents to offspring.
5th 7.2.3 Create a simple model illustrating the interspecies relationships within an ecosystem.
6th 7.2.1 Compare and contrast the different methods used by organisms to obtain nutrition in a biological community.
6th 7.2.3 Use a food web or energy pyramid to demonstrate the interdependence of organisms within a specific biome.
7th 7.1.7 Explain how different organ systems interact to enable complex multicellular organisms to survive.
7th 7.3.7 Describe structures that animals use to obtain oxygen.
7th 7.4.1 Classify organisms according to whether they reproduce sexually or asexually.
8th 8.2.3 Choose the appropriate biome for an organism, given a description.
8th 8.2.4 Identify biotic and abiotic factors in a biome.
8th 8.4.1 Differentiate between complete and incomplete metamorphosis

Experiment: Planet Frog!

Watch as live tadpoles transform into frogs in this realistic pond habitat. These frogs are living in style with a hideaway cave, a rock slide and plenty of place to play hide and seek. The habitat also has a vented, see-through lid for safe and easy viewing. The habitat is break resistant and escape proof.

Examples of Correlating Standards:

Kinder 7.3.2 Record information about the care, feeding, and maintenance of a living thing
1st 7.3.2 Describe what plants and animals need in order to grow and remain healthy
1st 7.2.1 Identify the basic characteristics of living things
1st 7.2.2. Record information about living or non-living materials based on their characteristics
2nd 7.3.2 Design a model of a habitat for an organism in which all of its needs would be met.
3rd 7.3.3 Identify structures used by different plants and animals to meet their basic energy requirements.
3rd 7.4.1 Sequence diagrams that illustrate various stages in the development of an organism
3rd 7.4.2 Create a timeline to depict the changes that occur during an organisms' life cycle.
4th 7.3.1 Create a food web that illustrates the energy relationships between plants and animals and the key issues or assumptions found in the model.
4th 7.5.1 Classify animals according to their physical adaptations for obtaining food, oxygen, and surviving within a particular environment.
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Sun, Moon, Sky and Beyond

Teaching kids about the energy of the sun is important! Let's face it, without the sun there would be no life on Earth. The good news is that our largest star is with us to stay, at least for another few million years.

Experiment: Sun Print Paper

Make amazing white on blue prints with your favorite objects! Just place leaves, flowers, shells, or whatever you choose on the photosensitive paper and place in the sun. Remove the objects after a couple of minutes and rinse the paper to "fix" it.

Examples of Correlating Standards:

2nd 7.10.1 Identify and explain how the sun affects objects on the surface of the earth.
2nd 7.10.2 Investigate how the sun affects various objects and materials
4th 7.9.1 Use appropriate tools to measure and compare the physical properties of various solids and liquids.
4th 7.9.2 Compare the causes and effects of various physical changes in matter.
4th 7.10.1 Design an investigation to demonstrate how different forms of energy release heat and light.
4th 7.10.2 Design an experiment to investigate how different surfaces determine if light is reflected, refracted, or absorbed.
6th 7.10.3 Design a model that demonstrates a specific energy transformation.
7th 7.8.2 Design an experiment to investigate differences in the amount of the sun's energy absorbed by a variety of surface materials.

Materials

- Sun Print Paper
- Water
- Cardboard and push pins to keep your prints in place or a shallow tub where the paper will be protected from blowing away in the wind
- Objects to take a "picture" of on the photosensitive paper

1. Have students place their Sun Print Paper, blue side UP, in the shallow tub or pin the corners to a piece of cardboard for stability.

2. Place the objects you wish to "print" on top of the paper. If your objects are particularly light-weight, you can hold them in place with a piece of clear plastic wrap.

3. Expose the paper to the sun for 2-4 minutes, until the Sun Print Paper turns very pale blue.

4. Remove the paper from the tray or cardboard and soak it in water for about one minute. In the video, Steve uses the Split Demo Tank to better observe the change that occurs when the paper is placed in water.

5. Remove the paper from the water and let it dry flat. The image will sharpen as it dries.

Now Try This!

Another interesting way to see the chemical reaction that occurs with Sun Print Paper is to test the effect of different types of light sources on the paper. You can test different light sources and the effect that various exposure times play in the process.

Some light sources to try:

- 100, 60, 40, 25 and 15 Watt light bulbs
- Gradeeen, Red, Blue, Yellow and Black light
- Fluorescent light
- Bug light
- Infrared heat lamp

Try exposing the paper to each light source for set intervals of time, with zero exposure being your control in the experiment. Record your data and compare results between the light sources and exposure times.

Observations

Learn about the nature of sunlight and how light-sensitive chemicals work. From here, launch a discussion about how color photos are developed, as each layer of chemicals on the film react to photons of different color.

How does it work?

The sun print paper is coated with light-sensitive chemicals, which react to light waves and particles when exposed to light. When you place objects on the paper, they block the light and turn white while the paper around them remains blue. Water stops the process and fixes your images on the paper.

In the lab, photosensitive paper is made by coating a sheet of paper with a water-soluble, bluish-Gradeeen compound called iron (III) hexacyanferrate (III), Fe[Fe(CN)6]. The common name for this chemical is Berlin Gradeeen - a well-known photosensitive chemical. When exposed to ultraviolet light (UV), a chemical reaction takes place where the water-soluble Berlin Gradeeen changes into a water-insoluble chemical called iron (III) hexacyanoferrate(II), Fe[Fe4(CN)6]3 The common name for this chemical is Prussian blue. When you rinse your print in water, the water-soluble Berlin Gradeeen washes away, but the water-insoluble Prussian Blue remains fixed on the paper. The intensity of the Prussian Blue depends on the amount of time the paper is exposed to the light source and the intensity of the light source. For example, Sun Print Paper doesn't work nearly as well on a cloudy day as it does on a sunny day.

Additional Experiments to Try

Test your sunscreen!

1. Cut a sheet of sun sensitive paper into squares.
2. Put each square into an individual zipper-lock bag.
3. Collect sunscreens with different SPFs and spread a different sunscreen on each zipper-lock bag.
4. Expose the bags with the Sun Print Paper inside to the sun, and see what happens!
5. Record your data and document your research. Is a sunscreen with 45 SPF more effective than one with a SPF 15?

Experiment: Solar Bag

Fill the Solar Bag with air and let solar energy make it float

Solar Bag measures 15 meters (50 ft) long and 74 cm (29 in) in diameter. The thin, black plastic bag holds over 60 cubic meters (200 cubic ft) of air. Simply fill with air by running, tie off the ends, and let the solar energy of the sun heat the air inside the bag. Within minutes, the bag rises to the sky and floats like a giant science sausage. Better tie it down or you'll be flying as well! Includes a complete science activity guide.

Examples of Correlating Standards:

4th 7.11.4 Plan and execute an investigation that demonstrates how friction affects the movement of an object.
4th 7.11.2 Design and investigation to identify factors that affect the speed and distance traveled by an object in motion.
5th 7.10.3 Describe the differences among conduction, convection, and radiation.
6th 7.8.2 Design an experiment to investigate differences in the amount of the sun's energy absorbed by a variety of surface materials.
6th 7.8.1 Recognize how convection currents in the atmosphere produce wind.
8th 8.10.3 Identify various energy sources.
8th 8.13.1 Distinguish between physical and chemical changes.
8th 8.11.1 Recognize that forces cause changes in speed and/or the direction of motion.

What's included?

- 1.5 meter (50 ft) long Solar Bag
- Activity guide with student worksheets

NOTE : Solar Bag String NOT included

How does it work?

After rolling out the bag and tying one of the ends, you have to run around and fill the bag with air. Once it is full, tie the other end so that air can’t escape and watch the power of the sun at work! The solar energy will heat up the air inside the bag causing the molecules to move around and bump into all sides of the solar bag and make it rise! This is a perfect experiment to learn about the properties of air, buoyancy and convection. It's amazing science at work!

What does it teach?

Learn about the properties of air and air pressure. Discover the science behind density and buoyancy and how they are affected by heat. Explore the energy behind the flight. Does it matter if there are clouds?

How high can it float?

The sky's the limit on this one. We have let a solar bag or two go and its been observed by satellites at over 120,000 feet in the air!! This is the main reason that it is best to have some string attached so that you can inflate it, watch it float, and bring it back in order to use it time and time again

Experiment: Shrink Wrap That Kid!

Before you start blasting me with comments… let me explain. This is a very cool science demo, not a classroom management technique (although it might just work). The demo was originated by Wayne Goates, and I saw had the fortune of seeing Bob Becker perform it live at a ChemEd conference years ago. You'll see why the Vacuum Packed Kid became an instant favorite. Peggy McCall from Houston County, Georgia attended our Science in the Rockies summer workshop in 2007 and immediately took home the idea to share with her 6th honors science classroom. Remember… the bag doesn't go over the kid's head - you're shrink wrapping from the neck down!

Examples of Correlating Standards:

1st 7.1.3 Make diagrams to record and communicate observations

The premise of the science demonstration is quite simple… Holding one end of a vacuum cleaner hose, the brave volunteer steps into a giant bag that is pulled up and around the base of the neck (to form a good seal). Remember… the bag NEVER goes over the person's head! With one flick of the switch, the air is removed and the bag will shrink and mold itself tightly around the contour of the person's body. It's great to watch the reaction on the person's face as he becomes immobilized by a plastic straight jacket (so to speak).

But what does it teach? As Wayne Goates describes, the common misconception is that air is "sucked" out of the bag, but as all good students of science know, Newton never used the word suction in any of his writings. Instead, he used words like push and pull to describe forces. The vacuum cleaner pulls the air out of the bag and allows atmospheric pressure (14.7 pounds per square inch) to push inward on the body of the person inside the bag. Before turning on the vacuum cleaner, the pressure inside the bag was the same as the pressure outside the bag. The vacuum cleaner pulls the air out of the bag and allows the form fitting plastic to tightly mold itself to the person's body. The pressure inside the bag is less than the air pressure outside the bag. Feeling the effects of this reduced atmospheric pressure pushing on your body is quite amazing.

Experiment: Elephant's Toothpaste

This is a kid-friendly version of the popular Elephant's Toothpaste demonstration. A child with a great adult helper can safely do it on his or her own and the results are wonderful.

Examples of Correlating Standards:

Kindergarten 7.9.2 Observe, discuss and compare characteristics of various solids and liquids
First 7.9.2 Compare liquids according to their color, ability to flow, solubility in water and use.
1st 7.9.3 Investigate and describe the results of mixing different substances such as salt and pepper, water and sand, water and oil, and water and salt.
2nd 7.9.3 Investigate and describe the results of mixing different substances such as salt and pepper, water and sand, water and oil, and water and salt.
2nd 7.12.2 Describe what happens when an object is dropped and record the observations in a science notebook
3rd 7.9.1 Use physical properties to compare and contrast substances.
3rd 7.9.2 Compare and contrast events that demonstrate evaporation, crystallization, and melting.
3rd 7.9.3 Make predictions and conduct experiments about conditions needed to change the physical properties of particular substances.
3rd 7.9.4 Classify combinations of materials according to whether they have retained or lost their individual properties.
4th 7.9.1 Use appropriate tools to measure and compare the physical properties of various solids and liquids.
4th 7.9.2 Compare the causes and effects of various physical changes in matter.
5th 7.9.1 Compare the simple chemical properties of common substances.
5th 7.9.2 Investigate how different types of materials freeze, melt, evaporate, or dissipate.
5th 7.9.3 Use data from a simple investigation to determine how temperature change affects the rate of evaporation and condensation.
8th 8.13.1 Distinguish between physical and chemical changes.
8th 8.13.4 Determine how temperature and concentration might affect the rate of a chemical reaction.
8th 8.13.5 Classify a reaction as exothermic or endothermic.

Materials

- 16 oz. empty plastic soda bottle (preferably with a narrow neck such as those made by Coca-Cola)
- 1/2 cup 20-volume hydrogen peroxide (20-volume is 6% solution, purchased from a beauty supply store)
- Squirt of Dawn dish detergent
- 3-4 drops of food coloring
- 1 teaspoon yeast dissolved in ~2 tablespoons very warm water
- Funnel
- Foil cake pan with 2-inch sides
- Lab goggles
- Lab smock

1. At each student's place: cake pan, plastic bottle, Dawn in small cup, food coloring, funnel, goggles and smock, 1/2 cup peroxide, dissolved yeast mixture.
2. Stand up bottle in the center of the cake pan. Put funnel in opening. Add 3-4 drops of food coloring to the peroxide and pour the peroxide through the funnel into the bottle. Show a water molecule diagram and a peroxide molecule diagram, pointing to the extra oxygen that will be set free.
3. Add the Dawn detergent to the peroxide in the bottle.
4. Pour the yeast mixture into the bottle and quickly remove the funnel.
5. The students can touch the bottle to feel any changes that take place.

Observations

The reaction creates foam that shoots up out of the bottle and pools in the pan. After a minute or so, it begins to come out in a moving stream that looks like toothpaste being squeezed our of a tube. The students can play with the foam as it is just soap and water with oxygen bubbles. The bottle will feel warm to the touch as this is an exothermic reaction.

How does it work?

Talk about the addition of the yeast as a catalyst which makes the peroxide molecule release the oxygen atom faster. The teacher who submitted this experiment claims to have done this with hundreds of students from kindergarten through fifth grade and some adults who all loved the experiment. It is very easy and safe to do again at home using regular hydrogen peroxide from the drugstore.

Dry Ice: A History

According to madehow.com dry ice was not invented, rather the properties of solid carbon dioxide were discovered in the early twentieth century. It was first produced commercially in the 1920s in the United States. A commercial venture trademarked the name dry ice in 1925 and solid carbon dioxide has been referred to as dry ice ever since. Until fairly recently, dry ice was often referred to as hot ice, a reference to the fact that when one touched the cold surface the hand felt burned.

It appears that the Prest-Air Devices Company of Long Island, New York first successfully produced dry ice in 1925. Also in that year, Schrafft's of New York City first used the product to keep its famous ice cream from melting inside their parlor. Dry ice was far more extensively used for refrigeration and freezing of foods in the mid-twentieth century than it is today. Virtually every ice cream parlor in the world used dry ice for keeping ice cream frozen until well after the World War II, when electric refrigeration became affordable and efficient. The manufacturing of dry ice has not changed significantly in many decades and is a relatively simple process of pressurizing and cooling gaseous carbon dioxide. Uses for dry ice have diminished somewhat with the advent of better electric refrigeration. Some recent developments for its use include using the pellets in blasting or cleaning and its increasing use in transporting medical specimens, including hearts, limbs, and tissues, for reattachment and transplantation.

Raw Materials

The only raw material used in the manufacture of dry ice is carbon dioxide. This raw material is the byproduct of the refinement of gases emitted during the manufacture or refinement of other products. Most carbon dioxide used in the manufacture of dry ice in the United States is derived from refinement of gases given off during the refinement of petroleum and ammonia. The carbon dioxide emitted during these processes is sucked off and "scrubbed" to remove impurities for food grade carbon dioxide that will eventually become dry ice.

The Manufacturing Process

Carbon dioxide is liquefied by compressing and cooling, liquefying at a pressure of approximately 870 lb/in2 (395 kg/cm2) at room temperature. Liquid carbon dioxide is pumped, via piping, into huge holding tanks so that dry ice manufacturers can remove the liquid required.

The liquid carbon dioxide is shipped in huge quantities, sometimes weighing many tons. Thus, most dry ice manufacturers choose to locate their factories close to the petroleum or ammonia refineries to keep transportation costs affordable. The pressurized, refrigerated liquid carbon dioxide is piped directly into a pressurized tank or rail car owned by the dry ice manufacturer and heads for the plant.

The tank trunk pulls up to the factory and dumps the liquid carbon dioxide into huge tanks on the premises. These tanks hold the liquid under pressure, keeping it refrigerated so that it remains in liquid state. These tanks are situated adjacent to the factory wall and, through piping, the liquid is brought directly inside when required for manufacturing.

The liquid carbon dioxide is released, again via piping, from the adjacent tanks through the factory wall and into the dry ice press. When the liquid moves from a highly-pressurized environment to atmospheric pressure, it expands and evaporates at high speeds, causing the liquid to cool to its freezing point which is −109°F (−78.3°C). A nozzle puts the liquid into the top block of a dry ice press, which stands approximately 16 ft (4.9 m) tall. This press includes a large block at the top that can exert extreme pressure on the product that is brought into it. When the liquid carbon dioxide hits the block of the dry ice press, it immediately solidifies since it is now at room temperature. The carbon dioxide now resembles snow.

This snow, now in the upper portion of the press, must be compressed into a block of dry ice. Thus, this top portion of the press goes up and down with extraordinary pressure (about 60 tons), squashing the snow into a solid block of dry ice. This is approximately a five minute process. When the block is solid, it is generally about 2 ft (61 cm) wide and 10 in (25 cm) high, weighing about 220 lb (100 kg).

This block of opaque white dry ice is pushed out of the press and onto a roller. A pneumatic saw cuts the block in half and the blocks are pushed to another saw that cuts the smaller blocks yet again. Thus, the single block made in the dry ice press is now in four pieces, each weighing about 55 lb (25 kg).

The smaller blocks are put into containers that keep the blocks cold so sublimation is kept to a minimum. If shipped as unwrapped pieces they must be tightly packed in a container,

The formation of dry ice is a series of chemical reactions. generally including four blocks, with very little air allowed inside to reduce sublimation. If a block is removed during shipping, the other blocks will quickly begin to dissipate. Many dry ice manufacturers wrap the blocks in paper using machines (it is wise not to touch the very cold surface) and send it distributors or wholesalers.

Experiment: Dry Ice Crystal Ball Bubble

It's the world's coolest crystal ball.

Great spooky Science It's the world's coolest crystal ball. Create a soap film on the rim of the bucket and you'll have what appears to be a crystal ball filled with a cloud-like mixture of water vapor and carbon dioxide. When the giant bubble bursts, the cloud of "smoke" falls to the floor followed by an outburst of ooohs & ahhhs from your audience!

Examples of Correlating Standards:

Kindergarten 7.9.2 Observe, discuss and compare characteristics of various solids and liquids
Kindergarten 7.2.2 Use the senses to investigate and describe an object
1st 7.9.2 Describe what happens when ice changes from a solid to a liquid
2nd 7.9.3 Investigate and describe the results of mixing different substances such as salt and pepper, water and sand, water and oil, and water and salt.
2nd 7.12.2 Describe what happens when an object is dropped and record the observations in a science notebook
3rd 7.9.1 Use physical properties to compare and contrast substances.
3rd 7.9.2 Compare and contrast events that demonstrate evaporation, crystallization, and melting.
3rd 7.9.3 Make predictions and conduct experiments about conditions needed to change the physical properties of particular substances.
3rd 7.9.4 Classify combinations of materials according to whether they have retained or lost their individual properties.
4th 7.9.1 Use appropriate tools to measure and compare the physical properties of various solids and liquids.
4th 7.9.2 Compare the causes and effects of various physical changes in matter.
5th 7.9.1 Compare the simple chemical properties of common substances.
5th 7.9.2 Investigate how different types of materials freeze, melt, evaporate, or dissipate.
5th 7.9.3 Use data from a simple investigation to determine how temperature change affects the rate of evaporation and condensation.
8th 8.13.1 Distinguish between physical and chemical changes.
8th 8.13.4 Determine how temperature and concentration might affect the rate of a chemical reaction.

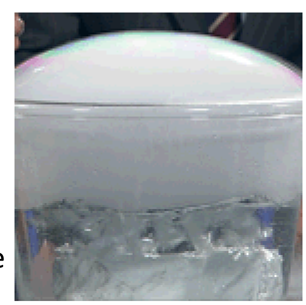
8th 8.13.5 Classify a reaction as exothermic or endothermic.
Materials

- Large bucket with a smooth rim
- Solution of dish soap and water
- A piece of cloth 18 inches long, gloves, safety glasses
- A few pieces of dry ice

Dry Ice - Grocery stores use dry ice to keep food cold during shipping. Some grocery stores and ice cream shops will sell dry ice to the public (especially around Halloween) for approximately $1 per pound. It's a good idea to take a beverage cooler with you along with a pair of gloves to protect your hands. If you are planning to perform a number of dry ice demonstrations, plan to purchase 5 to 10 pounds.

Select a bucket or container that has a smooth rim and is smaller than 12 inches in diameter. Cut a strip of cloth about 1 inch wide and 18 inches long. An old t-shirt works well. Soak the cloth in a solution of Dawn dish soap or use your favorite recipe for making bubble solution. Make sure that the cloth is completely soaked. Fill the bucket half full with water. Have tongs or gloves ready to transfer the dry ice to the bucket.

Place two or three pieces of dry ice into the water so that a good amount of fog is being produced. Remove the strip of cloth from the dish soap and carefully pull the strip across the rim. The goal is to create a soap film that covers the top. It also helps to have the rim wet before you start. This may take some practice until you get the technique mastered. Remember that a bubble's worst enemies are dirt, oil, and rough edges. Your patience will pay off in the long run.



If you accidentally get soap in the bucket of water, you'll notice that zillions of bubbles filled with fog will start to emerge from the bucket. This, too, produces a great effect. Place a waterproof flashlight in the bucket along with the dry ice so that the light shines up through the fog. Draw the cloth across the rim to create the soap film lid and turn off the room lights. The crystal bubbles will emit an eerie glow and you'll be able to see the fog churning inside the transparent bubble walls. Take your bows as the classroom erupts in a chorus of ooohs & ahhhs!

All About Dry Ice
First of all, here's the background information and safety lesson on dry ice. Dry ice is frozen

carbon dioxide. Instead of melting, dry ice turns directly into carbon dioxide gas but does not melt like real ice. Dry ice must be handled with care as it is -110oF (-78oC). It must be handled using gloves or tongs, as it will cause severe burns if it comes in contact with your skin. Never put dry ice into your mouth. When you drop a piece of dry ice in a bucket of water, the gas that you see is a combination of carbon dioxide and water vapor. So, the gas that you see is actually a cloud of tiny water droplets.

Materials

Dry Ice - Grocery stores use dry ice to keep food cold during shipping. Some grocery stores and ice cream shops will sell dry ice to the public (especially around Halloween) for approximately $1 per pound. It's a good idea to take a beverage cooler with you along with a pair of gloves to protect your hands. If you are planning to perform a number of dry ice demonstrations, plan to purchase 5 to 10 pounds.

Experiment: Disappearing Ice

Here's a quick experiment to help children better understand why it's called dry ice. Ask the children, "Why do you think they call this dry ice?" Place a regular ice cube on one plate and a similar size piece of dry ice on a second plate. Keep both plates out of the reach of the children. "Let's try to guess what is going to happen to the ice cube and the piece of dry ice if we leave it on the plate for one hour." Of course, the children are likely to tell you that both pieces of ice will melt, turning into a puddle of water.

Allow the children to view the plates after one hour and to discover the difference between real ice and dry ice. There should be a puddle of water on the plate where the real ice was, but the dry ice plate will be "dry." Where did the dry ice go? Dry ice is not made from water, it's made from some of the air that we breathe... it's frozen carbon dioxide. The dry ice turned into invisible carbon dioxide gas that disappears into the air. Magic!

Experiment: Burping, Bubbling, Smoking Water

Use the tongs or gloves to place a piece of dry ice in a glass of warm water. Immediately, the dry ice will begin to turn into carbon dioxide gas and water vapor, forming a really cool cloud! This cloud is perfectly safe for the children to touch and feel as long as they do not put their fingers far enough down into the water to accidentally touch the dry ice.

To create the best effect, be sure to use warm water. Over time, the dry ice will make the water cold and the "smoking" will slow down. Replace the cold water the warm water and you're back in business!

Experiment: Oooh Ahhh Awesome Bubbles

Who would have guessed that you could have this much fun with soapy water and a chunk of dry ice? Fill a tall glass or plastic cylinder with warm water and add a squirt of liquid dish soap like Dawn or Joy. Use gloves or the tongs to place a piece of dry ice into the soapy water. Get ready for a room full of ooohs & ahhhs!

Instead of the dry ice just bubbling in the water to make a cloud, the soap in the water traps the carbon dioxide and water vapor in the form of a bubble. The children will see the bubbles climb out of the cylinder of warm, soapy water and explode with a burst of "smoke" as they crawl over the edge.

Add some food coloring to the water to make the demonstration more colorful. If you want to give the exploding suds an eerie glow, drop a glowing light stick into the water along with the dry ice. The light stick will give the bursting bubbles an eerie look.

Experiment: Floating Bubble

You'll notice that when you add dry ice to water, the cloud of carbon dioxide and water does not go up into the air, but instead falls towards the ground. Why? This cloud-like mixture of carbon dioxide and water is heavier than the surrounding air. You'll use this little piece of science trivia to perform the amazing Floating Bubble trick.

A small fish aquarium works well for this activity. Fill the bottom of the aquarium about an inch deep with warm water. Use gloves or the tongs to add a few pieces of dry ice. Of course, the dry ice will begin to smoke turning into carbon dioxide and water vapor.

Using a bubble wand and a bottle of bubble fluid, blow a few bubbles into the aquarium (it's a little difficult so be patient). To everyone's amazement, a few bubbles will appear to float in mid-air in the aquarium. The bubble is really just floating on a cushion of invisible carbon dioxide gas. Of course, the spooky Halloween story is up to you... but I'm almost certain that the aquarium is the home of a ghost who has been known to play with soap bubbles!

Experiment: Floating Balls & Flying Toilet Paper

Make objects float in mid-air. Believe it or not, the secret to this mystery of levitation is right in front of your nose.

Examples of Correlating Standards:

5th 7.10.1 Design and conduct and investigation to demonstrate the difference between potential and kinetic energy.
5th 7.11.3 Design and conduct experiments using a simple experimental design to demonstrate that relationship among mass, force, and distance traveled.
6th 7.10.1 Compare potential and kinetic energy.
6th 7.10.3 Design a model that demonstrates a specific energy transformation.
8th 8.11.3 Recognize the relationship between mass, force, and acceleration.
8th 8.11.4 Identify the relationship between he mass of objects, the distance between them, and the amount of gravitational attraction.
8th 8.11.6 Identify Newton's three laws of motion and relate the first two laws to the concepts of inertia and momentum.

Materials

- Hair dryer
- An empty toilet paper tube
- A ping-pong ball/ balloon/beach ball
- A roll of toilet paper
- A leaf blower!

1. Set the hair dryer to cool, switch it on, and point it at the ceiling.
2. Carefully put the ping-pong ball in the stream of air. Hold the hair dryer very steady and watch as the ping-pong ball floats in the stream of air.
3. Carefully move the hairdryer from left to right and watch how the ball moves as well, staying in the stream of air.
4. Try floating other lightweight objects in the air stream at the same time! With the hair dryer on, place an inflated balloon over your levitating ping-pong ball. You might want to place a penny in the balloon before you blow it up to give it some added weight.

5. Try to float two or more balls in the same air stream. How many can you float at once? How do they behave when there is more than one?
6. Need more power? Try using a leaf blower in place of the hair dryer. Now you can float larger objects like beach balls.

Flying Toilet Paper! Just hold a roll of toilet paper in the stream of air and watch the paper take off! Be sure to hold the toilet paper roll on a long stick (piece of dowel) in order for it to spin fast and unroll the paper. Always conclude this demo with a thanks to Bernoulli (see below if you don't get it).

How does it work?

The floating ping-pong ball is a wonderful example of Bernoulli's Principle, the same principle that allows heavier-than-air objects like airplanes to fly.

Bernoulli, an 18th century Swiss mathematician, discovered something quite unusual about moving air. He found that the faster air flows over the surface of something, the less the air pushes on that surface (and so the lower its pressure).

The air from the hair dryer flows around the outside of the ball and if you position the ball carefully, the air flows evenly around each side. Gravity pulls the ball downwards while the pressure below the ball from the moving air forces it upwards. This means that all the forces acting on the ball are balanced and the ball hovers in mid-air.

Airplanes can fly because of this principle. Air rushing over the tops of airplane wings exerts less pressure than air from under the wings. So the relatively greater air pressure beneath the wings supplies the upward force, or lift, that enables airplanes to fly.

You can make the ball follow the stream of air as you move the hair dryer because Bernoulli's principle says that the fast moving air around the sides of the ball is at a lower pressure than the surrounding stationary air. If the ball tries to leave the stream of air, the still, higher pressure air will push it back in - so the ball will float in the flow no matter how you move.

When you place the empty toilet paper tube into the air stream, the air is funneled into a smaller area, making air move even faster. The pressure in the tube becomes even lower than that of the air surrounding the ball, and the ball is pushed up into the tube.

Experiment: Walking On Water

Mix cornstarch and water in this classroom experiment to form a gooey liquid and solid material that behaves like quicksand. Some people refer to this as the Oobleck recipe, others call it a Non-Newtonian fluid. After watching these video segments, you'll call it a great science lesson as your students learn about the amazing properties of this cornstarch and water mixture.

And yes... you can perform the "Cornstarch Walk on Water" on a much smaller scale - using only 100 boxes of cornstarch in a small pool and 10 gallons of water- instead of the 2,500 pounds he used on the Ellen Show.

Examples of Correlating Standards:

1st 7.9.1 Classify solids according to their size, shape, color, texture, hardness, ability to change shape, magnetic attraction, whether they sink or float, and use.
1st 7.9.2 Compare liquids according to their color, ability to flow, solubility in water and use.
1st 7.9.3 Investigate and describe the results of mixing different substances such as salt and pepper, water and sand, water and oil, and water and salt.
2nd 7.9.1 Use tools such as hand lenses, measurement devices, and simple arm balances to gather data about the physical properties of different objects.

Making Non-Newtonian Cornstarch Goo

1. Pour approximately 1/4 of the box of cornstarch into the mixing bowl and slowly add about 1/2 cup of water. Stir. Sometimes it is easier to mix the cornstarch and water with your bare hands — of course, this only adds to the fun.
2. Continue adding cornstarch and water in small amounts until you get a mixture that has the consistency of honey. It may take a little work to get the consistency just right. As a general rule of thumb, you're looking for a mixture of roughly 10 parts of cornstarch to 1 part water. Notice that the mixture gets thicker or more viscous as you add more cornstarch.
3. Sink your hand into the bowl of cornstarch goo and notice its unusual consistency. Compare what it feels like to move your hand around slowly and then very fast. You can't move your hand around very fast! In fact, the faster you thrash around, the more like a SOLID the gooey stuff becomes. Sink you entire hand into the goo and try to grab the fluid and pull it up. That's the sensation of sinking in quicksand!

Important – READ THIS!

Ironically, the cornstarch will not stay mixed with the water indefinitely. Over time, the grains of cornstarch will separate from the water and form a solid clump at the bottom of the plastic storage bag. It is for this reason that you must not pour this mixture down the drain. It will clog the pipes and stop up the drain. Pour the mixture into a zipper-lock bag and dispose of it in the garbage.

Experiment: Skewer Through a Balloon

Some things in this world just don't mix - dogs and cats, oil and water, needles and balloons. Everyone knows that a balloon's worst fear is a sharp object...even a sharpened, wooden cooking skewer. With a little scientific knowledge about balloons under your belt, you'll be able to perform a seemingly impossible task... pierce a balloon with a wooden skewer without popping it. Piercing takes on a whole new meaning!

Materials

- Several latex balloons (9 inch size works well)
- Bamboo cooking skewers (approximately 10 inches long)
- Cooking oil or dish soap
- Sharpie pen
- Nerves of steel

1. The first step is to inflate the balloon until it's nearly full size and then let about a third of the air out. Tie a knot in the end of the balloon.
2. If you carefully examine the balloon you'll notice a thick area of rubber at both ends of the balloon (where you tied the knot and the opposite end). This is where you will pierce the balloon with the skewer … but not yet. Keep reading.
3. Dip the tip of the wooden skewer into the cooking oil or soap, which works as a lubricant.
4. Place the sharpened tip of the skewer on the thick end of the balloon and push the skewer into the balloon. Be careful not to jab yourself or the balloon with the skewer. Just use gentle pressure (and maybe a little twisting motion) to puncture the balloon.
5. Push the skewer all the way through the balloon until the tip of the skewer touches the opposite end of the balloon where you'll find the other thick portion of the balloon. Keep pushing until the skewer penetrates the rubber. Breathe a huge sigh of relief and take a bow! Ta-Dah!
6. Gently remove the skewer from the balloon. Of course, the air will leak out of the balloon, but the balloon didn't pop.

Let's do it again, but this time you'll see the hidden "stress" in a balloon.

1. Before blowing up the balloon, use the Sharpie pen to draw about 10-15 dots on the balloon. The dots should be about the size of the head of a match. Be sure to draw them at both ends and the middle of the balloon.
2. Inflate the balloon half way and tie the end. Observe the various sizes of the dots all over the balloon.
3. Judging from the size of the dots, where on the balloon are the latex molecules stretched out the most? Where are they stretched out the least?

4. Carefully examine the wooden cooking skewer. Dip the tip in the vegetable oil and use your fingers to coat the skewer with oil.
5. Use the observations that you made previously with the dots on the balloon to decide the best spot to puncture the balloon with the skewer. Of course, the object is not to pop the balloon!

How does it work?

The secret is to uncover the portion of the balloon where the latex molecules are under the least amount of stress or strain. After drawing on the balloon with the Sharpie marker, you probably noticed that the dots on either end of the balloon were relatively small. You've just uncovered the area of least stress... the ends of the balloon. When the point of the skewer is positioned at the ends of the balloon, the solid object passes through the inflated balloon without popping it.

If you could see the rubber that makes up a balloon on a microscopic level, you would see many long strands or chains of molecules. These long strands of molecules are called a polymer, and the elasticity of these polymer chains causes rubber to be stretchy. Blowing up the balloon stretches these strands of polymer chains. Even before drawing the dots on the balloon, you probably noticed that the middle of the balloon stretches more than either end. You wisely chose to pierce the balloon at a point where the polymer molecules were stretched out the least. The long strands of molecules stretched around the skewer and kept the air inside the balloon from rushing out. It's easy to accidentally tear the rubber if you use a dull skewer or forget to coat the end of the skewer with vegetable oil or soap. When you remove the skewer, you feel the air leaking out through the holes where the polymer strands were pushed apart. Eventually the balloon deflates… but it never popped. Thanks to chemistry, you're amazing!

Oh, just to prove your point, try pushing the skewer through the middle part of an inflated balloon. At least you went out with a bang.

