Ketchup: America's Favorite Cartesian Diver

Devin Quinn – Post Baccalaureate

MATERIALS:

1 Liter plastic bottle
1 Ketchup packet from fast food restaurant
Kosher Salt

PROCEDURE:

1. Remove any labels from plastic bottle
2. Place ketchup packet in bottle full of water
3. If the ketchup floats you're ready for the next step. If the ketchup sinks add kosher salt a teaspoon at a time until the condiment floats.
4. Squeeze the plastic bottle hard and watch the ketchup dive to the bottom!

EXPLANATION:

This demonstration deals with the concepts of buoyancy and density. This classic demonstration is often referred to as the Cartesian diver after Rene Descartes. When the bottle is squeezed the diver (ketchup packet) will sink to the bottom of the bottle due to increased pressure. Also, there is a little bit of air inside each ketchup packet. This allows the packet to float. However, when you squeeze the bottle you exert pressure on the ketchup packet. This causes the air bubble in the ketchup packet to become smaller and consequently the entire packet becomes denser. The packet sinks when it is denser than water. When you stop squeezing the bottle the air bubbles in the packet enlarge and the ketchup packet rises.

SAFETY:

No safety concerns

Inseparable Books
Elizabeth Garren - Biology Senior

MATERIALS:
2 notebooks, phone books, or textbooks

SETUP:
No advanced set up is necessary.

PROCEDURE:
1. Line up the notebooks on a flat surface with the bindings facing outward
2. Overlap the covers completely with one another
3. Alternate pages from each notebook placing one over another until all of the pages are interlaced
4. Holding the books by the bindings try to pull them apart as hard as you can
5. Have two students each grab one end and try to pull the books apart, they will not budge

TIPS:
If you have two extra notebooks you can interlace the pages before the start of class. This will save the time of overlapping every single page during class time.

EXPLANATION:
The friction between the pages causes the pages to stick together. Friction is the force that opposes motion when two surfaces are in contact. The friction in-between each page is very minimal, but when it is multiplied by numerous pages, the amount of friction is intractable.

SAFETY:
Exercise caution when trying to pull the books apart.

SOURCE:
www.stevespanglerscience.com

THE IMPLODING CAN
Mel Daghestani – Earth Science Senior

MATERIALS:
One soda can
One shallow, clear dish
Hot plate
Water
Tongs

SETUP:
Allow the hot plate to heat up before beginning the demonstration

PROCEDURE:
1. Fill a pop can with a small amount of water
2. Place the can on top of the hot plate and bring water to a boil
3. Fill the shallow dish with cold water
4. Once the water comes to a boil, flip the can immediately into the dish of cold water. The can should crush once it hits the cold water.

TIPS:
Place the can on the hot plate before the demonstration begins so that the water is starting to boil before the demonstration begins

EXPLANATION:
As the water inside the can begins to boil, the water vapor replaces the air inside the can. When the can is inserted into the cold water, the temperature drops suddenly. The temperature decrease changes the evaporation phase to the condensation phase, meaning an abrupt decrease in pressure. As a new equilibrium is trying to be reached, the can will shrink.

SAFETY:
1. Hot plates appear exactly the same whether hot or at room temperature. Always assume they are hot and act accordingly.
2. Keep the electrical cord of a hot plate away from water and the heating surface.

CREDIT:
Credit for this demo goes to Dr. Courtney Willis (University of Northern Colorado)

EGG IN MILK BOTTLE

Mel Daghestani – Earth Science Senior

MATERIALS:

One glass milk jar
Matches/lighter
A strip of paper 3cm x 10cm
One peeled hardboiled egg

PROCEDURE:

1. Demonstrate that the hardboiled egg does not fit through the opening in the bottle
2. Next take the piece of paper and light it on fire
3. Drop the paper into the bottle and allow it to burn out
4. Place the egg on the opening and watch for the egg to fall into the bottle

TIPS:

For a larger bottle, use a larger piece of paper to account for the larger volume. Have paper already in bottle ready to light.

EXPLANATION:

The principle of the experiment has to do with hot air increasing pressure, thereby forcing gases out of the bottle, and then, once the burning paper is out, a quick change in temperature resulting in a lower pressure inside the bottle pulls the egg into the bottle.

SAFETY:

When lighting paper on fire, ensure that it is already in the bottle to prevent possibility of fire outside the system

CREDIT:

Credit for this demo goes to Dr. Courtney Willis (University of Northern Colorado)

INERTIA RINGS

Mel Daghestani – Earth Science Senior

MATERIALS:

A ring cut from a four or six inch PVC pipe (the ring should be approximately 1/2 in wide)
A bean or small dense object
A glass soda bottle

PROCEDURE:

1. Balance the ring upright on the top of the bottle
2. Place a small object (bean) on top of the ring directly over the mouth of the bottle
3. Snatch the ring from under the bean. The bean should fall into the bottle.

TIPS:

The key is to have the ring parallel to your body and catch the ring on the inside and on the side opposite to the hand you are using

EXPLANATION:

If the ring is struck firmly in the center, it will be jerked from under the bean without imparting any energy to it. The bean should then fall straight down into the bottle. The purpose is to show that objects at rest tend to stay at rest.

CREDIT:

Credit for this demo goes to Dr. Bill Brent (Stephens College)

WEIGHING A FINGER
Mel Daghestani – Earth Science Senior

MATERIALS:
Balance scales or (pencil & 12 inch ruler)
2 clear plastic glasses
Water

PROCEDURE:
1. Place a clear plastic glass at each end of the scale
2. Fill one glass to within 1/2 inch of the top with water
3. Slowly pour water into the second glass until it is just slightly heavier than the first glass
4. Put one finger into the lighter glass of water. Be careful not to touch the rim of the glass. The balance will tip to the cup where you inserted your finger due to the increase in volume
5. Remove your finger and watch the balance return to previous position
6. Repeat process and insert finger again

PROCEDURE: (FOR PENCIL& RULER)
1. Place a hexagonal pencil on a flat surface
2. Place a 12 inch ruler on the pencil so that is balanced and not touching the table on either side (like a teetertotter)
3. Place a clear plastic glass at each end of the ruler
4. Fill one glass to within 1/2 inch of the top with water
5. Slowly pour water into the second glass until it is just slightly heavier than the first glass
6. Put one finger into the lighter glass of water. Be careful not to touch the rim of the glass. The balance will tip to the cup where you inserted your finger due to the increase in volume.
7. Remove your finger and watch the balance return to previous position
8. Repeat process and insert finger again.

TIPS:
Tape a long straw or light flag to the top of the needle on the balance beam to see the movement easier in large classrooms

EXPLANATION:
The increase of volume makes the glass heavier. By sticking your finger in the lighter glass you increase the volume that the glass is holding by an amount equal to the volume of your finger. The increase in volume makes the glass heavier and it tips the balance to that side.

CREDIT:
Credit for this demo goes to Dr. Courtney Willis (University of Northern Colorado)

Straw Trombone
Adrianne Larson-Biology Post Bac

MATERIALS:
2 straws of different sizes

SETUP:
For advanced setup, have the straw already precut and placed inside the other straw.

PROCEDURE:
1. Take the smaller straw and cut it into to the shape of a triangle.
2. Then chew with your back teeth on the base of the triangle shape.
3. The warmth and the chewing will make the flaps very flat, this will help the straw vibrate.
4. Then place this cut up straw inside the other straw.
5. Blow through! You are ready!

TIPS:
Use a Subway straw and a Dixie brand straw, those work best! The longer the straw the higher the pitch, so you can use longer or shorter straws to show the difference.

EXPLANATION:
The inside straw is cut in a triangle, and is flat, so that it vibrates on each other to create a sound. If the straw is too wide then too much air flows through, if the straw is too flat on top of each other then it won't work either. The cut straw will work by itself however when you add a second straw it increases. Also, the length of the instrument changes the pitch.

SAFETY:
There are no safety concerns. Great for all ages.

Tuning fork and Ping pong ball
Adrianne Larson-Biology Post Bac

MATERIALS:
1 Tuning fork
1 Ping pong ball
1 Sting
1 piece of tape

SETUP:
For advanced setup, make sure to tape the ping pong ball to a string .

PROCEDURE:
1. Place one piece of tape on the string and connect it to the ping pong ball.
2. Hold it up high.
3. Then take a tuning fork and hit it, which allows it to vibrate.
4. Place the ping pong ball next to the side of the tuning fork.
5. Then the ping pong ball will bounce!

TIPS:
Make sure to hold the ball directly on the side of the tuning fork otherwise it will not work.

EXPLANATION:
In this demo, the tuning forks vibrations hit the ball enough to make it bounce

SAFETY:
There are no safety concerns.

Surface Tension using a Water Bottle
Alyssa Baker- Biology Senior

MATERIALS:
1 plastic water bottle
Nylon Rubber band
Permanent marker
Scissors

SETUP:
Poke a small hole into the water bottle and mark it with a permanent marker. Wrap a piece of nylon over the top of the bottle and secure it with a rubber band.

PROCEDURE:
1. Tip the water bottle upside down with your finger over the hole.
2. Ask your students what they think is happening to make the water stay in the bottle.
3. Explain the concept of surface tension and introduce air pressure
4. Ask your students to take a deep breath all together in order to decrease the air pressure in the room.
5. As soon as everyone takes a huge breath, take your finger off of the hole.
6. The water will fall.
7. Then explain the hole in the water bottle to your students.

EXPLANATION:
Surface tension is caused by the cohesive property of water. In liquid water, every molecule is pulling the other molecules toward it equally. This creates internal pressure and gives the surface strength. The water falls when you remove your finger from the hole because the atmospheric pressure on the bottom is no longer compensating for the force of gravity on the water column.

SAFETY:
None

Bending Water with Static Electricity
Brooke Lyons - Biology Post-bac

MATERIALS:
Balloon
Faucet at lab table (or pitcher to pour water from, water, and bowl)

SETUP:
Have balloon blown up with air. If no sink is available in classroom, have a full pitcher of water and a bowl to catch water.

PROCEDURE:
1. Turn on the water so it is falling from the tap in a narrow stream (just a few millimeters across but not droplets).
2. Rub the balloon against your hair for a few seconds.
3. Slowly move the balloon towards the stream of water (without touching it) while watching closely to see what happens.

TIPS:
None.

EXPLANATION:
Negatively charged particles called electrons jump from your hair to the balloon as they rub together, the balloon now has extra electrons and is negatively charged. The water molecules are polar, which means that they are positive on the end with hydrogen atoms and negative on the end with the oxygen atom. Positive and negative charges are attracted to each other so when you move the negatively charged balloon towards the stream, it attracts the water atom's positively charged sides and the stream bends.

SAFETY:
None.

SOURCE:
http://www.sciencekids.co.nz/experiments/bendingwater.html

Pressure Bottle

Materials

Large plastic soda bottle
Thumb tacks
Water
Large bowl
Food coloring

Set-up

Fill the bottle with water and food coloring. Cap the top.
Push the thumb tacks into the bottle vertically down the side of the bottle.

Procedure

Hold the bottle up and pull the tacks out of the bottle.
Unscrew the top and hold the streams of water over the bowl

The Science

Each hole created by the thumb tack has a different water pressure pushing the water out of the hole which is governed by the depth of the water (distance the hole is away from the cap). The difference in water pressure causes the streams to be different lengths and as the water level drops the streams get shorter.

Torque and Door Demo

For this demo, the only material that is needed is a door. Different ways of pushing on the door can demonstrate the concept of torque. Have students use their index finger to push the door from the end, middle, and by the hinge with equal force and note what differences they see. Have students try various other ways of pushing such as at an angle that is not perpendicular to the door. Using these observations, let students know that with this concept, if someone had a long enough lever, they could lift any object.

Water Pressure Demo

The materials required for this demo are a plastic bottle, tape, a puncturing device, and water. Start by puncturing various holes in the same vertical column from the top of the bottle to the bottom. Use the tape to tape over the holes. Afterward, fill the bottle with water. It is now ready to be used. When showing the demo, remove the tape quickly and have the observers look at how water squirts further away from the bottle if it was coming from a hole on the bottom.

Newton's 1st Law Egg Drop

Materials:

1 egg

1 glass of water

1 cake pan (or Tupperware with a lip or edge)

1 empty toilet roll

Procedure:

1. Set up your materials in the following order, from the table top: glass of water, cake pan, empty toilet roll, egg.
2. As quickly as you can, hit the cake pan to the side.
3. The egg should drop directly into the glass of water.

