30 Demos in 60 minutes

A presentation made at the

2001 Colorado Science Convention

by the Fall 2001 Secondary Science Methods Class

from the University of Northern Colorado

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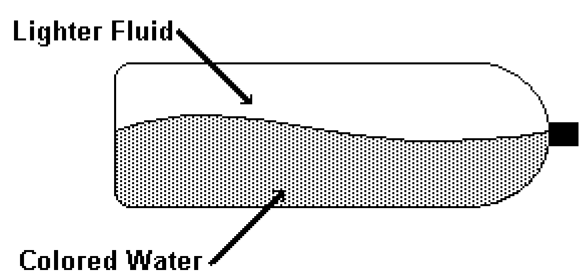
NOTE: The following collection of demonstrations do not list ALL safety precautions. The teacher should carefully review and TEST these demos before using them in class. These demonstrations are intended for teacher presentation and should not be attempted by students.

Waves in a Bottle — Jayne Shumaker

Procedure:
Fill half of a one liter plastic bottle with distilled water.
Add 50 ml of ethyl alcohol.
Add charcoal lighter fluid to fill the bottle to the brim.
Add four drops of blue food coloring, one at a time.
Place the lid on the bottle and seal it with tape.
Turn the bottle on its side and rock it for to aft to produce waves.

Explanations: This is similar to a number of commercial devices. The waves appear to be in slow motion because the density of the clear lighter fluid is much closer to the density of the blue water than the density of air. The increased inertia of the lighter fluid makes it much more difficult to move that air which is normally found above a water surface.

Water molecules are polar. Charcoal lighter fluid is non-polar and less dense than water. Thus, the lighter fluid will float on top of the more dense water. The food coloring is a polar solution so it will drop through the non-polar lighter fluid without dissolving (like dissolves like). When it reaches the water it quickly dissolves in the polar water coloring it all blue.



CAUTION: The lighter fluid is very flammable. Keep away from all sources of ignition.

Iron in Cereal **Jayne Shumaker**

Procedure: Place the entire box of Total cereal into a large bowl.
Use your hands to crush the flakes to pin-head size pieces.
Add water and stir for 15-20 minutes.
Continue adding water as necessary to ensure the mixture is thin and soupy.
Tape a small magnet on the end of the glass rod.
Stir the cereal soup with the magnet for several minutes.
Small pieces of iron will collect on the magnet.

Explanations: The human body needs iron to carry oxygen throughout the body. The iron in the cereal is pure iron. The very small particles react with hydrochloric acid in the digestive system to be easily absorbed by the body.

Chemical Sunset **Jayne Shumaker**

Procedure: Cut a hole the size of a Petri dish in a piece of cardboard large enough to cover the top of an overhead.
Place the Petri dish in the hole.
Add enough $Na_2S_2O_3$ to cover the bottom of the dish.
Add about 5 ml of concentrated HCl and quickly stir the solution.
(Wear gloves and a face shield when you use hydrochloric acid).
Observe the color changes.

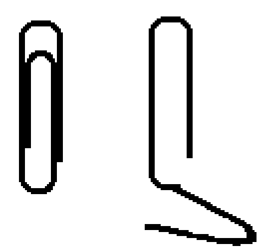
Explanations: The reaction produces colloidal sulfur that scatters light as it is being formed and produces different colors. A natural sunset is observed when light is scattered by dust particles in the atmosphere.

Solutions: The sodium thiosulfate pentahydrate solution, $Na_2S_2O_3 \cdot 5H_2O$ is 0.03 M: Dissolve 7g per liter of water.
The hydrochloric acid is concentrated.

Surface Tension **Guinevere Kulyan**

Materials: One large paperclip, one small paperclip, a plastic or glass container, water.

Procedure: Unfold a large paperclip to make the shape of an "L." Open up one side of the "L" to about a 45-degree angle. Place a smaller paper clip onto the open end of the "L" and use the "L" to lower that small paperclip onto the surface of the water. The surface tension of the water will hold the paperclip on the surface. You can see that the paper clip is not floating because none of the paper clip is actually under water, and sometimes the surface of the water around the paper clip is actually higher than the top of the paperclip itself.



Sinking Ice **Guinevere Kulyan**

Materials: Ice colored with food coloring, a glass or plastic container, rubbing alcohol.