Experiment: Practical Polymers and helpful Hydrogels

Water is everywhere – in the sky, in the ground, and in our homes. However, caring for this vital resource is often a challenge for each of us. Conservation means using water wisely. Protecting our groundwater is important because it is a source for drinking and irrigation. Consequently, scientists and engineers have developed amazing, superabsorbent polymers, called hydrogels, that can help.

Examples of Correlating Standards:

K-5th T/E.1 Explain how different inventions and technologies impact people and other living organisms.
K-5th T/E.4 Evaluate an invention that solves a problem and determine ways to improve the design.
6th-8th T/E.3 Explore how the unintended consequences of new technologies can impact society.
6th-8th T/E.4 Research bioengineering technologies that advance health and contribute to improvements in our daily lives.
8th 8.10.5 Infer that human activities may be helpful or harmful to the environment.

In this series of investigations, you will start by looking for a particular polymer at work. Once you discover what this type of polymer can do, you will experiment with other uses for the same polymer. A final step can be taken to consider solutions for water conservation and groundwater contamination.

A polymer is a long chain of molecules. Polymers are all around us, and they make up materials like bicycle helmets, CDs, tires, plastic water bottles, rubber bands, and glue. This experiment focuses on special kinds of polymers that are superabsorbent: hydrogel polymers. Hydrogel polymers are long molecule chains that grab onto water molecules. Some can soak up as much as 500 times their weight in water! This superabsorbent characteristic makes hydrogel polymers useful in water conservation and in solving other environmental issues.

Materials

- 1 Disposable diaper per student
- Water
- Newspaper
- Scissors
- Measuring cup and spoons

- 2 Zipper-lock bags, 3.78 liters (1 gallon) size
- Plastic cup, 266 mL (9 oz)
- 2 Clear plastic bottles with screw-on caps, 355 mL (12 oz)
- 1 Packet (6.2 grams/ 0.22 oz) of unsweetened powdered drink mix, red works the best
- Potting soil (not the "moisture control" type), 475 mL (2 cups)

Where are the polymers?

Collect a sample of hydrogel from the cotton and plastic lining of a disposable diaper.

1. Place a new diaper on the piece of newspaper. Carefully cut through the inside lining and remove all the cotton-like material. Put all the stuffing material and plastic lining into a clean, zipper-lock bag.

2. Scoop up any of the powdery material that may have spilled onto the paper and pour it into the bag with the stuffing. Blow a little air into the bag to make it puff up like a pillow, then seal the bag.

3. Shake the bag for a few minutes to remove the powdery hydrogel polymer from the stuffing. Notice how much powder falls to the bottom of the bag.

4. Carefully remove the stuffing and the plastic lining from the bag, and check out the powdery polymer left in the bag. Repeat steps 1-4 with another diaper, if needed, to get 15 mL (1 tbsp) of the hydrogel powder.

5. Now it's time to mix the powder with water to see what happens. Pour 15 mL (1 tbsp) of hydrogel powder into a 266 mL (9 oz) plastic cup. Measure 118 mL (½ cup) of water and pour it into the cup along with the powder.

6. After about 30 seconds, observe that the water has changed — it's no longer a liquid… it's a gooey solid!

Take a closer look at the gel by scooping up some of the gel with your fingers. You can poke holes in it and even tear it into smaller pieces. This hydrogel is safe and non-toxic, so you can touch it, but remember: even safe chemicals never go into your mouth, ears, or nose!

Things to Think About...

- How does this water-slurping powder work? Does it only absorb water?
- How much water will the average diaper absorb?
- What would happen if you let the gel dry out? Is this powder reusable?
- Besides diapers, how else could this powder be used?
- How does the absorbency of the hydrogel compare with other materials that are absorbent: cotton balls, paper towels, sponges?
- How could adding other ingredients (like salt) affect a hydrogel's water-absorbing properties?

Experiment: Soil Soakers

Can hydrogels help improve the environment?

As you discovered, a hydrogel is a superabsorbent polymer—which can hold up to 500 times its own weight in water. Could hydrogels be used to address water conservation and groundwater contamination? Create an experiment that tests how hydrogels could work in soil.

Set up two soil soakers, which are the experimental devices you will use for your experiment.

1. Prepare two Soil Soakers by cutting off the bottoms of the clear plastic bottles. Put one hole in each screw on cap using a 3/16" diameter nail and hammer or use a 3/16" drill bit (see drawing). Think safety — this step might require adult help.
2. Label one bottle as the Control Soil Soaker and the other bottle as the Experimental Soil Soaker.
3. Put 1 cup of potting soil into the Control Soil Soaker and place bottle into tall, narrow drinking glass, lid side down and open side up.
4. Obtain about 1 tablespoon of hydrogel powder (see the Engage activity if you are harvesting hydrogel powder from diapers).
5. Mix 1 cup of potting soil with 1 tablespoon of hydrogel, and place into the Experimental Soil Soaker. Place bottle into tall, narrow drinking glass, cap side down and open side up.
6. Mix 1 packet of unsweetened powdered drink mix into 1 cup of water. This solution represents a water soluble fertilizer application. (Water soluble means "capable of being dissolved in water.")
7. Record your results for the following steps:

- Step 1 - Pour 1/4 cup red solution into EACH of the Soil Soakers. Observe. Does any water drain through the soil into the glasses? For the Control: Yes or No? For the Experimental: Yes or No?
- Step 2 - Add another 1/4 cup red solution into each Soil Soaker. Observe the amount of water that seeps through the soil. Which Soil Soaker allowed the least amount of water to seep through? Control or Experimental?
- Step 3 - Wait 5 minutes and compare and contrast the solution from each Soil Soaker. Answer the following questions:

- Is there a difference in the amount of water in each glass? Yes or no?
- Is there a difference in color? Yes or no?
- Is there a difference in smell? Use a wafting technique (fanning the air over the glass) to check the smell. Yes or no?

How does it work?

Did the addition of the absorbent hydrogel polymer impact the movement of water through the soil? If yes, how?

If the red solution represented a water-soluble fertilizer or chemical pesticide, what conclusions can be drawn about this contamination entering the groundwater?

If more water is retained in the soil, what conclusions can be drawn about the amount of watering needed to help the plants grow? How might this affect water conservation issues?

FAQs about polymers and other useful information.

What are polymers?
Polymers are one of the classes of materials that we encounter throughout the day. Polymers (commonly known as plastics) are either naturally occurring (rubber, RNA and DNA, proteins, starch, and cellulose) or synthetic (manufactured).

What are hydrogels?

Hydrogel polymers are long molecule chains made up of repeating units that grab onto water molecules. This characteristic makes them a great solution for soaking up water.

How are hydrogels helping the environment?

Many environmental applications for hydrogels have been found for agriculture, as well as the construction and horticulture industries. Hydrogels help reduce water runoff and soil erosion, thus improving the quality of lakes, streams, and rivers. Hydrogels also help with moisture retention and water conservation by helping soil increase water holding capacity, allowing plants to survive during droughts. Erosion control, soil management, and environmental clean-ups are also ways hydrogels can help the environment. Many scientists continue to study the effect of hydrogels on the environment.

Additional Info

Go beyond...how much hydrogel works for you?

Use what you know about the environmental impact of adding hydrogel to soil. Follow the engineering design process to create a better soil for your garden.

Ask 1: How can I conserve water in my garden? How can I prevent contamination of groundwater from fertilizers? Can hydrogel help me accomplish this? Are there different kinds of hydrogels with different properties? Do different soils absorb water at different rates? What is the type of soil in my garden? Can I design a “better soil” that would conserve water and protect the water table from contamination?

Imagine: Designer soil that reduces the number of waterings and, therefore, conserves water. This soil would retain the fertilizer for the plants instead of entering the groundwater and contaminating it.

Create: To craft a designer soil profile, find out about your soil type*: Is it clay, sandy or loamy? Which soil is the most absorbent? Which is the least absorbent? Which one needs more hydrogel? Which needs less hydrogel?**

Test: Using the Soil Soakers experiment, test your own soil with varying amounts of the agricultural version of hydrogel (Polyacrylamide), available in the gardening section of stores. This form of hydrogel is frequently used as a soil conditioner on farmland and construction sites for erosion control, and to protect the water quality of nearby rivers and streams. What is the optimum amount that holds water without “saturating” the soil, making it too soggy for plants? What amount is necessary to retain water and reduce the number of watering times?

Ask 2: What is the optimum amount of hydrogel? Can I use other techniques to improve my soil conditions? What other ways can I conserve water in my garden?

- What are soil types? There are three basic different types of soils: clay soils, loamy soils and sandy soils. Loamy soils are the best; the other two soils present irrigation challenges. But how do you find out which type of soil you have? Here is the simplest way to check your own soil:
- Take a marble-sized chunk of moist soil and roll it between your thumb and finger; try to shape it into a small ball.
- With a clay soil, you can do it and you end up with a ball the size of a marble.
- With a sandy soil, you cannot do it—the ball will fall apart.
- With a loamy soil, you will be able to do it but the ball will fall apart when you quit applying pressure.

- What different kinds of hydrogels are there? The hydrogel polymers found in most disposable diapers are just one kind. Some scientists have found that hydrogels like these don't work well in soil and agricultural use. New, superabsorbent polymers are rapidly becoming one of the most exciting topics in environmental education. Take a trip to your local garden center, and ask the plant specialist if they carry water polymer crystals or water jelly crystals.
- Share your ideas for other applications of hydrogels. For example, hydrogels have been used to preserve and restore a submarine recovered from the Civil War era, and to make "cool ties" that soldiers can tie around their necks to beat the desert heat. What can you find out about these uses? What other ideas do you have?

Experiment: Slime - The Real Recipe vs. White Glue Putty

It's one of our most asked questions... How do you make real slime? Ask any special effects artist about slime and you're sure to hear the term polyvinyl alcohol (PVA). Combined with a Borax solution, this slime is the best in the world, and for whatever reason, you have voluntarily chosen to make slime in your classroom. It's too late to reconsider because you've already told the kids about it and you know how they can be when you don't deliver on the fun science stuff. Don't despair, however, because every step is outlined for you right here. You'll no doubt add quite a few ideas of your own. Slime is an unforgettable experience that lends itself to any classroom and any age student. As you do the "Year End Review" with them and revisit the incredible lessons and stimulating discussions you carefully planned and executed, they'll remember the day the slime was discovered in the principals' office. Game on!

Materials

You'll need a supply of polyvinyl alcohol (PVA)(stevespanglerscience.com) and a box of Borax soap.
You'll also need the usual supplies...
- A few plastic cups
- A stirring stick
- Measuring cups and spoons
- Some paper towel (for the inevitable).

Making the Borax solution:
Measure 1 cup of warm water into a large, plastic cup and add a tablespoon of Borax powder to the water. Stir the solution - don't worry if all of the powder dissolves. This Borax solution is the secret linking agent that causes the PVA molecules to turn into slime.

Making the Slime:

1. Measure 2 ounces of PVA into a plastic cup.
2. Add 1 teaspoon of Borax solution and stir. After several minutes of stirring, all of the PVA should be stuck together in one large clump stuck to the stirring stick. It's just that simple.
3. The slime can be stored in the zipper-lock bag for safe keeping. Clean up is easy if you have water and paper towels for slimy hands and for surfaces that have been "accidentally" slimed. When you're finished, you can just throw the slime and materials into the trash. Or, you could toss the slime back into the zipper-lock bag and send it home with your young scientist.

Okay, there is one last secret. The slime from the toy store has a shiny almost metallic-like appearance. How do they do that? The secret is a material called Pearl Swirl which contains an ingredient called titanium dioxide. Just a little squirt of Pearl Swirl in the PVA solution and you'll have cracked the code to making the perfect batch of slime!

How does it work?

Because you mixed two liquids together, there's a good chance that slime is a colloid, and it is! But, there's more to it than that and your kids need to understand how the molecules behaved in order to grasp it all. For starters, most liquids, such as water, are made up of small, unconnected molecules bouncing around and tumbling over and into one another. Single molecules are called monomers. Monomer liquids flow easily and are seldom gooey or sticky to the touch. In other substances, the monomers are linked together in identical, repetitive segments that form long chains of molecules known as polymers. These long chains don't flow over and across one another very easily. Like a bowl of cooked spaghetti, they sort of roll over and around one another but they're not linked to each other. Liquid polymers tend to be gooier and flow more slowly than liquid monomers. The PVA used in this activity is a liquid polymer.

You might use this analogy to help the kids understand what happened. Picture a box full of tiny, steel chains that slip and slide easily across one another. Each chain is made up of hundreds of individual links but one chain is not connected to another chain. If you reach in and grab one chain and pull it out, that's what you get: one chain. Suppose you stir a whole bunch of tiny magnets into the box of chains. The magnets randomly connect the chains together in many locations, making a single, large blob of chains. Now if you reach in and grab one chain, you'd lift out the entire pile. Adding Borax solution to the PVA does pretty much the same thing (only it's a chemical, not a magnetic connection). Borax loves to connect with water and billions of Borax molecules randomly link trillions of water molecules found anywhere on the chains of PVA. Now when you pull out one PVA chain, all the rest come with it in a blob. In the chemical reaction that the kids made, they got a slow-moving, glistening mass that's known as a hydrogen- bonded, cross-linked polymer gel. Slime is way easier to say.

In an effort to understand the world around them, scientists design models of what they can't see in order to understand and explain what they can see. The idea is to figure out how various molecules inside materials are arranged to produce the observable results. In general, molecules can be "seen" only with some serious electronic help and these images serve only to assist with the inferences of the model. If your kids understand how this inference modeling works, then they're way ahead of the game in their understanding of molecules.

Additional Info

What is PVA (polyvinyl alcohol) used for anyway? PVA is used by the plastics industry to form surface coatings and to make surface films resistant to gasoline. It's also used to make artificial sponges, hoses, and printing inks. Also, if you look at the ingredients of contact lens wetting solutions, you may find this stuff as a lubricant and a cleanser. The PVA solution in this kit contains coloring and a special disinfectant to help resist pesky germs on those not-so-clean hands.

Experiment: White Glue Putty - Yes, It's Silly

Is it a solid? Is it a liquid? Just what is this slimy, stringy, rubbery stuff? This variation on slime will probably remind you of a similar substance found in many toy stores. This is the most popular version of "slime" among teachers because it's so easy to make and serves as a great visual tool for introducing students to the properties of polymers.

Materials

- Elmer's Glue® (8 oz. bottle of Elmer's Glue-All)
- Borax (a powdered soap found in the grocery store)
- Large mixing bowl
- Plastic cup (8 oz size works well)
- Spoon
- Measuring cup
- Food coloring (the spice of life)
- Water
- Paper towel (hey, you've got to clean up!)
- Zipper-lock bag (don't you want to keep it when you're done?)
- Empty plastic soda bottle with cap
- Water

Here's the easiest way to make a big batch Elmer's Slime. The measurements do not have to be exact but it's a good idea to start with the proportions below for the first batch. Just vary the quantities of each ingredient to get a new and interesting batch of goo.

This recipe is based on using a brand new 8 ounce bottle of Elmer's Glue. Empty the entire bottle of glue into a mixing bowl. Fill the empty bottle with warm water and shake (okay, put the lid on first and then shake). Pour the glue-water mixture into the mixing bowl and use the spoon to mix well. Add the glue-water mixture to the glue in the mixing bowl. Go ahead… add a drop or two of food coloring.

Measure 1/2 cup of warm water into the plastic cup and add a teaspoon of Borax powder to the water. Stir the solution – don't worry if all of the powder dissolves. This Borax solution is the secret linking agent that causes the Elmer's Glue molecules to turn into slime.

While stirring the glue in the mixing bowl, slowly add a little of the Borax solution. Immediately you'll feel the long strands of molecules starting to connect. It's time to abandoned the spoon and use your hands to do the serious mixing. Keep adding the Borax solution to the glue mixture (don't stop mixing) until you get a perfect batch of Elmer's slime. You might like your slime more stringy while others like firm slime. Hey, you're the head slime mixologist – do it your way!

When you're finished playing with your Elmer's slime, seal it up in a zipper-lock bag for safe keeping.

How does it work?

The mixture of Elmer's Glue with Borax and water produces a putty-like material called a polymer. In simplest terms, a polymer is a long chain of molecules. You can use the example of cooking spaghetti to better understand why this polymer behaves in the way it does. When a pile of freshly cooked spaghetti comes out of the hot water and into the bowl, the strands flow like a liquid from the pan to the bowl. This is because the spaghetti strands are slippery and slide over one another. After awhile, the water drains off of the pasta, the strands start to stick together. The spaghetti takes on a rubbery texture. Wait a little while longer for all of the water to evaporate, and the pile of spaghetti turns into a solid mass -- drop it on the floor and watch it bounce. Many natural and synthetic polymers behave in a similar manner. Polymers are made out of long strands of molecules like spaghetti. If the long molecules slide past each other easily, then the substance acts like a liquid because the molecules flow. If the molecules stick together at a few places along the strand, then the substance behaves like a rubbery solid called an elastomer. Borax is the compound that is responsible for hooking the glue's molecules together to form the putty-like material. There are several different methods for making this putty-like material. Some recipes call for liquid starch instead of Borax soap. Either way, when you make this homemade Silly Putty you are learning about some of the properties of polymers.

The Borax solution is used in the wood industry to protect against fungus and to make new wood look old. It's also used to solder metals, to glaze and enamel pottery, to whiten your wash, and serves as an excellent soap in the medical industry. The students can add more Borax to achieve a firmer slime but there is a point of diminishing returns before the slime breaks down because of too much Borax and turns back into a liquid.

Additional Info

Jeff Harken contributed this "history" of Silly Putty.

The history of silly putty is quite amusing. In 1943 James Wright, an engineer, was attempting to create a synthetic rubber. He was unable to achieve the properties he was looking for and put his creation (later to be called silly putty) on the shelf as a failure. A few years later, a salesman for the Dow Corning Corporation was using the putty to entertain some customers. One of his customers became intrigued with the putty and saw that it had potential as a new toy. In 1957, after being endorsed on the "Howdy Doody Show", silly putty became a toy fad. Recently new uses such as a grip strengthener and as an art medium have been developed. Silly putt even went into space on the Apollo 8 mission. The polymers in silly putty have covalent bonds within the molecules, but hydrogen bonds between the molecules. The hydrogen bonds are easily broken. When small amounts of stress are slowly applied to the putty, only a few bonds are broken and the putty "flows". When larger amounts of stress are applied quickly, there are many hydrogen bonds that break, causing the putty to break or tear.

Elmer's Slime is very easy to make, but it's not exactly what you'll find at the toy store. So, what's the "real" slime secret. It's an ingredient called polyvinyl alcohol (PVA). The cross-linking agent is still Borax, but the resulting slime is longer lasting, more transparent... it's the real deal.

Experiment: Oil Absorbing Polymer

Changing the way environmental scientists approach oil spills!

Just imagine if the solution to an oil spill was this simple: Sprinkle a small amount of a non-toxic powder onto the layer of oil and in seconds the powder bonds to the oil, forming a sponge-like material that can be easily removed from the surface of the water. It's more than just a dream... a new form of superabsorbent polymer technology is changing the way environmental scientists approach oil spill and waste management problems. The results are amazing!

Materials

Enviro-Bond 403 Polymer is a specially formulated chemical designed to clean-up crude oil. The oil polymer kit comes with a special type of oil that is similar to crude oil for demonstration purposes.

Sprinkle a small amount of this polymer onto the layer of oil and in seconds the polymer bonds to the oil, forming a sponge-like material that can be easily removed from the jar of water. This polymer is specially formulated to bond quickly and safely to many types of liquid hydrocarbons including crude oil, diesel fuel and gasoline. The bonding is so complete that it literally encapsulates the liquid hydrocarbons in just seconds.

How does it work?

The chemical formulation of the polymer is carefully regarded as a trade secret and is under application for patent. However, the inventor agreed to share some limited information about the polymer for educational purposes. The hydrocarbon source (crude oil, diesel fuel, gasoline, etc.) consists of three basic components: Paraffinics, naptinics, and the aromatics. The polymer is specifically formulated to bond to these components. The mechanism is three dimensional with cross-link bonding, and the polymer structures are referred to as dieblock, triblock, branched, radial, and liner, according to the manufacturer.

When the polymer comes in contact with a liquid hydrocarbon, the free hydrocarbons bond to the polymer forming a solid mass. The hydrophobic properties of the polymer cause it to float on water, but the density of the polymer is great enough to allow it to sink through the hydrocarbon and maximize the bonding potential. There is no need for mixing since the polymer bonds to the free hydrocarbons automatically.

Enviro-Bond 403 Polymer is also used in treating oily sludge, effectively filtering oil drilling fluids, and stabilizing any other spilled or leaked liquid hydrocarbons that pose a threat to the environment.

Additional Info

Oil is a major source of ground water contamination and ocean pollution. The vast majority of this oil enters the ocean from oil spills on ships that transport petroleum or from manufacturing operations on land. However, oil can also seep into the ocean naturally from cracks in the sea floor. Oil well and oil tanker accidents at sea account for a small portion of ocean oil pollution. Yet, the lasting effects of these accidental spills can be disastrous.

A personal note from Steve Spangler...
Enviro-Bond 403 Oil Polymer was the invention of a great person in Michigan by the name of Larry Thompson. I first met Larry while researching other kinds of superabsorbent polymers in 1992. I often share the inspirational story of how Larry invented this polymer during my teacher workshops and keynote speeches. Larry was truly passionate about his discoveries and did everything possible to encourage children to better understand the world of chemistry.

Larry Thompson passed away in March of 2004 from a rapid spreading cancer in his liver and pancreas. Up until the last few days of his life, Larry was sending emails and talking with people on the phone about the benefits of his oil absorbing polymers. I recently spoke at the National Honors Society national convention in Florida. After the presentation, a ninth grade girl came up to me and said, "I don't think that I'll ever be as good a scientist as that man who invented the oil polymer, but I can only hope that I make a discovery that helps the world as much as his did." I shared this with Larry in our last email correspondence. He will be greatly missed.
-- Steve Spangler

Experiment: Moon Blob: A Self-Siphoning Gel

Everyone knows that water can't flow uphill. Not so fast... When a small amount of Polyox (polyethylene oxide) is mixed with water, it dissolves forming a thick, slippery, gooey, mucous-like gel. Oh, the visual imagery! When the gel is poured back and forth between two beakers, the gel mysteriously siphons from the higher held beaker to the lower one. Maybe water can flow uphill. You have to play with the stuff to believe it.

Materials

- Polyox (polyethylene oxide with a molecular weight of at least 4,000,000) (in the Gravi-Goo Kit, see below)
- Rubbing alcohol (90% isopropyl alcohol)
- Food coloring
- Two beakers or clear cups
- Water
- Lots of paper towel

Use the following mixing instructions if you are using Polyox.

1. Place approximately 4 grams of the Polyox powder into the bottom of the beaker.
2. Add about 10 ml of 90% rubbing alcohol (or any other extremely dry solvent) to the Polyox. Swirl the cup to wet all of the polymer with alcohol.
3. Fill the second beaker with approximately 400 mL of water. Add a few drops of food coloring for effect.
4. Pour all the water mixture into the beaker with the Polyox in one controlled, swift motion. If you pour too slowly, the polymer and the water will gel-block (clump up), and if you pour too quickly, the mixture is likely to spill everywhere. Remember, this is the part that takes a little practice.
5. Mix the water and Polyox together by pouring the liquid from beaker to beaker until the liquid begins to thicken. Don't attempt the self-siphoning activity just yet. Continue to pour the liquid from beaker to beaker to mix it thoroughly. After just a few minutes of mixing, you'll notice that the mucous-like gel flows very quickly from beaker to beaker. Hold the empty beaker below the full one and start to pour a little of the liquid into the lower beaker. What happens? The liquid will siphon itself from the top beaker to the bottom beaker. Notice how the liquid appears to defy gravity as it crawls up and over the sides of the full beaker in a "self-siphoning" kind of action.

WARNING: Don't be surprised if you become so transfixed on the self-siphoning action of the polymer that you forget to line up the bottom beaker with the top beaker. In other words, you're bound to miss the bottom beaker and your hands will be covered with goo. You'll feel like the stand-in creature in the Alien movies. Don't worry it easily washes right off your skin, but clothes, fabric and carpet is a little trickier.

How does it work?

Polyethylene oxide is a non-toxic, long chain, water soluble polymer. What makes this water based polymer so special is its high molecular weight of approximately 4,000,000. The molecular structure of Polyox promotes extensive hydrogen bonding, which allows it to be soluble in water despite the high molecular weight. It's been said that the length of the polymer chains in a single drop of the gel is some 1,700,000 miles long (give or take a few). Over the years, Polyox gained popularity by fire fighters who added very small amounts of the polymer to the water supply in pumper trucks. In theory the addition of the Polyox reduced the friction caused by the water molecules rubbing against the inside wall of the hose. The reduction of friction made the water flow more quickly through the hose. True? You be the judge.

In order to illustrate the molecular structure of Polyox, it might be helpful to picture a bowl of spaghetti all tangled up. The spaghetti-like structure causes the polymer to thicken water and provides a strong elastic effect. Although extremely elastic, the Polyox remains fluid like pancake syrup. The straight chain format of the Polyox molecule with no side chains to attach to other molecule strands allows the separate chains to slide past each other and stay fluid.

Experiment Resource Available

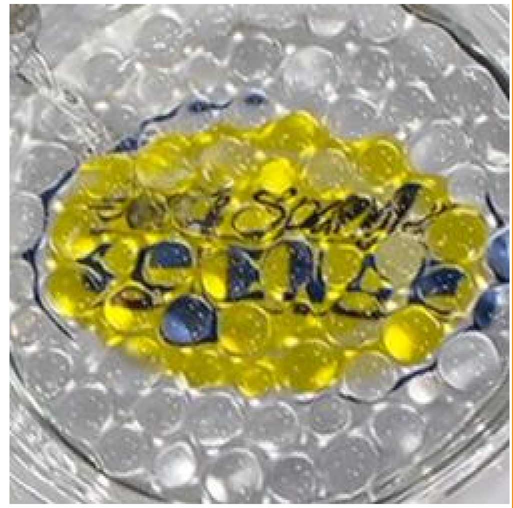
Gravi-Goo Kit ($19.95) available from stevespanglerscience.com

New and Improved! Everyone knows that water can't flow uphill. Not so fast... when this goo is poured back and forth between two beakers, Gravi-Goo mysteriously siphons from the higher held beaker to the lower one. Maybe water **can** flow uphill. You have to play with the stuff to believe it. The possibilities for exploration are nearly endless... try coloring your goo, add a squirt of Pearl Swirl or even a pinch of Clear Spheres. And now, we are providing you with a whole new gravity-defying experience... our new and improved Gravi-Goo comes with an amazing new polymer... Orbs. The roly, poly polymers are brightly colored and grab the Gravi-Goo, providing the ultimate visual experience! We'll provide the Gravi-Goo, you provide the audience to wow with your amazing scientific feats! Recommended for children ages 6 and up.

What's included?

- 150 gram jar of Gravi-Goo
- 2 Plastic beakers
- True Colors Color Mixing tablets
- Pearl Swirl
- 10 grams of Clear Spheres
- 10 grams of Orbs
- Blue measuring scoop

Experiment: Vanishing Jelly Marbles



Clear sphere polymers that vanish like magic in a glass of water

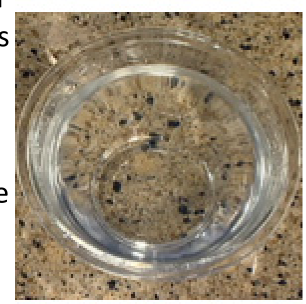
It looks like an ordinary glass of water... crystal clear water. But hiding just below the surface of the water are an amazing collection of large, jelly-like marbles that become invisible when submerged in water. The Jelly Marbles become invisible due to an identical index of refraction with the liquid. In other words, they vanish like magic! As you'll see, there's more to this experiment than meets the eye.

Materials

- Jelly Marbles - Clear Spheres
- Plastic cup
- Clear glass bowl
- Water

Jelly Marbles start out as hard crystals, but when you drop them in water, they expand by absorbing 300 times their weight in water.

1. Fill the plastic cup 3/4 full with warm water (warmer water helps to speed up the absorbing process).
2. Measure approximately one teaspoon of tiny Jelly Marbles into the water.
3. Allow the spheres to soak for at least three hours, but don't be afraid to pull a few out with a spoon every so often to check on their progress. Make sure to notice the changes in shape and size. As they grow, the spheres will take some very unique shapes along the way, but they'll eventually take on the shape of a clear sphere. The Jelly Marbles should reach their maximum growth at 5-6 hours, but leaving them overnight is even better. Pour off any excess water and you'll be left with a glass filled with clear marbles.
4. Here comes the fun part... Fill the clear glass bowl half full with water and drop the water-filled Jelly Marbles into the water one at a time. The spheres will vanish as they hit the water. When you're finished, you'll have what looks like a bowl of water. Reach into the water and gently remove a handful of Jelly Marbles. From this point on, it's impossible to keep your hands out of the bowl of water!



Another way to present this demonstration is to start by showing a bowl or a glass filled with the hydrated Jelly Marbles. Slowly fill the glass with water (you won't need much) and the Jelly Marbles seem to vanish.

You can also use the Jelly Marbles to reveal a hidden message. You'll need a glass pie pan or a shallow glass dish of water for this trick. Write the message that you want to appear on a piece of white paper, and place the dish on top of the message. Fill the dish with a layer or two of the hydrated Jelly Marbles. You will not be able to read the message because the refracted light breaks up the letter. When you want the message to appear, pour water slowly into the dish to cover all of the spheres. As the Jelly Marbles vanish, the message appears.

How does it work?

Jelly Marbles are actually made from a superabsorbent polymer that absorbs 300 times its weight in water. These hydrophilic spheres are approximately 99% water. If you look closely, you can barely see the outline of the sphere in the bowl of water. That's because light passing through the sphere is only refracted (or bent) by the edge of the sphere. Without this refraction along the edges, the Jelly Marbles would seem to vanish altogether. In other words, the water-filled Jelly Marbles become invisible due to an identical index of refraction with the water in the bowl. The secret is to keep the Jelly Marbles clean and free of oil from your skin. The more you touch the spheres, the less invisible they become because dirt and oil on your fingers is transferred to the surface of the sphere, which also reflects the light to reveal the sphere.

In the hidden message demonstration, the message looks scrambled because the rays of light are scattered by the water-filled Jelly Marbles. It's like trying to look through broken glass. When water is added to the dish, the light rays pass right through the water and the spheres without being scattered - due to the Jelly Marble's identical index of refraction with the water. So, it looks like you're looking through a plain dish of water.

Experiment: Instant Snow - The Erupting Snow

You won't believe your eyes. Just add water to the mysterious white powder and in seconds the transformation begins. The liquid magically changes into a fluffy white powder that looks just like snow. It's actually a safe, non-toxic polymer that absorbs water and fluffs up to look like snow.

Materials

Insta-Snow Powder (stevespanglerscience.com)
- Measuring cup
- 2 plastic mixing cups
- Water

1. Use the blue scoop that came in the Instant Snow package to measure out 1 scoop of Insta-Snow® powder into the empty mixing cup.

2. Measure 2 ounces of room temperature water into a second cup.

3. Quickly pour all of the water into the cup with the Instant Snow powder. Don't take your eyes off the erupting snow!

4. Go ahead... put your fingers in the fluffy fake snow. It looks so real that special effects artists are now using it in movies.

5. If you let the snow sit out, the water will evaporate and the once fluffy snow will turn back into the dry powder. That's right... it's reusable!!!

How does it work?

Insta-Snow, the original Instant Snow, is an amazing superabsorbent polymer that turns ordinary water into a fluffy substance that looks like real snow. This faux snow is so realistic that it is now being used on movie sets and in indoor snowboarding parks. See the picture above of an entire lawn covered in Instant Snow.

The mixologists at *Steve Spangler Science* coined the name *Insta-Snow, the Original Instant Snow*. This fake snow is in a classification of chemicals called a polymer. The word polymer simply means long chain of molecules ("poly" means many and "mer" is a unit or molecule). Instant Snow soaks up water using the process of osmosis (water molecules pass through a barrier from one side to the other). When water comes in contact with the polymer, it moves from outside the polymer to the inside and causes it to swell. The polymer chains have an elastic quality, but they can stretch only so far and hold just so much water.

Additional Info

Great Science Fair Idea - Use Steve Spangler's Instant Snow to learn about the conservation of mass. Start by accurately weighing 1 blue scoop of the snow polymer (about 3 grams). Perform the experiment described above by adding 2 ounces (60 mL) water to the powder to make snow. Accurately weigh the snow. Place the snow in an open container and allow the water to evaporate. This may take several days depending on the humidity. When all of the water has completely evaporated, accurately weigh the remaining powder. If the law of conservation of mass is correct, you should have recovered the same amount of Instant Snow powder you started with at the beginning of the experiment. This proves that the reaction that took place was a physical reaction and not a chemical reaction since the Instant Snow powder never actually changed.

Experiment: School Spear-It!

Get into the school spirit with this amazing hands-on science activity that is guaranteed to produce a room full of ooohs & ahhhs! Who would have ever thought that a plastic bag, some water, and a few pencils would frighten the thunder out of the Teacher? Learn how to poke a hole in a plastic bag filled with water and reseal it like magic. The secret has to do with a better understanding of the chemistry of polymers.

Materials

- 5 pencils with round edges
- A plastic bag
- Water
- A few paper towels

Before you get started… Practice this over a sink before you present it at the dinner table.

1. Start by sharpening the pencils.
2. Fill the bag 1/2 full with water and then seal the bag closed. Pose this question to your dinner guests, "What would happen if I tried to push one of these pencils through the bag of water?" Will the water leak out and make a giant mess?" Yes... unless you know the scientific secret.
3. Here comes the scary part. Hold the pencil in one hand and the top of the bag in the other hand. Believe it or not, you can push the pencil right through one side of the bag and half way out the other side without spilling a drop. The bag magically seals itself around the pencil. Sounds impossible? Try it… over the sink for the first time!
4. Continue to rekindle your "spear-it" for science by jabbing the remaining pencils through the bag.
5. When you are finished, remove the pencils while holding the bag over the sink. Throw away the bag and dry the pencils. Here are a few helpful hints… Make sure the tips of the pencils are sharpened to a point. Be careful not to push the pencils all the way through the bag, or your "spear-it" experiment will turn into a big "clean- up-the-water" activity.

How does it work?