Explanation:

The egg does not have any force directly action upon it. Since you hit the cake pan, the cake pan's movement affects the toilet roll, but the toilet roll doesn't directly affect the egg. This is because of Newton's 1st Law of Motion, which states that an object at rest will tend to stay at rest, until another force acts upon it. Since the egg is initially at rest, and the toilet roll does not exert any force on the egg, the egg will fall only due to its own weight (mass * gravity).

Tips:

- Practice this before you do your demonstration. You need to be quick with your hit. Don't wimp out! ☺
- Raw eggs work well, but for added safety, hard boiled works fine as well.

Safety: There may be a small "splash zone" when the egg falls into the glass of water and may be messy. Also, if not done correctly, the egg may break, and may also cause a mess. Be wary of students who may be allergic to eggs as well.

Eggs and Inertia
Karen Allnutt, Biology Major

Materials:
One raw egg
One hard-boiled egg

Procedure:
1. Set both eggs on the table, but don't let the audience know which one is which.
2. Spin both eggs.
3. Place your index finger on the eggs with enough pressure to stop them.
4. Remove your fingers and observe.

Explanation:
This demonstration is a great way to illustrate Newton's first law of motion: a body in motion or at rest will stay in motion or at rest unless acted upon by an outside force. This is also known as the law of inertia. When the eggs are spinning they are in motion and your finger acts as an outside force to stop them. The hard-boiled egg will stay at rest because the egg inside the shell is also at rest. However, the raw egg will start spinning again when the finger is removed because the liquid inside is still spinning: the finger did nothing to stop it.

Tips:
It might help to put a very small mark on the eggs to help you remember which is which.

Safety:
Be careful not to spin the eggs to the floor or drop them.

Sinking and Floating Lemons
Stephanie Clark, Biology Major

Materials:
2 lemons
- 1 whole
- 1 peeled

1 tank of water large enough to hold the lemons

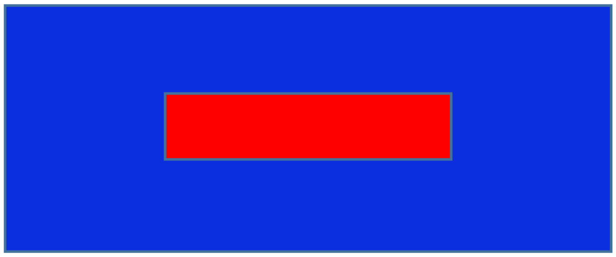
Procedure:
1. Peel one lemon completely. Insure that the lemon is well peeled and does not have any of the rind left on it.
2. Fill tank full of water. (Enough water that the lemons could be submersed.)
3. Place both lemons into the tank
4. Observe the results

Explanation:
The whole lemon will float because the skin is good at excluding water. The peeled lemon will sink and the lemon that still has the skin on it will float. The skin of the lemon acts as a life jacket for the lemon. There are small air pockets inside of the rind of the lemon that allow the lemon with the skin to float. When the life jacket is removed (the lemon is peeled) the lemon will sink because it no longer has the air pockets keeping it afloat.

Safety:
Insure that knife safety is followed while cutting the lemons.

Optical Illusion
Stephanie Clark, Biology Major

Materials:
The optical illusion squares – large enough for an audience to see them



Procedure:
1. Stare at the blue and red square for 30 seconds
2. Now stare at a flat white surface
3. What do you observe?

Explanation:
Staring at bright colors for a long period of time causes the color receiving parts of the eye, the cones to get tired. When you look at the white piece of paper, those original cones rest while other cones near that original location take over. This is why the image is still visible but it is in different colors.

Tips:
Make the picture large enough to see from a distance if the class size is large, or have individual printouts.

Safety:
Do not do this too many times. It will cause your eyes to become tired and might disrupt vision temporarily.

Egg Drop

Allison Hanlin, Biology Major

Materials:

1 hardboiled egg
Toilet paper roll
Small cake pan
Drinking glass filled half way with water

Procedure:

1. Set up the demonstration as pictured in the demo set up below.
2. Ask the students what they think will happen to the egg when the cake pan hit is hit from the side.
3. In one motion, hit the cake pan horizontally, while holding the drinking glass below.
4. The egg will ALWAYS drop into the drinking glass.
5. Ask the students why this occurs.

Explanation:

Newton's 1st Law of Motion tells us that an object at rest stays at rest and an object in motion stays in motion, unless acted upon by an outside force. This Law explains why the egg will always fall into the glass. When the pan is hit, there is not very much friction between it and the glass. This causes the pan to move very quickly from under the toilet paper roll and the egg. When the pan is moving, the rim of the pan hits the toilet paper roll and takes it with it. However, the egg has the force of gravity pulling down and once the toilet paper roll is moved away, the egg no longer wants to stay at rest. The force of gravity is greater than the force of friction, and the egg fall straight down into the glass.

Safety:

Make sure to hold the glass when hitting the pan. If this is not done, the glass could get knocked over with the motion. Make sure nothing is in the path that the pan will move when hit. If done in a classroom setting, goggles should be worn.

Egg Drop Demonstration Set-Up

http://simplescienceathome.wordpress.com/2012/11/23/impossible-egg-drop/

The Fire Proof Balloon
Allison Hanlin, Biology Major

Materials:
Balloons
Water
Matches or lighter
Candle
Safety glasses

Procedure:
1. Blow up a balloon and tie it off.
2. Put on your safety glasses.
3. Light a candle and place it in the middle of the table.
4. 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
5. Repeat the experiment but this time fill the balloon to the top with water.
6. Next blow it up with air and tie off the balloon.
7. Slowly lower the water-filled balloon over the candle. The balloon doesn't pop!!
8. Remove the balloon from the heat and carefully examine the soot on the bottom.

Explanation:
Water is a great substance for absorbing heat. When the candle is placed under the balloon with water, 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 at the bottom of the balloon, where it can absorb more heat. The soot on the bottom of the balloon is the carbon that was deposited on the balloon by the flame.

Safety:
When doing the first part of the demo, with the balloon without water, the balloon WILL pop! Make sure that students are wearing safety goggles. Also, a flame is used in this demo, so make sure students do not burn themselves.

Egg in a Bottle

Allison Hanlin, Biology Major

Materials:

1 hard-boiled egg per class (remove the shell)
One glass gallon jar with a small neck (about 1 1/2 in, in diameter)
Matches
Paper towels

Procedure:

1. Light a small piece of paper towel and immediately place it in the milk bottle.
2. Quickly put egg lightly on the opening and watch.
3. The egg will dance or jump around on top of the bottle.
4. The egg will be pushed through the small opening and into the milk jar.

Tips:

Add a little bit of cooking oil around the rim of the milk jar to keep the egg from breaking.

Explanation:

As the flame uses up the oxygen inside the jar, the air pressure in the jar decreases. This causes a vacuum to develop, which leads to the egg to jumping around. Then, the low air pressure in the jar causes a pressure difference with the outside air. The high air pressure on the outside pushes the egg through the small opening and into the jar. The students will think it is sucked in. This is NOT true. It is pushed!

Safety:

Make sure students are careful with the flame used in this demonstration.

Pouring Air Heath
George Linville, Biology Major

Materials:
2 clear plastic cups
1 Aquarium ½ to 2/3 full of water

Procedure:
1. Submerge 1 cup in the aquarium and turn the cup up to fill it with water
2. Turn the cup full of water so the opening is down in the aquarium.
3. Push the second cup into the water opening down so that it remains full of air.
4. Push the air filled cup below the water filled cup and pour the air up into the cup full of water.
5. Now you have poured up and poured air.

Tips:
- Wear short sleeves.
- Use shallow plastic cups so the aquarium does not need to be as full of water.

Explanation:
Air is a fluid like water and this demonstration makes the properties of air visible to an observer. Buoyancy can also be demonstrated as the water pushes the air up through the aquarium.

Safety:
Make sure the aquarium is on a stable platform or table so the aquarium does not break.

Twist in Time
Gwendolyn McIrvin, Chemistry Major

Materials:
Clear liquid soap
2 glasses (one must fit inside the other)
4 large binder clips
Food coloring
3 graduated pipettes
Water
3 small cups

Procedure:
1. Fill 1/3 of the large glass with soap. Place the smaller glass inside the larger one and fill with water. (a layer of soap should be between the small and large glass. If needed, add more soap between the glasses so that the soap is almost to the top.
2. Place three of the large clips evenly spaced around the lip of the larger glass. Leave room for the fourth clip (which is added later). This is to help keep the small glass from moving when you don't want it to.
3. Add a little soap to each of the small cups. Mix in food coloring so that each cup is a different color.
4. Fill the pipettes with the different colors of soap.
5. VERY CAREFULLY take the pipettes and add a "glob" of colored soap to the layer of soap between the two glasses. The different colored "globs" should be fairly close together but not touching. They should also a little ways from the top of the soap meniscus.
6. Add the final clip to the large glass. The smaller glass should now be secure (and not wobble around).
7. Slowly twist the small glass one direction to mix the colors.
8. When the small glass is twisted the other direction, the colors will "unmix"!

Tips:
• Be as smooth as possible when rotating the glass, otherwise the colors will not return to their original positions.

Explanation:
*Note: Physics professors are still determining the correct explanation for what is happening. The best explanation so far is …This is an example of laminar flow with a very low Reynold's number. Supposedly, there are several parallel layers to a viscous fluid. When the colored soap is added to the clear soap between the glasses, the dyes are placed in different "layers". As the small glass is rotated, the colors spread out between the individual layers but do not mix between the layers. Therefore, when the small glass is rotated the other direction, the process is revered and the dye no longer is spread out. As long as the rotations are smooth (not turbulent) the layers will not mix and will return to the original location almost perfectly.

Safety:
Goggles should be worn to protect eyes from splattered soap or dye.

Reference: www.stevespanglerscience.com

Floating and Sinking Ketchup (aka Cartesian Diver)
Gwendolyn McIrvin, Chemistry Major

Materials:
1 liter bottle with cap
Sealed ketchup packet
Water

Procedure:
1. Fill the liter bottle with water.
2. Add a ketchup packet to the bottle. (Before starting, test to see if ketchup packet floats)
3. Add water to the bottle so that the water is all the way up. There should be no extra air in the bottle. Put the cap on the bottle.
4. Squeeze the sides of the bottle to make the ketchup packet sink. Let go and the packet will float again.

Tips:
- This can also be done with an eyedropper filled with enough water so that it floats on its own.

Explanation:
The ketchup packet contains a little bit of air, and this is the only air in the bottle. When the sides of the bottle are squeezed, there is a greater presser on this air, therefore compressing it. This compression increases the mass of the ketchup packet (as well as the density) and the packet will sink. When the sides are not compressed, the air is no longer pressurized and the packet will float again.

Safety:
No special safety considerations required.

Balancing Hammer

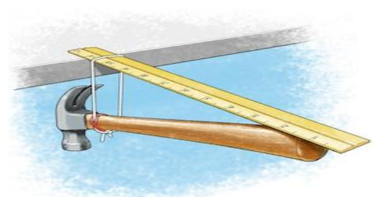
Gwendolyn McIrvin, Chemistry Major

Materials:

16 oz hammer
12 inch ruler, wooden
About 10 inches of string
Tape

Procedure:

1. Using the string, make a loop that can hold the weight of the hammer. Slip this loop around the handle. Tape can be used to hold the loop in place (but only tape it after the hammer is in the correct position).
2. Put the ruler also through this loop. The 12" side should be by the end of the hammer handle and the 1" side should be by the hammer head.
3. The hammer head should extend about 1" from the end of the ruler. The string on the handle of the hammer should be around the 3" to 5" mark on the ruler and the end of the hammer handle should rest against the ruler on the other end. The ruler and handle make an angle of about 30 to 45 degrees.
4. Carefully balance the device off the edge of a table so that the ruler is resting on the top and the hammer head is under the table.
5. With practice, the device will balance perfectly off the table with only 16th of an inch (or less) touching the table.
6. See diagram below for further clarification



Explanation:

Even though this looks unbalanced, the center of mass (somewhere close to the hammer head) is actually under the table where the ruler is supported. Therefore, it balances perfectly.

Safety:

Avoid dropping the hammer onto toes/other appendages.