Procedure: Ice is less dense than liquid water, thus it floats in water. However, what if ice was denser than liquid water (which is that case in other materials)? Ice sinks in alcohol. Make ice with food coloring in it so that student will be able to see the ice as it sinks. Place the ice into a container of alcohol and watch as it sinks.

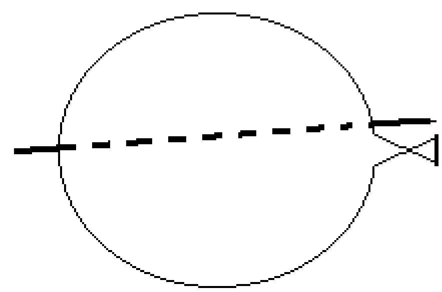
The Diaphragm and the Lungs **Guinevere Kulyan**

Materials: clear twenty-ounce bottle (old soda or water bottles work well), three large balloons, rubber band, scissors, y-valve (such as would be used to split a hose), clay or play-dough, straw.

Procedure: A common misconception students have is that the lungs themselves are what cause air to enter them when we breathe. To show students the importance of the diaphragm you can build a simple lung model. Use the scissors to cut the bottom off of the bottle. Using clay, mount the straw into one branch of the y-valve so that air can still move through the y-valve into the straw and visa-versa. Place one balloon over the end of each of the remaining branches of the y-valve. Use clay to mount the y-valve and straw in the bottle so that the straw is coming out of the mouth of the bottle. Be sure to use enough clay so that the y-valve is secure and so that air will only leave or enter the bottle through the straw at that end. Tie the end of the third balloon in a knot and cut the top of the balloon off. Make sure that the other balloons are flat. Place the last balloon over the large open end of the bottle and secure with a rubber band. When you pull on the knot of the final balloon, the balloons inside the bottle should inflate. (Note: This is difficult to see, but if you watch closely the balloons should inflate slightly. Also, this is possible to do with better results using a two-liter bottle, provided you can find a balloon large enough to fit around the end).

Magic Polymer Balloon **Ted Clapp**

In this demonstration a bamboo skewer pierces an ordinary, inflated balloon. You will need nothing more than a high quality helium grade balloon, a bamboo skewer (or long needle), and cooking oil. After inflating your balloon try pushing the bamboo skewer through near the tip and back out near the opening. If everything worked then you will notice the balloon did not pop when it was pierced at either end. If you are having trouble making this work then try coating the skewer with cooking oil for lubrication.



Non-Burning Dollar Bill **Ted Clapp**

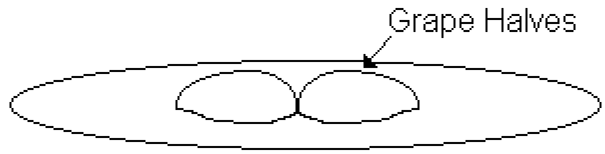
Fire is always an eye catcher when doing a demonstration. The non-burning dollar bill is no exception, however, it would be prudent to warn students not to try this at home just as a precautionary measure. In this demonstration you will need a solution of two parts alcohol and one part water. You may want to add a bit of NaCl to the alcohol in order to make the flame more visible to your audience. Simply soak the dollar bill in the mixture and hold it to a flame. Because of waters ability to withstand heat the dollar bill is protected from the flame as the alcohol is burned off.

Colors of "MOM" **Ted Clapp**

In this demonstration Phillips Milk of Magnesia (MOM) is used to help show the changes that occur as a solution changes pH. Start with about 300ml of water in a beaker with a magnetic stirrer. If a magnetic stirrer is not available then be sure to stir continuously throughout the rest of the demo. Add about twenty drops of universal indicator and a few tablets of MOM. Your solution should turn a cloudy purple. Add a few drops of one molar HCl to the beaker until the solution goes to red. You will notice that the solution goes through the color spectrum all the way back to purple. This is because the basic MOM in the solution is neutralizing the acid and the pH is retuning to where it started.

Grape Balls of Fire **Sarah Bieber**

This is a demo to introduce the class to observation and the scientific method. You present the class with a normal microwave, and a bunch of seedless grapes. Taking one grape, you place it on a paper plate and microwave it for 15 seconds. You then take a grape from the same bunch and cut it lengthwise, leaving just the tip connected by skin. Laying this flat on the paper plate, you microwave it for 15 seconds, making sure the class is paying attention. You then ask them for hypothesizes based on the observation they made and how you would go about finding the answers. (P.S. at present we have not been able to find a definitive explanation of the science behind what is happening.)