The plastic bag is made out of long chains of molecules called polymers. This gives the bag its stretchy properties. The sharpened pencil slips between the molecule strands without tearing the entire bag. Believe it or not, the long chains of molecules seal back around the pencil to prevent leaks. Now that’s the Spear-It of science!

Experiment: Screaming Balloons

What would life be without spooky sounds? Here's an easy-to-do experiment using only a balloon and a hex nut from the hardware store. Be sure to buy enough supplies for all of your party guests because everyone is going to want a screaming balloon!

Examples of Correlating Standards:

Kindergarten 7.2.2 Use the senses to investigate and describe an object
2nd 7.11.1 Use a variety of objects that vibrate to demonstrate how sounds are produced.
2nd 7.11.2 Describe the sounds produced by different types of vibrating objects.
3rd 7.11.2 Use a variety of materials to produce sounds of different pitch and volume.
3rd 7.11.3 Classify a variety of taped sounds according to their pitch and volume.
7th 7.11.6 Compare how transverse and longitudinal waves are produced and transmitted.
8th 8.11.1 Recognize that forces cause changes in speed and/or the direction of motion.

Materials

You'll need good quality latex balloons (9" to 11" in size) and some 1/4" hex nuts from the hardware store.

Squeeze the hex nut through the mouth of the balloon. Make sure that the hex nut goes all the way into the balloon so that there is no danger of it being sucked out while blowing up the balloon. Blow up the balloon, but be careful not to over inflate the balloon as it will easily burst. Tie off the balloon and you're ready to go.

Grip the balloon at the stem end as you would a bowling ball. The neck of the balloon will be in your palm and your fingers and thumb will extend down the sides of the balloon. While holding the balloon, palm down, swirl it in a circular motion. The hex nut may bounce around at first, but it will soon begin to roll around the inside of the balloon. What is that sound? Could the balloon be screaming? Once the hex nut begins to spin, use your other hand to stabilize the balloon. Your hex nut should continue to spin for 10 seconds or more.

How does it work?

This is actually a 2 for 1 experiment - you're learning about the science of inertia and sound. The hex nut circles inside the balloon due to centripetal force. Centripetal force is the inward force on a body that causes it to move in a circular path. The old concept of "centrifugal force" (an outward or center fleeing force) has been largely replaced by a more modernistic understanding of “centripetal force” (an inward or center seeking force). The sound is made by the sides of the hex nut vibrating against the inside wall of the balloon.

To prove this, repeat the experiment using a penny in place of the hex nut. While the penny spins beautifully inside the balloon, the “spooky” sound is gone. Experiment with different sizes of hex nuts or any other circular object whose edges might vibrate against the balloon and create a spooky sound. The Screaming Balloon makes for a great Halloween party give-away or a fun science experiment for teachers to do in classroom.

Experiment: Singing Glasses

What dinner party is complete without a song from the Wine Glass Symphony? You'll need a few wine glasses, some water, and a tune in mind to demonstrate the sounds of science. Amaze everyone and display incredibly bad manners all at once.

Materials

Round up a few wine glasses (the thin-walled kind work great), some water, a little vinegar (optional), and a bunch of crazy dinner guests.

1. Fill the glass about half-full with water. Dip your pointer finger into the water (or vinegar) to clean it. Use a napkin to wipe off any dirt or oil on your finger. Clean is good.
2. You'll need a little moisture to help, so dip your finger into the water again. Set your clean, moist finger on the rim of the glass, press down slightly, and rub it all the way around the rim without stopping. Keep going in a circular motion along the lip of the glass while maintaining the pressure, and in almost no time you'll have displayed a newfound musical talent.
3. Several things have to be just right for a tone to be produced: pressure, moisture, glass type, etc. Keep trying because it's worth it and once you get there, it's hard to stop.

How does it work?

You are demonstrating the principle of "stick and slide." As you rub your finger on the rim, your finger first sticks to the glass and then slides. This stick and slide action occurs in very short lengths and produces a vibration inside the glass which, in turn, produces a sound. Vinegar helps to clean dirt and oil from your finger. A clean finger improves the stick and slide action. As soon as the first few vibrations are produced, the glass resonates. That means you're causing the crystals in the glass to vibrate together and create one clear tone. You can change the pitch (highness or lowness of the sound) by adding to or subtracting from the amount of water in the glass. The volume (loud or quiet) can be changed only a little bit by increasing or decreasing the pressure from your finger. Just think about the "jam session" you'll have with your dinner guests!

Experiment: Pop Bottle Sounds

When you blow on a soda bottle or clink it with a spoon, the bottle makes a noise. Sometimes the sound is high and sometimes the sound is low. I want to find out how the liquid in the bottle makes the sound change. Here's my hypothesis... When I clink the bottle with a spoon, I think the bottle will make a low sound when it is full and a higher sound when it is empty.

Materials

- 8 glass Orange Crush bottles (all of the bottles must be the same!)
- Water
- Spoon
- Good ears

Test #1 Clink Two Bottles
You need two bottles for this experiment. Fill one bottle full with water and leave the other bottle empty. Clink both bottles. Are the sounds different?

Test #2 Clink Three Bottles
You need three bottles for this experiment. Fill the first bottle full of water. Fill the second bottle half full. Don't put water in the third bottle. Will the sound of bottle #2 (half full) be in the middle of the other two sounds?

Test #3 Blowing Air
This test used the three bottles from test #2. Instead of "clinking" the bottle, I want to blow air across them. My hypothesis is that they will make the same sound as clinking the bottles.

How does it work?

What I Learned About Sound
Sound comes from vibrations. When you hit the bottle with the spoon, it makes the glass vibrate. When you fill the bottle with water, the glass cannot vibrate as much. Fast vibrations make a high sound and slow vibrations make a low sound. A full bottle will produce a slow vibration and a low sound. An empty bottle will have a faster vibration and a higher sound.

My Big Discovery

I thought that blowing into the bottle would be the same as hitting it with a spoon, but I was wrong. Blowing into the empty bottle made a low sound. I learned that when you blow into the bottle, you are making the air vibrate - not the glass! When you put more water into the bottle, there is less air to vibrate. This means the air will vibrate faster and the sound is higher.

Experiment: Whirly - The Twirling Sound Hose

At first glance, it looks like your ordinary plastic tube. Hold one end of the tube and twirl the other end in a circle over your head. It's music to your ears! How does it work?

Materials

- The "Singing Tube" is a popular and inexpensive item in toy stores. There is really nothing to it - a corrugated plastic tube measuring about 3 feet long and 2 inches in diameter.

Spin the tube faster and notice how the pitch of the note goes up. Fast twirling creates high pitch notes and slower twirling creates lower notes. Amazing!

The Bag "Whirly"

1. Attach a plastic bag, such as a garbage bag or shopping bag to the end of your Sound Hose with tape or a rubber band.
2. With your mouth a few millimeters from the Sound Hose, blow into the open end. The bag will inflate with just a few big breaths.
3. Once the bag is inflated, twirl your Sound Hose. As the "music" plays from the hose, watch the bag deflate!

How does it work?

Imagine that the tube is filled with tiny pebbles. Twirling the tube overhead would shoot the rocks out of the tube. The same thing happens with the molecules of air. As you twirl the tube, air molecules are launched out of the other end. The faster the twirl, the faster the molecules come flying out the other end.

The Bag "Whirly" experiment creates a stunning effect because of the air molecules quickly exiting the Sound Hose. The plastic bag helps your audience visualize the movement of the molecules because you can see the bag deflating as the Sound Hose is being "played."

Not all plastic tubes sing. The tube must be corrugated on the inside. Why? The aerodynamics researchers in Japan put a whirly in a wind tunnel and used very tiny hot wire anemometers to measure the airflow near the corrugations. As the air flows first over one ridge then over a second it tumbles into a vortex. The faster the air flows through the tube the higher the frequency of the sound produced by the vortex. When the frequency of the vortex matches one of the natural resonant frequencies of the tube it is amplified.

Notice how the inside of your vacuum cleaner hose in NOT corrugated! Otherwise, your vacuum cleaner would play music (maybe a poor choice of words) whenever you cleaned the house.

In Search of More Tubes... While the toy store “Twirly” is fun, you’ll soon want to experiment with different size tubes (long, short, fat, skinny) to see how the size and shape change the sound.

Experiment: Singing Rod

Here's a classroom science demonstration that is sure to wake you up... and the people down the street... and every dog in the neighborhood! With a little practice and some science know-how, you'll turn an ordinary piece of aluminum rod into a singing virtuoso.

Examples of Correlating Standards:

Kindergarten 7.2.2 Use the senses to investigate and describe an object
2nd 7.11.1 Use a variety of objects that vibrate to demonstrate how sounds are produced.
2nd 7.11.2 Describe the sounds produced by different types of vibrating objects.
3rd 7.11.2 Use a variety of materials to produce sounds of different pitch and volume.
3rd 7.11.3 Classify a variety of taped sounds according to their pitch and volume.
7th 7.11.6 Compare how transverse and longitudinal waves are produced and transmitted.

Materials

You'll need a solid aluminum rod - approximately 5/8" in diameter and 24" long. You can experiment with different lengths of rod to produce different sounds. You'll also need some violin rosin... and some patience.

 Hold the rod in the middle with your first and second fingers on top and the thumb supporting the rod from below. The key is to make as little contact with the rod as possible so as not to dampen the vibrations.

 Apply some rosin to the thumb and fingers of your other hand and lightly coat the aluminum rod with rosin.

 Use your rosin coated fingers to pinch the metal while sliding your fingers from the middle to the end of the rod. Don't stop. As soon as your fingers reach the end, repeat this pinch-n-sliding process...and again...and again...maybe upwards of 20 times before the metal bar begins to resonate. Don't give up.

 Because of the sticky nature of rosin, your fingers should stick and slide across the rod causing it to resonate.

 The sound of the vibrations will be soft at first but will strengthen with each successive stroke. The resulting high pitch sound will be ear-piercing! Each stroke reinforces the vibrations of the last. Pinch and slide, pinch and slide, pinch and slide...don't give up!

**Try holding the bar in the middle and tapping on the sides. Compare this sound to the sound produced by hitting the bar directly on the end. How does this sound compare to the sound made by stroking the bar?

How does it work?

"Vibrations...the reason the bar makes the sound is because of vibrations." Your students might be inclined to offer this simple explanation before you increase their level of understanding by asking these questions:

- Why did the pitch of the bar sound different when you tapped the bar instead of stroking the bar?
- Why does the metal bar vibrate when you rub it with your fingers? Why is the rosin necessary?
- Where is the high pitch sound coming from (middle, sides, or ends of the bar) and why?

In terms of making the bar vibrate, the rosin is responsible for making your fingers stick and slide as they move across the bar. In turn, this repeated stick and slide action sets up vibrations in the bar.

You probably noticed that holding the bar in the middle and tapping slide produced a lower pitch sound and striking the bar on the very end created a higher pitch sound. The same high pitch sound is also made by stroking the bar with your fingers. In either case, the high pitch sound resulted from the formation of compression waves or longitudinal waves throughout the bar. Each successive stoke of the bar reinforces the strength of the previously established longitudinal wave, resulting in a louder sound.

Here's a way to illustrate a longitudinal wave using a Slinky toy. Picture a Slinky stretched out on the floor with another person holding the Slinky at the other end. Compress a section of the spring and let go. Notice how the energy of the released coil moves up and down the length of the spring. See the illustration below. This is an example of a compression or longitudinal wave. The high pitch sound of the metal rod is the result of a longitudinal wave which travels throughout the entire length of the bar.

It the rod is held in the middle and tapped on the slide with a solid object, a transverse wave is created. These waves have much longer wavelengths and, as a result have a much lower tone or pitch compared to the higher pitched longitudinal wave. A transverse wave is made by moving the Slinky in an up and down motion, creating nodes and antinodes. Notice the formation of standing waves.

Practice hitting the bar with a solid object close to the end with a slight diagonal stroke. By doing so, you can actually create both longitudinal and transverse waves at the same time, and you'll be able to hear both sounds at once.

Additional Info

Over the years, this activity has been published in a number of demonstration books, and my initial efforts to perform the Singing Rod always resulted in tired fingers and no sound. Success came after seeing Dr. Albert Baez present the demonstration in San Antonio in 1995. The motion of repeatedly sliding your hand down the bar is smooth and graceful. Dr. Baez effortlessly caused the metal bar to resonate a high pitched sound that filled the auditorium to everyone's amazement. So can you!

Experiment: Musical Straws

There's a straw... and straws are interesting. Is there anything you can do with a straw to "be amazing?" Keep reading - in a matter of minutes you'll have the entire room upset by your science antics.

Examples of Correlating Standards:

Kindergarten 7.2.2 Use the senses to investigate and describe an object
1st 7.11.1 Use familiar objects to explore how the movement can be changed.
2nd 7.11.1 Use a variety of objects that vibrate to demonstrate how sounds are produced.
2nd 7.11.2 Describe the sounds produced by different types of vibrating objects.
3rd 7.11.2 Use a variety of materials to produce sounds of different pitch and volume.
3rd 7.11.3 Classify a variety of taped sounds according to their pitch and volume.

Materials

You'll need:
- A straw, unwrapped
- Scissors
- An audience of music lovers

1. Flatten the last inch of the straw with your teeth, making sure that you don't curl the end. Flatter is better, so really press down hard. Cut the corners off the straight, flattened end of the straw.

2. Now you're ready to make music (and annoy everyone)! Place the cut end of the straw into your mouth, seal your lips around it, and blow until a "sound"� is produced. You'll feel the entire straw vibrate as the sound is made. Don't give up if you don't make music right away; you may need to re-position the straw and try it again. You've just made a "double reed"� mouthpiece, similar to an oboe.

3. Cut small sections off the bottom of the straw while you're making the sound. Listen for changes in the pitch as you cut the straw shorter and shorter. Watch out for your lips!

How does it work?

When adjusted properly, the flattened ends of the straw will vibrate as air flows over them. The vibration is passed on to the column of air inside the straw. This is just like the double reed on some woodwind instruments. The vibrating reed produces the oboe-like sound in the straw based on the length of the straw. By cutting off pieces of the straw, you alter the length of the air column and thus change the pitch. The English horn, oboe, and bassoon all use this same principle of vibration to make sound. These instruments, however, change the length of the column of air with holes, stops, and pads. Scissors are impractical.

Here's a variation: Find two straws, one smaller than the other (the smaller should fit snugly inside the larger straw). Using the smaller straw, repeat Step 1 above. Slide the bigger straw up over the smaller straw and start blowing. Move the larger straw back and forth to change the pitch of the sound. It's a straw trombone (although any brass player worth his or her salt will tell you it's a lame attempt). Brass rules!

Experiment: Bouncing Bubble Solution

There's something magical about a bubble. It's just a little puff of air trapped in a thin film of soap and water, but its precise spherical shape and beautiful, swirling colors make it a true wonder of science. A bubble's life expectancy is usually measured in seconds unless you know how to make a SUPER BUBBLE!

Examples of Correlating Standards:

Kinder 7.11.1 Use a variety of objects to demonstrate different types of movement (e.g., straight line/zigzag, backwards/forward, side to side, in circles, fast/slow).
3rd 7.9.1 Use physical properties to compare and contrast substances.
4th 7.10.3 Gather and organize information about a variety of materials to categorize them as translucent, transparent, or opaque.

Materials

- 1 cup of distilled water (240 mL)
- 2 tablespoons of Dawn® dish soap (30 mL)
- 1 tablespoon of Glycerin (15 mL)
- Make up a batch of Bouncing Bubble Solution (see above).
- Purchase a pair of inexpensive children's gloves from your local department store (100% cotton gloves or socks also work well).
- Blow a bubble about the size of a baseball.
- Bounce the bubble off of your gloves or socks. Try bouncing the bubble off of your shirt or pants. As you'll soon see, some fabrics work better than others.

About the Ingredients...

Water - The single most important part of the bubble solution is the water. Good quality water that does not contain high levels of iron or minerals is best. If you're uncertain as to the quality of your tap water, invest in a gallon of distilled water from the grocery store.

Soap - When it comes to soap, Dawn® dish soap just seems to work the best for home-made bubble solutions.

Glycerin - Glycerin is the secret additive that gives a bubble its extra strength. Don't be too shocked by the price on a bottle of high quality Glycerin. Contact the pharmacist at your local grocery store for availability. (Note: Some bubble recipes substitute Karo® Syrup for Glycerin due to the expense and availability of Glycerin.)

Bubble Colors - Similar to the way we perceive the colors in a rainbow or an oil slick, we see the colors in a bubble through the reflection and the refraction of light waves off the inner and outer surfaces of the bubble wall. You can't color a bubble since its wall is only a few millionths of an inch thick. A bubble reflects color from its surroundings.

Bouncing Bubbles - Experience tells you that regular bubbles burst when they come in contact with just about anything. Why? A bubble's worst enemies are oil and dirt. A "super" bubble will bounce off of a surface if it is free of oil or dirt particles that would normally breakdown the soap film.

How does it work?

The Science of Bubbles Check out these websites to learn more about the fascinating science of bubbles

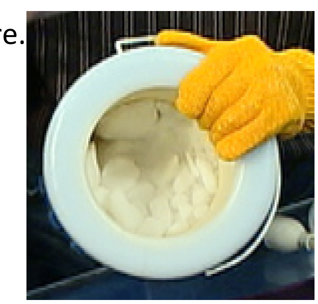
Experiment: Boo Bubbles

Bubbles are cool, but bubbles filled with fog are even cooler. Just imagine the cool factor going up ten fold if you could bounce and play with these bubbles. Boo Bubbles are what you get when you fill a bubble with a carbon dioxide cloud using Steve Spangler's cloud bubble generator. But he saved the best until last because you'll learn how to roll and bounce the bubbles in your hands. It's the combination of science and performance art!

Materials

- Dry Ice Cloud Generator (see below)
- Dry Ice
- Liquid soap (Dawn)
- Knit gloves
- Bath towel

Making the Dry Ice Cloud Generator The version of the Dry Ice Cloud Generator featured in the video was constructed out of a gallon size plastic jar with a 3 foot long piece of rubber tubing attached to the side. The goal is to attach the tubing to the top part of the jar so that the fog created by mixing dry ice and water blows out of the tube when you twist on the lid. The free end of the rubber tubing is attached to a small funnel or something similar to help blow bubbles when it's dipped into a soapy water solution. The best advice is to start with the plastic jar and spend some time walking through the plumbing aisles of your local hardware store.



Experiment

You'll need some thick gloves to handle the dry ice. The knit gloves used later in the activity do not give enough protection to your hands. Find a good pair of leather gloves to protect your hands against the cold temperature of the dry ice and you're set.

Fill the jar half full with warm to hot water. Dry ice produces the best fog when you use warm water. Attach the rubber hose to the side of the jar (if it's not already attached).

Drop a few good size pieces of dry ice into the jar. Immediately the fog will roll out of the jar. Practice covering the top of the jar with the lid to control the flow of fog out of the tube. You don't have to screw the lid onto the jar - just hold it on top of the jar to force or more less fog through the rubber tubing. Make a soapy solution by mixing a squirt (that's a technical term!) of liquid soap with about 4 ounces of water. For even stronger bubbles, use Extreme Bubble Solution.

Dip the free end of the rubber tubing into the bubble solution to wet the end of the tube. Remove the tube from the bubble solution with one hand while covering the jar with the lid in the other hand. This will take a little practice, but it's easy once you get the hang of it. The goal is to blow a bubble filled with fog. When the bubble reaches the perfect size, gently shake it off of the tubing and it will quickly fall to the ground (it's heavier than a normal bubble because the bubble is filled with carbon dioxide gas and water vapor). When the bubble hits the ground, it bursts and the cloud of fog erupts from the bubble. Very cool.

Touchable Boo Bubbles

Purchase a pair of inexpensive children's gloves from your local department store (100% cotton gloves also work well).

Blow a bubble about the size of a baseball. – Bounce the bubble off of your gloves. Try bouncing the bubble off of your shirt or pants. As you'll soon see, some fabrics work better than others. Try bouncing bubbles on a hand towel.

Steve Spangler combined the idea of filling bubbles with dry ice fog with his Bouncing Bubble activity to create a Bouncing Boo Bubble. While blowing bubbles indoors, you might have noticed the occasional bubble that fell to the carpet but didn't pop. Regular bubbles burst when they come in contact with just about anything. Why? A bubble's worst enemies are oil and dirt. Boo Bubbles will bounce off of a surface if it is free of oil or dirt particles that would normally breakdown the soap film. That's why you're wearing knit gloves.

Additional Info

The original idea of creating fog filled bubbles came from a demonstration presented by Bob Becker in 1995 called a Leaky Faucet. Fog filled bubbles dropped from a "faucet" made out of PVC pipe. Steve Spangler combined updated this idea by being able to control the flow of the carbon dioxide gas with his Dry Ice Cloud Generator. Steve also added his Bouncing Bubble demo using knit gloves to create a ghostly looking “touchable” bubble that vanishes with a burst of smoke.

Experiment: Giant Bubbles

Everyone knows that small bubbles are amazing... you can blow them, bounce them, catch them... the fun never ends! But what if you could a make a giant bubble over 1 meter (3 ft) tall? Once you know the secret behind these super bubbles, you can amaze your audience by surrounding them in a human-sized bubble!

Materials

- Pipette or other bubble blowing device
- Dawn dish soap (not anti-bacterial)
- Distilled Water
- Hula Hoops, small and large
- PVC pipe
- String
- Scissors
- Children's swimming pool
- Glycerin (optional)

Bubble Solution Recipe

In the swimming pool mix 19 L (5 gallons) of distilled water with 2.5 L (10 cups) of Dawn® Dish Soap. The best bubble solution ages with time, so allow your mixture to sit overnight before using it. For even stronger bubbles, add 1.2 L (5 cups) of Glycerin to the solution.

Blowing Bubbles with a Pipette

An ordinary plastic eyedropper, called a pipette, makes the perfect bubble blower. Just snip the round end off of the pipette and dip it in the bubble solution. Blow through the skinny end of the pipette and you will get a perfect bubble nearly every time!

Making a Bubble Wall

1. Take two pieces of PVC pipe (available at a hardware store... they will even cut it for you) 30-60 cm (1-2 ft) long.

2. Attach the two pipes with a long loop of string. Thread the string through the top pipe, down into the other pipe and back up to the original pipe. Tie the ends string together. The two pieces of pipe should be hanging about 90 cm (3 ft) apart. Dip the entire contraption into the bubble solution and slowly pull it back out. You will find that the bubble solution is in between the pipes like a bubble wall!

3. If you blow lightly into the wall, a bubble will pop out. Or, try putting your hand in the bubble solution so it is coated with solution. Now, put your hand through the bubble wall.... it goes right through without breaking the wall! Because you coated your hand with bubble solution first, the oils on your skin won't break the bubble.

4. You can also try this trick with a small hula hoop. You will have a bubble ring that you can put your hand through or blow out smaller bubbles.

5. Your audience will already be on their feet and you haven't even made it to the grand finale!

6. **GIANT Bubbles**

1. Place the larger hula hoop in the bottom of the swimming pool.

2. Ask for one or two brave volunteers to take off their shoes and step into the swimming pool and into the center of the hula hoop.

3. Now, very slowly, and with a steady hand, pull the hula hoop straight out of the pool and to the top of your volunteer(s) head.

4. Before they can say "No way!" Your volunteer is trapped inside a human-sized bubble!

5. Your audience will go wild with applause and you can take your well-deserved bow... after you release your volunteer from their bubble cage!

How does it work?

Bubbles form because of the SURFACE TENSION of water. Hydrogen atoms in one water molecule are attracted to oxygen atoms in other water molecules. They like each other so much, they cling together. Normal bubbles enclose the MAXIMUM VOLUME OF AIR with THE MINIMUM AMOUNT OF BUBBLE SOLUTION, so they are always round. When you stretch your bubbles across contraptions like the Bubble Wall or a hula hoop bubbles cling to the sides as you dip into the solution, making the bubbles all sorts of shapes. The surface tension of water, alone, is TOO STRONG to make good bubbles, ADDING SOAP REDUCES THE SURFACE TENSION.

It also adds oily film that slows down the evaporation process, so you get longer-lasting bubbles!

Experiment: Chilly Bubbles

If you ask your students how much air can fit in a bottle, they'll probably say it depends on the size of the bottle. True, but there's another factor to consider, and that's temperature. A bottle can hold more cold air than warm air. With this simple activity, your child can see for herself.

YOU WILL NEED:

- An empty 20-ounce plastic soda bottle, without the cap
- A glass of water (wide enough for the top of the soda bottle to fit in)
- Bubble solution (you can make your own by mixing a few drops of dish soap with N cup of water)

STEPS:

Place the soda bottle mouth down in the glass of water and watch what happens: not much. Dry the bottle and chill it in the freezer for 5 minutes. Once again, place it in the glass. Without being squeezed, the bottle will blow underwater bubbles.

Return the bottle to the freezer for another 5 minutes. Meanwhile, pour a little bubble solution into a shallow bowl. When the bottle is ready, dip the mouth in the bubble solution, then set the bottle upright on a table. A bubble should start to form almost immediately. When the bubble bursts, redip the bottle; it should keep on blowing bubbles until it nears room temperature.

WHAT'S HAPPENING:

When you put the bottle in the freezer, the air inside it gets cold. That's because air, just like everything else, is composed of molecules (tiny bits of matter) that react to changes in the environment. The colder the air, the closer together the molecules get. Because it's denser than warm air, you can fit more of it in the bottle. When you take the bottle out of the freezer, the air inside it starts to warm up and expand. The bottle can't contain it all. As it escapes, the air pushes against the water in the glass (or, in step 3, the bubble solution on the rim), creating bubbles.

Experiment: Balloon in a Bottle

How hard would it be to inflate a balloon in a plastic soda bottle?

Some things look so easy until you try them. Case in point... How hard would it be to inflate a balloon in a plastic soda bottle. Hey, no big deal. Just put the balloon down inside the bottle and puff away. That's until you realize something about the properties of air. Don't worry... Steve Spangler will show you how to be amazing.

Materials

- 1-Liter bottle
- Latex balloons
- Rubber stopper or cork
- Water
- Nail
- Hammer

Slip the balloon inside the neck of the bottle and stretch the mouth of the balloon over the bottle top. Take a deep breath and try to blow up the balloon inside the bottle. Good luck!

Remove the balloon, fill the soda bottle to the brim with water, then seal it with a cap. Ask an adult to punch a small hole with a nail and hammer in the side of the bottle, close to the base. Remove the nail, uncap the bottle, and empty the water out the top.

Place the balloon in the bottle again (Step 1) and try to blow up the balloon. Quite a difference! Blow hard until the balloon fills most of the bottle (a little water left in the bottle helps). Place a finger (or thumb) over the nail hole when you stop blowing. You are too cool! Now, move your finger.

How does it work?

The balloon won't inflate much the first time because the bottle is already filled with air. There's no room for the balloon to expand inside the bottle. However, when you punch a hole in the bottle, the air molecules in the bottle have an exit. They're pushed out as the balloon fills the space inside. As long as you plug the hole, the balloon stays inflated. When you take your thumb off the hole, outside air flows back into the bottle as the balloon collapses. Because of the elasticity of the rubber or latex, the balloon shrinks to its original size as the air rushes out the top of the bottle. By the way, when you filled the bottle with water, you made its walls more rigid and it was easier to push the nail through the flexible plastic. Who'd ever think that flowing, soft water could give that much support?

Try this! Inflate the balloon in the bottle again and cover the nail hole with your thumb. Pour water into the balloon while keeping your thumb over the hole. Go outside or hold the bottle over a sink before you remove your thumb. Watch out for that stream of water gushing out of the bottle top! You might decide to hand a full water-balloon-bottle to a friend and just "forget" to tell them about the hole.

Suppose your thumb gets tired while the balloon is inflated. Put a cap tightly on the bottle and remove your thumb. For the air to flow, both holes have to be open. How would more holes or even one large hole change the speed of inflating and deflating the balloon? What would more or bigger holes do to the stream flowing from the water-balloon-bottle? Try it out! Balloons and bottles make a great science combo!

Experiment: Do Not Open Bottle - Soda Prank

It's the ultimate prank using the simplest of props... a plastic soda bottle filled with water. Even though the words, "DO NOT OPEN" are printed on the bottle, people just can't resist the temptation. Watch out, the fun is just beginning.

Materials

- Two plastic soda bottles (1-liter size works well)
- Cap
- Large nail
- Sharpie pen
- Thumb tack

Hey, if you're a kid who is trying to do this experiment, get an adult to help you poke the holes in the bottle. You don't want to hurt YOUR hand!

The Leak-Proof Bottle

1. Use the nail to poke a hole on the side of the bottle close to the bottom.

2. Cover the hole with your finger while you fill the bottle with water all the way to the top. Screw on the cap.

3. Slowly take your finger away from the hole. Are you ready for the water to come rushing out. Hey, there's no leak?

4. Unscrew the cap and watch what happens. Okay, now it's time to stand back!

The "Do Not Open" Bottle Trick

1. Start with a new plastic soda bottle (don't use the one from the previous experiment). Use the permanent marker to write DO NOT OPEN! in fat letters on the bottom half of the bottle.

2. Use a sharp push pin (thumb tack) and carefully poke tiny holes through the bottle at the bottom of the letters (the letters will help hide the holes).

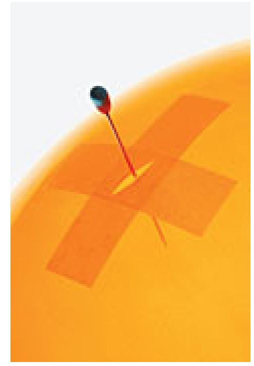
3. Place the bottle in a deep sink or pan and fill it with water. The tricky part is that the water will leak out of the holes as you're filling the bottle. Keep the water running as you screw on the cap. Don't squeeze the bottle or it will start leaking before you're ready.

4. Set the bottle on the classroom counter (word-side out) where someone can see it as they pass by. Stay close enough to watch what happens. Eventually, someone is bound to ask about the bottle. Play dumb with, I dunno, when they ask about it. Let them unscrew the cap and you'll witness science in action!

How does it work?

Think about why the bottle spews water when the cap is loosened. It's kind of a tag team combo between gravity and air pressure. Gravity is pushing downward on the water whether the lid's on the bottle or not. Air pressure can't do anything until it somehow gets into the bottle. When the lid is on, air pressure can't get into the bottle to push on the surface of the water. It does, however, push against the outside of the bottle on all sides. Since the outside atmospheric pressure is greater than the force of gravity, most of the water stays in the bottle. When the lid is uncapped, though, the outside atmospheric pressure (14.7 pounds per square inch at sea level) and the force of gravity push down on the water at the same time. The water shoots out and the nosy person gets a scientific (but well-deserved) soaking.

Experiment: The Un-poppable Balloon



Often, physics reveals that what seems to be the most likely explanation isn't always the correct one. (Remember that old theory about the sun moving around the earth?) Take something as simple as piercing a balloon with a pin. It's logical to assume that the balloon pops because air escapes through the hole. But as this simple experiment proves, there's something much more interesting going on.

YOU WILL NEED:

• Latex balloon
• Clear tape
• Straight pin

STEPS:

Blow up a balloon and stick two 2-inch pieces of tape to the surface in an X.

Use the pin to puncture the balloon at the center of the cross. Even though you'll be able to feel air leaking through the hole, the balloon will stubbornly refuse to pop (at least for quite a while).

Watch the hole through the tape. It will widen into more of a crack (if it doesn't, try squeezing the balloon to help things along). When the crack nears the edge of the tape, the balloon will suddenly pop.

WHAT'S HAPPENING:

When you puncture the balloon, it's not air rushing out the hole that causes it to pop. Instead, what actually occurs is something that physicists call a catastrophic crack propagation. The hole spreads, in effect ripping open the balloon. The tape, however, slows down the process dramatically, postponing the pop.

If you think that's cool, consider this: when the tear in the balloon finally makes it past the tape, it starts to rip through the latex faster than the speed of sound. So that pop you hear is actually a sonic boom.

Experiment: Seven Layer Density Column-- Think of it as a Science burrito…

Everyone knows that vegetable oil floats on water. That's because the two liquids have different densities. Density is basically how much "stuff" is smashed into a particular area… or a comparison between an object's mass and volume. So, the exact same volume of two liquids may actually have different masses, so they would have different densities. That's why vegetable oil floats on top of water.

But, vegetable oil and water are just one way to explore density. What if you could float seven different liquids in seven different layers? We'll show you how to be amazing and make a seven-layer density column!

Materials

- Light Karo Syrup
- Water
- Vegetable Oil
- Dawn dish soap (blue)
- Rubbing alcohol
- Lamp Oil
- Honey
- Graduated cylinder
- Food Coloring or True Color Coloring Tablets
- Food baster
- 9 oz. portion cups

1. Measure 8 ounces of each type of liquid into the 9 oz. portion cups. You may want to start the experiment by coloring each of the liquids to make a more dramatic effect in your column. Light Karo syrup is easier to color than the dark syrup. The only liquids that you may not be able to color are the vegetable oil and the honey.

2. Start your column by pouring the honey into the cylinder. Now, you will pour each liquid SLOWLY into the container, one at a time. Make sure you pour them in the following order.

   a. Honey

   b. Karo syrup

c. Dish soap

d. Water

e. Vegetable oil

f. Rubbing Alcohol

g. Lamp oil

3.

Note: It is VERY important to pour the liquids slowly and into the center of the cylinder. Make sure that the liquids do not touch the sides of the cylinder while you are pouring. Also, it's okay if the liquids mix a little as you are pouring, the layers will always even themselves out because of the varying densities.

4. As you pour, the liquids will layer on top of one another. After you pour in the liquids you will have a Seven-layer science experiment. Density is too cool!

Observations

We've had lots of teachers and scientists help contribute to this experiment. We inadvertently made an error in verbiage in the very first line of our experiment! It's true, vegetable oil and water are close enough in density that they actually don't mix because of the polarity of their molecules, not because of the slight difference in their densities. Oil molecules are non-polar and water molecules are polar, so the non-polar molecules like to hang out with other non-polar molecules and the polar molecules like to hang out with other polar molecules.

Special thanks to Joe F. and Cathy V. for helping us with the correction to our explanation!

How does it work?