Water sucked into a glass
Gwendolyn McIrvin, Chemistry Major

Materials:

Small clump of clay or Playdough
Plate or pie tin
Large glass or beaker
1 to 3 Candles
Matches
Water
Food coloring (optional)

Procedure:

1. Secure the candles to the plate in an upright position. Use the clay to hold the candles in place.
2. Add drops of food coloring to the water and then pour the water onto the plate. a. As a test: turn the glass upside down over the candles. The water level should be above the rim of the glass. If not, add more water.
3. Carefully light the candles.
4. Turn the glass upside down over the candles so that the rim is flat on the plate and covered by the water. When the candle goes out, the water will be sucked into the glass.

Tips:

- Experiment using 1 candle versus 3 candles. The more candles, the more water will be sucked into the glass.

Explanation:

The candle flame heats the air in the glass, and this hot air expands. Some of the expanding air escapes out from under the vase — you might see some bubbles. When the flame goes out, the air in the vase cools down and the cooler air contracts. The cooling air inside of the vase creates a vacuum. This imperfect vacuum is created due to the low pressure inside the glass and the high pressure outside of the glass.

A common misconception regarding this experiment is that the consumption of the oxygen inside of the bottle is also a factor in the water rising. Truth is, there is a possibility that there would be a small rise in the water from the flame burning up oxygen, but it is extremely minor compared to the expansion and contraction of the gases within the bottle. Simply put, the water would rise at a steady rate if the oxygen being consumed were the main contributing factor (rather than experiencing the rapid rise when the flame is extinguished).

Safety:

Be careful lighting the candles. Use necessary fire precautions.

Why is the sky blue?
Andy Potts, Biology Major

Materials:

500mL beaker of water
Bright light source
White paper or board
10 mL of milk
Dropper

Procedure:

1. Align the beaker of water with the light source such that it projects a vertical beam of light on the paper placed behind it
2. Add a small amount of milk to the beaker and stir it
3. Observe that the color of the water will now appear slightly blue
4. Observe that the color of the beam of light will now appear slightly yellow or orange

Tips:

- Too little milk will have no effect on the color, but too much will smother the effect

Explanation:

The milk particles scatter light much the way particles in our atmosphere do, creating the appearance of the sky as blue. When this occurs the remaining light transmitted will contain less blue light, causing the sun to appear yellow and sunsets to appear red. This effect is known as Rayleigh scattering, and occurs when light is scattered by particles smaller than the wavelength of light.

Safety:

Take care using the light source near water

Floating Paper Clip
Kayla Schinke, Biology

Materials:
Clean paper clips
Tissue paper
Bowl with water
Pencil with eraser

Procedure:
1. Fill the bowl with water
2. Try to make the paper clip float...not much luck, huh?
3. Tear a piece of tissue paper about half the size of a dollar bill
4. GENTLY drop the tissue flat onto the surface of the water
5. GENTLY place a dry paper clip flat onto the tissue (try not to touch the water or the tissue)
6. Use the eraser end of the pencil to carefully poke the tissue (not the paper clip) until the tissue sinks. With some luck, the tissue will sink and leave the paper clip floating!

Explanation:
This lab is demonstrating surface tension. If the conditions are right, water molecules can hold tight enough to support your paper clip. The paper clip is not truly floating, it is being held up by the surface tension.

Safety:
Paper clips should not be tampered with. They should not be used by students as a stabbing device.

Can Compaction
Paige Taylor Biology UNC

MATERIALS:
Ice
Water
Hot plate
Tongs
Aluminum can
Water

PROCEDURE:
1. Place a half-inch of water in an aluminum can
2. Heat the water in the can on hot plate until the water is boiling
3. Using tongs quickly take the can and flip upside down into ice water

EXPLANATION:
This demonstration shows how the volume of a gas changes with temperature change. The hot water vapor fills the can. When the gas comes in contact with the ice water, it will cool rapidly causing a vacuum in the can.

Mass Never Changes
Paige Taylor Biology UNC

MATERIALS:
Clay
Paper
Triple Beam Balance

PROCEDURE:
1. Set the triple beam balance to zero
2. Place the clay on the sale and measure its mass, record mass
3. Take the clay and rip it in smaller pieces, record the mass
4. Place the paper on the sale and measure its mass, record mass
5. Take the paper and rip it in smaller pieces, record the mass
6. This can be repeated with different objects

EXPLANATION:
This demonstration shows how the mass of an object never changes no matter how the object is altered.

Air Takes Up Space
Paige Taylor Biology UNC

MATERIALS:
Mason jar
Water
Tub
Plastic tubing – three times the length of the mason jar

PROCEDURE:
1. Fill the tub of water deeper then the mason jar
2. Put the plastic tubing in the jar
3. Flip the jar (with the tubing) upside down and place straight down in the water
4. Tilt the jar sideways and air bubbles will rise
5. Place the jar straight again and blow air into the tube, the air should fill the jar again and the water will exit the jar

EXPLANATION:
This demonstration shows that air takes up space. When the jar is placed upside down in the water, the jar will not completely fill with water because it contains air. When the jar is tilted sideways the air is released and the jar is filled with water. When air is blown into the tubing that is in the jar, the air refills the jar and the water exits.

Happy/Sad Balls
Paige Taylor Biology UNC

MATERIALS:
Happy Ball made of Neoprene (polychloroprene)
Sad Ball made of Norsorex (polynorbornene)

PROCEDURE:
1. Place a container a small distance away
2. Bounce the happy ball and try and make a basket
3. Ask a student to try
4. Switch the balls giving him/her the sad ball (without his/her knowledge)
5. Student tries
6. Switch the balls back and the teacher tries again (without students knowledge)

EXPLANATION:
Happy Ball: It has high resilience and dissipates little of its kinetic energy as heat or sound when bounced. An important use for this product is that it is used for swimwear. If you are a swimmer, scuba diver, or water skier, it is used for wet suits because it tends to hold heat. The Happy ball is common neoprene and rebounds very well.

Sad Ball: It has low resilience and tends to absorb the kinetic energy of the bounce. It produces a small increase in its temperature and the characteristic "thud" sound upon impact. This is the only material suitable for making body armor. It is dense, closed cell foam that has the ability to spread impact forces over a wide area. The Unhappy ball is norborene polymer rubber and possesses excellent impact absorption properties that allow it to hit the floor like a rock.

Laser Microscope
Danny Thistle, Physics

Materials:

1 laser pointer
1 eye dropper
Fresh pond water
2 Ring stands with clamps
Surface to project image on

Procedure:

1. Fill eye dropper with pond water (the fresher the better)
2. Clamp the eye dropper with the tip pointing down, and with a drop suspended from the tip
3. Clamp laser so it can be shined perpendicular to the drops spherical surface
4. Shine the laser through the suspended droplet
5. Observe the image projected on the wall/screen

Explanation:

The water droplet has spherical surfaces. Water and air have different indices of refraction. The spherical surfaces form a bi-convex lens. The micro-organisms in the pond water block some of the light, and this creates shadows on the viewing screen.

Safety:

Lasers can damage the human eye, and should not be shined directly into anyone's eyes.

Smoke Ring Gun
Danny Thistle, Physics

Materials:

Red Solo cups with hole cut in bottom (approximately ½ inch)
Plastic sandwich bags
Rubber bands or duct tape
Dry ice
Water
Candle or Styrofoam cup
Optional (trashcan version for demo and kids make one out of cups)
Optional the easiest and cheapest way I found to make a smoke ring gun is by sealing a cardboard box with duct tape. Then cutting a round hole on one end. Just slap the sides and a vortex is formed.

Procedure:

1. Cover the open end of the cup with the sandwich bag.
2. Stretch it tight and use rubber bands or tape to hold it in place.
3. Add dry ice and a small amount of water
4. Light the candle
5. Tap the sandwich bag while aiming at the candle
6. Blow the candle out with smoke ring gun
7. Optional bring out the trash can version and knock cups off the kids heads

Explanation:

A vortex is formed when air is forced through the small opening. The air near the edges is impeded due to friction, while the air in the center is unimpeded. This creates areas of reduced pressure in front of the ring around the edges, and behind the ring in the center. The air will circulate from high to low pressure areas.

Safety:

Dry ice is very cold and must be handled with gloves If the dry ice contained pressure will build up and explode

Fiber Optic Water
Danny Thistle, Physics

Materials:
2L plastic bottle w/ hole in the side near the bottom
Water
Bucket
Laser pointer

Procedure:
1. Fill 2L bottle with water
2. Let the water run in a parabolic path into the bucket
3. Play with the angle shining the laser up the water stream until it totally internal reflects up the stream
4. The water still in the bottle will glow from the light
5. Hint the better the hole, the better the effect. Small defects in the hole will create a turbulent stream of water. The more laminar the flow the better the effect.

Explanation:
The water and the air have different indices of refraction. When the critical angle is found all the light will reflect, and travel up the stream of water. This is how fiber optic cables work, but air and glass is used as the second media.

Safety:
Lasers can damage the human eye, and should not be shined directly into anyone's eyes.

Electromagnetic Induction
Danny Thistle, Physics

Materials:
PVC pipe
Copper Pipe
Neodymium magnet

Procedure:
1. Drop the magnet down the PCV pipe and time how long it takes to come out
2. Drop the magnet down the copper pipe and time how long it takes to come out
3. Flip the copper back in fourth with the magnet inside of it, keeping it inside

Explanation:
The PVC pipe is not a conductor, so the magnet is pulled to earth by the force of gravity. The copper pipe is a conductor. As the magnet moves, there is a changing magnetic field. A changing magnetic field induces a current in the copper pipe. The magnetic field and the induce electric field must oppose each other.

Safety:
Don't swing pipes around
Don't throw the magnet at people

Balloon Skewer

Amy Ordaz, Biology Major

Materials:

1 Balloon
1 Kebab skewer
Oil

Procedure:

Blow air into the balloon so that it is full but not completely inflated. Soak the kebab skewer in oil and slide through the balloon from the top region to near the bottom where it is tied off.

Tips:

Practice a few times to ensure the correct amount of air and the correct placement of the skewer. After putting the skewer through the ends, the demonstrator could also illustrate the tightness of the latex in the center and pop the balloon by sticking it through the middle.

Explanation:

The latex in the balloon is made of polymers that work to stretch out as the balloon inflates. Because the most stretch occurs in the center of the balloon, the long chains of polymers are under much more stress than the chains at either end of the balloon. But if the skewer is put through the middle region, the balloon will pop.

Safety:

Know that it is still possible for the balloon to pop while doing this experiment, just not as probable in the location specified.

Of Musical Proportions
Amy Ordaz, Biology Major

Materials:
8 metal pipes, cut in proportions of 1, then ½, 1/3, ¼, etc.
String to suspend the pipes
Spoon
A few volunteers to hold the pipes
Written out music for the pipes (optional)

Procedure:
Suspend the pipes and proceed to play a melody with them using the spoon. Each pipe is labeled with a number, that serves as the code to read the music provided.

Explanation:
Sound is created from each pipe when it is struck by the spoon because of the change in air pressure. Each pipe has a specific natural frequency that it vibrates at depending on the length of the pipe. These pitches, struck in the correct rhythm and order, create music.

Tips:
Be sure that the measurements for the pipes are exact.

Safety:
The pipes are heavy, so ensure that they are secured before striking with a spoon.

Non-Newtonian Substance on a Speaker

Amy Ordaz, Biology Major

Materials:

Corn Starch
Water
Speaker, connected to a stereo
Music, preferable with loud bass

Procedure:

Mix 5 Tbs of cornstarch with ¼ cup of water. Cover the speaker with saran wrap and pour 1/8 cup of the mixture on the saran wrap, right above the speaker. Turn up the music, with an amplified bass.

Tips:

The ratio of corn starch to water may need to be played with a bit to get just thick enough

Explanation:

When force is exerted on the substance, it exhibits the qualities of a solid substance, but when it's at rest, it appears liquid. This demonstration alternates between the two states of matter by the force of vibration from the stereo, so the substance appears to be "dancing".

Tips:

Use caution when using electrical outlets, and make sure the speaker is covered with saran wrap to keep from getting the substance on the equipment.

Break a Bottle with only your hands
Lucas Owens UNC Physics

MATERIALS:
Glass bottle
Water
Two hands
Bucket to catch water and broken glass

PROCEDURE:
Fill the bottle with water leaving a couple of inches of air at the top. Hold the bottle by the neck with your non-dominant hand. Hold the bottle over the bucket and strike the mouth of the bottle hard with the pad of your dominant hand. The bottom of the bottle should break off. TIP: Use cold water to prevent bubbles. Strike the bottle hard and fast.