Living or not? **Sarah Bieber**

Place a petri dish of water on an overhead projector, then ask the student to help you determine whether your new play toy is alive or not. You place a box over the petri dish and drop your 'critter' in. Then you remove the box and let the student watch the critter 'swim' around the dish. You may do this several times, having them write down whether or not they think it is alive and why they made that decision. Then discuss the qualities of life with the class.

The critter is made by dropping a drop of DuCo Cement into the water. It should have a head and possibly a long flagella-like tail, which helps with the illusion of life.

Chocolate chip mining **Sarah Bieber**

This activity shows the limited resources we have on Earth. Each cookie represents an area of Earth that has many minerals or other resources. Using toothpicks, remove the chocolate chips. After you have removed them all, try to put the cookie back together in a useful way so that you can use it in the future.

A variation of this may include showing different ways of mining. Soaking the cookie in water or milk, until you can strain the chips out, or crumbling the cookie into small bits to retrieve the chips.

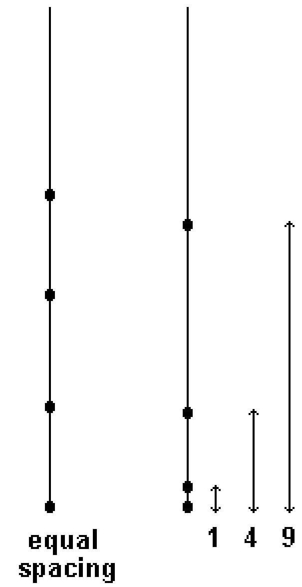
This can lead to a discussion on mining practices and how to save resources.

Archimedes Principal **Marshall Hahn**

What makes things float? Ask kids this question and see what kind of answers you get. Archimedes made a formal statement regarding this stating that floating objects are buoyed up with a force equal to the weight of the water that they displace. But what does that mean? This example will help make what is going on more clear. All you need is two clear plastic cups and some water. Fill the first cup (1) and float the empty cup (2) on top. Students will not be surprised by these results. Next pour one-third of the water from the full cup (1) into the empty cup (2), and ask the students if it will float in the first cup (1). Most will say yes and they will be correct. Now pour another third of the water into the second cup (2). Now ask them if the second cup (2) will float in the first cup (1). Most will say no. When the second cup that is now two-thirds full floats in the first cup that is only one-third full many students will be surprised. With the clear sups however, it is easy to point out that the water in the first cup (1) always rises to its original level while the second cup (2) always sinks far enough that its water level is equal with the original water level of the first cup.

Listening for Acceleration **Marshall Hahn**

How can I hear acceleration? It is easier than one might think. All you do is take two lengths of string. On the first one you tie washers or place fishing weights at equal intervals. On the second string place the washers or weights at distances equal to the squares of the integers (1,4, 9.etc). When the first string is extended and dropped the clicks of the washers or weights will occur more and more rapidly, showing that the washers or weights are being accelerated. When the second string is dropped, the clicks will occur at steady intervals. This is a good way to both hear and see acceleration.



On the Level? **Marshall Hahn**

Why isn't this table level? For this demonstration you will need a cylindrical can, rubber bands, and a weight that the rubber band can be strung through (heavy washers work well). String the rubber band from one end of the can to the other attaching it in the center of the bottom of the can and the center of the lid. The rubber band needs to pass through the weight so that the weight will cause the rubber band to wind-up as the can is rolled. This will cause the can to return too roughly its starting point. It will give the appearance that the table is not level, and can lead to a discussion involving the conversion of kinetic to potential energy and back, as well as other topics.

Proof of Stomata **Danny Quinn**

Purpose: To prove that there are stomata on leaves
Materials: Glass soda bottle (plastic will not work), ivy leaf and stem, clay, straw, pencil
Procedure: Fill the bottle to near the top with water. Wrap the clay around the stem of the leaf. Place the stem into the bottle. The end of the stem must be below the surface of the water. Cover the mouth of the bottle with the clay. Push the pencil through the clay to make an opening for the straw. Insert the straw so that its opening is in the air space in the bottle. Squeeze the clay around the straw. Suck the air out of the bottle through the straw. If there is a good seal air bubbles will come out of the stem of the leaf into the water.