The same amount of two different liquids will have different weights because they have different masses. The liquids that weigh more (have a higher density) will sink below the liquids that weigh less (have a lower density). To test this, you might want to set up a scale and measure each of the liquids that you are pouring into your column. Make sure that you are measuring the weights of equal portions of each

Material	Density
Dark Karo syrup or maple syrup	1.37
Light Karo syrup	1.33
Water with food coloring	1.00
Glycerin (colorless)	1.26
Vegetable Oil (yellow)	0.91
Dawn dish washing liquid (blue)	1.03
Rubbing alcohol (colorless)	0.87
Lamp oil	0.80
Honey	1.36
Baby oil	0.82

liquid. You should find that the weights of the liquids correspond to each different layer of liquid. For example, the honey will weigh more than the Karo syrup, etc. By weighing these liquids, you will find that density and weight are closely related.

Here are the densities of the liquids used in the column as well as other common liquids:

Have you found a way to make more than seven layers in your column? Let us know, we would love to hear you success story! Email us at webteam@stevespanglerscience.com

Additional Info

So, we've had the density column sitting in our office for a few days now and have noticed a very interesting change... the layers of vegetable oil and rubbing alcohol have switched places. The rubbing alcohol is now below the vegetable oil, indicating that the density has changed. We are not exactly sure why the change occurred.

Experiment: Liquid Layers - Straw Stack of Color

Who would have thought that playing with your food as a kid would lead to a cool science experiment as an adult? Better yet, it will keep the kids occupied for hours. The challenge starts with four different cups of colored water and a clear straw. When you mix red and blue liquid together, you get purple… right? Not so fast. How about a layer of blue liquid sitting on top of the red? Add two more colors and you have four layered liquids in one straw. The secret is density… and a steady hand.

Materials

- 5 clear, plastic cups (12-16 ounces)
- Salt
-Measuring spoons
- Food coloring
- Clear, plastic straw

1. Fill four of the plastic cups 3/4 full with water
2. Use food coloring to color each cup a different color – blue, red, green and yellow. You'll want the colors to be fairly dark, so add 15-20 drop of food coloring to each cup.
3. Add 1 tablespoon of salt to the blue water and stir.
4. Add 2 tablespoons of salt to the red water and stir.
5. Add 3 tablespoons of salt to the green water and stir.
6. Add 4 tablespoons of salt to the yellow water, and you guessed it, stir the water. Not all of the salt will dissolve immediately… and that's okay. Over time the salt will completely dissolve, but you don't have to wait for that to happen to get started.
7. This last step in preparing the solutions is very important… Add a little water to each cup so that the water level is the same in all four cups.
8. Let's practice the straw-dropper technique using plain water in the fifth cup. Place one end of the straw into the water – about an inch – and place your index finger over the other end of the straw. Pull the straw out of the water and notice how the water stays in the straw. If you release your finger, the water will fall out of the straw. Remember doing this as a kid with your drink? Hey, maybe you're still a kid and you're an expert! Make sure you can do this well before moving onto the next step.

9. It’s time to layer some liquids. Place the empty straw into the blue water (about an inch below the surface). Seal the other end of the straw with your index finger and remove the straw. There should be about an inch of blue water in the straw. Keep your finger firmly pressed against the top so the blue water doesn’t fall out.
10. Without releasing your finger, lower the straw into the red liquid about an inch lower than the blue liquid in the straw. Slowly release your finger from the top of the straw and the red liquid will push the blue layer up to the level of the water in the blue cup. Press your finger firmly on top of the straw and remove the straw. Look… you have two layers! Don’t get so excited that you release your finger from the top of the straw – you’ll have to start all over again! Also, be sure to hold the straw straight up and down (vertically) because tilting the straw will cause the liquids to mix and you’ll have to start again.
11. Lower the straw with the two colored layers into the green saltwater solution about an inch lower than the red solution in the straw. Slowly release pressure with your finger and the green solution will push the red and blue layers up about an inch. Seal the top of the straw with your index finger and move onto the yellow solution.
12. Lower the straw into the yellow solution (the suspense is killing you… it feels like your finger is going to fall off… but you continue!). Lower the straw about an inch below the top of the green layer and release your finger. The yellow liquid will push the top layers up. Put your index finger over the top of the straw one last time and remove the straw from the water. To everyone’s amazement, you have four layers of colored water in your straw! The on-lookers who have gathered to see what you’re doing start chanting, “We’re not worthy! We’re not worthy!”
13. All good things must come to an end. When it feels like your index finger is going to fall off, release the pressure and your masterpiece will fall into the fifth cup. The crowd yells, “Do it again!” and you can’t resist the temptation.

How does it work?

There’s really no trick to layering liquids as long as you understand the concept of density. In simplest terms, density is the quantity of something per unit measure (assuming that everything is at the same temperature and pressure). For example, you added 1 tablespoon of salt to the blue water, but you added 4 tablespoons of salt to the yellow water. So, the yellow solution has a greater density of salt than the blue water. The density of the yellow solution is greater than the green solution, which is greater than the red, which is greater than the blue. By increasing the amount of salt in each cup of water (and keeping the volume or the amount of water in each cup the same), each liquid had a different density. The solution with the highest density (yellow) stayed at the bottom of the straw while the solution with the least amount of salt (and the lowest density) remained at the top.

Experiment: Smoke Rings

Create a small blast of air or a giant ring of smoke!
Years ago, toy manufacturers like Wham-O used to sell air blasters that sent bursts of air sailing across a room to the surprise and delight of any innocent victim. With a little practice, it was quite easy to shoot a cup off of someone's head from 20 feet away. Whether you buy one from your favorite toy store or make your own, you'll have a blast with this retro science toy.

Materials

- 5 gallon bucket
- Bungee cord
- Plastic shower curtain or thick plastic sheet

It's easy to make your own air blaster using materials that you can easily find at the hardware store. Start by finding a 5 gallon plastic bucket (about $3 in any hardware store). Carefully cut a 2 to 3 inch hole in the bottom center of the bucket. The only thing left is to stretch a membrane across the top of the bucket. Believe it or not, a piece of clear plastic shower curtain works great. Just stretch a piece of the shower curtain over the top of the bucket and secure it in place using a bungee type cord. That's it! When you lightly hit the shower curtain with your hand or the end of a stick, an invisible blast of air shoots out of the hole. Just aim the air cannon at someone or something across the room and send a blast of air with a whack of the membrane.

How does it work?

This activity demonstrates the fact that air occupies space. As the rubber sheet is pushed into the interior of the bucket, the volume decreases and pressure increases. The increase in pressure forces some of the air out of the hole. The velocity at which the air leaves the bucket is inversely proportional to the diameter of the hole; the smaller the hole the greater the velocity of the air. Students may have experienced a similar phenomenon as they constrict a garden hose to increase the velocity of the flowing water.

The proper name for the air cannon device is vortex generator. The "ball" of air that shoots out of the cannon is actually a flat vortex of air, similar to rings of smoke blown by a talented cigar smoker.

Additional Info

Smoke Ring Launcher - Start by finding a round, plastic trash can. Rubbermaid makes trash cans that work quite well. Carefully cut a 25 cm hole in the bottom of the trash can. The only thing left is to stretch a membrane⍰ across the top of the can. I stretch a piece of clear plastic show curtain over the can and secure it in place using a bungee⍰ type cord. That's it! When you lightly hit the show curtain, a transparent ring of spinning air shoots out of the hole. Just aim the air cannon at someone or something across the room and send a blast of air with a whack of the membrane.

How can you make the invisible ring of smoke visible? With a little smoke, of course. The best smoke rings are made by filling the trash can with theatrical smoke. Smoke machines (foggers) are commonly used in stage productions. Check to see if your theater department has one, or see if you can borrow one from the disc-jockey who plays for your school dances!

The best smoke rings are made by gently tapping the shower curtain. A hard smack results in a fast, blast of air that is difficult to see. The flying vortices are best seen against a dark background with light coming from either side.

A vortex is generated because the air exiting the bucket at the center of the hole is traveling faster than the air exiting around the edge of the hole. That swirling or vortex motion can be observed if a little smoke is blown into the bucket just before giving the rubber membrane a gentle push.

Experiment: Color Changing Milk

It's an explosion of color! Some very unusual things happen when you mix a little milk, food coloring, and a drop of liquid soap. Use the experiment to amaze your friends and uncover the scientific secrets of soap.

Materials

- Milk (whole or 2%)
- Dinner plate
- Food coloring (red, yellow, green, blue)
- Dish-washing soap (Dawn brand works well)
- Cotton swabs

1. Pour enough milk in the dinner plate to completely cover the bottom and allow it to settle.

2. Add one drop of each of the four colors of food coloring - red, yellow, blue, and green - to the milk. Keep the drops close together in the center of the plate of milk.

3. Find a clean cotton swab for the next part of the experiment. Predict what will happen when you touch the tip of the cotton swab to the center of the milk. It's important not to stir the mix just touch it with the tip of the cotton swab.

4. Place a drop of liquid dish soap (the Dawn brand works well) on the tip of the cotton swab. Place the soapy end of the cotton swab back in the middle of the milk and hold it there for 10 to 15 seconds. Look at that burst of color! It's like the 4th of July in a bowl of milk: mini-explosions of color.

5. Add another drop of soap to the tip to the cotton swab and try it again. Experiment with placing the cotton swab at different places in the milk. Notice that the colors in the milk continue to move even when the cotton swab is removed. What makes the food coloring in the milk move?

How does it work?

Milk is mostly water but it also contains vitamins, minerals, proteins, and tiny droplets of fat suspended in solution. Fats and proteins are sensitive to changes in the surrounding solution (the milk).

When you add soap, the weak chemical bonds that hold the proteins in solution are altered. It's a free for all! The molecules of protein and fat bend, roll, twist, and contort in all directions. The food color molecules are bumped and shoved everywhere, providing an easy way to observe all the invisible activity. At the same time, soap molecules combine to form a micelle, or cluster of soap molecules. These micelles distribute the fat in the milk.

This rapidly mixing fat and soap causes swirling and churning where a micelle meets a fat droplet. When there are micelles and fat droplets everywhere the motion stops, but not until after you've enjoyed the show!

There's another reason the colors explode the way they do. Since milk is mostly water, it has surface tension like water. The drops of food coloring floating on the surface tend to stay put. Liquid soap wrecks the surface tension by breaking the cohesive bonds between water molecules and allowing the colors to zing throughout the milk. What a party!

Repeat the experiment using water in place of milk. Will you get the same eruption of color? Why or why not? What kind of milk produces the best swirling of color: skim, 1%, 2%, or whole milk? Why?

Additional Info

Detergent, because of its bipolar characteristics (hydrophilic on one end and hydrophobic on the other), weakens the milk's bonds by attaching to its fat molecules. The detergent's hydrophilic end dissolves in water and its water-fearing end attaches to a fat globule in the milk.

Experiment: Supersaturated Solution

Just one tiny crystal turns this liquid into a solid

Did you ever sneak an extra spoonful of sugar into your Kool-Aid as a kid but got caught when Mom saw the un-dissolved sugar at the bottom of the glass. If you had only known how to make a supersaturated solution, Mom would have never been the wiser. If you attempt to dissolve sugar in water, you reach a point where you cannot dissolve any more sugar. This is called a saturated solution. However, if you heat this solution, more sugar will dissolve. When the solution is cooled, the sugar will remain in solution. This is called a supersaturated solution, which is very unstable and will crystallize easily.

Materials

This is a popular demonstration performed by chemistry teachers that illustrates an exothermic reaction or the heat of crystallization. A similar demonstration can be performed using rechargeable hand warmers.

- Sodium acetate trihydrate
- Flask
- Hot plate
- Water

This experiment requires adult supervision.

Commercially available hand warmers use a supersaturated solution of sodium acetate. Chemistry teachers often demonstrate a supersaturated solution in the following manner:

1. Put 160 grams of sodium acetate in a flask and add 30 mL of water.
2. Heat gently and stir until the crystals of sodium acetate dissolve. Use a small amount of water to rinse down the inside of the flask.
3. Remove the flask from the heat and let it cool slowly without disturbing it.

4. Add one or two crystals (that's right, it only take a single crystal) to the liquid in the flask. Don't take your eyes off of the liquid as beautiful crystals begin to form inside the flask.

5. Feel the flask… it's warm! The process of crystallization gives off heat. It's said to be exothermic. That's why the solution is used in hand warmers.

How does it work?

How do Hand Warmers Work?
These products consist of a concentrated aqueous salt solution together with a flexible metallic activator strip (usually stainless steel) in a sealed, flexible container. Sodium acetate and calcium nitrate are examples of suitable salts. These salts are much more soluble in hot water than in cold water.

The flexible metal strip is bent back and forth a few times, whereupon a white cloud of crystals begins to precipitate. Within seconds, the entire pack is filled up with solid crystalline needles of sodium acetate without any solution left, and the temperature raises to 130°F for about 30 minutes. Because heat is released upon this precipitation, it is called an exothermic reaction (the opposite is called an endothermic reaction).

Supercooled liquids can be cooled below their normal freezing point without turning solid. Then, at the flick of button, the super cooled liquid is triggered to solidify (crystallize) and at the same time release large amounts of heat. Salt solutions that have been processed in such a way that their temperature can be lowered well below their solidification (or melting) temperature and still remain in liquid are defined as super cooled or metastable liquids.

The triggering device initiates the rapid solidification of the solution. In the case of salt solutions that release or absorb large amounts of energy during phase changes (common table salt sodium chloride does not do this), the solidification process is a rapid crystallization that releases large amount of heat at the salt solution's normal melting temperature.

The activator is a thin metal piece with ridges and a specially roughened surface. The flexing causes metal-to-metal contact that releases one or more very tiny particles of metal from the roughened surface. This acts as a nesting site for one crystal deposited from the solution and (voila!) all of the crystals fall out instantly. These heat packs are reusable because, by re-heating the pack in boiling water for a few minutes, the salt re-dissolves and the pack again contains a clear solution. Best of all, the activator strip can be reused dozens of times!

Experiment: Vanishing Styrofoam

Styrofoam vanishes like magic... or maybe not

You won't believe your eyes when you see what happens to ordinary packing peanuts when they come in contact with a solvent called acetone. They seem to just "disappear" like magic. In fact, the Styrofoam reacts with the solvent to reveal the fact that Styrofoam is made up of long strands of styrene molecules with lots of air pockets. This demonstration also reminds us about the importance of reducing our use of Styrofoam and replacing it with more Earth-friendly packing materials.

Materials

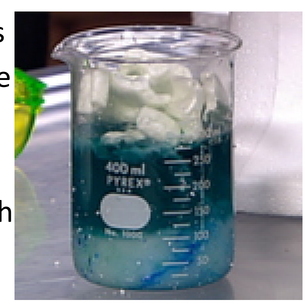
For the traditional Vanishing Peanuts demo, you'll need some Styrofoam packing peanuts and a few Styrofoam cups. Gather up a glass jar and some acetone solvent (this chemical can only be used by adults. Read all warnings and use as directed).

For the Enviro-Head demo, you'll need to find a Styrofoam head used to display wigs and a sheet of Styrofoam insulation. You can find the Styrofoam sheet at your local hardware store in the area where insulation is sold. This product comes in a variety of thicknesses - Steve used 3/4" for the demo in the video.

The final part of the demonstration uses starch peanuts that easily dissolve in water.

WARNING: Please follow all of the manufacturer's safety precautions listed on the container of acetone. This solvent is very flammable. Keep away from all flames.

Vanishing Peanuts

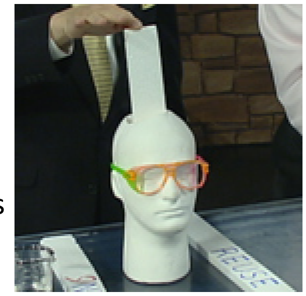


Use a solvent like acetone to show that polystyrene packaging material is mostly air. The acetone easily dissolves the polystyrene, leaving very little residue. Even though the experiment is called Melting Peanuts, the packaging material is actually dissolving (not melting) in the acetone (melting requires heat). Engage students in a peanut race by seeing which team can fill a bowl first with polystyrene peanuts. Of course, one bowl will secretly contain acetone! Use extreme care when handling acetone — follow the manufacturer's directions for proper use and disposal.

Air Head - Vanishing Styrofoam Strips

A Styrofoam head used to display wigs is placed on the table along with long strips of Styrofoam board, approximately 4 cm wide and 70 cm long (but this can vary). The demonstrator using a Sharpie pen to write down anything important she wants the "head" to know. For this demo, the three R's of recycling were written down on each of three strips - REDUCE, RECYCLE and REUSE. You'll also need a 250 mL beaker or similar size glass.

1. The first step is the trickiest one - to carve a huge hole in the top of the Styrofoam head. You want the hole big enough to hold the 250 mL beaker. For those non-metric people, you'll want a glass that holds about 8 ounces of liquid. You can use an electric drill with a door knob hole cutter blade to get the hole started, but it's going to take a little patience until the hole is just the right size.

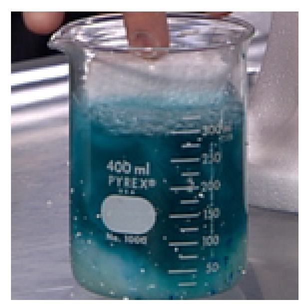


2. Fill the beaker with 200 mL of acetone (about 6 oz.) and carefully lower the beaker into the hole. Be careful not to spill any acetone on Styrofoam head or it too will dissolve!

3. You'll need a sharp knife (and an adult helper if you're a kid reading this) to cut the Styrofoam board into long strips. The width of each strip is determined by the diameter of the glass container in the head (250 mL beaker or otherwise). Cut as many strips as you feel the urge to make disappear.

   Important Note - Some of the Styrofoam board material has a thin, plastic covering on both sides. Remove any plastic wrapping before doing the demo.

4. Use a Sharpie pen to write down any words or phrases or whatever you want to "cram" into the Styro-Head.



5. It's show time! The story line is up to you... be creative. When it's time to make the strip vanish, slowly push the strip into the beaker of acetone, being careful not to make the acetone erupt onto the Styrofoam head. The illusion is great as it looks like the strip is "melting" into the head.

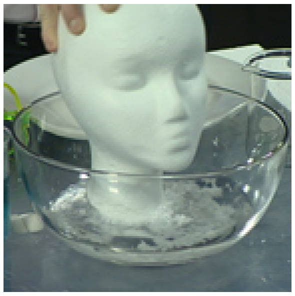
Starch-based Packaging Material
As a science teacher or an environmentalist, you are also aware of the bad effects that Styrofoam has on our environment. That's why many companies have turned to starch packing peanuts as a substitute for Styrofoam. Instead of taking up space in the landfills, starch peanuts dissolve in water to make landfill gravy!

Magic Noodles

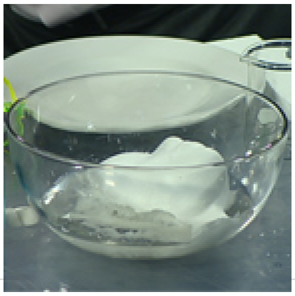
There's a product call Magic Noodles that help students learn the importance of environmentally friendly packing material while using their creativity. Here's how it works... Simply wet one end of the colored starch peanut with a dab of water and stick it to another peanut. Build houses, hats, glasses, letters, people, a medieval castle with flying buttresses... just build anything! Use the colored starch peanuts as an icebreaker or team building activity with adults or kids. They're great for staff meetings!

How does it work?

Currently about 200 million cubic feet per year of polystyrene "loose fill" (packaging material) is used in the United States. Although some companies try and reuse the packing material, most of the polystyrene loose fill is disposed of in a landfill. As students of science, we need to carefully examine such products and ask these questions: How is the material made, and what happens to it after it is used? One of the properties of polystyrene loose fill is that it does not compress easily. While this is beneficial when trying to protect something from being crushed or broken, it poses a problem when trying to dispose of it in a landfill. As a result, environmentally conscious companies sought a solution to these problems. One such solution is called Eco-Foam loose fill. It provides the ease of use and cushioning of polystyrene, but gives us many other re-use or disposal options for the future. It readily decomposes in water and can be re-used for your own packages, or you can dispose of it by putting it in your compost pile, watering it into your lawn, or washing it down the sink.



Eco-Foam is almost entirely made from an annually renewable resource… corn! The remaining ingredient is a water-soluble organic polymer called "polyvinyl alcohol." This organic polymer is made from carbon, hydrogen, and oxygen… the building blocks of life. When polyvinyl alcohol is exposed to water, naturally occurring bacteria feed on this organic polymer. Under wet conditions, the bacteria will use the starch (which is also composed of carbon, hydrogen, and oxygen) and polyvinyl alcohol as food to begin the cycle of life again.



Many people feel that the answer to our solid waste problem is recycling. While this method will go a long way to help our solid waste problems, it is not the whole solution. One good suggestion is to use as little of the material as possible. Secondly, it is makes sense to use a natural product (instead of a synthetic product) that will break down when we are finished using it. We must remember how to re-use!

Additional Info

Steve Spangler first saw the Styrofoam head demonstration performed by Patti Duncan at the NSTA Convention in Boston. Patti is a high school chemistry teacher who attributes the activity to Doug De La Matter from Canada.

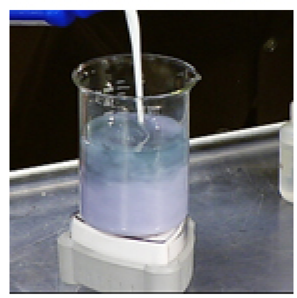
Experiment: Color Changing Milk of Magnesia: How Antacids Work in Your Stomach

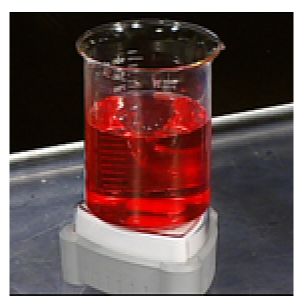
Sometimes great food and heartburn go hand in hand. Many people rely on products like Milk of Magnesia to settle their stomachs, but have you ever wondered how those antacids really work? This highly visual demonstration will show you exactly how Milk of Magnesia neutralizes the acids in your stomach - using some cool color changing chemistry - and saves the day after a great meal.

Materials

- Milk of Magnesia - almost any brand will work. Make sure the primary ingredient is magnesium hydroxide - $Mg(0H)_2$
- Universal Indicator - this is available from a chemical supplier. Cabbage Juice Indicator will work in place of Universal Indicator, but the color change is not as dramatic.
- Vinegar
- Magnetic stirring bar and stirring plate

1. Place about 100 mL of Milk of Magnesia in a 500 mL beaker and dilute with tap water until the beaker is about 1/2 full.
2. Add about 10 mL of Universal Indicator. (The Universal Indicator will provide the sharp color change you saw on TV). Remember that Universal Indicator will turn red on the far acidic end of the scale and dark blue on the alkaline side.
3. Use the magnetic stirrer to create a steady mix of the liquids. If you don't have a magnetic stirrer, hire a kid to stir it by hand. You'll see that the solution turns a light blue indicating that it is slightly basic due to the small amount of the $Mg(OH)_2$.
4. While stirring the solution, add a 10-20 mL of vinegar (it doesn't have to be precise) and observe the rapid color change. The mixture quickly changes red because the acid disperses throughout the beaker.





5. The acid neutralizes the small amount of hydroxide ion from the Mg(0H)2 that has dissolved first, then turns the solution acidic. However, as more of the Mg(0H)2 from the suspensions gradually dissolves into solution, the acid is neutralized and eventually the solution becomes basic.
6. You'll hear screams of "Do it again!"... and why not? Add more vinegar and watch as the liquid goes from red to orange to yellow to green and eventually settles at the bluish-purple color. In other words, the mixture changes through the entire Universal Indicator color range!
7. In time, all of the vinegar (acid) will react with the magnesium hydroxide and the solution will remain red. Take your well deserved bow and collect the check.

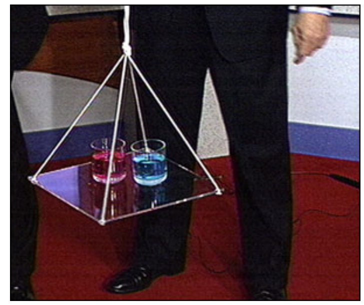
How does it work?

Milk of magnesia is a liquid used as an antacid and, sometimes, a laxative. Also known as magnesium hydroxide or Mg(OH)2, the solution is taken orally. The original concentrated formula was concocted by a man named Charles Henry Phillips in 1880, and sold under the brand Phillips' Milk of Magnesia. Today, the rights to the name "milk of magnesia" appear to be owned by Bayer Corporation and, interestingly, "Phillips' Milk of Magnesia" is owned by Sterling Drug.

Milk of magnesia is an alkaline suspension, meaning that it undergoes a neutralizing reaction when encountering anything acidic. This makes it an effective combatant of excess stomach acid when taken internally. Too much hydrochloric acid (HCl) excreted by the parietal cells in the stomach can lead to indigestion, heartburn and stomach ulcers. Milk of magnesia in the form of an antacid is dosed from 500 mg-1.5 mg (0.02-0.05 oz) and readily enters the stomach, where the hydroxide ions in milk of magnesia combine with the hydrogen ions in HCl to calm over activity in the stomach.

Experiment: Spinning Tray of Glasses and Hoop

Who can resist the temptation of swinging a pail of water over their head? This science stunt isn't just for kids as Steve Spangler proves with his swinging tray of glasses... filled with coffee. Steve has a most unusual way to mix his morning coffee. Thanks to a little help from gravity and centripetal force, a cup of coffee never tasted so good. Where's a stirring stick when you need one?



This demo is a slight modification of the classroom swinging pail of water demo. The picture shows the construction of the "spinning platform". The base is made from a square piece of Plexiglas measuring approximately 12 inches. Drill holes in all four corners large enough to accommodate a piece of rope. The ropes attached to each corner of the platform and are joined together in a knot about 2 feet above the platform.

Now that all of the difficult work is finished, it's time to swing the tray and plastic cup (several plastic cups if you're feeling lucky) around in a complete circle without spilling the liquid or flinging the cup around the room. It's the tendency for the plastic cup and its contents to go in a straight line that allows it to seemingly defy gravity. The centripetal force provided by the tension in the cords is large enough to create enough friction to hold the plastic cup(s) in place.

Here's a little advice... practice swinging the tray around without the cups in order to get the feel of a smooth, circular motion. Then add the cup filled half full with water. The liquid adds mass to the cup and to keep the cups in place. Some demonstrators even glue a thin piece of rubber to the bottom of the cup to give it a little gripping power (okay, friction) to help the cups stay in place. Shhhh! That's a little secret between you and me.

Spinning Hoop & Cup Trick - This is yet another variation on the classroom "swing the pail over your head trick", but this version uses a large hoop and a cup of... whatever you want spilled on the floor! Steve

Spangler learned this juggling stunt from Mike Caveny, a world-classroom entertainer who gave Steve this advice: "There's really no trick to it... just start practicing your spins and hoop twirls until the cup doesn't fall on the floor. Good luck." When asked about the origins of the stunt, Mike recalls reading about the trick done by a Russian circus performer at the turn of the century. To see Mike Caveny perform the hoop trick is poetry in motion.

How does it work?

Here's the heavy-duty science for people who really care...

According to Newton's first law of motion, objects in motion tend to remain in motion unless acted upon by an external force. In this case, Newton's law requires the water to continue moving along a tangent to the circle. Thus a force is required to keep it always turning toward the center of the circle. The interpretation of this demonstration is potentially confusing when one considers that at the top of its arc, the water is accelerating downward because of the motion, but that the force of gravity is also downward. One can explain that $F = ma$ is thus satisfied without the water leaving the bucket. This demonstration provides the opportunity to discuss non-inertial (accelerated) frames of reference and inertial (fictitious) forces (such as the centrifugal force).

Additional Info

Okay, the lawyers remind us to inform you that twirling, spinning or otherwise throwing cups of water around can be harmful to the walls, furniture, flooring and any living being with a 30 foot radius. It's best to perform this demo outdoors away from all civilization. You should be wearing a helmet and protective body armor as well. Have fun.

Experiment: Incredible Growing Marshmallows

The Classroom Vacuum Packer is an amazing device that vacuum packs food to seal in the freshness... according to those late night infomercials. It's also a great device to explore the amazing properties of air pressure. Fill the special storage container with marshmallows (okay, a poor little marshmallow bunny) and remove the air. Watch out! it's the incredible growing marshmallow trick!

Materials

- Classroom Vacuum Packer machine from your local department store (Foodsaver® or Black & Decker FreshGuard® devices work well)
- Classroom Vacuum Packer storage containers
- Marshmallows of various sizes
- Marshmallow chickens, bunnies or anything else that's in season

Not many kids have their own classroom vacuum packer, so it goes without saying that adult supervision is required. Hey kids you'll have to fight for time with the vacuum packer machine after Mom and Dad figure this one out! Be sure to read and follow the manufacturer's direction for using your specific classroom vacuum packer.

1. Fill the storage container jar a quarter full with marshmallows and replace the lid.
2. Attach the special vacuum hose that came with the unit.
3. Place the hose over the vacuum port on the lid and start the vacuum packer.
4. Don't take your eyes off those marshmallows! Why are they getting so big? When the unit turns off, remove the hose and stare at the marshmallows in amazement.
5. Make sure everyone is watching when you release the vacuum. Watch as the marshmallows shrink when the air comes rushing back into the container.
6. Repeat the experiment using a marshmallow bunny or try filling the container with marshmallow Peeps®. Wake the kids those little chickens are getting huge!

How does it work?

The job of the vacuum packer is to remove the air from inside the storage container. Under normal conditions, molecules of air from the atmosphere (called atmospheric pressure) are pushing on the outside of the marshmallow. When the vacuum packer removes the air that was once pushing on the outside of the marshmallow, the air trapped inside the marshmallow pushes out (expands) causing it to get larger. The marshmallows shrink when the vacuum seal is broken and air rushes back into the container.

READ THIS! Please note that no marshmallow bunnies were actually harmed while conducting this experiment except for the fact that a kid in the audience bit the bunny's ears off after the experiment. On the advice of my wife's husband, be sure to return the Classroom Vacuum Packer home before someone notices that it's gone.

Additional Info

Now that you understand the concept, try using a small balloon in place of the marshmallows or fill the storage container with soap bubbles. What would happen if you placed a small bag of potato chips into a large storage container and removed the air? Let's say the goal was to shrink the marshmallows - how would you do it? Place the marshmallows into one of the plastic storage bags that came with the vacuum packer. When the air is removed from inside the bag, you get to see how the powerful properties of the air in the atmosphere as it compresses the marshmallows. Also see the Marshmallow Masher experiment.

Thanks to Patti Duncan from High Point High School in Sussex County New Jersey for sharing this idea.

Experiment: Lemon Suds

Here's a twist on a classroom chemical reaction made for young children. Just squeeze a little lemon juice into the container and stir the concoction… lemon suds appear like magic! It's so simple to do and kids scream, "Do it again!" When you're finished making a mountain of bubbles, use the lemon-scented suds as a great cleaner.

Materials

- Lemon (cut into quarters)
- Plastic cup (8 oz.)
- Liquid soap (Ivory or Dawn)
- Baking soda
- Measuring spoon
- Straw
- Safety glasses
- Paper towel (you can't be a messy scientist)

- Measure 1 teaspoon of baking soda into the empty cup.
- Add a squirt (okay, about a teaspoon) of liquid soap to the cup. Use the straw to stir the mixture. Your set-up is complete!
- It's show time! Hold the cup in your left hand – being careful to conceal the secret mixture in the bottom of the cup with your hand – and pick-up the piece of lemon with your right hand. "Some people use lemon to flavor their ice tea… I use lemon to make soap. Watch this…"
- Put on your safety glasses (this only adds to the suspense!) Squeeze the lemon into the cup (squeeze hard to get as much lemon juice as possible) and stir the mixture with your straw. In just a few seconds, a chemical reaction occurs and the cup fills with lemon suds! "Can you guess what I made? No, not a drink… it's lemon suds soap!"
- Scoop out some of the suds with your hands to show the incredible cleaning power of your new concoction. "So, what do you think I used to make the lemon suds?" After your audience has exhausted all of their guesses, pull out a new cup and show them your secret recipe.
- When you're finished, this mixture can be poured down the drain.

How does it work?

This is a simple but elegant example of a classroom chemical reaction between baking soda and citric acid (lemon juice). When the citric acid combines with the baking soda, a chemical reaction takes place producing carbon dioxide gas (those are the bubbles) and water. You also produce a small amount of sodium citrate (just in case you were wondering).

Additional Info

This was a favorite demonstration of the late Dr. Babu George from Sacred Heart University in Connecticut. Dr. George was a highly respected organic chemist who had a passion for getting elementary teachers excited about teaching science. Dr. George used simple demonstrations like "Lemon Suds" to introduce both students and teachers to the magic of chemistry. Thanks to Laura Slocum from University High School of Indiana for sharing this idea.

Experiment: Think Ink! - The Clock Reaction

Two clear liquids are mixed together and the audience is told to watch closely... "Don't take your eyes off the liquid or you'll miss it!" Then, in a flash, the clear water changes to ink (or so they think!). Clock reactions like this never fail to capture the student's attention, and the Iodine Clock Reaction is one of the most startling chemical demonstrations you'll ever see. "How did that happen?" is almost always the reaction, and when students ask "How?", they're ready to learn.

Think Ink! illustrates the amazing chemistry behind the classroom clock reaction where molecules meet up and change over time to create this startling reaction. Unlike the classroom iodine clock reaction from your high school chemistry classroom, our new Think Ink! formula uses a classroom chemistry approach to achieve even better results. And yes... this is the same reaction that Steve Spangler shares in his live performances and recently featured on the Ellen DeGeneres Show.

What's included?

This kit includes enough materials to do the demonstration 30 times!

- 2 Mega Test Tubes and Rack
- Timing Mixture
- Trigger Powder
- Starch pellets
- Recycling Powder
- 3 White measuring scoops
- 2 Stirring rods
- 1 Pair of safety glasses

What does it teach?

The Think Ink! kit helps teach the following chemical concepts...

- Rate of reaction as a function of temperature

- Rate of reaction as a function of reactant concentration

How does it work?

This reaction is referred to as the Landolt Clock Reaction, named after There are three steps in the process that cause this amazing reaction. When you prepare the Solutions A, B and C, the chemicals begin to mix and form new chemical compounds. This is a very slow reaction, though, so you don’t see any outward changes. When you begin to pour the solutions together a much faster reaction occurs, which leads to the third reaction which is instant. Suddenly, and immeasurably quickly, the clear liquids turn into a jet black iodine-starch complex. These reactions happen at different intervals because different chemicals react at different speeds.

Additional Info

Discussion of the Chemistry...