EXPLANATION:
The bottom of the bottle breaks off due to a process called Cavitation. When it is struck, the bottle moves faster than the water inside creating a vacuum. The water then rushes into the empty space and at a high speed crashes into the bottom of the bottle breaking it.

SAFETY:
Be careful that all of the glass is caught on the bucket. The glass will be sharp and could easily cut you or an observer. Wear safety goggles to protect your eyes from shards of glass.

A HOT TONE

Lucas Owens UNC Physics SUBJECT AREA: (Physics, General Science, Sound)

MATERIALS:

PVC drain pipe, 1.5 to 2 inches diameter, possibly several lengths.
Propane torch

PROCEDURE:

1. Light propane torch and turn on to largest (hottest) setting.
2. Hold the torch in a position so that the flame is perpendicular.
3. Lower the pipe over the flame. Adjust height until tone develops.
4. Repeat with each pipe length.

EXPLANATION:

The heat of the flame causes the air in the tube to suddenly expand. The hot air begins to oscillate up the tube, resulting in a resonating tone. A standing wave is created in a tube with open ends. The longer the tube, the longer the wavelengths produced in the standing wave and thus the lower the tone.

SAFETY:

Caution always has to be used when working with a flame, be careful where you point the torch you could easily burn yourself or set something on fire.

Van De Graff Generator

Lucas Owens UNC Physics Secondary Ed

MATERIALS:

Van De Graff generator
Rubber pad or plastic stool
Volunteer with longer hair

PROCEDURE:

First ask for a volunteer with medium length to long hair who is not afraid of a little electricity. Have the volunteer stand on the stool and place their hand on the generator. Turn the generator on and wait for the volunteers hair to stand up.

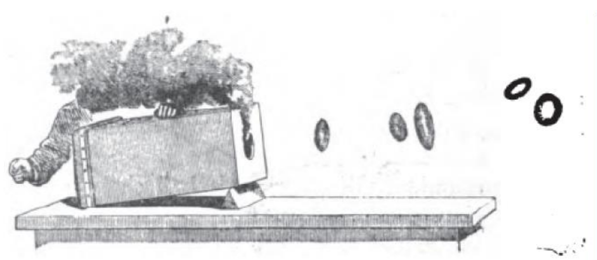
EXPLANATION:

The Generator causes a buildup of like charges in the volunteer's hair. These like charges repel each other and cause the hair to stand on end

Smoke Rings Demo
Lucas Owens UNC Physics Secondary Ed

MATERIALS:
Trash bin with circular hole cut in the bottom
Shower curtain
Bungee cord or duct tape
Fog machine
Candle

PROCEDURE:
Use the shower curtain to cover the large open end of the trash bin and use the bungee cord or duct tape to hold it in place. Light a candle and from the other side of the room use the trash bin to put out the candle by tapping on the shower curtain forcing air out of the small hole. Fill the trash can with smoke and hit it again, showing how the air looks as it travels.



EXPLANATION:
When air is forced through the small opening in the trash can, the air near the edges is slowed by friction while the air in the center is unimpeded. This creates areas of reduced pressure in front of the ring at the edge and behind the ring in the center. The air then circulates moving from high to low pressure areas.

CRUSH A CAN WITH HEAT

Lucas Owens UNC Physics Secondary Ed

MATERIALS:

Aluminum soda cans
Water
Ice Water
Hot plate
Tongs to hold can

PROCEDURE:

1. Pour just a little water into aluminum can
2. Heat can on hot plate until water is boiling
3. With tongs, quickly take can and flip over into ice water

EXPLANATION:

This shows how the volume of a gas changes with temperature. The hot water vapor expands to fill the can and then when that gas is in contact with the ice water, it will cool rapidly causing a vacuum in the can. The air outside of the can rushes to fill the vacuum which crushes the can.

"Can" You Come Back!
Lucas Owens UNC Physics Secondary Ed

Materials:
-A coffee can with plastic lid
-An object to use as a weight (The object must be heavy enough to resist movement while suspended by rubber band. Some experimentation may be necessary)
-Two rubber bands or one if it is large enough to reach both end of the can plus be attached to the weight

Procedure:
Some assembly required.

1. Punch a hole in the metal end of the can and also in the plastic end of the can
2. Push the rubber band through the holes and place a tooth pick through the loops.
3. Attach the weight to the rubber band in the center of the can so that the rubber band twists as the can rolls and replace the plastic lid. It works well to use two rubber bands and attach the weight to only one of them.

Experiment and demo Roll the can across a level surface. The can will roll and stop and then return close to the original starting point.

EXPLANATION:
This demo uses several principles that could be talked about and worked with in class. By using your hand to push the can originally kinetic energy was used. While the can was rolling the rubber band inside was being twisted and therefore potential energy was being stored. The weight in the middle of the rubber band was heavy enough that its own inertia prevented it from turning with the can. When the can stopped due to friction and the energy taken up by the rubber band the potential energy in the rubber band was released. Since the weight was heavier than the can, it was easier for the can to roll than for the weight to turn. Therefore the can rolled back toward your hand until the energy in the rubber band could not overcome the friction of the can being rolled.

Friction Meter Stick
Kai Ficek, Physics Senior

Materials:

- Meter Stick
- Variety of Weights in Paperweight Size

Procedure:

Using both index fingers, place hands at opposite sides underneath the meter stick. Move fingers together at the same pace and note that they meet up at the center of mass; the stick is perfectly balanced. The marks on the meter stick can be used as a reference to show that the distance travelled by each side is equal. Next, start fingers at different points on the stick. Once again move fingers together at the same pace and note that they will meet at the same place as before. Now add a weight to one end and perform the demonstration again. The center of mass will have shifted in favor of the weight but the stick will still be perfectly balanced. Experiment with various amounts of weights at different points. The meter stick will always remain balanced.

Explanation:

The friction caused by the weight of the stick causes the forces to equalize when there is no additional weight. When weight is added, the force of static friction causes the side with more weight to move more slowly until the forces are equalized. Thus, the fingers will always meet at the center of mass.

Disappearing Test Tube
Kai Ficek, Physics Senior

Materials:
- Beakers
- Test Tubes (shorter than beaker)
- Vegetable Oil

Procedure:
Place test tube in beaker. Begin pouring vegetable oil into beaker. After the oil has reached nearly the height of the test tube, gradually move the pouring point to the test tube and fill the tube. The test tube completely disappears!

Explanation:
The reason the test tube disappears is that both the glass and the vegetable oil have the same index of refraction so the light entering both mediums does not bend at all. The experiment can be expanded by performing the same experiment in water. The tube will remain visible because water and glass have different indexes of refraction.

Fiber Optic Water
Kai Ficek, Physics Senior

Materials:
- 2 liter soda bottle with small hole punched in the side
- Water to fill soda bottle
- Clear cylindrical receptacle to catch water
- Laser pointer; any color
- Prop for laser: book, tubberware, ring stand etc.

Procedure:
Puncture the soda bottle with a small (<1cm) hole near the base of the bottle and plug the hole if possible. Set the laser on the prop so it is level with the hole. Position the receptacle near the bottle so it will catch the stream of liquid from the hole. Remove the plug and observe that the stream of water leaving the bottle is illuminated by the laser. Upon closer examination, the angles of reflection inside the stream itself can be observed. The receptacle may even glow with the same light. After the stream grows weaker the angle shifts and the stream no longer glows.

Explanation:
The reason the light follows the path of the water is because it is being totally internally reflected. Every medium has a critical angle at which any light that enters will be totally internally reflected, meaning that no rays of light exit the medium. By finding this angle with water using the laser we can illuminate the water.

Black Whole
Kai Ficek, Physics Senior

Materials:

- A coffee can which has been specially constructed (a slanted metal or plastic piece attached on the inside to keep water in).
- A glass of water.

Setup:

When making your coffee can the metal or plastic piece on the inside should be slanted down towards the bottom of the can. That way when the can is tipped on its side it will hold in the water better. Using the lid of the coffee can works well since it is already the correct shape and diameter. A hidden mark can be made on the inside rim of the can so that you can easily tell which way to tilt it.

Procedure:

1. Hold the coffee can above the observers to ensure that they cannot view what is inside it.
2. Pour a glass of water directly into the coffee can. Note: do not let observers see inside the coffee can.
3. Tip the can over onto the side which will allow no water to spill out of the coffee can.

Questions:

1. Describe exactly what you observed.
2. Based on your observations, describe or draw what might be in the coffee can.
3. How might you collect further information to support your ideas?
4. Write down some examples of how scientists use observations to explain the world around them.

Explanation:

This demonstration is an excellent way to introduce the Scientific Method because it deals with observing and recording those observations. It is meaningful for students to observe that things are not always as they seem. Students can be introduced to the idea that in science there are many wonders that scientists cannot fully explain. Scientists can only make observations and try to collect as much information as possible and based on the knowledge they gain from these observations they can use analysis to begin to form a hypothesis.

Magnet Airplane
Kai Ficek, Physics Senior

Materials:
- Steel straight pin
- Sewing thread, at least 12 inches
- Tissue paper
- Strong magnet
- Scissors
- Table

Setup:
Cut a small wing, 1-2 inches long from the paper. Insert the pin through the center to create a mini "airplane". Tie the thread to the head of the pin. Place magnet on the edge of a table.

Procedure:
Start with the airplane touching the magnet. Slowly pull the airplane away from the magnet with the string until it is suspended. Experiment with how far you can pull the airplane before it starts to fall.

Explanation:
The pin and the magnet both have magnetic properties. They pull on each other with enough force to overcome the pull of gravity. This demonstration shows how strong the magnetic field is and how far it extends. The strength of attraction between two magnets depends on how orderly the magnetic domains are in the magnets.

Shot Put and Styrofoam Sphere
Sara Heidel- Earth Science Senior

Materials:
Empty two liter bottle
16 lb shot put
Styrofoam sphere same size as the shot put

Procedure:
1. Acknowledge the shot put and the sphere are the same size, and therefore hold the same volume
2. Have a student come up and hit the sphere with all their might with the two liter bottle, watch it fly.
3. Have the same student hit the shot put with all their might, watch the 2 liter bottle fly in the other direction.

Explanation:
Force is defined as mass times acceleration. By applying force to the sphere, it is easy to see it accelerate forward. By applying the same force to the shot put it may be shocking to not see it move at all. This shows that in order to move a more massive object, you have to apply more force. Due to Newton's laws, the two liter bottle fly's in the opposite direction when opposed by the shot put.

Safety:
When hitting the two objects, stand back and make sure there are not any obstacles in the way in front or behind the batter.

Alka-Seltzer Rocket
Sara Heidel- Earth Science Senior

Materials:

1- Empty, film canister with lid that snaps inside
½- Alka-Seltzer tablet
Water

Procedure:

1. Take the lid off of the film canister.
2. Add water to the canister to one-quarter full.
3. Add a half tablet of Alka-Seltzer to the film canister and quickly snap on the lid.
4. Place the rocket on the table, lid down.
5. Stand back and wait for launch.

Explanation:

This experiment demonstrates Newton's third law of motion, "For every action there is an opposite and equal reaction." Gas pressure builds up inside the canister due to the reaction between the Alka-Seltzer and water which releases carbon dioxide. This reaction continues until enough pressure builds to blow the canister apart from its lid.

Safety:

Safety goggles are encouraged to protect the eyes. Everyone involved in the demonstration should stand away from the rocket when it is on the launch pad. It may take 15-20 seconds to build up enough pressure, do not approach prematurely. These rockets can shoot up to 5 meters in the air, no sharp object should be attached to the canister.

Water Balloon in a Jar
Sara Heidel- Earth Science Senior

Materials:

1 ordinary party balloon
1 wide mouthed jar or bottle
1 pair of tongs
Matches or a lighter
1 tissue

Procedure:

1. Fill the balloon with water, until it is slightly bigger than the mouth of the jar
2. Light a half-tissue while holding the tissue with tongs
3. Place the tissue in the jar, quickly
4. Immediately place the balloon on the mouth of the jar
5. Watch as the balloon is suctioned into the jar

Explanation:

As the tissue burns in the bottle it heats up the air inside. Air will always expand when you heat it up. So the hot air will press up against the edge of the jar, creating more pressure, and might make the balloon jump or jiggle. After the flame goes out, the air will cool and contract and the balloon will not let air enter the jar. The pressure drops inside of the jar, and the pressure from the air in the room pushes the balloon into the jar. We need water in the balloon to make sure the balloon does not fall off of the jar when the air inside of it is expanding and wanting to flow out of the container.