Leaf Straw **Danny Quinn**

Purpose: To demonstrate the purpose of stomatas on a leaf
Materials: Glass soda bottle, leaf and stem, clay, straw, pencil, mirror.
Procedure: Cut the stem in half lengthwise from the bottom to about halfway up toward the flower. Pour about .5 cups of water into each glass. Add enough food coloring to make the water in each glass a deep color, one red and one blue. Place one end of the flower into each glass. Leave the flower standing on the water for 48 hours
Results: The flower will turn half red and half blue
Why? Small tubes, xylem, run up the stalk to the flower. This is the mechanism that carries nutrients to the rest of the plant.

Balloon Races **Lee Harrison**

Purpose: To demonstrate the affects that heat has on a chemical reaction.

Materials: 1) Three medium sized balloons, 2) Three tablets of Alka Seltzer TM, 3) Three Elymerer Flasks, 4) Hot Plate

Procedures: Fill the flasks one quarter full of water. Place one flask in a refrigerated environment, another flask leave at room temperature, and place the third flask on the hot plate at medium heat. Put the crushed Alka Seltzer TM in the balloons, (one tablet per balloon). Wrap the mouth of the balloon around the opening of the flask. Make sure that the crushed substance in the balloons does not fall into the flask. When all the balloons are attached to the flasks, find two volunteers and simultaneously lift the balloons so that the crushed substance falls into the flasks and observe.

Findings: The balloon attached to the heated flask expanded quickest due to the heated reactions. The flask at room temperature comes in a close second, and the chilled flask is a distant third.

The Balloon that Can Take the Heat **Lee Harrison**

Purpose: To demonstrate the heat capacity of water.

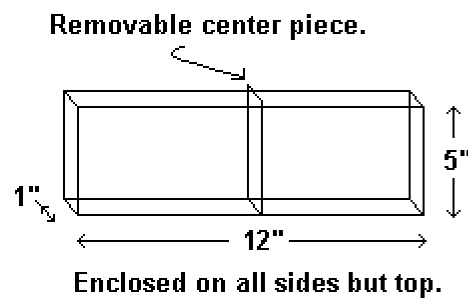
Materials: 1) Two medium sized balloons, 2) Matches or lighter.

Procedures: Blow one balloon up and tie off the end. Fill the other balloon with water, (enough to fill the lower bottom of the balloon). Light the match or lighter and place the balloon without water, directly over the flame. The balloon will pop immediately. Now, place the balloon with the water over the open flame and the balloon will not pop immediately.

Findings: The water in the second balloon will absorb the heat of the open flame and extend the integrity of the balloon surface.

DENSITY OF WATER

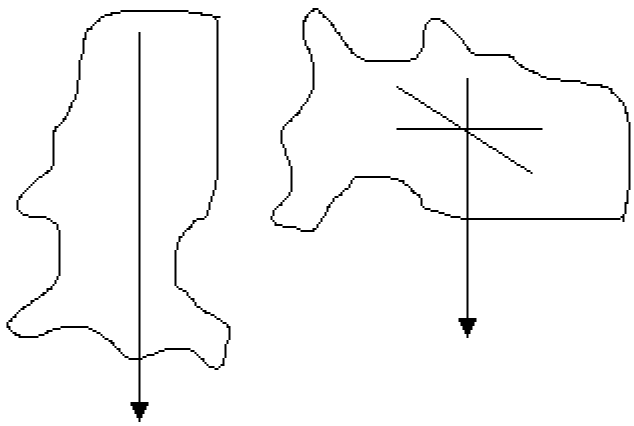
A very interesting demo can be performed with a transparent trough of plastic with a center divider similar to the diagram shown at right. The dimensions are not critical*. A drop of blue food coloring in dropped into a beaker containing about 500 ml of cold tap water. A drop of red food coloring is dropped into a beaker containing about 500 ml of hot tap water.
Both beakers are then poured into the trough; warm water on one side of the center piece and cold water on the other side. The water is allowed to calm down for about a minute. The center piece is then quickly removed. The heavy cool (blue) water moves under the lighter warm (red) water and two distinct layers are formed. Cool dense water on the bottom and warm less dense water on the top. If the water is allowed to sit for some time the layers will gradually dissipate as the temperature of the two layers equalize. The demonstration is ideal for discussing temperature distribution in lakes or the atmosphere.