The sudden change from a colorless solution to the blue-black solution is the result of four sequential reactions. First, the bisulfite ions (HSO3-) reduce some of the iodate ions (IO3-) to form iodide ions (I-). Next, the iodide ions (I-) are oxidized by the remaining iodate ions (IO3-) to form triiodide ions (I3-). The solution now consists of triiodide ions (I3-) and soluble starch. In the third reaction, the triiodide ions (I3-) get reduced by the bisulfite ions (HSO3-) to become iodide ions (I-). That continues until all of the bisulfite has been consumed. Finally, the triiodide ions and starch combine to form the dark blue-black starch complex that looks like ink.

Experiment: Make Your Own Bubbling Lava Lamp

Learn how to make an inexpensive science toy that will be a guaranteed hit with the kids! Okay, so everyone knows that oil and water don't mix. Try adding a few drops of food coloring and a little Alka-Seltzer fizz to the solution and the bubbling concoction is guaranteed to provoke a few ooohs & ahhhs!

Materials

- One clean, plastic soda bottle (16 oz. size works well)
- Soda bottle cap
- Vegetable oil (the cheaper the better)
- Food coloring
- An Alka-Seltzer tablet
- Water

- Fill the bottle 3/4 full with vegetable oil.
- Fill the rest of the bottle with water (almost to the top but not overflowing).
- Add about 10 drops of food coloring. Be sure to make the water fairly dark in color. Notice that the food coloring only colors the water and not the oil. Hmmm?
- Divide the Alka-Seltzer tablet into 8 pieces.
- Drop one of the tiny pieces of Alka-Seltzer into the oil and water mixture. Watch what happens. When the bubbling stops, add another chunk of Alka-Seltzer. It's just like a lava lamp!
- When you have used up all of the Alka-Seltzer and the bubbling has completely stopped, screw on the soda bottle cap. Tip the bottle back and forth and watch the wave appear. The tiny droplets of liquid join together to make one big lava-like blob.

How does it work?

First of all, you confirmed what you already knew... oil and water do not mix. The molecules of water do not like to mix with the molecules of oil. Even if you try to really shake-up the bottle, the oil breaks up into small little drops, but the oil doesn't mix with the water. Food coloring only mixes with water. That's why it does not color the oil.

When you poured the water into the soda bottle with the oil, the water sank to the bottom. That's because water is heavier than oil. Scientists say that the water is more dense than the oil. If oil from a ship spills in the ocean, the oil floats on top of the water.

Here's the surprising part... The Alka-Seltzer tablet reacted with the water to make tiny bubbles of carbon dioxide gas. These bubbles attached themselves to the blobs of colored water and cause them to float to the surface. When the bubbles popped, the color blobs sank back to the bottom of the bottle. Now that's a burst of color!

Soft Drinks and Coca Cola: A History

Soft drinks can trace their history back to the mineral water found in natural springs. Bathing in natural springs has long been considered a healthy thing to do; and mineral water was said to have curative powers. Scientists soon discovered that gas carbonium or carbon dioxide was behind the bubbles in natural mineral water.

The first marketed soft drinks (non-carbonated) appeared in the 17th century. They were made from water and lemon juice sweetened with honey. In 1676, the Compagnie de Limonadiers of Paris were granted a monopoly for the sale of lemonade soft drinks. Vendors would carry tanks of lemonade on their backs and dispensed cups of the soft drink to thirsty Parisians.

In 1767, the first drinkable man-made glass of carbonated water was created by Englishmen **Doctor Joseph Priestley.**

Three years later, Swedish chemist **Torbern Bergman** invented a generating apparatus that made carbonated water from chalk by the use of sulfuric acid. Bergman's apparatus allowed imitation mineral water to be produced in large amounts.

In 1810, the first United States patent was issued for the "means of mass manufacture of imitation mineral waters" to Simons and Rundell of Charleston, South Carolina. However, carbonated beverages did not achieve great popularity in America until 1832, when **John Mathews** invented his apparatus for the making carbonated water. John Mathews then mass-manufactured his apparatus for sale to soda fountain owners.

The drinking of either natural or artificial mineral water was considered a healthy practice. The American pharmacists selling mineral waters began to add medicinal and flavorful herbs to unflavored mineral water. They used birch bark, dandelion, sarsaparilla, and fruit extracts. Some historians consider that the first flavored carbonated soft drink was that made in 1807 by **Doctor Philip Syng Physick** of Philadelphia. Early American pharmacies with soda fountains became a popular part of culture. The customers soon wanted to take their "health" drinks home with them and a soft drink bottling industry grew from consumer demand.

Over 1,500 U.S. patents were filed for a cork, cap, or lid for the carbonated drink bottle tops during the early days of the bottling industry. Carbonated drink bottles are under a lot of pressure from the gas. Inventors were trying to find the best way to prevent the carbon dioxide or bubbles from escaping. In 1892, the "Crown Cork Bottle Seal" was patented by **William Painter**, a Baltimore machine shop operator. It was the first very successful method of keeping the bubbles in the bottle.

In 1899, the first patent was issued for a glass-blowing machine for the automatic production of glass bottles. Earlier glass bottles had all been hand-blown. Four years later, the new bottle-blowing machine was in operation. It was first operated by the inventor, **Michael Owens**, an employee of Libby Glass Company. Within a few years, glass bottle production increased from 1,500 bottles a day to 57,000 bottles a day.

During the 1920s, the first "Hom-Paks" were invented. "Hom-Paks" are the familiar six-pack beverage carrying cartons made from cardboard. Automatic **vending machines** also began to appear in the 1920s. The soft drink had become an American mainstay.

Fascinating facts about the invention of Coca-Cola® by John S. Pemberton in 1886.

AT A GLANCE:

The product that has given the world its best-known taste was born in Atlanta, Georgia, on May 8, 1886. Dr. John Stith Pemberton, a local pharmacist, produced the syrup for Coca-Cola®, and carried a jug of the new product down the street to Jacobs' Pharmacy, where it was sampled, pronounced "excellent" and placed on sale for five cents a glass as a soda fountain drink.

The Story:

It was a prohibition law, enacted in Atlanta in 1886, that persuaded physician and chemist Dr. John Stith Pemberton to rename and rewrite the formula for his popular nerve tonic, stimulant and headache remedy, "Pemberton's French Wine Coca," sold at that time by most, if not all, of the city's druggists.

So when the new Coca-Cola debuted later that year--still possessing "the valuable tonic and nerve stimulant properties of the coca plant and cola nuts," yet sweetened with sugar instead of wine--Pemberton advertised it not only as a "delicious, exhilarating, refreshing and invigorating" soda-fountain beverage but also as the ideal "temperance drink."

Dr. John Stith Pemberton, a local pharmacist, produced the syrup for Coca-Cola®, and carried a jug of the new product down the street to Jacobs' Pharmacy, where it was sampled, pronounced "excellent" and placed on sale for five cents a glass as a soda fountain drink. Carbonated water was teamed with the new syrup to produce a drink that was at once "Delicious and Refreshing," .Dr. Pemberton's partner and bookkeeper, Frank M. Robinson, suggested the name and penned the now famous trademark "Coca-Cola" in his unique script. The first newspaper ad for Coca-Cola soon appeared in The Atlanta Journal, inviting thirsty citizens to try "the new and popular soda fountain drink." Hand-painted oilcloth signs reading "Coca-Cola" appeared on store awnings, with the suggestion "Drink" added to inform passersby that the new beverage was for soda fountain refreshment.

Dr. Pemberton never realized the potential of the beverage he created. He gradually sold portions of his business to various partners and, just prior to his death in 1888, sold his remaining interest in Coca-Cola to Asa G. Candler. An Atlantan with great business acumen, Mr. Candler proceeded to buy additional rights and acquire complete control.

On May 1, 1889, Asa Candler published a full-page advertisement in The Atlanta Journal, proclaiming his wholesale and retail drug business as "sole proprietors of Coca-Cola ... Delicious. Refreshing. Exhilarating. Invigorating." Sole ownership, which Mr. Candler did not actually achieve until 1891, cost a total of $2,300.

By 1892, Mr. Candler's flair for merchandising had boosted sales of Coca-Cola syrup nearly tenfold. He soon liquidated his pharmaceutical business and focused his full attention on the soft drink. With his brother, John S. Candler, John Pemberton's former partner Frank Robinson and two other associates, Mr. Candler formed a Georgia corporation named The Coca-Cola Company. Initial capitalization was $100,000.

The trademark "Coca-Cola," used in the marketplace since 1886, was registered in the United States Patent Office on January 31, 1893. (Registration has been renewed periodically.) That same year the first dividend was paid; at $20 per share, it amounted to 20 percent of the book value of a share of stock.

A firm believer in advertising, Mr. Candler expanded on Dr. Pemberton's marketing efforts, distributing thousands of coupons for a complimentary glass of Coca-Cola. He promoted the product incessantly, distributing souvenir fans, calendars, clocks, urns and countless novelties, all depicting the trademark. The business continued to grow, and in 1894, the first syrup manufacturing plant outside Atlanta was opened in Dallas, Texas. Others were opened in Chicago, Illinois, and Los Angeles, California, the following year.

While Mr. Candler's efforts focused on boosting soda fountain sales, another concept was being developed that would spread the enjoyment of Coca-Cola worldwide. In 1894, in Vicksburg, Mississippi, Joseph A. Biedenharn was so impressed by the growing demand for Coca-Cola at his soda fountain that he installed bottling machinery in the rear of his store and began to sell cases of Coca-Cola to farms and lumber camps up and down the Mississippi River. He was the first bottler of Coca-Cola.

Large-scale bottling was made possible in 1899, when Benjamin F. Thomas and Joseph B. Whitehead of Chattanooga, Tennessee, secured from Mr. Candler the exclusive rights to bottle and sell Coca-Cola in practically the entire United States. With contract in hand, they joined another Chattanoogan, John T. Lupton, and began to develop what is today the worldwide Coca-Cola bottling system.

A variety of straight-sided containers was used through 1915, but as soft-drink competition intensified, so did imitation. Coca-Cola wanted a unique package, and in 1916, the bottlers approved the contour bottle designed by the Root Glass Company of Terre Haute, Indiana.

The now-familiar shape was granted registration as a trademark by the U.S. Patent Office in 1977, an honor accorded only a handful of other packages. The bottle thus joined the trademarks "Coca-Cola," registered in 1893, and "Coke®," registered in 1945.

In 1919, the Candler interests sold The Coca-Cola Company to Atlanta banker Ernest Woodruff and an investor group for $25 million. The business was reincorporated as a Delaware corporation, and 500,000 shares of its common stock were sold publicly for $40 per share.

The Company pioneered the innovative six-bottle carton in the early 1920s, for example, making it easier for the consumer to take Coca-Cola home. The simple cardboard carton, described as "a home package with a handle of invitation," became one of the industry's most powerful merchandising tools. By the end of 1928, Coca-Cola sales in bottles had for the first time exceeded fountain sales.

During 1886, Coca Cola's first year, sales averaged a modest nine drinks per day. In 2004, over 1.3 billion beverage servings are sold each day. Although Coca-Cola® was first created in the United States, it quickly became popular wherever it went. Today, they produce nearly 400 brands in over 200 countries. More than 70 percent of their income comes from outside the U.S., making The Coca-Cola Company a truly global company.

Experiment: Making Lemonade Fizzy Drink

What you'll need:

- Lemon
- Drinking glass
- Water
- 1 teaspoon of baking soda
- Some sugar to make it sweet

Instructions:

1. Squeeze as much of the juice from the lemon as you can into the glass.
2. Pour in an equal amount of water as lemon juice.
3. Stir in the teaspoon of baking soda.
4. Give the mixture a taste and add in some sugar if you think it needs to be sweeter.

What's happening?

The mixture you created should go bubbly and taste like a lemonade, soda, fizzy or soft drink, if you added some sugar it might even taste like a lemon flavored soft drink you've bought at a store. The bubbles that form when you add the baking soda to the lemon mixture are carbon dioxide (CO_2), these are the same bubbles you'll find in fizzy drinks. Of course they add a few other flavored sweeteners but it's not much different to what you made. If you are wondering how the carbon dioxide bubbles formed, it was because you created a chemical reaction when you added the lemon (an acid) to the baking soda (a base). Now, experiment with other juices, will they work the same?

Experiment: Try a Spooky, Bubbling Beverage

The next time you have a craving for a sparkling beverage, make your own batch using what you know about dry ice. Fill a bowl or pitcher with apple juice and use gloves or tongs to add a few large pieces of dry ice. While the mixture is bubbling and burping, the apple juice is being carbonated by the dry ice. That is, carbon dioxide gas is mixing with the juice to make a "sparkling" drink. Wait until the dry ice is completely gone before serving the apple juice. It's a spooky, carbonated drink.

Additional Soda Recipes:

Homemade Ginger Ale

Serves 6

3 c. ginger, peeled and sliced
3 c. sugar
3 c. water
2 qts. **soda water**
lime wedges
4 mint sprigs

Mix ginger, sugar, and water in a saucepan and bring to a slow simmer. Reduce by half and strain. As the liquid cools it will become thicker and syrupy.

In a tall glass of ice, add mint sprig and a ratio of 1 part ginger syrup to 7 parts soda water. Squeeze a little juice from the lime, stir, and add a lime wedge to the drink.

Variations:
For a Ginger Ale Float add a scoop of vanilla ice cream.

Homemade Blackberry Soda

With some fruity syrup and seltzer water you'll have a delicious homemade soda pop!

1 1/4 cups granulated sugar
1 cup water
12 oz (about 1 1/2 cups) frozen blackberries or raspberries, thawed

In a medium saucepan combine all of the ingredients and bring to a boil over medium high heat. Reduce heat slightly and simmer 5 to 7 minutes, gently stirring once, if needed, to separate the berries.

Set syrup aside to cool. Strain.

Add a couple of tablespoons of syrup (or to taste) to glass of sparkling water. Stir and serve. Try other flavors as well.

Experiment: Brew Your Own Flavored Soda or Root Beer (Kit)

Before people could buy root beer (the original American soda), they made it themselves using sugar, herbs, and (of course) roots.

Many kits provide premixed root beer extract, special brewing yeast, funnel, blank labels, and complete instructions for up to four gallons of root beer, bottled in recycled soda bottles with your own custom-designed labels.

Experiment: Brew Soda without a Kit

Making soda is really very easy and much less expensive than store bought soda and makes for a delicious experiment. It is carbonated just like "regular" soda from a store and you can control the flavors. The yeast in the soda consumes some of the sugar and creates natural carbonation or "fizz".

Materials:

- Several empty screw top 2 liter soda bottles to hold your creation
- Sugar
- A container to mix all the ingredients in (ex. a one gallon jug)
- Yeast (ex. regular Red Star or Fleischmann's yeast)
- a funnel to fill the 2 liter bottles,
- a measuring spoon set
- a cup to dissolve the yeast in
- soda flavorings (Supermarkets sell them in Root Beer, Ginger Ale, Cola, Cream Soda, Orange, Grape, and Dr. P.)

Basic recipe: Dissolve 1/8 teaspoon of yeast in a coffee cup of warm water for about 5 minutes. Yeast should be fresh and the water should be about baby bottle warm (98-110 degrees F). Too little yeast will not yield enough carbonation, too much will give the soda a "yeasty" taste and might burst your soda bottles. Water too hot or too cold will have the same effect as not enough yeast because in cold water it will stay dormant and in too hot water it will be killed off.

Then mix 2 ¼ cups of white sugar, 1 tablespoon + 1 teaspoon of flavoring extract, the dissolved yeast and enough extra water to make 1 gallon together in the gallon jug. Shake to mix for about 2 minutes until the sugar is completely dissolved in the water. Pour ½ the mix into each of the two 2 liter bottles, cap tightly and wait 4-6 days. You can tell how your carbonation is coming along by just squeezing the bottles. If they get too firm open the cap and let off a little of the carbonation.

Experiment: Sinking Soda Surprise

Plug the drain, fill the sink with water, and take the plunge with Steve Spangler's floating science challenge. We all know that certain things float in water while other things sink, but why? Do all heavy things sink? Why does a penny sink and an aircraft carrier floats? Think you know the answers? Well, get ready for a few amazing surprises!

Materials

- An assortment of unopened soda cans (diet, regular, brand name, generic)
- A large, deep container of water like a 5 gallon bucket or an aquarium

1. Ask your audience the question: "Will this can of regular soda float or sink in the bucket of water?" After gathering everyone's answer, place the can of regular soda in the water and notice that it sinks to the bottom. Note: If the can of regular soda floats, you might have an air bubble trapped under the bottom of the can. Make sure that you select a can of regular soda that sinks.
2. Pick up a can of diet soda and pose the same question. Be sure to point out the fact that the cans are exactly the same size and shape and contain the same amount of liquid (compare the number of milliliters… probably 355 ml). Place the can of diet soda in the water and notice that it floats! Show your audience that there are no bubbles trapped under the bottom. It still floats. Why?
3. Let your group experiment with different kinds of soda. Why do the diet sodas float and the regular soda cans sink?

How does it work?

This is a fascinating demonstration, and is an excellent way to learn about density. We are all familiar with the basic concept of sinking or floating. Objects less dense than water float, and those more dense than water sink. Empty cans float, rocks sink. This is only possible because of differences in density. If both cans could be placed on a double pan balance, it would be clear that the regular soda is heavier than the diet soda. This demonstrates the difference between mass and volume.

Mass refers to how much stuff exists within an object. If something is heavier than another object, it contains more mass. Mass is measured in grams. Volume, on the other hand, refers to how much space an object occupies. For fluids, volume is usually measured in liters (L) or milliliters (ml). There are 1000 ml in one liter. Since both cans have the same volume, the heavier can must have a greater mass. We can now conclude that the heavier can is denser than the lighter can.

Diet sodas usually contain aspartame, an artificial sweetener, while regular sodas use sugar. Take a look at the nutritional information on the side of the cans. Notice how much sugar is in a regular soda (look under carbohydrates). Most regular sodas have about 41 grams of sugar. How much is 41 grams? Try 18 packets of sugar like the ones you might find at a restaurant! Diet soda is flavored with a relatively small amount of an artificial sweetener (like aspartame) which is 200 times sweeter than an equal amount of sugar. Therefore, only a tiny amount of aspartame is needed. Both sugar and aspartame are denser than water, which can be easily demonstrated by adding small amounts of each to a container of water. So it is actually a matter of how much of each is used. The 41 grams or so of sugar added to a can of regular soda makes it sink. The relatively tiny amount of aspartame used in diet sodas will have a negligible effect on the mass, enabling the can to still float.

So why then do cans of diet soda float? It is all due to the fact that there is a little bit of space, called "headspace," above the fluid in each can of soda. This space is filled with gas, which is much less dense than the soda, itself. It is this space above the soda that lowers the density of diet drinks just enough to make them float. Sugared drinks still have this headspace, but the excessive amounts of sugar added makes the can denser than water.

For this experiment, there is an easy way to calculate the density of the two types of soda, to further examine why one floats and the other sinks. Mathematically speaking, density is mass per unit volume. Therefore, the formula for calculating density is:

$$\text{Density} = \frac{\text{mass}}{\text{volume}} = \text{g/mL}$$

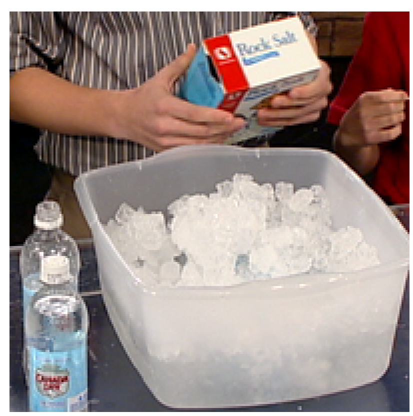
Now, you can calculate the density in both the Diet Soda and Regular Soda by dividing the mass (weight) of the soda, in grams, by the volume of the soda, in milliliters. You will quickly see that the density of the Regular Soda is greater than the density of the Diet Soda... so, one sinks and one floats!

Experiment-Instant Freeze - Soda Ice

It might have happened to you... You put a bottle of soda in the freezer for a few minutes just to get it ice cold. When you take the soda out of the freezer, it's still a liquid (nothing unusual has happened just yet). However, the second you twist off the cap, the soda instantly freezes! The process is amazing to watch... but it's a real bummer if you were thirsty (because it's tough to suck ice out of the bottle). This is a great illustration of how carbon dioxide can lower the freezing point of water. Get some ice, some salt and some plastic bottles of soda water and try this very cool science demo.

Materials

- Seltzer water - flavored or plain in plastic bottles. Do not use glass bottles as the liquid may accidentally freeze in the bottle, causing it to explode.
- Large bucket
- Ice
- Rock salt
- Thermometer



1. The demonstration works best if you place the unopened bottles of soda in the refrigerator for a few hours before attempting the activity.
2. Start by filling the bucket or container 3/4 full with ice.
3. Cover the ice with a thin layer of rock salt.
4. Place the cooled bottles of soda in the ice-salt mixture.
5. Place the thermometer in the ice mixture - position the thermometer as close to one of the bottles as possible to get the most accurate reading of the bottle temperature.

6. Watch the thermometer closely. The temperature of the soda needs to get down to about 17°F (that's -8°C) for approximately 10 minutes. If the soda gets any colder, the liquid will freeze prematurely.

7. Once the soda has been at the appropriate temperature for 10 minutes, gently remove the bottle from the ice-salt mixture and open the bottle. Ice crystals should immediately form at the top of the bottle and quickly make their way down to the bottle, creating an instant freeze.

Again, never use glass bottles for this demonstration as the soda may accidentally freeze, causing the bottle to explode.

How does it work?

We offer two explanations for this phenomenon - be sure to read the second one!

Explanation #1
When soda is produced, large quantities of additives (like sugar and flavoring) and carbon dioxide bubbles are pumped into water to create bubbly, sugary soda pop. These additives are called solutes and when solutes are added to a liquid such as water, the freezing point of the water decreases. By lowering the freezing point, the soda has to reach a much colder temperature to freeze than water. However, the concentration of carbon dioxide in the soda is only maintained as long as the bottle is kept sealed. As soon as the soda is opened, and you hear that "whoosh" of fizz (carbon dioxide) rushing out of the bottle, the concentration of solutes in the water goes down, and the freezing point goes up. Now, without all that extra carbon dioxide, the soda will freeze much quicker.

Another Explanation?
Well, that's the explanation that many science teachers have used over the years. But Joe Franek from the Department of Chemistry at the University of Minnesota, offers another explanation...

"The more likely explanation is that you have a super cooled solution that is simply waiting for something to allow it to begin freezing. Opening the bottle allows carbon dioxide bubbles to form and these bubbles provide a place for the nucleation of the ice crystals to begin occurring. You can test this explanation by tapping the chilled bottle without opening it. You should manage to get some bubble formation from the tapping and you should see the freezing occur."

We think Joe Franek is pretty smart since we've noticed that some of the bottles will freeze *without* opening the caps. Hmmm? Joe Franek hit the nail on the head! Opening the caps and releasing the bubbles is just one way to allow the freezing to begin. Taping or giggling the bottle will also release a few bubbles - just enough for ice crystals to begin to form.

Thanks to Joe Franek and the Chemistry Department at the University of Minnesota for their help.

Experiment: Soda Can Shake-up

Have you ever wondered why shaking a soda results in a great explosion when it's opened? What causes a 2-liter bottle of soda to go flat? Is there anything that can be done to keep fizz in a bottle of soda? Get ready to uncover some amazing soda secrets that will change your soda drinking habits.

Materials:

Cans of unopened soda. It's best to practice with clear liquids! Try club soda. IMPORTANT: Diet soda does not work... you'll learn why later.

Since the fizz in the soda is actually dissolved carbon dioxide gas, the goal is to keep as much of the gas in the bottle as possible. Soda fizzes when dissolved carbon dioxide gas is released in the form of bubbles. At the bottling plant, carbon dioxide molecules are forced into the soda in an amount that is greater than would ordinarily dissolve under atmospheric conditions. As soon as you open the bottle, most of the excess gas escapes into the room - that's a given! So, it's your job to find a way to keep the remaining gas in the liquid.

Experiment:

- Vigorously shake a sealed can of soda.
- Invite a dinner guest to immediately open the can! Of course, most sane people will refuse the offer.
- With a little science know-how, you'll be able to open the can without spilling a drop. The secret is to use your finger to snap the side of the can. This action dislodges the bubbles attached to the side of the can and they float to the top. When the can is opened, the gas simply escapes. As you will soon discover, tapping the top of the can does nothing.

How Does It Work:

Shaking the unopened can of soda causes bubbles of carbon dioxide to line the inside walls of the can. When you open the can, the pressure in the can goes down and the volume of each bubble goes up (Boyle's Law). The quickly expanding bubbles force the liquid that rests above it out of the can.

Additional Information:

Most people have learned to tap the top of the can before opening it. Scientifically speaking, THIS DOES NOTHING! However, tapping the side of the can knocks bubbles off the bottom and sides of the can, at which point they rise to the top. The trick is to dislodge the bubbles from the sidewalls and bottom of the can so they can float to the top of the can (because gas is lighter than liquid) and there is only a small amount of liquid blocking their escape when you open the can. Remember, SNAP the SIDE instead of tapping the top.

Experiment: Mentos Geyser - Diet Coke Eruption

Mentos + Pop = Fun. Words cannot begin to describe the awesome eruption that is created from adding Mentos candies to a 2-liter bottle of soda. The eruption is enormous... and so is the learning if you consider the chemistry.

Materials

A roll or box of Mentos (candy mints) and a 2-liter bottle of diet soda. Either diet or regular soda will work for this experiment, but diet soda is less sticky when you're cleaning it up!

Steve's new Geyser Tube is available!

1. This activity is probably best done outside in the middle of an abandoned field, or better yet, on a huge lawn.
2. Carefully open the bottle of soda. Position the bottle on the ground so that it will not tip over.
3. Un-wrap the whole roll of Mentos. The goal is to drop all of the Mentos into the bottle of soda at the same time (which is trickier than it looks). One method for doing this is to roll a piece of paper into a tube just big enough to hold the loose Mentos. You'll want to be able to position the tube directly over the mouth of the bottle so that all of the candies drop into the bottle at the same time.

4. Don't drop them into the bottle just yet! Warn the spectators to stand back. Okay, you're going to drop all of the Mentos into the bottle at the same time and then get trucking' (move out of the way... so long... bye- bye... hasta la vista!)

5. It's just like fireworks on the 4th of July. The spectators erupt, of course, in a chorus of ooohs and ahhhs. Someone yells out, "Do it again" and you do.

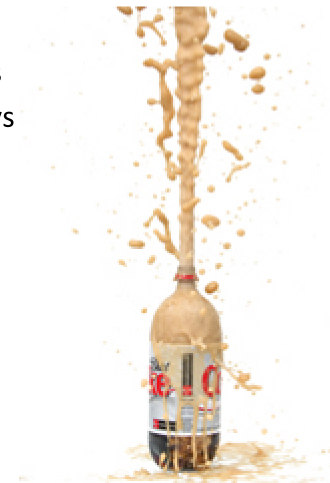
How does it work?

Here's the question of the day... Why do Mentos mixed with soda produce this incredible eruption? You should know that there is considerable debate over how and why this works.

While we offer the most probable explanations below, we also understand and admit that other explanation could be possible... and we welcome your thoughts.

As you probably know, soda pop is basically sugar (or diet sweetener), flavoring, water and preservatives. The thing that makes soda bubbly is invisible carbon dioxide gas, which is pumped into bottles at the bottling factory using tons of pressure. Until you open the bottle and pour a glass of soda, the gas mostly stays suspended in the liquid and cannot expand to form more bubbles, which gases naturally do.

But there's more... If you shake the bottle and then open it, the gas is released from the protective hold of the water molecules and escapes with a whoosh, taking some of the soda along with it. What other ways can you cause the gas to escape? Just drop something into a glass of soda and notice how bubbles immediately form on the surface of the object.



For example, adding salt to soda causes it to foam up because thousands of little bubbles form on the surface of each grain of salt. Many scientists, including Lee Marek, claim that the Mentos phenomenon is a physical reaction, not a chemical one.

Water molecules strongly attract each other, linking together to form a tight mesh around each bubble of carbon dioxide gas in the soda. In order to form a new bubble, or even to expand a bubble that has already formed, water molecules must push away from each other. It takes extra energy to break this "surface tension." In other words, water "resists" the expansion of bubbles in the soda.

When you drop the Mentos into the soda, the gelatin and gum arabic from the dissolving candy break the surface tension. This disrupts the water mesh, so that it takes less work to expand and form new bubbles. Each Mentos candy has thousands of tiny pits all over the surface. These tiny pits are called nucleation sites - perfect places for carbon dioxide bubbles to form. As soon as the Mentos hit the soda, bubbles form all over the surface of the candy.

Couple this with the fact that the Mentos candies are heavy and sink to the bottom of the bottle and you've got a double-whammy. When all this gas is released, it literally pushes all of the liquid up and out of the bottle in an incredible soda blast. You can see a similar effect when cooking potatoes or pasta are lowered into a pot of boiling water. The water will sometimes boil over because organic materials that leach out of the cooking potatoes or pasta disrupt the tight mesh of water molecules at the surface of the water, making it easier for bubbles and foam to form.

When a scoop of ice cream is added to root beer, the float foams over for essentially the same reason. The surface tension of the root beer is lowered by gums and proteins from the melting ice cream, and the CO2 bubbles expand and release easily, creating a beautiful foam on top. Next question... Why should you use diet Coke or diet Pepsi? The simple answer is that diet soda just works better than regular soda. Some people speculate that it has something to do with the artificial sweetener, but the verdict is still out.

More importantly, diet soda does not leave a sticky mess to have to clean up. Hey, that's important.

What's the record for the biggest Mentos fountain? My official record is a 18 foot blast that shot up and almost took out a half million dollar, high-definition television camera.

You might be thinking to yourself, “Can I use the MENTOS Geyser for my upcoming science project in school?” The answer is YES, but you'll need to learn how to turn a cool science activity into a real science experiment. The secret is to focus your attention away from the flying soda and concentrate on setting up an experiment where you isolate a single variable and observe the results. Tests and trials will lead you to more and more questions, which will eventually uncover a discovery. The examples below are a good starting place, but you'll stumble upon even more questions and ideas once you get started.

If you don't know how the Mentos Geyser activity works, read the experiment first.

Materials

The materials you'll need will change depending on which variables you're testing, but it's safe to say you'll need soda and Mentos® chewy mints. It's very important to use fresh soda for your experiment. Two liter bottles of soda will lose their fizz (carbonation) over time and you'll get poor results. Go to the store and buy fresh soda to get the best results.

The Fairness Factor

Before the invention of the Geyser Tube, everyone had a different method for dropping MENTOS into the bottle of soda. You might have used the test tube method while someone else made a tube out of notebook paper. Unfortunately, the method for dropping the MENTOS was never consistent. The Geyser Tube removes the inconsistency (make the drop the same every time) and lets you focus on the true variables (what you're trying to test).

When you're conducting the test below, you might want to remove the top cap of the Geyser Tube. This will make it easier to record how high the soda shoots up into the air because the column of soda is bigger and stays together better. Make sense?

The Scale

You want to be able to easily record how high your geyser goes. One method is to select a launching site that is up against the side of a tall building. You'll also need an adult to help you with the next part. With permission from the owner of the building, use chalk (and an adult helper) to mark off one foot increments on the side of the building. Since you're a scientist, it's best to use metrics for all of your measurements.

You might want to enlist the help of another adult who own a camcorder. By recording every launch, you'll be able to replay the tape in slow motion in order to get the best measurement possible. You see... science and technology go hand in hand.

How Many MENTOS?

It's a question that everyone who does this project asks. What is the best number of MENTOS to use to make the highest shooting geyser? This is a great topic for a science project, but you'll need lots of soda and MENTOS and a few friends to help record all of the data.

Let's start with one single MENTOS. All of the bottles of soda should be the same and they should also be the same temperature. Use the Geyser Tube to make sure every launch is the same. You'll also need a way to measure how high the soda shoots up into the air. Use a scale attached to the side of a building as one way to measure the height. It's also a good idea to record each launch on video in order to go back and watch the launch in slow motion. Now you know your data will be accurate.

Attach the Geyser Tube to the top of the 2-liter bottle of diet soda. Push the trigger pin through the holes and load one MENTOS into the tube. You might decide not to attach the top cap – this makes it easier to record how high the soda goes because it's not spraying everywhere. The launch site is ready... the MENTOS is loaded... the video camera is recording... and you pull the pin! Record the height (at least your best guess for right now). Repeat this same procedure for 2 MENTOS, 3 MENTOS... you get the idea. Based on your data, how many MENTOS do you need to make the highest shooting soda geyser?

The Brand Test

You guessed it... it's time to put your favorite soda to the test. Does one brand produce higher flying geysers? How does generic soda stack up again the big name brands? Using the procedure outlined in the previous experiments, it's easy to determine the clear winner. Remember, it's important conduct each test the same way using the Geyser Tube and the same number of MENTOS for each launch. You'll also want to make sure all of the soda is at the same temperature because temperature plays an important role in the reaction.

Just think... your results could help determine the next MENTOS Geyser craze.

The Temperature Test

How does the temperature of the soda affect the height of the geyser? Does a warm soda shoot up higher than a cold soda? The key to keep every launch fair and to make sure the only variable is the temperature of the soda. You'll also need a thermometer to record the temperature of the soda just before you launch it into space.

It's best to stick with one brand of soda for the entire test. Let's decide to use Diet Coke. You'll want to purchase three bottles of Diet Coke and several rolls of MENTOS. You're going to set-up three tests: Warm soda, room temperature soda and cold soda. Place one bottle of Diet Coke in the refrigerator and let it sit over night. Place the second bottle in a place where it can reach room temperature over night. There are two safe ways to warm the bottle of soda. The simplest method is to let the unopened bottle sit in the sun for several hours. You can also place the bottle of unopened soda in a bucket of warm water. Never use a stove or microwave to heat a bottle of soda.

It's time to return to your launching site. Check to make sure the scale is in place and the video camera is loaded with tape. Let's start with the bottle of cold Diet Coke. Open the bottle and dip the thermometer down into the soda. Record the temperature on your data table. Attach the Geyser Tube with the trigger pin in place. Load seven MENTOS into the tube and get ready to launch. Pull the pin and record the data. Repeat the same procedure for the soda at room temperature and the warm soda.