Safety:

Use caution when lighting the tissue, to not burn yourself or others.

Straw Drill

Sara Heidel- Earth Science Senior

Materials:

1 potato
1 sturdy plastic straw

Procedure:

1. Hold the potato in a way where the straw will not penetrate your hand
2. Hold the straw in your other hand, about 2/3 of the way up the straw with your thumb on top.
3. Use a sharp thrusting movement to force the straw though the potato

Explanation:

The secret is inside the straw. Placing your thumb over the end of the straw traps the air inside. When you trap the air inside the straw, the air molecules give the straw strength, which in turn keeps the sides from bending as you jam the straw through the potato as air is being compressed. The trapped, compressed air makes the straw strong enough to cut through the skin, pass through the potato, and exit out the other side. Without your thumb covering the hole, the air is simply pushed out of the straw and the straw crumples and breaks as it hits the hard potato surface.

Safety:

Hold the potato at an angle where you will not stab your hand when the straw penetrates the potato.

Hot Air Balloon
Sara Heidel- Earth Science Senior

Materials:
1 large plastic bag Hair dryer

Procedure:
1. Close off the bag with your hand, leave a small opening
2. Insert the hair dryer through the opening
3. Heat the air in the bag with the hair dryer for a few minutes
4. Observe the bag rise

Explanation:
As the air inside the bag is warmed, it expands and becomes less dense than the air outside the bag. Therefore when released, it rises. Warm air will naturally rise in comparison to the cooler air surrounding it. A hot air balloon, in a small scale, was created.

Safety:
There is a possibility of the bag melting due to the high heat of the hair dryer. Be sure to choose a plastic bag that is a little thicker than a grocery bag.

Are you Strong Enough to Break an Egg?
Dene Gallagher, Biology Major

Purpose:

The purpose of this demonstration is to show that the curved, oval shape of an egg allows for force to be spread out over the whole egg. If there is a specific sharp force to the egg it will break.

Materials:

-Eggs
-Gloves or ziplocks for the weary

Procedures:

-Ask everyone to be make sure that they have taken off all their rings
-Place the egg in the palm of hand and squeeze evenly as hard as you can
-Repeat until convinced

Explanation:

pressure=force/area. When you squeeze the egg, the shape of the egg allows the force you are exerting to be spread out throughout the egg, meaning the pressure the egg is experiencing is not that great at any specific point on the egg. So, it will take a much greater force, or a smaller area for the egg to break. This explains why you can break an egg on the edge of a bowl, but you can’t squeeze it to break it.

Bed of Nails
Dene Gallagher, Biology Major

Purpose:
To show that spread out force is less effective than a sharp concentrated force.

Materials:
Mini bed of nails model
2 balloons
A visible medium to write on

Procedures:
1. Pull out a single nail and ask students how much effort it will take for you to pop the balloon.
2. Pop the balloon with the single nail
3. Write down pressure= Force/area and briefly explain - you can use rough measurements as to the area of the head of the nail and just ask from 1-10 how much force it took for you to pop your balloon so that the numbers will still reflect your point
4. Show the bed of nails and ask how much force it will take to pop the balloon
5. Lay the balloon on the nails, slide the board down, and ask students to come try to pop the balloon. They will notice a lot more force is needed
6. Use the same equation as above to reflect how area affects the force needed to aquire the same amount of pressure.

Explanation:
Pressure=Force/area. When the small point of a nail pops the balloon there is very little area used, so it doesn't take a very great force for the balloon to pop. When the area in which the force is being exerted is increased the force also needs to be increased in order for the pressure to be great enough to pop the balloon.

Floating Finger Sausage
Shelby Hojio-Ratzlaff - Biology Senior

MATERIALS:
Two fingers
Two eyes

PROCEDURE:
1. Extend your arms out in front of you
2. Place your index fingers pointed at each other in front of your face at eye-level.
3. Your finger tips should be approximately 1 inch apart.
4. Focus your eyes on something in the distance.
5. Between your fingers you should see a floating finger or sausage in the overlapping region.

EXPLANATION:
Our eyes are only a few centimeters apart from each other, each sees a different image, but the brain combines the two images. When we relax our eyes, the two images overlap, allowing you to see a combination the images, creating the floating sausage.

SAFETY:
As the majority of people have these materials around them at all times, safety should not be an issue. However, please be sure not to poke yourself in the eye.

Crunching Cans with Heat
Justin Little-Earth Science Senior

MATERIALS:
Aluminum soda cans
Water
Ice Water
Hot plate
Tongs to hold can

PROCEDURE:

1. Pour just a little water into aluminum can
2. Heat can on hot plate until water is boiling
3. With tongs, quickly take can and flip over into ice water

EXPLANATION:
This shows how the volume of a gas changes with temperature. The hot water vapor expands to fill the can and then when that gas is in contact with the ice water, it will cool rapidly causing a vacuum in the can. The vacuum will cause the can to crumple.

SAFETY:
Be careful with the hot aluminum cans, they will get hot enough to burn.

Bimetallic strip and thermal energy
Casey McGaughey Earth Science-senior

MATERIALS:
1 stainless steel, nickel bimetallic strip
1 small candle
Method for lighting the candle

SETUP:
Light candle, hold bimetallic strip on edge over the flame.

PROCEDURE:
The above set up covers the extent of the demo, hold the strip over the flame until the desired amount of deformation has been reached. TIPS: Follow the above procedure.

EXPLANATION:
Metals have different coefficients of expansion where change in length is directly proportional to the product of the linear coefficient of expansion, the length of material, and the change in temperature ($\Delta L = A x L x \Delta T$). As the strip is heated the differing coefficients of expansion lead to different expansion rates of each of the two types of metal in the strip causing an otherwise straight strip of metal to bend, the more the strip is heated the more it will bend.

SAFETY:
Caution must be used with the lit candle.

Can with internal inertial mass
Casey McGaughey-Earth Science Senior

MATERIALS:
Coffee Can
Item with mass greater than that of the can
One or two rubber bands to hold mass centered in coffee can
Two toothpicks or small nails tape or something to tie mass to rubber band/bands

SETUP:
Drill holes in bottom and top of coffee can; attach inertial mass to rubber band, put loop of rubber band out holes, insert toothpicks through loops to secure and center mass in coffee can.

PROCEDURE:
Roll the coffee can on a flat smooth surface, the mass weighing more than the coffee can will remain in the same relative position inside the coffee can winding the rubber band as the coffee can rolls forward. When the initial kinetic energy provided by the push is gone the rubber band will have wound enough that energy stored will be released because the mass of the center item is greater than the coffee can this energy will be released as movement of the coffee can in the opposite direction.

TIPS:
Trial and error may be needed to find a mass rubber band combination that does what is desired.

EXPLANATION:
This is a good demonstration of energy conversion from kinetic energy to potential energy and then back to kinetic energy .

SAFETY:
There are no safety concerns other than the possible breakage of the rubber band.

The Live Wire
Casey McGaughey

MATERIALS:
Item 1 Nitinol wire, a nickel and titanium alloy
Item 2 very hot water

SETUP:
Bend twist and otherwise deform the piece of nitinol wire.

PROCEDURE:
Place deformed wire in hot water bath.

TIPS:
Ensure the water is very hot the wire needs this thermal energy to return to its original shape.

EXPLANATION:
Nitinol is a wire that has been heat treated and thus has a memory. Any deformation can be reversed by the addition of heat the wire turns the thermal energy into motion. It is used in space to control robotic arms, in greenhouses for temperature control, and by orthodontists in the wire for braces.

SAFETY:
Some caution is required while handling the hot water.

The apple battery
Casey McGaughey-Earth Science Senior

MATERIALS:
1 apple
1 Micro ammeter, could use multi-meter if micro ammeter is not available
large, medium, and small zinc nails
large, medium, and small gauge pieces of bare copper wire (about 4" long)

SETUP:
Largest needle deflection (current is produced by the large nail and heavy gauge wire) Insert each into apple about one centimeter notice deflection, increase insertion depth another centimeter note increased current.

PROCEDURE:
Insert one nail and one piece of copper wire into apple about one centimeter deep, make sure they do not touch inside the apple. Connect the ammeter to each electrode, positive to the copper wire and negative to the zinc electrode. There will be needle deflection on the ammeter indicating current flow produced by the chemical reaction of the apple with the two dissimilar metals.

TIPS:
Use the larger electrodes for demo purposes allow the students to experiment with electrode size and depth of insertion to investigate DC current produced by this simple battery.

EXPLANATION:
It is the malic acid within the apple that allows the two electrodes used to produce an electric current.

SAFETY:
There are no major safety concerns.

Can Buildings be Safer?
Laura Pedersen – Earth Science Senior

MATERIALS:

Materials needed to assemble one building model

1. 21 jumbo craft sticks,
    a. about 15cm x 2 cm x 2 mm thick sticks
    b. Paint sticks may be a cheaper alternative
2. Electric drill with 3/16" bit
3. 1 piece of thin wood (about 2 mm thick) about 18 in. x 2 in
4. 1 piece of sturdy wood (2 x6) for a base (about 18 in long)
5. 16 machine bots, 10 x 24, about ¾ in
6. 16 machine screw nuts (10 x 24)
7. 32 washers, #8
8. Small wood screws

Materials for demonstration

1. Stock paper (15cm x 15cm squares)
2. 10-15 Paper clamps
3. String
4. Strips of paper

SETUP:

1. Build the wall beforehand
2. Stack 21 craft sticks one on top of the other. Wrap a rubber band around the center to hold them together.
3. Using a 3/16 in. bit, carefully drill a hole through all the sticks at once, 1 cm from the end of the stack.
4. Drill slowly to avoid cracking the wood.
5. Select the thinner of the two large pieces of wood (45 cm x 6 cm).
6. Drill a 3/16 in. hole 1 cm from one end and 1 cm from the edge.
7. Measure the distance between the holes drilled in the craft sticks and space three more 3/16 in. holes at that distance 1 cm from the edge so that a total of four holes are drilled
8. Use the small wood screws to mount this piece of wood on the base (the 2 x 6), fastening at the bottom and in the center.
9. Leave the pre-drilled holes sticking up far enough above the top to accept the drilled craft sticks
10. Using the bolts, washers, and nuts, assemble the craft sticks to build a model wall
11. Experiment with tightening bolts and washers until they are just tight enough for the wall to stand on its own

PROCEDURE:

1. Show students building and tell them that it represents a 3-story building
2. Demonstrate what happens to the building during an earthquake by shaking the structure
3. Ask students if they noticed which story collapsed first
4. Then add support to only the first story and simulate another earthquake
    a. Will supporting the first story keep the entire building up?
5. Repeat these steps with all of the stories, until the building stays upright during earthquake

TIPS:

1. Do not tighten the screws all the way. They should be just tight enough to hold the building up
2. The craft sticks are very fragile, while constructing building, drill with smaller drill bit and work up to larger bit

EXPLANATION:

During an earthquake, the ground motion that is important in determining the forces on a building is acceleration. As the seismic waves move through the ground, the ground moves back and forth. In a building with a mass in the thousands of metric tons, tremendous forces are required to produce the same motion. These forces are transmitted throughout the structure, so if the movement repeats for some minutes the building may shake to pieces. To overcome the effects of these forces, engineers rely on a small number of components that can be combined to form a complete load path.

Different structural support systems are used: diaphragms, shear walls, braced frames, and moment-resistant. This demonstration shows how some of these support structures can direct the forces back to the ground. In a simple building with shear walls at each end, ground motion enters the building and moves the floor diaphragms. This movement is carried by the shear walls and transmitted back down through the building to the foundation. Braced frames act in the same manner as shear walls, but may not carry as much load depending on their design.

SAFETY:

No safety concerns for this demonstration, but use caution during construction of model

Defying Gravity – Lenz's Law
Laura Pedersen – Earth Science Senior

MATERIALS:

1. One copper pipe (at least 2 ft in length)
2. Strong magnet (neodymium)
3. PVC pipe; same length as copper pipe (Optional)

SETUP:

No setup is required!

PROCEDURE:

1. Drop the magnet into the PVC pipe
2. Have students count the time it takes to exit the PVC pipe
3. Show students that the magnet does not stick to the copper
4. Drop the magnet into the copper pipe
5. Have the students count the time it takes to exit the copper pipe

EXPLANATION:

Lenz's law states, "There is an induced current in a closed, conducting loop if and only if the magnetic flux through the loop is changing. The direction of the induced current is such that the induced magnetic field opposes the change in the flux."