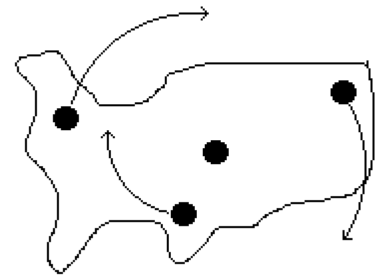


* A workable device has been constructed with from a plastic shoe box with a center piece cut from a milk carton held in place by toy modeling clay although a thinner trough seems to work a bit better. A commercial version of this device is available from Flynn Scientific Inc., P.O.Box 219, Batavia, IL, 60510 catalog #AP4784 for about $30.00

CENTER OF GRAVITY

The center of gravity is an important concept when studying an object in equilibrium. When resting on a surface, the center of gravity must be above the support base or the object will fall down. When ever an object freeley hangs from a support the center of gravity is always directly below the support point. This latter fact can be utilized to find the center of gravity of an irregular shaped object. (I cut out the shape of the United States from 1/4 inch plywood and drilled 3 arbitrary holes somewhere near the edges) Hang the object from an arbitrary point and draw a plumb line down from the supporting point. Hang the object from another point and draw a second plumb line. The point where the two lines cross is the center of gravity. If the object is hung from any other point, a plumb line from the point of support will pass through the same point.





The center of gravity is important for another reason that can easily be demonstrated. On the reverse side of the object place a colored dot at the center of gravity and a few other arbitrary points. Throw the object with a spinning motion. All the dots will blur except for the dot at center of gravity. The center of gravity will undergo a much simpler motion than any other point on the object. Thus when describing the motion of an object we usually just describe the motion of the center of gravity because the motion of the other parts of the object might be quite complicated.

MOLECULAR MOTION

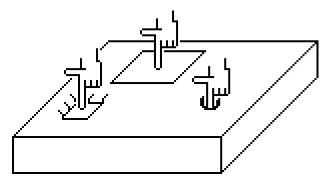
One of my favorite demos is one of the simplest of all but demonstrates a very abstract concept. While nearly everyone is familiar with the concept of temperature, few people really understand that it is directly related to the microscopic motion of the molecules. The hotter something is, the faster the molecules of the material are moving. In fact, by knowing the temperature and the substance, it is possible to calculate the average speed of the substance's molecules. This is a very difficult concept to teach because it is not possible to directly observe molecules in a classroom. However, a demonstration that shows the results of different molecular speeds at different temperatures is very simple to perform. Simply fill two 400 ml beakers, one with hot water the other with cold water. Drop in about two drops of food coloring in each beaker and observe. The food coloring in the cold water will usually just drop to the bottom and just sit there. It will disperse very slowly. The food coloring in the hot water will quickly begin to disperse and soon the entire beaker of water will be colored. This is because the faster moving molecules in the warm water knock the food coloring molecules around much quicker than the slow moving molecules in the cold water.

PRESSURE

It is always difficult to try and introduce students to ratio concepts such as density, velocity and pressure. Students often tend to associate the concept with the numerator and pass up the denominator.

When discussing density for example students' generally associate it with mass (or weight) and forget about volume. Try asking students which weighs more lead or Styrofoam. You will seldom get the answer, "It depends on how much of each you have." Pressure is one of these ratio concepts that can be easily demonstrated. All you need is a piece of foam rubber about the size of a seat cushion and a couple of squares of wood.