Beyond the Fizz

Warm soda tends to fizz much more than cold soda. Why? The answer lies in the solubility of gases in liquids. The warmer the liquid, the less gas can be dissolved in that liquid. The colder the liquid, the more gas can be dissolved in that liquid. This is because as the liquid is heated, the gas within that liquid is also heated, causing the gas molecules to move faster and faster. So, they will diffuse out of the liquid, leaving less gas dissolved in that liquid. In colder liquids the gas molecules are moving very slowly, causing them to diffuse out of solution much more slowly, and more gas tends to stay in solution.

Did you know… At the bottling plant, carbon dioxide is pumped into the cans or bottles when the fluid is very cold—around 35 degrees Fahrenheit. This low temperature allows the maximum amount of carbon dioxide to dissolve in the soda

Experiment: Glowing Tonic Geyser

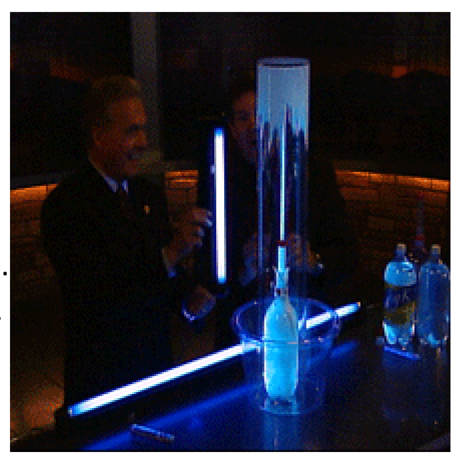
Tonic water might not be your first choice for a beverage, but it's the secret ingredient you'll need to make a glowing geyser. It turns out that tonic water will glow under a black light because tonic water contains quinine, a chemical that was originally added to tonic water to help fight off malaria in places like India and Africa. While the tonic water we drink today only contains a small amount of quinine, it's still enough to make your drink glow under black light. Combine this with Steve Spangler's joy of shooting off soda geysers, and you have yourself a very cool Halloween party idea.

Materials

- Portable ultraviolet light
- Bottle of tonic water (unopened)
- Drinking glass, clear
- Darkened room

If you want to do Steve's Mentos Glowing Geyser demo, you'll need a roll of Mentos, a 2-liter bottle of tonic water and a Geyser Tube (or another creative way to drop the Mentos into the soda).

1. Open the tonic water and pour some into a large, clear drinking glass.
2. Place a white sheet or poster board behind the glass to create a white background.
3. Turn off all the lights and completely darken the room. Turn on the black light and shine it on the tonic water. Hey, what happened? The water is glowing blue!



Glowing Tonic Geyser

The following explanation uses the Geyser Tube as a triggering device for the glowing geyser.

1. You'll need a 2-liter bottle of tonic water and an outdoor lo

location for your geyser.

2. Start by tying one end of the string to the trigger pin (the string might already be attached to the pin).

3. Open the bottle of soda and attach the Geyser Tube. Put the trigger pin into the hole at the base of the Geyser Tube.

4. Twist off the top cap on the Geyser Tube and drop 7 MENTOS candies into the tube. The trigger pin will keep the candy from falling into the soda… before you're ready. Replace the twist-on cap.

5. Warn everyone to stand back and turn on your black light. Countdown… 3-2-1… and pull the trigger. The MENTOS will drop and the tonic water will go flying into the air!

Remember that electricity and flying soda do not mix! It's best to use a battery powered black light instead of anything that requires regular electricity from the wall.

How does it work?

The black light gives off UV light which is a higher energy light than visible light and the human eye is not able to see it well. So, if ultraviolet light is virtually invisible, how can the tonic water glow so brightly? The tonic water's color under the UV black light is fluorescent-blue because it contains quinine, a substance that changes when it absorbs UV light. When the black light shines on the tonic water, the tonic water absorbs the light and excites the electrons. Since the electrons naturally want to return to their original relaxed state (who wouldn't?), they give off energy that has a wavelength in the blue part of the visible spectrum. That's why the tonic water has an eerie blue glow in the presence of ultraviolet light!

Experiment: Tornado in a Bottle

How long does it take to empty a soda bottle full of water? You'll amaze your dinner guests and explore some of the scientific properties of air and water when you learn how to empty a full bottle of water in just a few seconds!

Materials

- Two plastic soda bottles (1 or 2 liter size)
- Pitcher of water
- Stopwatch or watch with a second hand to record your times
- Tornado Tube connector toy

1. Fill the soda bottle to the top with water. If you do not have access to a sink nearby or you don't want to move the dinner party to the classroom, use a large pitcher to fill the bottle.
2. Here's the challenge: How long will it take to empty all of the water in the bottle into the pitcher on the table? Record your prediction on a piece of paper.

3. Without squeezing the sides of the bottle, time how long it takes to empty all of the water. You might want to repeat this several times to validate your time.
4. Fill the bottle to the top with water just as you did before. However, this time swirl the water by moving the bottle in a clockwise or counter-clockwise motion while the water is pouring out. Keep swirling the water until you see the formation of what looks to be a tornado! The water begins to swirl in shape of a vortex and flows out of the bottle very quickly. To everyone's amazement, you are the Quick-Pour Soda Bottle Master.

How does it work?

Swirling the water in the bottle while pouring it out causes the formation of a vortex. The vortex looks like a tornado in the bottle. The formation of the vortex makes it easier for air to come into the bottle and allows the water to pour out faster. If you look carefully, you will be able to see the hole in the middle of the vortex that allows the air to come up inside the bottle. If you do not swirl the water and just allow it to flow out on its own, then the air and water have to essentially take turns passing through the mouth of the bottle.

Additional Info

The "Tornado Tube" is a very popular science toy that connects two soda bottles, one filled with water, the other filled with air. Simply swirl the liquid in the bottles and in seconds a twisting, turning, spiraling vortex appears.

Twist of Color - Try adding 2 ounces of colored lamp oil to the water. Lamp oil is available at most department stores were oil lamps are sold. The oil will float on the surface of the water since oil is less dense than water. When the oil and water swirl together, the less dense oil travels down the vortex first and creates a "colored tornado" effect.

Additional Info

The following information is excerpted from The Tornado Tube Book.

How Does a Hurricane Start? The hurricane takes its name from the West Indian word huracan which means "big wind." Storms that occur over the Atlantic or the eastern Pacific Oceans are called hurricanes. The same kind of storm that forms over the western Pacific or Indian Oceans is called a typhoon. This name comes from the Chinese word taifun or “great wind.”

Hurricanes and typhoons are not just violent winds. They are giant, whirling storms that develop in a special way. Hurricanes form only in the tropics where extremely moist air and heat are concentrated over the ocean, near the equator. The water temperature must be at least 80o Fahrenheit both day and night. A wet season with increased rainfall begins in late spring and lasts to early autumn. This is the time of year when hurricanes develop. Evaporation of the warm water into the atmosphere over the ocean makes the air very moist. Winds blowing across the ocean in different directions begin to push masses of warm, moist air toward each other. This event is called convergence. When the air masses collide, the air in the center starts to rise, forming an updraft. At high altitudes, the moist air of the updraft begins to cool and water droplets form. These water droplets form clouds. Large cumulonimbus clouds begin to grow and thunderstorms develop. More thunderstorms form as more convergence and updrafts occur. If the thunderstorms do not dissipate, they may start to gather together. This formation is called a tropical disturbance. Many more thunderstorms join the disturbance. This weather event becomes large enough to be influenced by forces created from the Earth's rotation.

The tropical disturbance begins to swirl and becomes a vortex of thunderstorms. Updrafts are continuously pulling more air into the disturbance. When the winds begin to blow continuously at 23 miles per hour, the storm becomes a tropical depression. The tropical depression continues to gain power and becomes a tropical storm when the wind speed becomes 40 miles per hour. At any time, the disturbance, depression, or storm can run out of hot, moist air and weaken or die out. If it continues to gain strength and reaches 74 miles per hour we call it a hurricane.

Hurricanes have top wind speeds of at least 74 miles per hour, but wind speed can reach 180 miles per hour. The closer you are to the storm's center, the faster the wind will be. The top wind speed will be reached within 60 miles from the center of the hurricane. As you move away from the center, wind speed is slower. At 300 miles from the center, the wind speed may be only 18 miles per hour. The energy of a hurricane comes from the heat released when water vapor condenses to liquid water. The atmosphere above a tropical ocean is the only place enough warm, moist air is available to produce the energy necessary to create a hurricane.

The movement of a hurricane is somewhat predictable. It is so large that it moves with the Earth's wind currents that surround it. These wind currents are very large and steady and don't change course abruptly. Therefore, hurricanes usually travel in one of these wind currents until they meet another wind current, then they may change direction. If a hurricane changes course, it could pass over the same area twice. Sometimes one of these storms stalls over an area for days.

A hurricane covers a very large area. Sometimes a tropical storm can have a cloud system that is 2,000 miles in diameter. Typically, a hurricane is about 300 miles across. That is about the distance from Chicago, Illinois to Columbus, Ohio. An average hurricane is about 800 to 5,000 times as wide as an average tornado. Hurricanes usually travel across the sea and land at 10 to 32 miles per hour. Some may travel at speeds up to 50 miles per hour. The path of a hurricane usually covers thousands of miles, most of it over the ocean.

It is very important to track these huge storms and to make accurate predications about their movements. Many people live in areas affected by hurricanes. If the National Hurricane Center scientists believe a hurricane is threatening to reach a populated area within 24 hours, they will issue a hurricane warning. People prepare by gathering and sheltering property and boarding up homes and businesses. Sometimes people will even be evacuated from an area if the forecast calls for an extremely strong storm. Many lives have been saved by these preparations.

To study conditions inside hurricanes, teams of pilots and weather scientists fly regular missions into these storms. They get measurements of wind speed, temperature, air pressure, and other weather conditions at different altitudes. These investigations help scientists make predictions about hurricane formation and movement. The National Weather Service names hurricanes to quickly identify them. The names are assigned in alphabetical order alternating between female and male names. There are separate lists of names for hurricanes in the Atlantic and Pacific oceans.

Experiment: Floating Water

Turn the glass over and nothing spills

Fill the glass jar with water and cover it with a card. As you turn the whole thing upside down, the audience can hardly contain themselves. The room quiets down as you precariously position the inverted jar and card a few feet above someone's head. Just as they thought, no water spills out because the card magically sticks to the mouth of the upside down jar. But wait. . . there's more.

Materials

- Mason jar (pint size) with twist-on lid
- Circular plastic screen insert
- Index cards

Place the plastic screen material over the opening of the jar and screw on the lid (sealing ban). Remove the lid and use scissors to cut around the indentation "ring." What you're left with is the screen insert that fits perfectly into the top of the sealing band.

Place the screen over the opening of the jar and twist on the lid. Make sure that you do not accidentally show the audience the secret screen. When you're ready to perform the trick, fill the jar with water by simply pouring water through the screen.

Cover the opening with the index card. Hold the card in place as you turn the card and the jar upside down. Carefully remove the card from the opening and the water mysteriously stays in the jar! Replace the card, turn the whole thing over, remove the card and pour out the water. That's amazing!

How does it work?

Air Pressure: The atmosphere exerts about 15 pounds of pressure per square inch of surface at sea level. Because it's a gas, it not only pushes down, but also upwards and sideways. The card remains in place because the air pressure is pushing upward harder than the water is pushing downward.

Surface Tension: The surface of a liquid behaves as if it has a thin membrane stretched over it. A force called cohesion, which is the attraction of like molecules to each other, causes this effect. The surface tension "membrane"� is always trying to contract, which explains why falling droplets of water are spherical or ball shaped. The water stays in the jar even though the card is removed because the molecules of water are joined together to form a thin membrane between each opening in the screen. Be careful not to giggle the jar or touch the screen because you'll break the surface tension and surprise everyone with a gush of water!

Additional Info

Use the demonstration to explore the properties of air, air pressure and surface tension. For the older students, you can have them calculate the amount of force being applied to the circular opening of the jar by the air pressure as compared to the downward force resulting from the weight of the water. For example, if the diameter of the jar's opening is 3 inches, then the surface area is found by multiplying π (pi) times the square of the radius, or 3.14" x 1.5"� x 1.5"� = 6.75 square inches. Multiply that times 15 pounds per square inch to determine the total force exerted by the air pressure (6.75 square inches x 15 pounds per square inch = 101.25 pounds). Your jar contains about a pint (16 ounces) of water. The weight of the water is about 448 grams or slightly less than 1 pound, so it's easy to see why the card stays in place when the jar is turned upside down. Another interesting statistic to ponder is that the density (mass/volume) of air at sea level is about 1/800th that of water.

The Mysterious Water Suspension provides the framework for a hands-on lab that's both, fun and effective. Kids can work alone or in teams, applying the scientific method to formulate theories, do research, devise and conduct experiments, gather data, and present their conclusions.

Experiment with different screens, some with fine mesh and some with coarse mesh to observe how surface tension and air pressure work together to accomplish the feat. For different screens, try materials such as cloth, plastic mesh from produce bags, etcetera. See what happens when different sizes and shapes of bottles are used.

Have your students explain why the card sticks better to the inverted jar when it's completely filled as compared to when it's only partially filled. Discuss the elastic properties of the trapped air inside the jar.

Let's recap. The jar was filled with water, a card covered the mouth of the jar, and the whole thing was turned upside down. Voila! The card held the water in place. Here comes the science magic. You do the unthinkable. You remove the card! Your volunteer dives for cover! Fear not, the water magically "floats" in the upside down jar. Kids scream, "How did you do that?" Take your well-deserved bow as you turn the jar right side up and empty the water back into the pitcher. Now that's science magic!

Experiment: Anti-Gravity Water

Amaze your friends by making water defy gravity. It's a simple experiment that dramatically demonstrates the amazing physical properties of water.

Materials

- Tall glass with a round edge
- A handkerchief
- A pitcher of water

1. Drape the handkerchief over the glass making sure that you push the center of the handkerchief down into the glass.

2. Fill the glass 3/4 full with water by pouring water into the middle of the handkerchief.

3. Slowly pull the handkerchief down the sides of the glass making it taut (stretched tightly across the surface of the glass). Grip the ends of the handkerchief at the bottom of the glass.

4. Place one hand over the mouth of the glass and turn it over with the other hand.

5. Pull the lower hand away from the glass (slowly) and the water should stay in the glass! This just goes to prove that the handkerchief has anti-gravity properties. The thunderous applause will drowned out the cries of, "How did you do that?"

6. For the big finish, put your hand over the mouth of the glass and turn the glass right side up. Remove the handkerchief from the glass and pour the water back into the pitcher. Of course, take your well-deserved bow.

How does it work?

Most people predict that the water will leak through the holes in the handkerchief because the water leaked through the holes as it was poured into the glass. The holes in the handkerchief literally disappeared when the cloth was stretched tightly across the mouth of the glass. This action allowed the water molecules to bond to other water molecules creating was it called surface tension. The water stays in the glass even though there are tiny holes in the handkerchief because the molecules of water are joined together to form a thin membrane between each opening in the cloth. Be careful not to tip the glass too much because you'll break the surface tension and surprise everyone with a gush of water!

Experiment: Fire Water: Coolest Conductor of Heat

Common sense tells you that it's impossible to boil water in a paper bag, but this classic parlor trick was a favorite of the Victorian magician. The real difficultly in performing this effect is making it look harder than it is! As you might imagine, the secret lies in yet another amazing property of water - it's ability to conduct heat. Instead of using a paper bag, this modern day version of the demonstration uses an ordinary balloon, some water and a candle. It's a combination that's guaranteed to make people stand back.

Materials

- Safety glasses
- Balloons
- Water
- Matches

Warning! This science activity uses matches which means you need to find a very cool supervising adult to help with this experiment.

Blow up a balloon just as you normally would and tie it off. Light a candle and place it in the middle of the table. Put on your safety glasses because it's time to pop the balloon. Hold the balloon a foot or two over the top of the flame and slowly move the balloon closer and closer to the flame until it pops. You'll notice that the flame doesn't have to even touch the balloon before the heat melts the latex and it pops. Let's just say you had to prove what you already know.

Let's repeat the experiment but this time the bottom of the balloon will have a layer of water. To do this, fill the balloon to the top with water – it probably holds a few ounces (60 mL for the scientists) – and then blow it up with air. If you accidentally let go of the balloon before you tie it off, you'll spray yourself and your friends will love it. Just tie off the balloon and get ready for the next step.

You're going to slowly lower the water-filled balloon over the candle and watch as people start to run. Everyone knows that it's going to pop... but for some strange reason it doesn't. If you're very brave, you can actually allow the flame to touch the bottom of the balloon and it still doesn't pop.

Remove the balloon from the heat and carefully examine the soot on the bottom. Yes... there's soot and the balloon didn't pop. Before reading the explanation, try to figure out why the layer of water kept the balloon from popping.

How does it work?

Water is a great substance for soaking up heat. The thin balloon allows the heat to pass through very quickly and warm the water. As the water closest to the flame heats up, it begins to rise and cooler water replaces it a the bottom of the balloon. This cooler water then soaks up more heat and the process repeats itself. In fact, the exchange of water happens so often that it keeps the balloon from ever popping!

The soot on the bottom of the balloon is actually carbon. The carbon was deposited on the balloon by the flame, and the balloon remains undamaged.

Using water to control heat is a valuable process. In fact, firefighters in Colorado often use a polymer foam to control large wildfires. Since polymers soak up a tremendous amount of water, they are useful in controlling and stopping the heat energy in the fire.

Your body even uses water to control heat. When you exercise, what’s that dripping from your armpits? EWWW... it’s sweat! But your body actually uses the water in your sweat to control your internal temperature so you don’t get overheated.

Experiment: Strong Sand

How can sand be used to stop a speeding bullet? Just take the "Strong Sand" challenge and you'll discover an amazing fact about the science of sand.

Materials

- Cardboard tube from a roll of paper towel
- Sand (salt can be used in place of sand)
- Sheet of tissue paper
- Rubber bands
- Scissors
- Stick - dowel rod approximately 1 foot in length or a drumstick works well

-

1. Cut a piece of tissue so that it measures approximately 8 inches square.
2. Cover one end of the cardboard tube with the tissue paper and hold it in place tightly with a rubber band.
3. Challenge someone to poke a hole in the piece of tissue paper using the stick. Hey, that's easy! Don't worry… let's try it again.
4. Replace the torn paper with a new piece of tissue paper. Fill the cardboard tube three quarters of the way full with sand. This makes for even a better challenge in the minds of many people because not only will be paper break but the sand will spill out everywhere!
5. Instruct your volunteer to push the stick into the sand and keep pushing until the stick breaks through the tissue paper. What's the matter? This time it's not so easy to break through the paper. In fact, it's impossible! How did the tissue paper get to be so strong?

How does it work?

The secret is literally in the sand. As you push the stick into the sand, the granules of sand are pushed away from the stick in all directions. Contrary to what seems logical, the sand pushes against the sides of the cardboard tube instead of the entire force pushing downward against the tissue paper.

This demonstration is a good illustration of why seismic waves move slowly through sand. When the vibrations from seismic waves travel through sand, the sand redistributes the forward energy from the waves and pushes it out in all directions.

Experiment: The Brazil Nut Effect

Want to shake up a group of physicists? Just show them something that acts in an unexpected way. That's what led to the discovery of a physics principle called the Brazil nut effect. For some time, hungry physicists had noticed that when you shake a jar of mixed nuts, the big, dense Brazil nut moves to the top of the jar. (You'd think it would sink to the bottom.) Check it out by performing the experiment with some mixed nuts of your own, or try this colorful variation.

YOU WILL NEED:
•Marble
•An empty transparent plastic jar with a lid
•Cornmeal, salt, or sand (enough to fill the jar 1/2 to 2/3 full)

STEPS:
1. Put the marble in the jar. Add the cornmeal, salt, or sand.
2. Seal the jar, then shake it up and down. It may take a little time, but eventually the marble will rise to the top. You might even hear it pop against the lid before you spot it.

WHAT'S HAPPENING:
You'd expect something denser than cornmeal, salt, or sand to stay at the bottom of the jar. Instead, when you shake the jar, both the cornmeal and the marble move up and down, and a bit of the cornmeal fills the space below the marble before it can fall back to its original position. Once the marble reaches the top of the heap, it gets buffeted around and sometimes falls just below the surface. But keep shaking, and it will resurface.

What will Sink and What Will Float?

Experiment: Floating Bowling Balls

Today we will finally answer the question that has puzzled viewers for years: do bowling balls float? Not so fast - you'll have to see it to believe it! Plug the drain, fill the sink with water, and take the plunge with Steve's floating science challenge. We all know that certain things float in water while other things sink, but why? Do all heavy things sink? Why does a penny sink and an aircraft carrier floats? Think you know the answers? Well, get ready for a few amazing surprises!

If you've ever been bowling you know that bowling balls range from about 8 to 16 pounds. However they are all the same size! According to the official bowling rules, "The circumference of a ball shall not be more than 27.002 inches nor less than 26.704 inches, nor shall it weigh more than 16 Ibs (no minimum weight)." This means that the average density of an 8 pound ball must be HALF the average density of a 16 pound ball. In general, bowling ball manufacturers vary the size, shape and material of the core of the ball to adjust the weight. Enough about bowling balls! Let's try the experiment.

Materials

- A bowling ball weighing 9 pounds or less
- A bowling ball weighing 11 pounds or more
- A large aquarium or a bath tub filled with water

1. The next time you're at the bowling alley, sneak an aquarium filled with water in under your coat. Too risky? Ok, just collect a few bowling balls of various weights (from 8 to 16 pounds).

2. Fill the aquarium three quarters full with water.

3. Carefully place (do not drop!) the bowling ball in the water. Does it float or sink? Repeat this experiment, noting the weight of each bowling ball, until every ball has taken the plunge.

4. What did you discover? It seems that anything heavier that 12 pounds will sink, but bowling balls between 8 and 12 pounds float. Amazing!

How does it work?

Let's start with some properties of water. How heavy is 8 pounds? It just happens to work out that one gallon of water weighs 8 pounds. Hmmm? Something smells a little fishy because 8 pound bowling balls float. If one gallon of water weighs 8 pounds and an 8 pound bowling ball takes up more space than a gallon of water, the ball will float! What did Archimede say about all of this? When an object is placed in water it will displace it's weight in water. The 8 pound ball is displacing 8 pounds of water. However, the ball also takes up more volume than 8 pounds of water, so it floats. It might be less confusing to simply say the 8 pound ball is less dense than water and the 16 pound ball is more dense than water where density is the mass of the ball divided by its volume. Hey, are you pulling my leg? NO! The bowling balls that we used on television were legitimate, competition-sanctioned bowling balls. For those disbelievers, the water was real, too. We suggest using an 8 pound ball for your less dense ball since it floats fairly high but a 9 pound ball will work just as well. A 10 pound ball will almost "hover" in the water! Anything heavier than 11 pounds will sink. You might want to stop by your local bowling alley to see if the pro shop is throwing away any old bowling balls that you might be able to use for your science entertainment pleasure.

Experiment: Floating Lemons and Sinking Limes

Why do lemons float in water but limes don't? Scientists seem to be infatuated with objects that float and sink. Even non-scientists find great joy in dropping stuff in water to see if it floats or sinks. Fans of David Letterman are quick to point out one of Dave's favorite segments called "Will It Float?" Here's the latest float or sink challenge: Why do lemons float in water but limes sink? Think you know the answer? Not so quick...

Materials

Take a trip to your local grocery store in search of few lemons and limes that are roughly the same size and weight. A big lemon and a tiny lime will throw off your test results. You'll also need a deep container like a large bowl to conduct the float and sink test.

1. Fill a bowl with water and drop in the lemons. Float or sink? They should float.
2. Toss the limes into the water. Float or sink? You might get a few that float but just barely. The limes in our test sank to the bottom.
3. Now it's time to figure out why. Your first guess might be the rinds of both fruits. Peel the rind off of the lemon and you'll find that it is thick and porous “ similar to the rind of an orange (that also floats in water). The lime rind is much thinner than the lemon and does not contain the same porous material.
4. It's time to test the peeled lemon and lime. Drop both in the water and you might be surprised. The lemon floats and the lime sinks! So, it's not the rind.
5. That's as far as we're going to take you. Keep experimenting and exploring before reading any further.

How does it work?

At first, our team of lemon lime researchers were certain that it had everything to do with the rind because of their experience with floating and sinking oranges. Drop an orange into water and it floats, but remove the peel from that same orange and it will sink. The unpeeled orange floats because the rind is very porous and filled with tiny pockets of air. Even though you're removing mass when you peel the orange, the peeled orange is more dense and sinks in the water. But the lemon lime mystery is a little different.

We have to turn to the Internet for more information. According to the USDA website, a lime is 88.26% water by weight and a lemon is 87.4%. This could mean that lemons have a higher air content, but we're still not sure.

So, our next step was to weigh the lemon and the lime. Digging through our grocery bag of lemons and limes, we found two that were very similar in size and weight. Both the lemon and the lime weighed exactly 101 grams. If you know the weight, it only makes sense to determine the volume of each fruit. Using displacement of water, we determined that that the lemon had a volume of 99 mL and the lime had a volume of 90 mL. You might remember doing this in school when you learned about volume. Fill a container to the very top with water and then submerge the item (the lemon in this case). Collect and measure whatever water spills out over the edge of the container and you've got the volume.

So, using the density formula (D=M/V) it was easy to determine the density of each fruit.

The Lemon “ Density =101g/99 mL = 1.02 g/mL

The Lime “ Density = 101g/90 mL = 1.12 g/mL

Since the density of water is approximately 1 g/mL, it makes sense the at the lemon in our experiment floated and the lime sank.

But we're still a little confused as to why limes sink and lemons float. Some people have suggested that lime flesh is much more dense than lemon flesh, and as a result it holds its juice better. People who "juice"� fruits know about this phenomenon. If you want to get more juice from a lime, warm it up in the microwave briefly and then firmly roll it along the worktop before slicing it lengthways and juicing it. It makes a huge difference.

Since the density of the lemon and lime are very close to water, even very small changes in composition could mean the difference between sinking and floating.

Experiment: Amazing Egg Experiments

Squeeze an egg as hard as you can without breaking it. Learn how to tell a raw egg from a hard boiled egg without cracking the shell. Perform the amazing floating egg trick. It's Egg Olympics in your very own classroom!

The old egg in the bottle trick!

Materials

- Eggs
- Salt
- Water
- Two tall containers to conduct the float and sink test

Squeeze an Egg Without Breaking It
Eggs are amazingly strong despite their reputation for being so fragile. Place an egg in the palm of your hand. Close your hand so that your fingers are completely wrapped around the egg. Squeeze the egg by applying even pressure all around the shell. To everyone's amazement (mostly your own) the egg will not break. If you're a little nervous about the outcome, try sealing the raw egg in a zipper-lock bag before putting the squeeze on it, or hold the egg over the sink if you're in the super-brave category.

Eggs are similar in shape to a 3-dimensional arch, one of the strongest architectural forms. The curved form of the shell distributes pressure evenly all over the shell rather than concentrating it at any one point. By completely surrounding the egg with your hand, the pressure you apply by squeezing is distributed evenly all over the egg. However, eggs do not stand up well to uneven forces which is why they crack easily on the side of a bowl. Be careful not to wear a ring while performing our squeezing act. The uneven pressure of the ring against the shell will result in an amusing display of flying egg yolk for your audience members.

Hardboiled or Raw?
The answer is only a spin away. Simply spin the egg and pay close attention to how well it spins. If the egg spins well, it's hardboiled. However, if the egg wobbles and spins slowly, it's the raw one. A hardboiled egg is solid inside whereas a raw egg is fluid. When you spin the raw egg, its center of gravity changes as the fluid inside the egg moves around. This results in the wobbling motion you noticed in the raw egg. As soon as the raw egg starts spinning, touch it briefly with

your finger just long enough to stop it. When you take your finger away, the egg will continue to spin for just a quick second. This is due to the inertia of the fluid inside the egg. When the hardboiled egg is spun, the solid center immediately moves with the shell, causing little resistance to the spinning motion.

The Floating Egg

It's so simple and amazing. A raw egg will float in very salty water but will sink in plain tap water. Why? Salt water is more dense than regular water. You'll need to make a very saturated salt solution by dissolving roughly 4 tablespoons of salt in about 2 cups of water. Use pickling or Kosher salt to make a clear salt solution. Table salt may be used, but the solution will be somewhat cloudy due to the additives used to make the salt free-flowing.

Fill a glass half full with the salt water. Slowly add plain water by pouring it down the sides of the glass being careful not to mix the two liquids. Gently drop the egg into the water and watch as it sinks through the plain water only to abruptly stop when it hits the salt water. It's amazing to see how the egg floats on the top layer of the salt water (even more amazing if you don't know about the bottom layer of salt water!).

The Rising Egg

Fill the bottom 1/5 of a tall glass with salt. Add just enough water to make a wet salt layer. Carefully lower an egg down on top of the wet layer of salt. Slowly add more water by pouring it down the sides of the glass so as not to disturb the bottom layer of water. Cover the top of the glass with cellophane and a rubber band. Notice how the egg rests on the layer of undissolved salt on the bottom of the glass.

Over the course of the next several weeks, the bottom layer of salt will begin to dissolve in the water above it. As the salt dissolves, the egg will rise off the bottom and float on the layer of salt water. As more time passes, the salt level continues to drop and the egg continues to rise. Be sure to put this the glass in a place where no one will be able to disturb it. You can even record the egg's progress by marking on the outside of the glass using a felt tip marker. Remember, this process is supposed to take a long time (months!) which is why it is so interesting.

You might wish to substitute a golf ball in place of the egg to avoid the decay of the egg's shell over time. The "golf ball" idea was originally published by Bob Becker, a great chemistry teacher from St. Louis, Missouri.

Experiment: Dancing Raisins - The Bubble Lifter Chemistry you can eat!

Who taught these raisins to dance, anyway? Go on—gather up some raisins, turn up the music, and get ready for a raisin romp. Just when you thought you were done at the dinner table... here is some kitchen chemistry that you can eat!

Materials

- Clear drinking glasses
- Raisins
- Clear carbonated beverages, i.e. 7Up, Tonic Water, etc.
- Macaroni
- Spaghetti
- Lentils
- Craisins®
- Corn

1. Fill the glass with soda.
2. Drop 10-15 raisins into the soda.
3. Focus all of your attention on those raisins. Are they moving? Yes! They're floating, they're bobbing up and down, they're dancing! OK, maybe it has something to do with those bubbles attached to the surface of the raisins. Watch closely as you read the explanation.

Dancing Raisins Variation

1. Set up your drinking glasses with different types of soda.
2. See which type of soda makes the best dancing raisins.
3. Try using all of the same type of soda but different kinds of "dancers."
4. Throw in corn, macaroni, noodles, lentils, craisins, even corn!
5. Which combination of soda and dancers "performs" the best show?
6. Keep experimenting until you find the best combination!

How does it work?

You can guess why this is an extremely popular activity among elementary teachers. With each rise and fall of the dancing raisins a new chorus of ooohs and ahhhhs erupt from the students.

The raisins will bob up and down for several minutes. This "raisin dance" is captivating to watch. Since the surface of the raisins is so rough, tiny bubbles of CO2 will be attracted to it. These bubbles will increase the volume of the raisin substantially, but contribute very little to its mass. As a result, the overall density of the raisin is lowered, causing it to be carried upward by the more dense fluid surrounding it.

Archimedes' Principle states that the buoyant force exerted on a fluid is equal to the weight of fluid displaced. Since the raisins now have a greater volume, they displace more water, causing the fluid to exert a greater
buoyant force. The buoyant force of the surrounding fluid is what pushes the raisins to the top.

Once the raisins reach the top, the bubbles pop upon exposure to the air. This makes the raisins more dense, causing them to sink. As more bubbles adhere to the raisins, they again become less dense and are pushed back up by the fluid. This experiment very clearly shows that an increase in volume (as long as
the mass increase is negligible) will lead to a decrease in density. The bubbles that attach themselves to the raisins can be thought of as little life jackets that make the raisins more buoyant by increasing their volume.

If the raisins are added directly to the bottle, replace the cap on the bottle after they have made several cycles. After a few minutes, all of the raisins will rest at the bottom. This is because carbon dioxide gas is prevented from leaving the bottle. As a result, pressure builds up in the space above the fluid. This pressure is transmitted throughout the fluid, and the bubbles cannot grow as large. Therefore, the volume of the raisins does not increase enough to lower their density to the point where they are less dense than the fluid. When the cap is removed, the pressure above the raisins is decreased, allowing the bubbles to grow larger, causing the raisins to resume the cycle of their "dance."

You can see the same thing happening with set of inflated Water Wings™ or an inner tube. The volume of the Water Wings increases the person's volume considerably. However, the mass of the Water Wings is very small. The overall effect is to lower the density of the Water-Wings-person combo to less than that of water, so that the person can float. Deflating (don't try this with someone who can’t swim!) the Water Wings would reverse the process and cause the person to sink.

Microwaves: A History

January 24 marks the anniversary of the granting of the patent for the microwave oven, “Method of treating foodstuffs.”

Dr. Percy L. Spencer noted that a chocolate bar in his shirt pocket had melted when he was working around an operating radar tube, at Raytheon Corp., during World War II (the patent application for microwave cooking was filed on October 8, 1945). With a little experimentation, he determined the microwaves from the radar tube were rapidly cooking things — think exploding egg, think popping corn.

The rest of the story:

It's true that Spencer was a Raytheon engineer involved in creating the microwave oven. But like any engineer, he didn't need a melted chocolate bar to know about the connection between heat and microwave radiation. After all, sunlight is radiation.

Spencer proposed the creation of a microwave technology-based oven in 1945 as a commercial operation for Raytheon to pursue after the lapse of their military contracts. The idea was enthusiastically received, and a team of engineers began working on a prototype microwave oven. One of the problems Spencer and the team had to overcome was that radar tubes cooked foods way too fast. They had to tune the magnetron tubes to produce wavelengths with less energy, to heat food more slowly so the cooking could be controlled. The designer and builder of this new microwave oven was a Raytheon engineer named Marvin Bock.

Bock's careful experimentation with microwave heating technology is the reason why some people credit him as being the inventor of the microwave oven. The challenges were numerous: a microwave oven had to be small enough for commercial use; federal regulations prohibited Bock from using microwaves that were not either 915 or 2450 megahertz; and he had to figure out how to deal with uneven heating.

Bock's initial solution was to use a small motor to move one wall of the microwave back and forth during cooking. But this device was too expensive and caused radiation leakage. Bock's eventual answer to uneven heating was the use of hanging, rotating rods.