In layman's terms, the magnetic field of a magnet creates a downward flow through the copper pipe and as it is pushed closer to the pipe, the magnetic field increases. To oppose this change, as Lenz's law requires, the pipe will generate an upward-pointing magnetic field. Thus as the magnet approaches the pipe, the pipe induces a counterclockwise current around the pipe to oppose this increase of magnetic field. Once the magnet stops moving (changing), then the induced current will cease as well.

SAFETY:

1. Neodymium magnets are VERY strong and should not be handled by anyone who:
    a. a pacemaker
    b. Has a Diabetic pump
2. May pinch skin when handling with two neodymium magnets
3. May be fatal if consumed – do not let children play with magnets
4. Neodymium magnets will ruin cell phones, credit cards, computers, etc. if placed near these types of items

The Black Whole

Lauren Christine Burns

MATERIALS:

1. A coffee can which has been specially constructed (a slanted metal or plastic piece attached on the inside to keep water in).
2. A glass of water.

SETUP:

When making your coffee can the metal or plastic piece on the inside should be slanted down towards the bottom of the can. That way when the can is tipped on its side it will hold in the water better. Using the lid of the coffee can works well since it is already the correct shape and diameter. A hidden mark can be made on the inside rim of the can so that you can easily tell which way to tilt it.

PROCEDURE:

1. Hold the coffee can above the observers to ensure that they cannot view what is inside it.
2. Pour a glass of water directly into the coffee can. Note: do not let observers see inside the coffee can.
3. Tip the can over onto the side which will allow no water to spill out of the coffee can.

QUESTIONS:

1. Describe exactly what you observed.
2. Based on your observations, describe or draw what might be in the coffee can.
3. Are you making an educated guess about what occurred?
4. What is the scientific word for making an educated guess?
5. How might you collect further information to support your educated guess?
6. Write down some examples in which scientists have made educated guesses about natural events that occur to try to explain what is happening in the world.

EXPLANATION:

This demonstration is an excellent way to introduce the Scientific Method because it deals with observing and recording those observations. Furthermore, the students can make an educated guess (hypothesis) about what might be occurring.

Students can also be introduced to the idea that in science there are many wonders that scientists cannot fully explain. Scientists can only make observations and try to collect as much information as possible and based on the knowledge they gain from these observations they can hypothesize about what is happening. For example, scientists did not actually see the dinosaurs that lived during the Triassic Period, however they can predict because of the evidence that was left behind in the fossil record.

It is important to inform the students that even though their educated guess about what was inside the coffee can was correct they would have to do millions of tests to definitively state that it was. This is because in order for a hypothesis to become a fact or a theory an enormous amount of data must be collected to support the hypothesis and millions of tests must have taken place.

Mystical Cylinder Lauren Christine Burns

MATERIALS:

1. A large print-out of the words TITANIUM DIOXIDE (must be in all capital letters).
2. A cylinder filled with water and closed at the top so it can be turned sideways (a smooth water bottle without bumps or ridges works well for this).

SETUP:

When filling your cylinder with water try to make sure that there is no air bubble or only a very small one. A large air bubble may interfere with student's ability to see the effect. For the print-out of TITANIUM DIOXIDE a plain sans serif font works best. The height of the letters should be about the same as the width of the cylinder being used.

ROCEDURE:

1. Tell the class that you have special cylinder and have them watch what it does.
2. Hold the cylinder of water in front of the words TITANIUM DIOXIDE. See what happens.

QUESTIONS:

1. Why does the word TITANIUM invert and the word DIOXIDE does not?
2. Why does the cylinder invert the words?

EXPLANATION:

Both words actually invert, however when the word DIOXIDE inverts it still appears the same. This is because all of the letters in that word look the same whether right side up or upside down.

This demo can be used to start a discussion about science and how a scientist has to think everything out. A scientist should not be easily tricked.

This can also be used as a discussion of lenses and why the cylinder causes the letters to invert.

Now You See It, Now You Don't

Lauren Christine Burns

MATERIALS:

1. A small white candle
2. An apple
3. Lemon juice
4. An almond
5. Matches or a lighter

SETUP:

Skin the apple and soak it in lemon juice to prevent it from browning. Carve the apple into the shape of a candle as similar in size and shape as possible to the real candle you are using. Carve the almond into the shape of a wick and poke it into the top of the apple to complete your apple candle.

PROCEDURE:

1. Light the candle and give it to the audience so that they can observe it.
2. While they are observing the candle, light the apple with the almond wick.
3. Show the apple/almond "candle" to the audience.
4. Blow the apple/almond "candle" out and quickly eat it.

TIPS:

Be sure to practice this a few times to make sure your apple "candle" works and is convincing.

QUESTIONS:

1. What do you know about candles?
2. Based on previous knowledge you have on candles, are they edible?
3. Is it possible that what we already know about candles (they are not edible) could be incorrect?
4. How do we know if candles are edible or not?
5. Do you think that the second candle (the edible candle) was really a candle? Why or why not?
6. In science, what is it called when we assume without actually observing it?
7. Why did we infer that the second candle (the edible candle) was really a candle?
8. Name 3 different examples of inference.

EXPLANATION:

This demonstration is a great tool to introduce the idea of inference. It is important for students to understand and distinguish the difference between inference and observation.

The first candle was given to the students to observe. In this instance they could easily tell that the candle was made out of wax and was indeed a candle. However, the second candle the students were not able to observe using all their senses. Instead they had to rely on seeing which as we know is not always reliable. This demonstration teaches students that it is important in science to be observant and try not to make inferences.

SAFETY:

This demo involves candles with an open flame. Be sure to handle with care and instruct students to do the same. Keep all flammable material such as paper as well as loose and hanging items well away from the flame. **Be sure to blow out the apple/almond "candle" before eating it!**

Magic Coin
Danielle Thuringer - Biology Post-Bac

MATERIALS:
Glass Bottle
Quarter
Ice Water

PROCEDURE:
Dip a quarter and the neck of a glass soda bottle into a bowl of cold water. Allow them to sit for five minutes. Take them out and place the bottle right side up. Put the coin over the opening of the bottle, then cover the bottle with both hands for 15 seconds. Remove your hands and watch the coin pop up.

EXPLANATION:
The coin jumps because the hands create heat inside of the bottle, which causes the air inside to expand and create pressure. Once enough pressure is created, it slowly releases the hot air through the top of the bottle, causing the coin to move.

Disappearing Test Tube
Danielle Thuringer - Biology Post-Bac

MATERIALS:
Wesson vegetable oil
Water
Pyrex glassware (test tube, beaker, stirring rod)

PROCEDURE:
Put a piece of lab glassware into a large beaker of water, taken note that it is still visible. Add the same type of glassware to a beaker of vegetable oil. The glassware will seem to disappear! You can also fill a beaker half with water and half with vegetable oil to observe the glassware in both liquids.

PROCEDURE (ALTERNATE):
A test tube is placed in the vegetable oil before the lecture. During the lecture, the lecturer smashes another test tube in an envelope and pours it into the oil and stirs it. Then reaching in with a pair of tongs is able to pull a whole test tube out of the oil, telling the students it was put together with a magic fluid.

EXPLANATION:
Pyrex glass has the same index of refraction as the vegetable oil, making the glassware seem to disappear. When light moves from one medium to another, it generally bends slightly. This is because the properties of the media allow light to move through them at different speeds. When light hits the change in media at an angle, one side of it moves faster than the other. This is like planting one foot and moving the other - you'll twist around. The light does the same. People can see window glass and clear water mostly because light distorts between the glass or water, and the air. People can also see the distortions between the pyrex and the air. By coincidence, though, there is no difference in the speed of light through vegetable oil and through pyrex. No distortions, and no tinting to the pyrex, mean that no one can see the difference between them. Surrounded by oil - the pyrex disappears.

Hanging Water
Abby Lundien-Earth Sciences Senior

MATERIALS:

- Water
- Nylon
- Rubber band
- Mason jar with ring
- Card stock

PROCEDURE:

- Fill up Mason jar with water.
- Put a few drops of food coloring in the water so it is easier to see.
- Place a piece of nylon without seams over the top of the glass.
- Secure it by screwing on the ring
- Place a piece of card stock on top of the jar
- Slowly turn the glass of water upside down
- Remove the card stock from underneath the jar

EXPLANATION:
This demonstration shows the effects of air pressure and the surface tension of water. When the glass is turned upside down, no water should fall out due to the pressure that is pushing up on it mixed with the surface tension of the water that is enhanced by the piece of nylon.

Compass

Abby Lundien- Earth Sciences Senior

MATERIALS:

- Bowl of water
- Needle
- Cork
- Magnet

PROCEDURE:

- Magnetize the needle by rubbing it on the magnet.
- Push the needle all the way into the cork.
- Place it into the bowl of water and it should float.
- Move the magnet around the outside of the bowl and the needle should follow it.
- Remove the magnet and it should return to pointing towards magnetic north.

EXPLANATION:

This represents to students how a compass works as well as why magnets point to magnetic north. This could be expanded to represent the changing of the direction of the magnetic pole, and how it creates the shift in the orientation of the magnetism in lava coming out of the Mid Atlantic ridge.

Why is the Sky Blue?
Rayleigh Scattering Alice Arbogast

MATERIALS:
Plastic or class transparent container with parallel sides (.5-2 gallons. A plastic aquarium is a relatively inexpensive container)
Water (amount enough to fill your container)
20 mL Milk
Flashlight (some work better than others)

PROCEDURE:
1. Fill your container with water. Place the light on one side of the water to show the audience that the beam of light is not very visible.
2. Add 10 mL of milk to the water and stir (does not need to be precise, but do not over pour)
3. Shine the light through the container, from the side, the milk/water solution may look bluish. Looking straight at the beam, the light may look reddish
4. Continue adding small quantities of milk until you can see blue light from the side and red light from the front.

TIPS:
Try different lights, some give you the blue light effect better and some give the red light effect better. An overhead projector light may work as well.

EXPLANATION:
This is an example of Rayleigh scattering, the effect that takes place in our atmosphere to make the sky blue. Our atmosphere is full of very small particles of water, organic matter, gases, and so on. When sunlight hits these particles, different wavelengths of light scatter. The milk mimics our atmosphere. Shorter blue wavelengths scatter the most, which results in our being able to see blue out the sides of the container. Red light scatters the least. At sunset, when the sun has to penetrate more atmosphere, red is often the only color we can see, which is why the sun looks red.

Boomerang Coffee Can: Potential and Kinetic Energy
Alice Arbogast

MATERIALS:
Metal coffee can with plastic lid
1-2 Rubber bands
~.5 kg weight (fishing weights, washers, dead batteries taped together)
2 Popsicle sticks or pens

SETUP:
Puncture holes in the center of the lid and the center of the bottom of the can (you can use a drill or hammer and nail). Attach a rubber band (2 if needed) to the weight and thread the ends of the rubber band through the holes in the can. Use a pen or like devise to secure the rubber bands and replace the lid on the can.

PROCEDURE:
Place the can on its side and push it away from you. A hard surface is best as there is less friction. The can will roll back toward you.

TIPS:
It might take several tries to get the weight right. The weight needs to be heavy enough that it doesn't roll with the can but light enough that it allows the can to roll on its own. Be sure the weight does not hit the sides of the can as it rolls.

EXPLANATION:
When you push the can you give the can kinetic energy. As the can rolls it builds up potential energy by the winding of the rubber bands. When friction slows and stops the can from moving in the direction you pushed it, the potential energy is released and the can returns to the pusher.

Harmonics of Knives

Amy Bekins- Chemistry Post-Bac

MATERIALS:

Knives

Something to hit the knives with

PROCEDURE:

1. Hold the knives.
2. Hit the knives with something that will allow a sound to be produced.
3. Use more than one knife to show different harmonics.

TIPS:

Try to find a good place to hold the knife where you will hear the best harmonic from the knife.

EXPLANATION:

When you hit knives they produce sound waves. Different knives will produce different sounds because of the harmonics of the knives and the differences in the sound waves.

Disappearing Glass
Ashley Summerton - Biology Junior

MATERIALS:
Item 1: Wesson Oil
Item 2: Water
Item 3: 3 Beakers or (Plastic Cups)
Item 4: 3 Pyrex stirring rods

SETUP:
Setup requires having all of your materials ready and the oil poured into one beaker and the water into a second beaker, before the student come to class. You want them to see the difference between the two liquids you are using and by having this part of the experiment setup it gives you more time to talk about different properties of water vs. oil and how it effects the refraction of light.