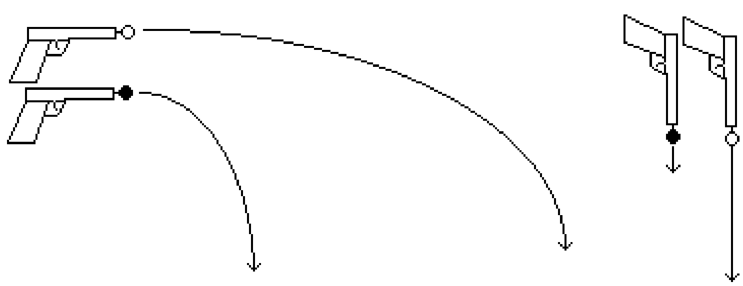
Have a student come forward and ask them to take their index finger and very gently press down on the foam rubber. It will compress only slightly. Next, have them press as hard as possible on the foam rubber. This time they will be able to press nearly all the way to the table. Have them observe that the harder they push, the further down the foam compresses. Then, because their finger may be getting tired, offer to help them out by giving them a small piece square of wood about 2" (5 cm) on a side. Point out that gravity will pull down on the wood so they will not have to push as hard. When they try it, they will find that they can only push down about half way. You can then offer to give them a much bigger and heavier square of wood about 6" (15 cm) on a side. This piece will weigh nearly 10 times as much as the smaller one. When the student pushes down, the wood will hardly dent the foam. You might even say that they can start any time they want when it is obvious that they are already pushing down very hard. This should be a good place to start talking about what things affect how far down the foam will compress. The compression has a direct relationship with force BUT an indirect relationship with area. Now is the time to introduce the formal concept of:



$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$

PISTOLS AT 20 PACES

A couple of toy dart pistols can be used to explain a great deal about mechanics, gravity and Newton's laws. Tape a light rubber ball onto a toy dart and a similar sized steel ball bearing onto a second dart. Load the two darts into two identical toy dart guns. Ask the students which dart will land first if the two dart guns are simultaneously fired horizontally. When both darts hit the floor at the same time but a vastly different distances away, you can discuss the independence of the horizontal and vertical motions. Then stand on a chair and ask the students which dart will hit the ground first if they are simultaneously fired vertically down. It surprises many people who know a little science that the lighter dart always hits first. While gravity will always increase the speed of the darts as they move down, the lighter dart, because it leaves the gun with the greatest velocity will always be moving the fastest.



TALKING CUPS

Most people at one time or another have tied a string through the bottom of a cup and found that by pulling the string through our fingers we can make a variety of sound from a clucking to a roar. A company has taken this commercial. They have formed strips of plastic to actually talk and say things. They have a variety of quotes. Mine says "Science is Fun." They may be ordered from:

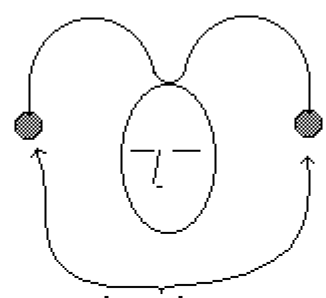
Science Fun Talking Cups
11 Marion Road
Westport, CT 06880
(203) 226-4938

SOUND TUBE

While sound is caused by vibrations, the sounds do not have to be due to a vibrating object. Organ pipes produce sound by simply getting the air to vibrate. A simple example is a sound tube which can easily be made from a tube about 1.5 in. in diameter and 24 in. long. Plastic PVC plumbing pipe is cheap and works well. If the air inside a vertical pipe is heated with a Bunsen burner inserted up into the pipe the pipe will begin to "sing" as long as the Bunsen burner remains in place. If a piece of wire gauze is pushed about 6 in. into the pipe and heated with the Bunsen burner until it is red hot the pipe will sing for come time. To show that it is the heated air that is producing the vibrations, the pipe can be turned horizontally stopping the sound and then turned back vertically so that it starts to sing again. Different lengths of tube will produce different notes. if you are adventuresome (and careful) you can do this on a grand scale by getting an old cast old carpet tube 12" in diameter and several feet long. I have found it takes two Meeker burners to produce enough heat but it produces an amazing bass note.

INERTIAL HEADWEAR

Scientific Principle: This demonstration can be used to demonstrate Newton's first law: Objects at rest tend to stay at rest, objects in motion tend to stay in motion.



Preparation: Headgear is formed from a coat hanger that has been bent into two C's that are joined in the middle. A mass is placed on either end. The mass could be two colors of clay. It is important that the two masses are below the point at which the headgear contacts the head. This is important because it improves the balance of the system.

Demonstration: To demonstrate, place the apparatus on top of the demonstrator's head. Have the demonstrator quickly turn ninety degrees in either direction. The balls of clay will remain motionless. A discussion can then follow on why the balls do not move with the demonstrator.