The notes Bock took once he moved on to cooking experiments provide a humorous insight into the engineer at work. "Refreshing corn popped takes 20 seconds is good," he wrote. And on another occasion: "Noted that chicken Fricassee took a minute and tasted good."

Eventually Bock's experimentation led to the production of the first microwave oven. It was over 5 feet tall, weighed 670 pounds, and required a 220-volt power line and separate water pipe for cooling the radar tube. Raytheon began selling their Radarange microwave oven in 1948, but microwaves would be a money-losing business until the end of the 1960s.

Experiment: Ivory Soap Science - Floats and Grows

The microwave oven is not just for warming leftovers!

The microwave oven is not just for warming leftovers. It's another tool in Steve Spangler's bag of science tricks. Wrangle up a bar of soap, clear out the microwave and get ready for the expanding soap trick.

Examples of Correlating Standards:

Kindergarten 7.2.2 Use the senses to investigate and describe an object
Kindergarten 7.9.2 Observe, discuss and compare characteristics of various solids and liquids
1st 7.9.1 Classify solids according to their size, shape, color, texture, hardness, ability to change shape, magnetic attraction, whether they sink or float, and use.
2nd 7.9.3 Describe what happens when water is heated to the point of evaporation
2nd 7.9.1 Classify solids according to their size, shape, color, texture, hardness, ability to change shape, magnetic attraction, whether they sink or float, and use.
3rd 7.9.1 Use physical properties to compare and contrast substances.
3rd 7.9.3 Make predictions and conduct experiments about conditions needed to change the physical properties of particular substances.
3rd 7.9.4 Classify combinations of materials according to whether they have retained or lost their individual properties.
4th 7.9.2 Compare the causes and effects of various physical changes in matter.
4th 7.9.1 Use appropriate tools to measure and compare the physical properties of various solids and liquids.
5th 7.9.1 Compare the simple chemical properties of common substances.
5th 7.9.2 Investigate how different types of materials freeze, melt, evaporate, or dissipate.
5th 7.9.3 Use data from a simple investigation to determine how temperature change affects the rate of evaporation and condensation.

Walk down the detergent isle and you'll see dozens of different kinds of soap. Green soap, smelly soap, big soap, even soap that floats. Ivory soap is famous for floating. How do they make some bars of soap float and others sink? Believe it or not, we're going to cook the soap in the microwave oven to uncover the secret. Just wait until you see what happens when the soap that floats also cooks. You get a bar of soap that grows bigger than a football.

Materials

- Bar of Ivory soap
- Various bars of another brands of soap
- Deep bowl of water (or a plastic tub)
- Paper towel
- Microwave oven

1. Fill the bowl with water.
2. Drop the bars of soap in the bowl of water. Notice how all of the bars of soap sink except for the Ivory brand soap. Why?
3. Remove the Ivory soap from the water and break it in half to see if there are any pockets of air hiding in the middle of the bar. (By the way, there are no pockets of air! Hmmmm?)
4. Place the bar of Ivory soap in the middle of a piece of paper towel and place the whole thing in the center of the microwave oven.
5. Cook the bar of soap on HIGH for 2 minutes. Don't take your eyes off the bar of soap as it begins to expand and erupt into beautiful puffy clouds. Be careful not to over cook your soap soufflé.
6. Allow the soap to cool for a minute or so before touching it. Amazing... it's puffy but rigid.

How does it work?

Ivory soap is one of the few brands of bar soap that floats in water. If it floats in water, it must mean that it's less dense than water. When you broke the bar of soap into several pieces, no large pockets of air were discovered. Ivory soap floats because it has air pumped into it during the manufacturing process. The air-filled soap was actually discovered by accident in 1890 by an employee at Proctor and Gamble. While mixing up a batch of soap, the employee forgot to turn off his mixing machine before taking his lunch break. This caused so much air to be whipped into the soap that the bars floated in water. The response by the public was so favorable that Proctor and Gamble continued to whip air into the soap and capitalized on the mistake by marketing their new creation as the Soap that Floats!� Why does the soap expand in the microwave? This is actually very similar to what happens when popcorn pops. Here's the secret: All soap contains water, both in the form of water vapor inside trapped air bubbles (particularly important in the case of Ivory) and water that is caught up in the matrix of the soap itself. The expanding effect is caused by the heating of the water that is inside the soap. The water vaporizes, forming bubbles, and the heat also causes trapped air to expand. Likewise, the heat causes the soap itself to soften and become pliable. This effect is actually a demonstration of Charles' Law. When the soap is heated, the molecules of air in the soap move faster causing them to move far away from each other. This causes the soap to puff up and expand to an enormous size. Charles' Law states that as the temperature of a gas increases so does its volume. Other brands of soap without whipped air tend to heat up and melt in the microwave.

Additional Info

This experiment requires adult supervision and permission to use the microwave oven.

Experiment: Diving Ketchup

Cause a packet of ketchup to rise and fall on command in a bottle of water. People will think that you have the ability to move object with your mind! Telekinesis? No, just cool science!

Materials

- Plastic soda bottle (1-liter size works great)
- Ketchup packets from a restaurant
- Tall drinking glass
- Soda bottle cap
- Water

1. First, you'll need to perform a float or sink test to see how the ketchup packet works. Fill the bowl with water and drop the packet into it. If it floats, great! If it sinks to the bottom, no sweat. This shows that atmospheric pressure in the packet is pressing hard enough on the air bubble inside the packet to sink it. If this happens, you get to make more trips to your favorite fast-food restaurant to find a ketchup packet that just barely floats!

2. Scrunch the packet in half lengthwise and carefully push it into the soda bottle. Fill the bottle full to the brim with water and screw on the cap. Squeeze the sides of the bottle and hold the squeeze to make the packet sink. Let go and it rises.

How does it work?

The packet floats because an air bubble gets trapped inside the packet when it's sealed at the factory. If the packet sinks when you test-float it, then the air bubble is too small to make it float. That's the easy part.

As you squeeze the bottle and push the water against the floating packet, you compress the air bubble into a smaller space. This happens because gases are more squishable than liquids. When you decrease the volume (making the bubble of air smaller), you increase the density of the packet and it sinks! When you release the pressure on the bottle, the compressed air expands inside the packet and the diver floats to the top of the bottle.

Experiment: Fun Fly Stick

NEW Battery powered static electricity generator that makes objects fly OR make your own

The Fun Fly Stick is an ingenious, battery-operated static electricity generator that allows you to float tinsel shapes on a cloud of electrons. Press the button on the Fun Fly Stick for a few seconds to generate a static charge. Drop the tinsel shape onto the stick to quickly transfer the negative charge to the tinsel. Since like charges repel each other, the negatively charged tinsel shape floats above the negatively charged stick. The learning curve is about two minutes and you're ready to amaze everyone with the Fun Fly Stick.

Materials

- Fun Fly Stick
- 5 Tinsel shapes included with Fun Fly Stick
- Piece of fur or wool sweater
- Golf Bag Plastic Tube - These flexible plastic tubes are available at sporting goods stores and are used to keep club shafts scratch free and the golf bag more organized. These tubes are about a meter (3 ft) long.

The Homemade Static Stick

This activity was originally developed by our good friend Bruce Yeany who uses it to teach the science of static electricity to his students.

Try It!
1. Rub the fur up and down on the golf bag plastic tube to build up a negative static charge. Be careful not to touch the tube to anything or you'll lose the static charge.
2. Hold the tube in one hand and pick up the tinsel in the other hand.
3. Hold the tinsel in the air and drop it onto the plastic tube. You don't want to be touching the tinsel when it touches the tube or you'll steal away the static charge.
4. If it worked correctly, you'll immediately see the tinsel shape "puff up" and float above the tube. The static charge that you built up on the plastic tube will slowly dissipate, but it stays on the tube long enough to float the object for a minute or two.

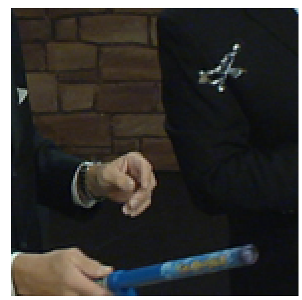
How Does it Work?

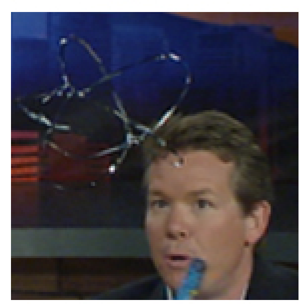
Rubbing the fur against the plastic tube builds up a negative charge on the tube. Touching the tinsel to the tube transfers the negative charge to both objects. The tinsel floats above the wand because the like charges repel one another.

If you buy the Fun Fly Stick

Tips and Tricks

Here are a few tips and tricks that we've learned from playing with the Fun Fly Stick...





- Spend a few minutes with the accompanying tutorial in the Fun Fly Stick box. It's well worth your investment of time.
- The AA batteries go into the handle with the (+) end first. This detail is not explained well in the instructions. If the Fun Fly Stick doesn't buzz when you press the button, the batteries are loaded backwards and need to be reversed.
- The tinsel shapes are very, very delicate! Use extreme care with these shapes as they tear very easily. We strongly encourage an adult to help young children with handling these tinsel shapes. Store the tinsel in a heavy duty zipper-lock bag for safe keeping.
- Remember the two second rule. As you're learning how to float the tinsel shapes, remember that you don't have to constantly press the button. Just press the button for a few seconds to build up a static charge. Pressing the button continuously both drains the batteries and lessens the effectiveness of the Fun Fly Stick.

How does it work?

When you press the button on the Fun Fly Stick for a few seconds a negative static charge is generated. When you drop the tinsel shape onto the stick, the negative charge is quickly transferred to the tinsel. Since like charges repel each other, the negatively charged tinsel shape floats above the negatively charged stick. If you want to impress someone with your newly acquired knowledge, just tell them that the Fun Fly Stick is a demonstration of "electrostatic propulsion and the repulsion of like charges." Okay, if you really want to impress someone, just make the shapes float!

Experiment: Static Electricity Zingers

Rinse out a 1-liter soda bottle and let it completely air dry. Fill the bottle with 1/4 cup of Styrofoam beads and seal the bottle with a cap. Rub the bottle on your head (or better yet, your friend's head) or on a wool sweater. Observe the effects of static electricity on the beads. Simply run your hand over the plastic bottle and build up a static charge. Watch the static beads inside jump from side to side to stay away from your finger.

Charge a balloon and bring it close to a ping-pong ball. The ball will begin to move very slowly toward the balloon. Move the balloon around and the ball will follow.

Fill a balloon with small Styrofoam balls and then inflate the balloon. Be careful to blow and not inhale -- otherwise you'll get a mouthful of tiny Styrofoam balls! Tie off the balloon and rub it on your head. Observe the movement of static balls in the balloon as the static charge jumps from place to place.

Charge a balloon and then blow soap bubbles. Bring the balloon close to the bubbles and they rise rapidly toward the balloon. Now you can tease the bubble around the room with the balloon.

Space, a Science Frontier

Rockets: A History

Everything on Earth – including us – is held down by the force of gravity. Without gravity, we would all float off into space. It is said that Isaac Newton discovered gravity when an apple fell on his head.

In order to reach space, we use a rocket-powered launcher to overcome the pull of Earth's gravity. Other ideas have been put forward from time to time. In 1865, the science fiction writer Jules Verne suggested using a powerful gun to send people to the Moon. More recently, scientists have been studying the use of powerful magnets to send a spacecraft into orbit.

Rockets have been around a long time. They were invented in China, more than 800 years ago. The first rockets were very simple – a cardboard tube packed with gunpowder and attached to a guide stick - similar to the fireworks we use today.

In 1232, the Chinese used these 'fire arrows' to defeat the invading Mongol army. The knowledge of how to make rockets soon spread to the Middle East and Europe, where they were also used as weapons. Later, they also became popular for spectacular firework displays.

How does a launcher work?

Have you noticed what happens if you let the air out of a balloon? The air goes one way and the balloon moves in the opposite direction. Rockets work in much the same way. Exhaust gases coming out of the engine nozzle at high speed push the rocket forward.

Most modern launchers, such as those used by NASA, are very complicated and weigh hundreds of tons at liftoff. Most of this weight is fuel, such as liquid hydrogen and liquid oxygen.

Rockets need so much fuel in order to overcome Earth's gravity. Only when they reach a speed of 28 000 km/h are they travelling fast enough to enter orbit.

Experiment: Squeeze Bottle Rocket

It's easy to turn a juice bottle into a rocket launcher. How? Grab a few straws, some modeling clay and an empty juice bottle to make a launcher that will send the straw rocket soaring across the room. Ok, you'll learn something about Newton's Third Law of Motion at the same time.

This experiment was designed using the Kool-Aid Bursts juice product. While other flexible juice bottles may work, the Kool-Aid product works very well. The larger of the two straws should fix loosely over the smaller straw. There should be no friction or resistance at all or the straw will not be able to launch. If you're tired of searching for straws, just stop by Starbucks® to enjoy a drink and pick up a few straws.

Materials

- Kool-Aid Burst juice bottle (flexible plastic bottle)
- Modeling clay
- 2 straws - one large and one small. The larger diameter straw must be able to slip over the smaller straw. The large and small straws from Starbucks® work great.

1. Drink the juice! Clean and dry the bottle.
2. Push the smaller straw into the opening of the bottle. The straw should fit snuggly in the hole at the top of the bottle.
3. Use modeling clay to seal any possible leaks between the straw and the hole in the bottle. The clay will also make the straw more stable and less likely to wobble.
4. Push one end of the bigger straw into another piece of modeling clay. This "plug" will seal the end of the straw. Cover the plugged end with something soft like a Styrofoam packing peanut to keep the straw rocket from hurting anyone in case they accidentally get hit.
5. It's time to launch... Place the larger straw over the smaller straw. Ready, aim, squeeze! The larger straw launches off the smaller straw and the room erupts in a chorus of oohs & ahhhs!

How does it work?

While you're having fun launching straws, you're actually learning about Newton's Third Law of Motion. According to Newton, for every action there is an equal and opposite reaction. As you squeeze the bottle, air is forced out of the straw and pushes against the clay plug in the larger straw. The resulting force causes the straw to "launch" through the air.

Additional Info

Be careful! Never point the straw rocket at anyone. The goal here is to launch the rocket up in the air (not at someone). Be sure to cover the plugged end of the straw with something soft and round to protect someone from accidentally getting hurt by a sharp edge. Be creative! Once you've mastered the simple straw rocket, challenge your friends to a straw rocket design contest. Add a nose cone, some fins, a few decorations, and don't forget to name your straw rocket!

Experiment: PVC Rocket Launcher

How to make an amazing rocket launcher out of PVC and compressed air.

Examples of Correlating Standards:

Kindergarten 7.11.1 Use a variety of objects to demonstrate different types of movement (e.g., straight line/zigzag, backwards/forward, side to side, in circles, fast/slow).
1st 7.11.2 Investigate and explain how different surfaces affect the movement of an object
4th 7.11.2 Design and investigation to identify factors that affect the speed and distance traveled by an object in motion.
5th 7.10.5 Demonstrate different ways that energy can be transferred from one object another.
5th 7.11.1 Predict how the amount of mass affects the distance traveled given the same amount of applied force.
5th 7.11.3 Design and conduct experiments using a simple experimental design to demonstrate that relationship among mass, force, and distance traveled.
5th 7.12.1 Explain and give examples of how forces act at a distance.
5th 7.12.2 Demonstrate how the shape of an object affects how it falls toward the earth.
5th 7.12.3 Design and explain an investigation exploring the earth's pull on objects.
7th 7.11.3 Summarize the difference between speed and velocity based on the distance and the amount of time traveled.
7th 7.11.4 Recognize how a net force impacts an object's motion.

I was first introduced to this incredible teaching tool in 2001 while speaking the U.S. Space Camp for Educators. As part of the week-long experience, teachers learned how to use Homer Hickam's Rocket Boys with multi-grade levels and in a variety of subject areas to not only inspire students to work hard to see that their dreams come true, but to also introduce and reinforce skills and concepts in some very creative ways. The documents below are offered by the U.S. Space Camp and the Space Academy for Educators in an effort to bring the wonder, discovery and exploration of space and rocketry into a wide variety of classrooms.

Magnets: A History

Magnets have been in use for thousands of years. The first known reference to magnetism dates back to the 4th century B.C.E. from a Chinese literary work called "Book of the Devil Valley Master." In this book, it was written that "lodestone attracts iron to it."

Magnets are mysterious objects. They have an invisible force, by which they can attract or repel other objects. Magnets are being used by people in many devices. For example, you can find magnets in hairdryers, telephones, vacuum cleaners, electric mowers, and cassette recorders. Computers use magnets to save information. Huge magnets are used to separate different kinds of garbage. The earth itself is a huge magnet too. Now people use electromagnets in trains. This is a train without wheels. It moves without touching the rails. In the train and in the rails are magnets that repel each other. The train is kept in the air by the magnetic power and is moved forward by it too.
Did you know...

- The colors of the north- and south pole are made by the magnetism of the earth.
- Some academic people think that homing-pigeons, birds used to carry messages, find their way home by the magnetic field of the earth.
- Magnets are made by pouring hot liquid steel into molds and then letting it cool down in an area that has a strong magnetic field.
- At one point in history, it was thought that lodestone could be used to keep the skin looking youthful. In fact, Cleopatra was reported to have slept on a natural magnet for many years. The therapeutic reputation of lodestone was passed on to the Greeks, as well, who began using magnets for healing around 2500 B.C.E. Aristotle and Plato frequently wrote of the benefits of lodestones in their works.

The black isometric mineral, magnetite, is among the most abundant of the Earth's minerals and can be found in beach sand, in meteorites, and in the natural abrasive emery. The naturally magnetic variety is known as a lodestone, first discovered in the Chinese desert around 3000 B.C.

The magnetic property of lodestone was first studied by the Greek philosopher Thales (624 B.C.-546 B.C.); his samples were found in the region of Magnesia, undoubtedly giving rise to the name "magnet."

Magnets were useful in making compasses, the invention of which is credited to the Chinese. Chinese sailors used compasses to help them navigate around the world. The next advance did not occur for nearly 2,000 years when French scholar Petrus Peregrinus (1240-?) considered the possibility of using magnetic force to run a motor. In this he anticipated Michael Faraday and Joseph Henry by nearly 600 years.

In 1269 Peregrinus discovered that magnets had a north and south pole, and he was able to determine north from south (identical poles repelled each other; opposites attracted). He also showed that breaking a magnet in half did not isolate the two poles; each half became a complete magnet having both poles.

It was Peregrinus' belief that a magnetized needle pointed to the pole of the earth, which later led William Gilbert (1544-1603) to speculate about the earth having a magnetic field. Peregrinus also suggested an improvement to the compass by mounting the needle on a pivot, as opposed to mounting it on a cork floating in water.

Hans Christian Oersted discovered that an electric current produced a magnetic field, paving the way for the invention of artificial magnets called electromagnets.

Experiment: Make a Compass

Make a compass, and you'll always know which direction you're headed. You can make a floating compass or a Chinese hanging compass -- or both!

What You'll Need:

- 2 needles (one for each compass)
- Magnet
- Straight pin
- Cork
- Scissors
- 2 clear plastic cups (one for each compass)
- Water
- Thread
- Pencil

Magnetized Needle for Both Compasses

Step 1: Rub the pointed end of the needle along one side of the magnet, always rubbing in the same direction. Do this about 30 times to magnetize the needle.

Step 2: Test the magnetized needle by trying to pick up the straight pin with it. If you can pick up the pin, the needle is ready.

Step 3: If you will be making both compasses, repeat the process with the other needle.

Floating Compass

Step 1: Cut a small piece of cork, and push the magnetized needle through it.

Step 2: Fill a plastic cup with water.

Step 3: Carefully place the cork with the magnetized needle into the cup so the cork floats in the center. The magnetized end will always face north.

Chinese Hanging Compass

Step 1: Tie an end of a short piece of thread to the center of the magnetized needle.

Step 2: Tie the other end of the thread to a pencil.

Step 3: Place the pencil over the rim of the plastic cup. Again, the magnetized end of the needle will point north.

Experiment: Magnetized Paper Clip Chain

A magnetized paper clip chain shows how magnetism can be created by induction. That means an object can become magnetized itself if it is placed next to a magnetized object. Try this to see how one paper clip in the chain magnetizes the next.

What You'll Need:

- Strong magnet
- Paper clips

Step 1: Take a strong magnet, and hold a paper clip to it.

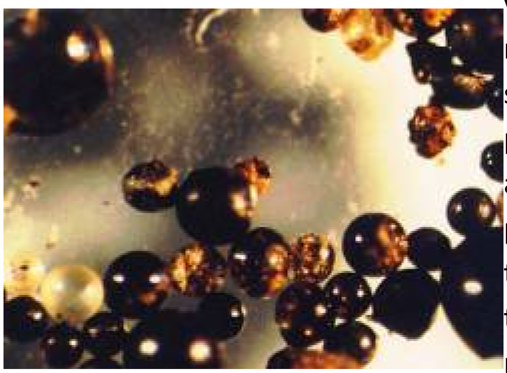
Step 2: Touch a second paper clip to the first one that is hanging from the magnet. The second paper clip will be attracted to the first one because the first clip has become a magnet.

Step 3: Continue adding paper clips in this way to see how long of a chain you can create.

Step 4: Take the first paper clip off the magnet. Do the other paper clips stay joined together, or do they immediately fall?

Experiment: A Meteorite Hit Your House!

It's true. Your home or school was hit by a meteorite and you survived the impact. Okay, so maybe the meteorite was small in size… very small… so small you'd need a microscope to see it… but you were hit. Chances are your school has been hit by a few thousand micrometeorites, and you'll be able to find a few if you know the secret place to look. The next time it rains, place a bucket under a drain spout in order to collect a good quantity of rain. Get rid of the leaves and roofing materials and then sift the remains through a bit of old window screen. What



you're after is so small that you'll need a very strong magnet (neodymium magnet) to find them. Use this super-strong magnet to determine if any of the remaining particles contain iron. Those particles may be space dust, also known as micrometeorites. Place the collected particles under a microscope - high power will be required to see them clearly. The micrometeorites will show signs of their fiery trip through the atmosphere — they will be rounded and may have small pits on their surfaces. Most meteorites falling through earth's atmosphere will burn up before landing on earth, but some will reach the earth in microscopic sizes.

Pieces of rock and metal frequently collide with Earth's upper atmosphere. Most of these are no bigger than a golf ball but are traveling at tens of thousands of kilometers per hour. The atmosphere is very thin at this altitude of 80 to 100 kilometers (50 to 62 miles), however, it creates enough friction to cause these travelers from space to heat up to temperatures that make them burn brightly. These are the fireballs in the sky that are rightly called meteors, although they are often referred to as "shooting stars."

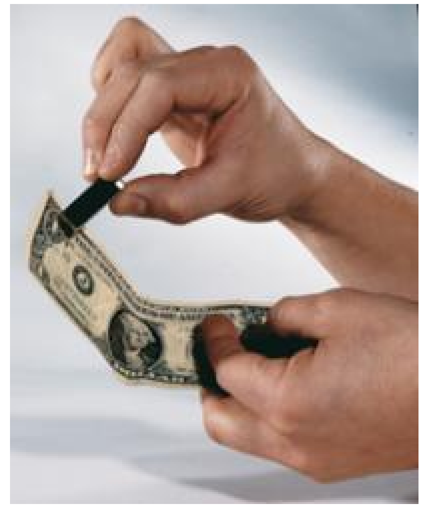
Most meteors burn up completely in the atmosphere and never reach the ground. Those that survive the trip and reach the surface of Earth are called meteorites. While it is generally believed that meteorites are fairly rare, in reality about 30,000 tons of extraterrestrial material are deposited on Earth each year; bits of comets, chunks of asteroids, debris from the formation of our solar system more than four billion years ago. So why aren't meteorites seen more often sitting on the ground? First of all, the largest portion of this material falls into the oceans, and secondly, most of the material that reaches the surface is microscopic, much too small to be noticed. These are the tiny specimens known as micrometeorites. As tons of micrometeorites fall each year, they gently land in our fields, on our homes, and on us.

One of the best places to study micrometeorites is Antarctica. In this isolated environment, very little earth-born debris falls, so any particles found on the clean South Pole ice have a greater likelihood of being extraterrestrial. In fact, what may be the largest collection of micrometeorites is in the hands of the Cold Regions Research and Engineering Laboratories.

Since most of us can't arrange a field trip Antarctica, here is a way that you can collect micrometeorites in your hometown with the help of the rain. Micrometeorites fall everywhere, but collect very nicely on roofs. When rain falls, "space dust" is washed off the roof and through the downspouts. Position a deep bowl or bucket under a downspout. Many things will collect in your bucket; leaves, twigs, sands, etc. Collect this material from your bucket and dry it out. Remove the larger pieces of debris, such as leaves, and spread the remaining material on a sheet of paper (or plastic). Slowly run a strong neodymium magnet back and forth under the paper. (Note: Whenever using a neodymium magnet to collect particles, it's always a good idea to place it in a plastic bag to keep it clean.) When you feel you have attracted most of the metallic particles, tilt the paper up so that the non-ferrous materials fall from the sheet.

Much of what you have collected will be Earth born debris. To find the micrometeorites you will need to examine the collected particles under a microscope. High power will be required to see them clearly. Look for particles that are rounded and may have small pits on their surface. This is evidence of a micrometeorite's fiery trip through the atmosphere.

Experiment: Magnetic Money



It's true, money is magnetic! You'll need to get your hands on a super strong neodymium magnet to uncover an amazing secret.

Materials

Super Strong Neodymium Magnet

Believe it or not, dollar bills are printed with magnetic inks as a way to reduce counterfeiting. Fold the dollar bill in half as shown and hold the neodymium magnet near the bottom of the bill. Notice how the bottom of the bill moves when the iron in the bill is attracted to the magnet. Bob Becker, a teacher in Kirkwood, Missouri, take the experiment one step further by turning a dollar bill into soup in a blender. That's right, he blends a dollar bill with about 200 mL (1 cup) of water. The magnet is held on the outside of the blender while the slurry is whirling around. The blender is stopped and the magnet is slowly pulled away from the blender to reveal the spot of iron. Be sure to perform the experiment with a borrowed bill! Just remind the lender that you're increasing his "liquid assets" or that you've found a way to increase her "cash flow" problems. Yes, Bob Becker is a funny guy... or at least that's what his attorney says.

How does it work?

Neodymium magnets (Nd-Fe-B) are composed of neodymium, iron, boron and a few transition metals making them some of the strongest magnets in the world. Magnets of all types create a magnetic field, with both a north and south poles. The magnetic field created by the neodymium magnets is so strong; it will line up to match the magnetic north and south of the earth. It makes a great compass!

On a more serious note, the large magnets are so strong that they may even be dangerous if not handled properly. A pair of these magnets will leap into a deadly embrace from over 6 inches apart and may knock chips off themselves from the force of the impact. You'll be amazed at the super strength of the magnets, but we must warn you to be careful. Any type of magnetic media will be history in the presence of one of these large neodymium magnets.

Experiment: Money in a Blender-A Money Smoothie

U.S. dollar bills are printed with special inks that contain traces of iron and other magnetic material in an effort to prevent counterfeiting. So, the only logical question that follows is, "Can you get the iron out of a dollar bill?" Steve Spangler accepted the challenge with the help of his friend, Bob Becker, who found a most unusual way to extract the iron from a dollar bill. You'll be amazed at how much iron is in a single dollar bill.

Materials

You'll need:
- A $1 bill (be sure to borrow it from a friend)
- A kitchen blender
- Water
- A zipper-lock bag
Super Strong Neodymium Magnet
- Some adult supervision.

1. You'll need a dollar bill. Now you could just dig down deep into your own pocket to find a bill or you can take Bob Becker's advice and borrow the bill from a friend. Hey, why should you have to provide the entertainment and pay for it too?
2. Fill the blender half full with water (between 3 and 4 cups).
3. After the bill has been thoroughly examined to verify that it's real, drop the dollar bill into the blender and put on the lid.
4. What's next? Make dollar bill soup! Grind it, blend it, liquefy it just make sure it's torn into thousands of little pieces. Oh, by the way, the U.S. Treasury has an unofficial comment on this activity “ As long as you don't try to spend your ˜liquid money", you can do whatever you want with your dollar bill, I guess." So, don't try to spend the money after you blend it.
5. After the money has been grinding away for at least a minute, stop the blender and pour the contents into a quart size zipper-lock bag.
6. Place the Super Strong Neodymium Magnet in the palm of your hand and place the bag of money soup on top of the magnet. Place your last remaining hand on top of the bag and rock the slurry back and forth in an effort to draw all of the iron to the magnet. Flip your hands over and look closely at the iron that is attracted to the magnet. You can slowly pull the magnet away from the bag to reveal the iron!

How does it work?

Neodymium magnets (Nd-Fe-B) are composed of neodymium, iron, boron and a few transition metals. These magnets are extremely strong for their small size. As it turns out, at least some of the iron in the dollar bills is elemental. The inks are magnetic which makes it easy to read the bills with machines. Bob Becker shared the following information to help students better understand the real-world application:

1. What evidence is there that the ink in a dollar bill is made of iron, instead of some other metal? The ink is strongly attracted to a magnetic field. Iron is one of only a few metals that is attracted to a magnet.
2. Is the iron in currency present as ions or elemental iron? Elemental iron. The ions are not that strongly attracted to a magnetic field.
3. What are the advantages to having magnetic materials in currency. The bill may be read by machines more easily. It may also help prevent counterfeiting.

Bob Becker adds, "Once the blender has been turned on, the distraught student can be comforted with such remarks as 'Don't worry, I'm just increasing your liquid assets!' or 'Just think, you'll never have a problem with cash flow again!' "

Additional Info

Wait... isn't it illegal to destroy money? When Steve Spangler originally demonstrated this experiment on television, he contacted the U.S. Mint officials in Denver, Colorado and asked for clarification on this law...

Section 333. Mutilation of national bank obligations

Whoever mutilates, cuts, defaces, disfigures, or perforates, or unites or cements together, or does any other thing to any bank bill, draft, note, or other evidence of debt issued by any national banking association, or Federal Reserve bank, or the Federal Reserve System, with intent to render such bank bill, draft, note, or other evidence of debt unfit to be reissued, shall be fined under this title or imprisoned not more than six months, or both.

The officials at the U.S. Mint tell us that **the law only prohibits you from destroying or defacing money if you still intend to use it as money**. If you're destroying it for some other reason, it's legal. That's how the companies that make the souvenir coin-flattening machines or magicians who make special coins get away with it. In fact, this law is actually printed on the side of some of the coin-flattening machines as a result of so many questions from people who have heard about the law but do not really understand it. Destroying a one dollar bill for the sake of extracting the magnetic ink probably means that you are not going to try to return the liquefied bill into circulation. So, there's your get out of jail free card.

Experiment: Magic Sand

How can something submerged in water stay dry? When ordinary sand gets wet, the result is a clumpy mess. However, "Magic Sand" begins as normal looking sand, until it's coated with a substance that repels water. This special coating keeps the sand dry even after it has been dumped into a container of water. Build castles and other structures under the water, then simply pour the water off when you're finished and the sand is still dry!

Materials

- Magic Sand
- Regular sand
- Water, cups
- Plastic soda bottle
- Vegetable oil
- Food coloring
- Plastic spoons.

What Makes Magic Sand Magic?

1. Fill a cup 3/4 full with water.
2. Slowly pour Magic Sand in a continuous stream into the water. Look closely at the sand. What is that silver-like coating on the sand?
3. Pour off the water from the sand into a second container. Let them touch the sand and see what they find. To everyone's amazement, the sand is completely dry! To better understand how Magic Sand works, try this demonstration…
    - Fill a plastic soda bottle (16 oz. works well) 3/4 full with water.
    - Fill the remaining portion of the bottle with vegetable oil or mineral oil. Immediately, the students will notice that the oil and water do not mix.

- Add a few drops of food coloring to the mixture. Notice how the food coloring only colors the water and not the oil… even when the bottle is shaken.

How does it work?

This is a great demonstration to introduce students to the properties of substances that are hydrophobic and hydrophilic. Hydrophobic substances do not mix with water. The term "water-fearing" is often used to describe the word hydrophobic. Hydrophilic substances, on the other hand, are "water-loving". Notice how the drops of food coloring color only the water and not the oil. Since oil is hydrophobic, the oil did not mix with the food coloring or the water. What are other examples of oil and water not mixing? A newly waxed car will make water form beads on its surface. Oil from cars will float on top of puddles. Oil and vinegar salad dressings need to be shaken up before using. So, how does Magic Sand work? The surface of sand grains is made wet by water, which means that water molecules are attracted to sand grains. Remember, this water-loving property of sand is called a hydrophilic property. Magic Sand is regular sand that has been coated with an oil- like substance that is water-hating or hydrophobic.

Additional Info

Regular Sand vs. Magic Sand
For this activity you'll need a small amount of regular sand and Magic Sand. Fill 2 cups with water. Use a spoon to sprinkle a small amount of regular sand into one of the cups. Notice how the sand immediately sinks. Sprinkle a thin layer of Magic Sand on the surface of the water in the second cup. Why does the Magic Sand float on the surface whereas the regular sand sinks? The surface of the regular sand grains is made wet by water, which means that water molecules are attracted to sand grains. Magic Sand is regular sand that has been coated with an oil-like substance so it is water- hating. The Magic Sand grains like to stay in contact with each other. Also, the surface tension of the water makes the Magic Sand float.

Making Magic Sand Wet
Pour a small amount of Magic Sand in a cup of water. As expected, the Magic Sand stays dry. Add about 12 drops of liquid detergent to the water and use a spoon to stir the mixture. Soap breaks down the oil coating on the sand and lowers its hydrophobic properties. Adding soap removes the "magic" from Magic Sand and causes it to behave like regular sand. The secret is revealed!

Other Uses for Magic Sand
The coating on Magic Sand is like Scotchguard, which is sprayed on fabric to protect it from stains. Magic Sand was originally developed as a way to trap oil spilled from oil tankers near the shore. The idea was that when Magic Sand was sprinkled on floating petroleum, it would mix

with the oil and make it heavy enough to sink. This would prevent the oil from contaminating beaches. However, it is not being used for this purpose, perhaps because of the expense of making Magic Sand. Another potential use of Magic Sand is to bury junction boxes for electric and telephone wires in the Arctic in order to protect the utilities from the extreme cold temperatures but make it easy to dig up for repairs. Normal earth is frozen so hard because of moisture content that it is difficult to dig. However, Magic Sand remains dry and is easy to dig, regardless of how cold it is.