PROCEDURE:
Start with the 2 glass beakers and fill them about half way, one with the Wesson Oil and the other with water. Using Pyrex stirring rods (3) take one and place it into the beaker that is halfway full of water. Then ask the students what they see, or if they can see the rod in the water. Taking the other rod, place that in the beaker with the oil. As you watch your student's eyes in amazement, ask them what they see. The rod will have "disappeared". The very last beaker is going to be used for a half and half demonstration of the water and oil combined. I started with adding in the water first to avoid bubbles from the oil. You will need to fill the beaker at about half way with water and then add the oil to make the beaker full and now we have a 3rd beaker that is layered with oil and water combined. Ask your students what might happen before you put the rod into the beaker so that you can create some class discussion. You will then place the last stirring rod into that beaker and allow for your students to discuss in groups why they think the reaction happened like that.

TIPS:
Make sure you use Pyrex Stirring rods or else this experiment will not work successfully.

EXPLANATION:
This experiment is demonstrating how light works and how with different materials it can bend in any direction giving it an illusion appearance. In this experiment however we focus on the refractive index which measures the speed at which light moves through the substance. The more light we have going through the substance the high refractive index number we have in a particular substance. So in this experiment we have two different substances being used, one is water the other is Wesson Oil. If we were to compare the two we would find that the oil has a higher refractive index number than water because when we place that glass rod into the oil it disappears, light is being bent a different way than water. Our initial trial when we put the rod into the beaker filled with water it was visible to our eyes because we had light moving more quickly through the water rather than the stirring rod. For our second trial we then saw the rod being placed in the oil but we weren't able to see the rod itself. You can see that the two substances have similar refractive index numbers; the rod and the Wesson oil. Because the oil and Pyrex are similar, the light is not altered as it is passes through the stirring rod making light only pass through the oil and the rod becomes invisible.

SAFETY:

With any experiment wear goggles just in case you get splash up of oil into the eye when putting in the stirring rod.

Resources:
http://www.stevespanglerscience.com/experiment/vanishing-glass1

Balloon Skewer
Ashley Summerton - Biology Junior

MATERIALS:
Item 1: Kabob Skewers
Item 2: Oil
Item 3: Medium Balloons

SETUP:
Have skewers soaking in oil, and have the balloons already inflated. This will save time during your class period.

PROCEDURE:
Soak the skewers in oil for period of time. Blow the balloons up but not too big in size; the softer it is the easier it is to skew. Start by going through the top of the balloon near the darker color region of the balloon. Once the balloon is pierced through the top then continues through the middle of the balloon and pierce it out on the bottom next to the tie. If you keep the balloon in a spinning rotation it is easier to skew without popping the balloon.

EXPLANATION:
In this experiment we are using balloons that are made of latex, a polymer made of long-chain like molecules that are essentially all tangled together. When you are pushing the sharp skewer through the latex you are simply pushing those molecules to the side and not breaking them which allow the balloon to stay in tacked. When you force a pop on the balloon you are breaking the strands. It's easier to push the skewer in at the ends, where the strands have more "give," vs. around the side of the balloon, where the strands are stretched more tightly; they are more likely to break. Once a tear begins, it continues to enlarge, the air rushes out of the balloon, and it pops.

Standing Wave with a Bass Guitar
Ross Kononen – Earth Science Graduate Student

MATERIALS:
Bass Guitar (Any string instrument will work)
Adjustable Strobe Light
An Electrical Outlet

PROCEDURE:
1. Plug strobe light in to outlet
2. Turn on strobe light
3. Pluck a guitar string
4. Play with strobe frequency until wave is clearly visible

TIPS:
Try the demo beforehand to calibrate the strobe frequency to the string frequency. Bigger guitar strings are easier to see because of their lower frequencies.

EXPLANATION:
String instruments produce sound through the vibration of a string. A plucked string vibrates forming waves that travel in both directions until they hit the fixed end of the string. The waves reflect back from the ends and return toward the middle. On a well-tuned string instrument the crests and troughs of the wave will occur at fixed points between the two ends. This alignment is called a standing wave. The strobe light is present to create the illusion of slow motion and makes the standing wave visible.

SAFETY:
Strobe lights can cause seizures in photosensitive epileptics. Warning should be given before turning a strobe light on in a crowd. The crowd should be advised that if they begin to feel sick or disoriented the best thing to do is look away and close their eyes.

Sound in a Vacuum

Ross Kononen – Earth Science Graduate Student

MATERIALS:

Alarm clock
Garbage Bag
Vacuum
Strip of Tape (stronger is better)

This demo can be done with anything that is containable in a garbage bag and will produce an audible noise.

SETUP:

Plug in all items that require power (the alarm clock and the vacuum) before hand.

PROCEDURE:

1. Have the alarm clock go off so it is making noise or playing music
2. Place the noise source in the garbage bag
3. Place a hooked-up hose from the vacuum in the bag
4. Gather the tube and any cords into a handful with the garbage bag
5. Wrap tape around the tube and cords forming an air tight seal with the alarm clock in the bag
6. Turn the vacuum on
7. Observe the noise becoming quieter as the air (vibration medium) is being sucked out of the bag

TIPS:

The tighter the seal is between the vacuum and the garbage bag, the more convincing the sound reduction will be.

EXPLANATION:

We hear sound because air vibrates and our eardrums are sensitive to the pressure changes caused by the vibration. At its most basic level, sound is the vibration of any substance. The substance can be anything that will vibrate: air, water, wood, metal, plastic, etc. In the absence of a substance to vibrate, sound cannot propagate. Suction on the sealed garbage bag removes the air and makes it so the alarm clock has nothing to vibrate, causing the volume to drop (if the seal is perfect, sound will cease).

Non-Newtonian Substance Dancing on a Speaker
Keri Bowling – Post-baccalaureate Teaching Candidate – Secondary Science

MATERIALS:
Speaker
Speaker wires (positive and negative)
2 Wire clips
Frequency Generator
Power source (power outlet)
Pitcher
Corn Starch
Water
Stirrer (examples: toothpick or twisty tie)

SETUP:
Place speaker so the sound will travel upward. Hook speaker to frequency generator with the speaker wire and the wire clips.

PROCEDURE:
Mix 5 Tablespoons of cornstarch with ¼ cup of water. Pour 1/8 cup of the mixture onto the speaker. Turn on the frequency generator and set it to approximately 45 Hertz. Turn the amplification to the mid-point (halfway to maximum). Use the stirrer to help the mixture begin "dancing".

TIPS:
The substance sometimes needs to become a bit thicker, if you think this is the case, stir it around or add a minute amount of dry corn starch to the mixture in the speaker.

EXPLANATION:
The corn starch and water mixture shows properties of both a liquid and a solid, depending on the pressure exerted on the mixture. The pressure from the sound waves coming out of the speaker push the mixture up, which also makes the mixture harden. Then, the mixture falls back into the speaker and displays the qualities of water again.

SAFETY:
Use caution when using electrical outlets. Only run the frequency generator for less than ½ hour because it may overheat. Don't eat the mixture it may give you a stomach ache.

CO2 Has Mass
Shawn Murphy – Biology Postbac

MATERIALS:
1 can of cold soda
Digital Scale

SETUP:
Place a can of soda on a digital scale and record its weight.

PROCEDURE:
Open the can of soda and let it sit for a minute. Be careful not to spill any of the contents. Weigh the open can of soda and record its weight. The can will have less weight after it is opened than before it was opened because some of the CO_2 has escaped.

TIPS:
Cold soda is used to keep it from fizzing over and spilling, thus changing the weight.

EXPLANATION:
It is hard for younger students to understand the concept that Carbon Dioxide has weight and mass. These students tend to think that air is “weightless.” This demonstration shows that the loss of CO_2 from a can of soda will change its weight.

SAFETY:
None.

Physics of Music
Connor Saller

MATERIALS:

1. PVC Pipes with lengths proportional to 1, (1/2), (1/3), (1/4), (1/5), (1/6), and (1/8) the original pipe length
2. String
3. A hand

SETUP:

It is important to have the pipes measured correctly so the proper sounds will resonate through each pipe. If possible, arrange the pipes that resemble an organ type instrument.

PROCEDURE:

Begin the demonstration by describing the lengths of each pipe relative to the original or longest pipe. Strike each pipe with an open hand and determine the tone of sound that is heard (octave down, fifth, or third).

Obtain three audience members so four pipes can be struck simultaneously. Gather the appropriate pipes in order for a major chord to be heard by the audience. When ready, strike the pipes at the same time so a first, third, fifth, and an eighth of an octave is heard by the audience.

EXPLANATION:

When the top of the pipe is struck by an object, there is a change is air pressure inside the pipe which creates a sound. This occurs because the pipe resonates sound waves that are traveling through an air medium. This sound has a specific wavelength and frequency due to the length of the pipe. Depending on the length of the pipe, we can obtain three sounds that construct a major chord.

SAFETY:

All equipment should be treated with respect and care. Careless use of the pvc pipe can result in destruction of the setup or undesired injury to an individual.

Length of a Pendulum
Connor Saller

MATERIALS:

1. Long, medium, and short strings
2. Multiple weights
3. String holder (homemade).

SETUP:

There will be three different lengths of string attached to a string holder so the strings can swing freely back and forth. The strings will have various weights, or pennies, attached to the end of the string during the demonstration.

PROCEDURE:

Using the longest string on the pendulum setup, attach the weights or pennies to the end of the pendulum. Bring the end of the pendulum to a consistent height and drop the pendulum so it will swing back and forth freely. Measure how many times the pendulum swings back and forth in ten seconds. Repeat this action with lesser or greater mass on the end of the long pendulum.

If possible, obtain two volunteers from the audience. Each person will raise a pendulum, varying in length, to the same height. All three people drop their pendulum at the same time and we observe what occurs.

TIPS:

The height and time of the released pendulum needs to somewhat exact to obtain expected results. The string should swing back and forth two-dimensionally in order to illustrate the effect of gravity.

EXPLANATION:

Since gravity has only one direction (downward), we can illustrate that pendulums swing back and forth at a frequency that is dependent of its length and not mass. The distance traveled by the long string is greater than the short string which affects the frequency of each pendulum. Since the acceleration of gravity is the same for a long, medium, and short pendulum, we see the shorter pendulum swings with a greater frequency than the longer pendulum. This is due to the various path distances each pendulum has to travel during one complete cycle.

Double Slit Experiment
Connor Saller

MATERIALS:

1. Laser
2. Double slit
3. Blank screen

SETUP:

Place the laser in front of the double slit so the laser strikes between the double slit. A blank screen will be placed behind the double slit to illustrate interference.

PROCEDURE:

Position the laser so it is shining directly through the double slit. With a screen placed behind the double slit, turn on the laser and observe the phenomenon of constructive and destructive interference. There should be an interference pattern where light fringes appear brighter in the middle of the pattern and darker on the outside of the pattern.

TIPS:

If possible, turn the lights down or off in order to view the interference pattern with clarity. It is important to make the interference pattern visible to everyone in the audience by moving the screen or laser accordingly.

EXPLANATION:

Since light travels as a wave, we can demonstrate the wave-like properties of light with constructive and destructive interference. When light passes through one of the slits, light waves will travel a certain distance until they hit the blank screen. Light waves from the other slit will travel the same distance and in the same direction. The light waves interact with each other when they are in phase and out of phase. When waves are in phase, constructive interference occurs and we illustrate this with the brighter fringes on the interference pattern. Destructive interference is shown on the screen where dark fringes occur.

SAFETY:

Lasers can be harmful to the eye if looked at directly. It is important to shine the laser away from the audience so there is no eye damage for any audience member.

Ringing Rod

Benito Espinoza - Biology Senior

MATERIALS:

Metal rod about one meter or less in length, and some rosin.

SETUP:

There is no big advance set up. Just be sure you have the rosin and the metal rod.

PROCEDURE:

Find the midpoint of the rod by balancing it on one finger. Hold it in your hand at the midpoint that you just determined. Rub the rosin on your other hand between your thumb and your index finger. Now slide your hand down the bottom half of the metal rod with light pressure. The rod will begin to "whine" a screeching sound if done correctly. The more you slide your fingers down it, the louder it gets.

TIPS:

You can tie this demo into a lesson on frequency, wave motion, or sound. You can also obtain a wave with more than one node. By finding the center of one of the halves you have already and holding it there. You now have three nodes. You will need to apply a significant force of vibration, because this frequency is much higher. Any more nodes are usually not going to be heard. You can experiment with different length rods, though.