Science and Literature Connection

Experimentation with Magic Sand is fascinating. You might begin by reading the story Johnny Castleseed written by Edward Ormondroyd. After introducing the story, have the students experiment with different types of sand (beach sand, colored sand, etc.). Let them mix sand and water and feel the sand. Ask them why it feels wet. Then it's time to introduce Magic Sand.

Experiment: Bounce No Bounce Balls

You might be surprised to find balls that don't bounce, squish, change color or even splat on the floor. It's a great way to explore the science of toys.

Materials

- Bounce No Bounce Balls look and feel the same, but one bounces and the other one is completely dead!
- Poppers can either be made using the instructions below or purchased from stevespanglerscience.com.

Bounce No Bounce Balls
The black rubber balls look and feel identical in every way except in the way they bounce. One ball bounces like a super ball while the other ball is "dead ." Since the balls look and feel the same, it's easy to cleverly switch the "no bounce" ball for the one that bounces which results in questions and laughter.

The secret is in the type of material used to make the balls. The ball that bounces is made out of a natural rubber that is highly resilient and very elastic - it's great for bouncing. The "no bounce " ball is made out of a special type of rubber (usually butyl rubber) that absorbs the kinetic energy of the falling ball instead of changing it into potential energy. This "no bounce" rubber was considered for use in making car bumpers less resilient in a crash. In running shoes, the superior shock-absorbing ability of the "no bounce" rubber helps alleviate problems caused by the tremendous pounding suffered by feet, legs and ankles.

Racquet Ball Conserves Energy!
This activity requires an adult one who is smart and one who can use sharp objects!

With a sharp knife or razor blade (caution!!!), slice a racquet ball into two halves. Trim each half so that it is slightly smaller than a hemisphere. Turn the he hemisphere inside-out and drop it, bulge-side-up, on a hard surface. The ball will snap and rebound to a height much greater than that from which it was dropped.

Work is required to turn the hemisphere inside-out and this work is stored as potential energy. As the dropped ball hits the hard surface, this potential energy is released and converted to kinetic energy, allowing the ball to rebound to a greater height.

If you don't want to ruin a perfectly good racquet ball, try our Poppers. They are colorful fun and give you the same effect!

Experiment: Disappearing Ink

It's a joke shop classic... disappearing ink. There's just something funny about squirting dark blue "ink" on someone's shirt only to have it disappear like magic. Best of all, there's actually some great acid-base chemistry behind all of the prankster fun.

Materials

It's probably cheaper to buy 99¢ bottles of disappearing ink from the toy store than to purchase the chemicals required to make the solution.

If you do decide to make your own ink, you'll need:

- thymolphthalein (a common acid-base indicator in the form of a powder)
- ethyl alcohol
- 3 molar sodium hydroxide
- water
- safety glasses.

Safety first... Never spray disappearing ink into anyone's face.

1. Add 1 gram of thymolphthalein into 100 mL of ethyl alcohol. The solution will require stirring to dissolve all of the powder.
2. Add 900 mL of water to the solution and stir. Don't worry if the solution looks white - that's because the thymolphthalein indicator is not soluble in water. No worries, the next step will fix everything.
3. Slowly add 10 mL of 3 molar sodium hydroxide to the solution to turn the liquid a dark blue.

Caution: Sodium hydroxide (commonly known as lye) is a caustic solution and must be handled by an adult. Once the sodium hydroxide is diluted with water, the solution is safe to use as disappearing ink, but care must be taken because the pH of the ink solution is about 10 (basic). Be sure to wash your hands well with water after handling the more concentrated solution.

Always test the disappearing ink on a small piece of white fabric to make sure that it actually disappears. In a few seconds, the ink stain will disappear. The color will vanish more quickly if you apply a cotton ball dampened with vinegar or if you blow on the spot (the carbon dioxide in your breath is the secret!). The pH of the ink solution is 10-11, but after exposure to air will drop to a pH of 5-6. The damp spot will eventually dry. A white residue may be visible on some dark fabrics. Be sure to store the disappearing ink solution in a sealed container. All of the materials may be safely poured down the drain.

How does it work?

The secret to making the ink disappear is carbon dioxide in the air which reacts with the water in the solution to form carbonic acid. The carbonic acid then reacts with the sodium hydroxide in a neutralization reaction to form sodium carbonate. This lowers the pH of the solution with the alcohol acting as an acid to turn the indicator colorless and the ink stain magically disappears. The "fading time" can be prolonged by adding a small amount (use drops to make these adjustments) of sodium hydroxide. But care should be taken not to add too much sodium hydroxide. By the way, did you know that red disappearing ink can be made using phenolphthalein (a very common acid-base indicator) in place of thymolphthalein.

In Steve's version of the demonstration, he used a carbon dioxide fire extinguisher to make the stain vanish quickly very quickly. This should not be done by anyone who has not been properly trained in how to select the right fire extinguisher and how to use it for this purpose. Thanks to Lee Marek for inspiring thousands of science teachers to use a carbon dioxide fire extinguisher with the disappearing ink demonstration.

Experiment: Make a CO2 Sandwich

Explore the pop factor of vinegar and baking soda.

Mom always warned us never to play with our food… but no one said that the wrappers were off limits. Here's a fun activity that uses some common items that you'll find around the house and a little creativity to explore the "pop" factor of vinegar and baking soda.

This activity requires safety glasses and adult supervision. Why? Just because (that's something Mom said all of the time).

Materials

- Safety glasses
- Measuring cup and spoons
- Vinegar
- Baking soda
- Reclosable bag (a quart-size zipper-lock bag)
- Toilet Paper

1. Tear off a square of toilet paper.
2. Twist or fold the toilet paper around the pile of baking soda making a small packet.
3. It's best to have someone help you with the next few steps. Open the zipper-lock bag and measure a 1/4 cup of vinegar into the bag. Add a 1/4 cup of warm water to the bag.
4. Zip the bag closed, but not all the way. You want a small opening just large enough to sneak in the wrapped up baking soda.
5. IT'S TIME FOR A FIELD TRIP. Move the experiment to the sink, or better yet OUTSIDE! Remember, it's all about teamwork. Drop the baking soda bundle into the bag and quickly seal the bag closed. Place the bag on the ground (or in the sink if you're indoors) and get out of the way. Watch closely as the bag begins to puff up… it gets bigger and bigger until… BAM! Pop goes the sandwich bag.

How does it work?

Sure, bubbling liquids and popping bags are fun, but what's the science behind the exploding lunch bag? When you mix vinegar and baking soda, a chemical reaction takes place producing a gas called carbon dioxide (CO2). If you really want to impress your friends, use the chemical names for each of the ingredients. Acetic acid (that's vinegar) plus sodium bicarbonate (baking soda) produces carbon dioxide gas and water. The bag puffs up because the carbon dioxide gas takes up lots of space, eventually filling the bag. If there's more gas than the bag can hold… KABOOM! If you're lucky, the zipper-lock seal will bust open, but the bag will not break. Now you can reuse the bag to make another CO2 sandwich. Wrapping the baking soda in tissue paper is a clever way of slowing down the reaction. It takes a few seconds more for tissue paper to dissolve so that the vinegar and baking soda mix.

But Wait! There's More…

- How does the temperature of the water affect the pop? Repeat the experiment using cold water instead of warm water.
- Try changing the amount of vinegar and baking soda you use to see how the reaction changes. Remember to only change one thing (variable at a time). For example, you can increase the amount of vinegar you use to 1/2 cup, but be sure to keep the amount of baking soda (one tablespoon) and the water (1/4 cup) the same. By changing only one variable at a time, you'll be able to determine which ingredient has the most impact on the POP!
- Wrap the baking soda in two or three pieces of tissue. How will this affect the reaction?
- What are 3 more variables you can change?

Ice Cream: A History

According to NationalGeographic.com , some believe that ice cream originated in China around 200 B.C., when a concoction of milk and rice was packed in snow to harden. Another legend has it that the Roman emperor, Nero, is credited as the first person to make ice cream. Nero commanded slaves to bring snow down from the mountains. Then the slaves sprinted back to the kitchen before it could melt, where cooks flavored the snow with fruit, wine, or honey.

In 1846, Nancy Johnson invented the hand-cranked ice cream churn and ice cream surged in popularity. Then, in 1904, ice cream cones were invented at the St. Louis World Exposition. An ice cream vendor ran out of dishes and improvised by rolling up some waffles to make cones.

Americans love ice cream. The United States produces 1.6 billion gallons of frozen desserts annually. We export about 40 million of those gallons to other countries, especially Japan.

And the rest? We eat it. Each year Americans spend almost $20 billion on ice cream and other frozen desserts.

The one thing Americans didn't do with ice cream was invent it. So who did? No one knows for sure. The following list is a taste of the history and mystery of this popular food.

OLD WORLD

At first, ice cream was mainly a treat for the rich and the royal. Before refrigeration, ice was rare and expensive. Making ice cream also took hours, so it helped to have servants who could do it.

Sweet Snow
A.D. 54: Nero became emperor of Rome. He knew how to throw a feast. For dessert, he served a one-of-a-kind treat: sweet snow. To make it, Nero's slaves ran up into the mountains and gathered snow. Then they sprinted back to the kitchen, where cooks flavored the snow with fruit, wine, or honey.

Cool Legend
1295: Italian explorer Marco Polo returned home after 17 years in China. His *Description of the World* amazed Europeans. Among the strange things he saw was "milk dried into a kind of paste." Over time, that piece of Polo's story grew into the legend that he brought home a recipe for ice cream. He didn't.

Rare Treat
1660s: Wealthy Europeans enjoyed a rare new treat—"water ices." Before long, creative cooks

added cream to the mix. To make things really fancy, they used metal molds to form ice cream into all sorts of shapes.

COMING TO AMERICA

Like most Americans, ice cream was an immigrant. And, like most immigrants, it changed a lot after arriving. With the rise of factories in the 1800s, ice cream became a mass-produced treat. By 1900, almost anyone could afford it.

Founding Fans

1744: In his diary, colonist William Black mentioned "fine Ice Cream" at a dinner party in Maryland. That's the first record of American ice cream. Fans of this cool treat later included George Washington and Thomas Jefferson. In the 1780s, Jefferson was a diplomat in France. He became fond of vanilla and probably introduced it to America. Vanilla is now the best-selling ice cream flavor.

Mighty Machine

1843: Making ice cream took a lot of muscle. The first step was putting a pail of cream inside a bucket of ice. For the next few hours, cooks had to stir the cream and shake the ice. Things got much easier when Nancy Johnson invented an ice cream machine. Turning a crank stirred the ingredients and made the ice cream freeze smoothly.

First Factories

1850s: Jacob Fussell opened America's first ice cream factories. "More than anyone else," says one history book, he "was responsible for starting the Americans' love affair with ice cream." Fussell's partner, James Horton, later opened a New York factory.

Ice Cream Sodas

1870s: "Soda," or bubbly water, became popular during the 1800s. Sweet syrups flavored the soda. Who thought of adding ice cream? That's a mystery. Depending on whom you believe, it happened in Philadelphia or New York or Detroit. In any case, going out for ice cream sodas was still a favorite activity in the 1950s.

Sundaes

1880s: The sundae is probably named for the first day of the week. One popular tale is that many places banned selling sodas on Sunday. In response, a crafty merchant put just ice cream and syrup into a dish. The gooey result was a hit. At least five towns claim to be the sundae's birthplace.

First Cone?

1904: Countless visitors attended the World's Fair in St. Louis, Missouri. Many marveled at their first sight of an ice cream cone. But just who invented it? Several fair vendors claimed that they had made the first cone. Generally the glory goes to Ernest Hamwi, an immigrant from Syria. He was selling thin, waffle-shaped cakes. Next to him was an ice cream stand. The ice cream seller ran out of dishes. So, Hamwi said, he quickly shaped his cakes into cones that could hold ice cream.

NEW TWISTS ON AN OLD TREAT

Today 90 percent of American households eat ice cream. Ever inventive, ice cream makers constantly seek new ways to keep customers interested.

Brick on a Stick

1919: Danish immigrant Christian Nelson sold candy in Iowa. One spring afternoon, a young customer wanted some chocolate. Then he changed his mind. What he really wanted was ice cream. That gave Nelson an idea. He created the I-Scream Bar—a small brick of ice cream coated with chocolate. Nelson then placed his creation on a stick, just as factories do today.

Hitting the Road

1934: Thomas Carvelas, a Greek American, began selling ice cream in New York State. He used his profits to invent a freezer that could produce soft "Carvel" ice cream. Carvelas paired his invention with a favorite American machine—the car. Carefully placing shops along highways, Carvel built an ice cream empire.

Far-Out Flavors

2003: Some things about ice cream haven't changed. Back in the 1790s, a New York cookbook included recipes for parmesan, ginger, and brown bread ice cream. Today's New Yorkers can try rose, ketchup, spam, or potato chip ice cream. American ice cream—like the nation itself—is as flavorful as ever

Fun Facts from icecream.com

It takes 12 lbs. of milk to make just one gallon of ice cream. Wonder how they fit it all in one carton?

The U.S. enjoys an average of 48 pints of ice cream per person, per year, more than any other country. Maybe we should make ice cream the fifth food group!

It takes an average of 50 licks to polish off a single-scoop ice cream cone. Challenge your family to a Lick-a-Thon, and see who finishes first!

Experiment: Making Rock and Roll Ice Cream

Making ice cream is a fun and delicious way to build science skills. Students will experience a change in state from a liquid to a solid. They will discover the difference of temperature between ice without salt and ice mixed with salt. They will practice following directions and measuring with accuracy to complete a recipe.

Materials

- 1 Large coffee can or plastic jar
- 2 quart size zipper-lock bag
- Half & Half Cream or Whole Milk
- Crushed ice
- Salt (rock salt works great)
- Vanilla
- Sugar
- Towel (or winter gloves)

1. Fill the coffee can or large plastic jar half full with crushed ice.
2. Add about 6 tablespoons of salt to the ice. Seal the container and mix for a few minutes by rolling the container back and forth on the floor. Hey, you might even have to wear gloves! Why? Measure the temperature of the mixture with a thermometer. The salt and ice mixture gets down to about 14 degrees F (-10 degrees C)!
3. Use the quart size zipper-lock bag to mix the following ingredients:
    - 1/2 cup of half & half cream
    - 1 tablespoon sugar
    - 1/2 teaspoon vanilla extract
4. Seal tightly, allowing as little air to remain in the bag as possible. Too much air left inside may force the bag open during shaking.
5. Place the bag inside the coffee can with the ice mixture and seal and place the lid on tightly. Here comes the fun part... find someone who will roll the can back and forth on the floor with you. Only the people who help get to enjoy the ice cream! Roll it everywhere... on the floor, over the bed, under the table, on top of Uncle Bill... just keep

rolling it. Five to eight minutes is adequate time for the mixture to freeze into ice cream. You might need to check on your ice cream concoction after 5 minutes to see if it's frozen. If not, keep rolling.

6. Remove the bag from the can and rinse it well with water. You don't want any salt water accidentally getting into your ice cream.
7. Use your spoon to eat the ice cream right out of the bag!

How does it work?

What does the salt do? Just like we use salt on icy roads in the winter, salt mixed with ice in this case also causes the ice to melt. When salt comes into contact with ice, the freezing point of the ice is lowered.

The lowering of the freezing point depends on the amount of salt added. The more salt added, the lower the temperature will be before the salt- water solution freezes. For example, water will normally freeze at 32 degrees F. A 10% salt solution freezes at 20 degrees F, and a 20% solution freezes at 2 degrees F.

When salt is added to the ice, some of the ice melts because the freezing point is lowered. Always remember that heat must be absorbed by the ice for it to melt. The heat that causes the melting comes from the surroundings (the warmer cream mixture). By lowering the temperature at which ice is frozen, you were able to create an environment in which the cream mixture could freeze at a temperature below 32 degrees F into ice cream.

Experiment: Homemade Ice Cream in a Bag

Forget endlessly cranking the handle of an ice-cream maker. After combining the ingredients, each student can simply shake up his or her own pouch of soft serve--and it's done in just 5 minutes.

- 2 tablespoons sugar
- 1 cup half and half or whole milk
- 1/2 teaspoon vanilla extract
- 1/2 cup salt (The bigger the granules, the better. Kosher or rock salt works best, but table salt is fine.)

- Ice cubes (enough to fill each gallon-size bag about half full)
- 1 pint-size zip lock bag
- 1 gallon-size zip lock bag

Step 1

Combine the sugar, half and half, and vanilla extract in the pint-size bag and seal it tightly.

Step 2

Place the salt and ice in the gallon-size bag, then place the sealed smaller bag inside as well. Seal the larger bag. Now shake the bags until the mixture hardens (about 5 minutes). Feel the small bag to determine when it's done.

Step 3

Take the smaller bag out of the larger one, add mix-ins, and eat the ice cream right out of the bag. Easy cleanup too! Serves 1.

Bubblegum: A History

In 1928, bubble gum was invented by a man named Walter E. Diemer. Here's what Walter Diemer, the inventor himself, said about it just a year or two before he died: "It was an accident." "I was doing something else," Mr. Diemer explained, "and ended up with something with bubbles." And history took one giant pop forward. What Mr. Diemer was supposed to be doing, back in 1928, was working as an accountant for the Fleer Chewing Gum Company in Philadelphia; what he wound up doing in his spare time was playing around with new gum recipes. But this latest brew of Walter Diemer's was -- unexpectedly, crucially -- different. It was less sticky than regular chewing gum. It also stretched more easily. Walter Diemer, 23 years old, saw the bubbles. He saw the possibilities. One day he carried a five-pound glop of the stuff to a grocery store; it sold out in a single afternoon.

Before long, the folks at Fleer were marketing Diemer's creation and Diemer himself was teaching cheeky salesmen to blow bubbles, to demonstrate exactly what made this gum different from all other gums. The only food coloring in the factory was pink. Walter used it. That is why most bubble gum today is pink.

Gilbert Mustin, President of Fleer named the gum Dubble Bubble and it controlled the bubble-gum market unchallenged for years, (His bubble gum was so successful that it sold over a million and a half dollars worth of gum in the first year.) at least until Bazooka came along to share the wealth. Walter Diemer stayed with Fleer for decades, eventually becoming a senior vice president.

He never received royalties for his invention, his wife told the newspapers, but he didn't seem to mind; knowing what he'd created was reward enough. Sometimes he'd invite a bunch of kids to the house and tell them the story of his wonderful, accidental invention. Then he'd hold bubble-blowing contests for them.

Making gum

People have been chewing gum for thousands of years. Ancient Greeks, Mayas, and Native Americans, for example, chewed on the sap, or resin, of certain types of trees.

Today, gum is a little more complicated, says Ron Ream, a food scientist in Plano, Ill. Gum manufacturers start by mixing resin, wax, and a molecule called polyvinyl acetate to make a gum base. By varying the types and amounts of these ingredients, scientists can make thousands of formulations.

Giant mixers then combine vats of melted gum base with powders, syrups, and sweeteners. Other machines roll the goo into sticks or press them into pellets. Packaging is the final step.

Americans chew about 1.8 pounds of gum per person each year, according to the U.S. Census Bureau. By showing that gum chewing can be healthy, companies that make and sell gum hope that we'll chew even more.

Nutritionist Gil Leveille, executive director of the Wrigley Science Institute, says that chewing gum might also be good for your brain. One Japanese study of nine participants, he says, found that chewing gum boosted the flow of blood to participants' brains by up to 40 percent. Blood carries oxygen, which fuels brain cells.

Other small studies have found that people perform better on memory tests while chewing gum. And a study in the United Kingdom found that people who chewed gum while memorizing a list of words did about 25 percent better at recalling those words than people who didn't chew gum.

Fun Facts:

•The ancient Greeks chewed mastiche - a chewing gum made from the resin of the mastic tree.

•The ancient Mayans chewed chicle which is the sap from the sapodilla tree.

•North American Indians chewed the sap from spruce trees and passed the habit along to the settlers.

•Early American settlers made a chewing gum from spruce sap and beeswax.

•Thomas Adams first tried to change chicle into automobile tires, before inventing a chewing gum that tasted good.

Experiment: Bubble Gum Science

Get ready for a lesson in the science of food polymers.

Times have changed. At one time chewing gum in school got you into big trouble. Not only did you have to spit it out but you had to write, "I will not chew gum in school" a hundred times. Today, kids are learning how to make gum in science class as a lesson in the chemistry of food. Get ready for a lesson in the science of food polymers... or the secret to making the world's best bubble gum.

Materials

The bubble gum made on-air contained a specially formulated starch- polymer gum base, sugar, high fructose corn syrup and artificial flavoring. All of these ingredients are included in the Bubble Gum Kit.

The difference between bubble gum and chewing gum is the gum base. Chewing gum base is a natural gum called chicle harvested from the sap of a tropical tree called a sopapilla tree. This kind of gum is chewy but it will not blow a large bubble. Bubble gum base, on the other hand, is a mixture of starches and polymers made in a laboratory and specially formulated to blow bubbles.

Believe it or not, chewing gum is actually beneficial. It relieves boredom, eases tension and aids in concentration -- tell your teacher that little fact! It also helps to pull food particles from between your teeth and even freshens breath. Okay, sometimes it freshen breath. A stick of gum containing sugar has about 10 calories compared to sugarless gum which has only 6 calories. Contrary to popular belief, swallowing gum will not do any harm... or so they say.

Ancient Greeks chewed the gum of the Mastic tree. More than 1,000 years ago the native people of Central America and North America chewed the sap and resins found in trees. Today, the United States is the world's leading manufacturer of gum (go figure!). With all of this fascination with bubble gum, it only stands to reason that bubble gum was invented in 1928 by Walter Diemer, an accountant from Philadelphia.

And now you know the rest of the bubble gum story.

Experiment: "Speediest Chomper"

A speed calculation activity.
Have the students work with partners. One partner chews and the other partner helps count how many times his/her partner can chomp on a 1 piece of
bubblegum (the big pink ones work well)in a 15 second period;
then 30 second; then 1 minute time period.

The teacher keeps track of the time and tells them when to start and to end. Then the students switch roles.

The number of chomps represents distance. When divided by the time this equals the rate of speed in chomps per second.

Option: Hold a “Chomp Off” between the fastest chewers in the class, with the rest of the class doing the calculations.

Experiment: Biggest Bubble

Have students write directions on how they would advise someone to blow the biggest most “bodacious” bubble possible. Be clear and go step by step. Write complete sentences and be sure to use correct punctuation.

Then, put their theories to the test by dividing them into pairs. As one partner gets a piece of gum and follows their directions the other partner will measure the resulting bubble. Then they will switch roles.

Then, have students compare their success with the rest of the class in a bubble blowing competition. The biggest, longest lasting bubble blower wins. Then, everyone else gets to follow the winner’s directions and see if they succeed in blowing a giant bubble too.

Sunscreen/Tanning Lotions: A History

In the early 1930's, South Australian chemist, HA Milton Blake, experimented to produce a sunburn cream.

The founder of L'Oreal, chemist Eugene Schueller, invented the first sunscreen in 1936.

In 1944, Florida pharmacist, Benjamin Green invented a suntan cream in his kitchen that became "Coppertone Suntan Cream."

In 1980, Coppertone developed the first UVA/UVB sunscreen.

Invention of Sunscreen

While it's tempting to bask in the sun like a French fry under a heat lamp, it's not the best idea – sunburn significantly increases the risk of developing skin cancer.

The ancient Greeks used olive oil as a form of sunscreen, which (unfortunately for them) would have exacerbated the sun's harmful effects. In fact, it was not until the 1940s that an effective sunscreen was invented. Ancient humans desired to avoid sunburn and look attractive. For example, Egyptians considered light skin more beautiful than dark skin. Egypt's sun-drenched environment made it difficult to maintain light, luminous skin. Recently translated papyri scrolls and tomb walls reveal the ingredients of potions used to ward off sunburn and heal damaged skin.

Some of the ingredients used by the Egyptians are also used by modern scientists. For example, the Egyptians used rice bran extracts in some of their sunscreen formulas . Today, gamma oryzanol is extracted from rice bran because of its UV-absorbing properties. The Egyptians also used jasmine, recently shown to heal DNA at the cellular level in the skin, to mend skin damage.

During World War II, many soldiers suffered from serious sunburn, which inspired a pharmacist named Benjamin Greene to invent a solution. Greene concocted a sticky, red substance that he called "red vet pet" (red veterinary petrolatum), a new product so thick that it worked mainly by physically blocking the sun's rays. Greene tried the invention on his own scant hairline and found it to be reasonably effective.

Sunscreen established its roots during WWII when airman and future pharmacist Benjamin Green helped develop a sun protective formula for soldiers. In 1944, Green used his invention as the basis for Coppertone® Suntan Cream - the very first consumer sunscreen product. In fact, this mixture of cocoa butter and jasmine was concocted on his wife's stove and tested on his own bald head.

Sunscreen was first developed to help protect soldiers stationed in the South Pacific during World War II from obtaining severe sunburns.

Coppertone Sunscreen Lotion

A physician from Miami named Dr. Benjamin Green had been giving credit for inventing the United State's first sunscreen along with the help of the military. After the war, Green had taken an interest in the tourists of Miami. They had been using all sorts of different homemade concoctions to tan in the sun. Dr. Green had decided to come up with his own formula while testing the product on his own bald head. In 1944, he had developed a recipe for his Coppertone suntan cream that also contained the essence of jasmine. At the start of its career, Coppertone had a picture of an Indian chief with the slogan "Don't be a Paleface." They had later replaced him with Little Miss Coppertone in 1953.

Coppertone sunscreen lotion is often thought of as having the single purpose of protection from the sun. However, there are a handful of people who have discovered what you can use Coppertone for around the home. With this product, you can:

· Prevent chapped lips by replacing lip balm with Coppertone to keep lips moist and healthy.
· Prevent skin damage by using sunscreen whenever you have to be in the sun's rays for prolonged periods of time. Without sunscreen you are increasing the risk of developing cancerous lesions, discoloration, and wrinkling.
· Moisturize your hands by rubbing the sunscreen into the skin. The emollients will rejuvenate dry skin.
· Remove oil and grease from the skin by rubbing Coppertone into the skin and then washing with clean warm water.
· Repel Insects by rubbing Coppertone on to your skin to keep insects away.
· Relieve itching from insect bites by applying Coppertone over the affected area to alleviate the itch.
· Enjoy a massage by substituting massage oil with Coppertone.
· Take a soothing bath by replacing bath oil with two tablespoons of Coppertone to warm bath water.
· Clean grease and dirt by squirting the sunscreen on to a soft cloth and wiping the surfaces clean.
· Remove scuff marks from leather shoes by applying Coppertone to a soft cloth and rubbing

gently over the leather.
· Remove tar spots from car finishes by applying Coppertone to a cloth and then rubbing until the tar is removed.
Modern sunscreens have come a long way since then. Formulas of sunscreen designed specifically for athletes, swimmers and children have been invented, and various SPF (Sun Protection Factor) levels are available. :

A: For children six months of age and older, we recommend sunscreens with an SPF 30 or higher. Babies under six months should be kept out of the sun. Adults of all skin types should use a sunscreen with an SPF of at least 15.

A: UVA rays penetrate deeply into the skin and contribute to premature skin aging and skin cancer. Our exposure to UVA is more constant than to UVB - we encounter UVA rays no matter what the season or time of day.

UVB rays are the main cause of sunburn, but they also contribute significantly to premature skin aging and skin cancer. High SPF sunscreen products (those with an SPF higher than 30) are designed primarily to absorb UVB plus the shorter UVA rays.

Experiment: UV Beads

Use the Beads to try these experiment ideas:

Experiment: Sun Screen Test -- With all of the SPF (Sun Protection Factor) numbers available, we want to know what SPF lotion really works best at keeping out the sun's harmful UV rays? Start by collecting various strengths of sunscreen (SPF 4, 15 and 50, for example). Since the UV Color-Changing Beads are very sensitive to changes in UV energy, you can use the beads to determine the blocking potential of the sunscreen. Place the beads in a zipper-lock bag and apply a layer of sunscreen to the outside of the bag. Use a permanent marker to write the SPF number of the sunscreen you're testing on the outside of the bag. Be sure to set-up one bag without any sunscreen coating for comparison purposes. Expose the beads to direct sunlight for 5 minutes and look for any changes in color.

#2 Tanning Oil Test: Find out if tanning oils block any UV rays when they claim to do so.

#3 Light Test -- Place a handful of UV beads near a fluorescent light. Do any of the beads change color? Can you get a sun burn or a tan by sitting next to a fluorescent light?

#4 Black Light -- "Black light" (long wave ultraviolet light) can also be used to change the color of the beads. You can purchase a black light at many specialty stores or hardware stores that have a large section of light bulbs. Sometimes those high intensity lights (mercury vapor) found in a gymnasium emit just enough UV light to make the beads barely change color.

#5 Cloudy Day -- Test to see if the beads change color on cloudy day. If they change color, then you can see why doctors warn people to wear sunscreen even on a cloudy day. Observe how well the beads change color when exposed to sun light at different times of the day. According to your data, what time of day does the sun give off its most intense UV light?

#6 Sunglasses -- Test the ability of your sunglasses to block out ultraviolet light by covering a few beads with the lens of your sunglasses. If the bead do not change color, your sunglasses block out harmful ultraviolet light from your eyes. If not, you paid too much for that UV coating!

#7 Windshield --Does the glass in your car shield you from UV radiation? Is the glass in the windshield the same as the glass on the side windows?

#8 Different Materials--Experiment which different types of materials, like paper, sandwich bags, etc to see what blocks UV and what does not.

 # 9 Make a UV Bead Bracelet - Thread a few beads onto a piece of leather rawhide or string to make a bracelet. Remember to stay away from any door or windows where ultra-violet light could come into the room. When you're finished, cover the bracelet with your hand and walk outside into the sunlight. Don't take your eyes off the beads as you expose them to sunlight. Like magic the beads change from white to a rainbow of colors.

How does it work?

The UV Beads contain different pigments that change color when exposed to ultraviolet light from any source including the sun. The beads are all white in visible light. In UV light, depending on the pigment added to each bead, you will see different colors. Each bead will change color about 50,000 times before the pigment will no longer respond to UV light.

The beads will always change color regardless of how good the sunscreen blocks UV - the beads are very sensitive! The key is to rate the color of the beads on a scale of 1-5, with 5 showing the most color or "burning" and 1 showing the least color. The bag without any sunscreen is an automatic "5". You can also test the difference between new and old sun screen. Sunscreen manufacturers suggest that you throw away old sun screen because it does not block out harmful UV light. Do your tests support this claim?

Possible Results (from other testers)... SPF 4 did not do well at all (got the worst rating of 5). SPF 15 did a little better with a rating of 3 (still not blocking the harmful UV rays very well). SPF 30 was the best blocker and received the best rating of 1. Our teachers also tested tanning oils (even cooking oil) and all of them did very little to block any UV (rating of 5 on our UV blocker scale). Shortening was rated a 5 and olive oil was rated a 4. SPF 4 doesn't do much at all, while 15 and 30 do about the same. The cooking fats didn't do much at all, which showed us that even though the shortening is thick and opaque, it sure doesn't block UV rays.

Additional Experiments:

If you are able, take the beads to a tanning parlor and expose them to the UV radiation from the tanning lamps. How does this UV radiation compare to the sun's UV?

If you take a trip into the mountains, take the beads along and see if there is any difference between colors at high altitudes and at sea level.

Experiment: Teflon Tape Secret Messages

Making secret messages with polymers!

If you are a fan of Steve Spangler's experiments, you know that he will use any excuse to make a trip to the hardware store for a little "toolbox" science. Today we found Steve wandering down the plumbing aisle looking for just the right Teflon Tape to make some pretty cool secret messages.

Plumbers use Teflon Tape to form a water-tight seal and prevent leaking on pipes. Turns out, this plumber's tool is also a pretty cool example of a polymer that gets lots of use in everyday situations.

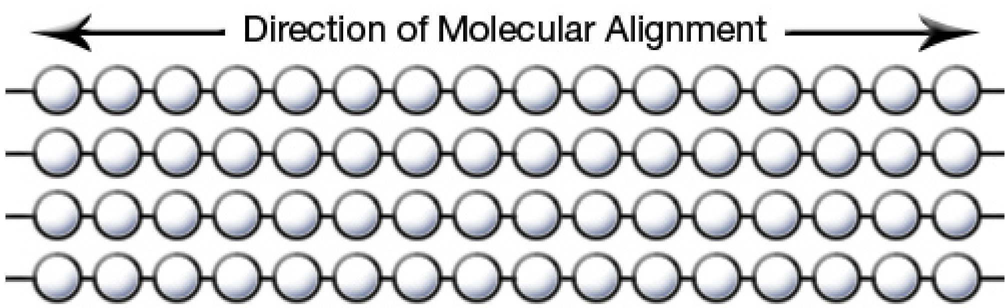
Materials

- Teflon Tape
- Sharpie Marker
- Scissors
- Plastic shopping bag

1. Cut a piece of Teflon Tape about 10 to 15 cm (4-6 in) long.
2. Write a secret message on the tape.
3. Now stretch the tape from top to bottom, making your message taller, not longer. Pull carefully so that you don't tear your message.
4. Suddenly you can't read your message anymore! Give the message to a friend and see if they can figure out how to make the letters their original shape again.
5. Just when they are about to give up, surprise them with a little science magic... Pull on the tape from end to end making the letters short again.
6. When you are done pulling your message will look normal again and your friends will be amazed.

How does it work?

Teflon Tape is a type of polymer called polytetrafluroethylene (PTFE). That's a really long word for a kind of polymer that has long chains of molecules lined up side-by-side and next to each other. If you try to stretch the tape end to end before stretching it from top to bottom, you won't be able to stretch much at all. That is because the polymers are bonded to each other very tightly, but there are lots of chains stacked on top of each other. These stacks make it possible to pull the tape from top to bottom and stretch your secret message. When the polymer chains are pulled from top to bottom they slide over one another and reduce the number of chains in a section without breaking the chains themselves. When the tape is pulled back end to end, the chains are realigned and your message is legible again.



Additional Info

What other materials are made from PTFE? Try writing a message on a plastic grocery bag. Now pull the bag from top to bottom just like the tape... does your message "disappear"? Pull the bag back from end to end. Can you read your message again?

Supply List

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List of Experiments I want to Do:

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