EXPLANATION:

By holding the rod at its center, you are allowing it to act like a wave. The center is the node of the wave, and both sides resonate as you apply the frictional vibration. By pulling your "sticky" fingers down the rod, you are causing a vibration, and at certain levels you can hear this vibration.

SAFETY:

As a precaution, make sure there iron rod has no rough edges where your fingers will be rubbing with the rosin. Rubbing your fingers over some rough areas can cause some cuts on your fingers.

Credits:

Bonnstetter, 1995 (http://www.theteachersguide.com/Sciencedemos1.htm)

Conservation of Momentum
Kyle Kingsley – Chemistry and Physics Senior

MATERIALS:
Item 1 Basketball
Item 2 Tennis Ball
Alternative balls can be used for the tennis ball. Be careful to avoid balls that could cause injury to students

SETUP:
No advance setup necessary

PROCEDURE:
Drop the basket ball from waist height. Have the class note the height of the bounce. Repeat with the tennis ball. Place the tennis ball on the basketball and drop both simultaneously.

TIPS:
The tennis ball will shoot off the basketball in the direction it is placed relative to the top of the ball. If placed directly on top, it will shoot directly up, if placed off-center towards the class, it will shoot into the class.

EXPLANATION:
The momentum of the basketball bouncing off the ground is transferred into the tennis ball.

SAFETY:
As long as care is taken in the drop position of the balls and no potentially injurious materials (golf ball, etc) are used, the safety risk is minimal.

Induction of Current
Kyle Kingsley – Chemistry and Physics Senior

MATERIALS:
Item 1 Tape Player/Signal Source
Item 2 Speaker/Signal Receiver
Item 3 Two coils of wire adapted to plug into Items 1 and 2

SETUP:
Attach the wire coils to the signal source and receiver. Ensure the signal source has power.

PROCEDURE:
Turn the source and receiver on while the wire coils are separated. Bring the coils together side by side without touching. Show that the signal dies off if the coils are placed orthogonally.

TIPS:
Show the signal is transferred very well if the coils are parallel and close but dies quickly with orientation change or distance change.

EXPLANATION:
The signal in the first coil is inducing a current in the second coil through a magnetic field generated when current moves through the first coil. The variation of the magnetic field causes a current in the second coil.

SAFETY:
The electricity used in this demo is very small. The greatest danger is poking yourself with the wires during setup. This is generally not lethal

Hot Air Balloons

Sandra Pike – Biology, Post Bac

MATERIALS:

7 sheets of tissue paper (20”X26”)
1 glue stick
1 pair of scissors
Source of heat (propane torch, butane burner, heat gun, hair dryer)

SETUP:

Create your hot air balloon using the tissue paper. Four sheets will be used for the sides (20”X26”). One sheet should be cut into a square to use for the top (20”X20”). Two sheets will be cut in half and used to make four trapezoids (20” at the top and 10” at the bottom). These will create the tapered look on the bottom of the balloon.

PROCEDURE:

Once you have constructed your balloon, use your source of heat to launch the balloon.

EXPLANATION:

This is a great demonstration for density. Hot air rises above cool air because it is less dense.

SAFETY:

Be careful not to catch the balloon on fire during the launch.

"Think" Tube

Sandra Pike – Biology, Post Bac

MATERIALS:

1 tube, cardboard or PVC
2 pieces of rope, each a little longer than the tube itself
5 washers
2 objects that can cover each end of the tube

SETUP:

Drill two holes opposite each other in each end of the tube. Thread a rope through one hole, then through a washer, and through the hole opposite the first one. Thread the other rope through the other end, through the same washer, and through the hole opposite the first. Tie the other four washers to each end of the rope. Then cover the ends of the tube so that you cannot see inside.

PROCEDURE:

Start with the two pieces of rope near you pulled down equally and the two pieces in the front pulled tightly to the tube. Place your thumb on one of the long rope ends to prevent it from moving and pull the string on the opposite front end. This will pull the same rope creating the appearance that the rope is thread straight through the tube. Do the same with the other end. Now, place your hand on another long piece of rope and pull the rope on the same end of the tube. This will cause the rope on the other end to move.

EXPLANATION:

This is a great was to develop problem solving skills. Students can be asked to hypothesize what is going on based on their observations. Students can also draw a diagram of what they think is going on inside the tube. This is useful in explaining that we don't always see what is going on but we can use our observations to consider all options.

Electromagnet

Jacob Romig – Biology Senior

MATERIALS:

- Power Source (batteries)
- Battery holder
- Copper wire (Insulated with two sets one longer than the other)
- Wire connectors (two)
- Switch
- Nail (Any piece of metal that is attracted to a magnet)

SETUP:

Connect the longer wire to the positive lead on the battery holder using the wire connector. Place the nail in the middle of the wire connected to the battery holder. Tightly coil the wire around the nail, leave enough of the unconnected end to be able to connect it to the switch. Next connect the other end to one prong of the switch. Connect the other wire to the ground lead on the battery case with the other wire connector. Then connect the other end to the other prong on the switch. Place batteries into the holder. Turn on the switch and test with metal objects.

PROCEDURE:

Have some small metal objects laid out. Try picking up the metal objects with the electromagnet. Then turn on the magnet and pick up the small metal objects. Hold up the objects and then turn off the magnet. The objects should drop back down on the table.

TIPS:

I placed a piece of electrical tape at the end of the coil on the nail to hold the coil in place.

EXPLANATION:

Current running through a wire creates a magnetic field. When the wire is coiled around the nail and current is running through the wire, the magnetic field aligns the magnetic domains of the nail creating a magnetic field in the nail. The nail than has the properties of a permanent as long as the current is on.

SAFETY:

Two to four D batteries are enough power causing no safety concerns working with electricity.

Making Water Rise
Jacob Romig – Biology Senior

MATERIALS:
Water
Plate (must be able to hold water)
Candle
Glass (a jar can be used)
Matches or Lighter
Food color

SETUP:
Add food coloring to the water

PROCEDURE:
Pour water into the plate. Place the candle in the middle of the plate and on the water. Light the candle. Hold the glass over the candle for 1 to 2 minutes. Then place the glass completely over the candle. The candle should go out and after the candle is out the water will be sucked up into the glass.

EXPLANATION:
The air caught in the glass is heated while it is held over the candle. As the air is heated the air expands in the glass. The air than cools when the candle goes out cause the air to condense leaving empty space that causes a vacuum that is filled by the water.

SAFETY:
Safety needed with the use of fire.

Which Balloon will Deflate
Jacob Romig – Biology Senior

MATERIALS:
Two balloons
Spool
Two clips

SETUP:
Blow up one balloon and make it large, use a clip at the end to cut off the release of air. Blow up the second balloon much smaller than the first. Clip the second balloon like the first. Take the ends of both balloons and stretch over each end of the spool.

PROCEDURE:
Present the balloons attached to the spool. Release the clips from both balloons and then let go of the ends to allow air transfer through the spool. The smaller balloon will deflate, inflating the larger balloon.

TIPS:
The more the size difference between the two balloons the better.

EXPLANATION:
You would think the larger balloon would deflate since it has more air. The smaller balloon has a larger elastic force. The elastic potential is greater in the smaller balloon than the larger as it has been stretched further.

Liquid Marbles
David Conway – Senior Chemistry

MATERIALS:
1 jar of Aqua-Gem liquid marbles (other brands can be bought at most dollar stores)
1 plastic clear square container
1 liter of water

SETUP:
The setup is quite simple. Combine the liquid marbles and the water into a clear plastic container is all that needs to be done.

PROCEDURE:
You start the demonstration by asking, "What are the properties of a liquid"? Students will say that is has definite mass but not definite shape. You then pull out the marbles to their surprise and ask the students why their eyes deceived them. You can squeeze the balls, and bounce them into the water for a cool effect. Have the students try to figure out what characteristics of the marbles allowed them to be completely invisible in an aqueous solution.

TIPS:
It is smart not to use food coloring as it will take the balls a long period of time to become the same color as the solution. Overall this is a very safe and easy demonstration that can be used at the beginning of a many number of lessons.

EXPLANATION:
Liquid marbles are a made of a polymer that absorbs, stores, and releases water. They have an index of refraction identical to that of water and this is mainly linked to the fact that they are almost entirely composed of water.

SAFETY:
Liquid marbles are nontoxic and the solution is composed of tap water. It is still smart for students not to eat the substance. The marbles are also somewhat easy to break.

Karate and pressure

David Conway – Chemistry Senior

MATERIALS:

1 newspaper
1 long thing piece of wood (meter stick)
1 karate hand

SETUP:

Prior to the demonstration test the wood to make sure it is stiff enough to break and thin enough that a person of average strength could break it.

PROCEDURE:

Start the demo by placing the stick on the table and asking everyone what would happen if you tried to break it. The answer is it would fly off in some direction. Then take a sheet of newspaper and lay it over the side of the stick that is on the table. Flatten out the newspaper to get out all of the creases. Then give it your best karate chop. The newspaper will be enough to break the stick.

TIPS:

Make sure that the stick is not too flexible and not too thick. It would be smart to test this demo prior to the demonstration to ensure that the newspaper is the right size and the stick is the right time

EXPLANATION:

This demo is a great example of the strength of atmospheric pressure. Air pressure is pushing down on the unfolded piece of newspaper. Although it seems like a miniscule amount the air is actually exerting 150 pounds on the piece of wood. This is an example of the principle that the force of air pressure on an object is proportional to that objects area.

SAFETY:

Be careful when karate chopping the piece of wood. A piece of wood that is too thick would result in a hurt hand. Also take care in the direct the stick is pointing as it may fly in that direction.

Magnetic Liquids: Make a Ferrofluid
Aaron Adamson – Physics Senior

MATERIALS:

- Oil (Vegetable Oil, Mineral Oil, Motor Oil – anything viscous will work)
- Toner (You can either get this in a bottle from the office store (MICR toner) or use unwanted toner cartridges)
- Magnets (Different shapes, sizes, and strengths will produce different effects)
- Beaker and Stirring Rod (Or similar container)
- Demonstration container (Pie tin, etc)

SETUP:

Pour the toner into a beaker. It can be messy, so do this in an area that is easy to clean. Gradually pour oil into the mixture, stirring as you go. Try pouring a few mL at a time so you don't get too much. You should get an even, black liquid that is of a similar viscosity to the oil by itself.

PROCEDURE:

Pour the mixture you've created into a pie tin, tray, or other wide, flat surface that will keep the mess contained but allow students to see the ferrofluid easily. Get a variety of magnets, and move them underneath the container. You will observe the liquid forming a variety of shapes under the influence of the magnetic field. Experiment with different magnets to see what you can produce. Feel free to manipulate the shapes with a stirring rod – you can spin many of them and watch them rotate while maintaining their structure.

EXPLANATION:

A ferrofluid is simply a liquid that responds like a ferrous metal to a magnetic field. Toner works well for this because the particles are very fine, but they are also highly affected by a magnetic field. These qualities are what allow the toner to be effective for printing – these printers rely on electromagnetic attraction to get the toner to form into the image that will be printed, and then use heat to affix the toner to the page permanently. When toner is mixed with oil, all of the particles are suspended in the viscous liquid, which causes the liquid to interact with a magnetic field.

Alcohol Rocket
Aaron Adamson – Physics Senior

MATERIALS:

- 2-Liter Bottle
- Matches
- Alcohol in a dropper bottle or pipette (Isopropyl works best, although Methanol or Ethanol work as well)
- Leather Gloves
- Safety Goggles

PROCEDURE:

1. Take your two-liter bottle, and drip several drops of alcohol around the inside rim of the opening, to thinly coat the inside surface with alcohol.
2. Allow 20-30 seconds for the alcohol to begin evaporating and forming alcohol vapor.
3. Set the bottle on a flat surface without any obstructions.
4. Make sure that the area behind the bottle is clear.
5. Light a match, and very carefully place the flame right behind the opening of the bottle. Make sure that you approach from the side, so that your hand is not in the path of the flame.
6. Liftoff!

EXPLANATION:

This bottle launches for precisely the same reason that a rocket takes off. When the alcohol vapors are lit, the gases inside of the bottle expand rapidly and stream out of the back of the bottle. Since the bottle is expelling all of that matter out at a high velocity, there is a lot of momentum given to the gas particles. Because of conservation of momentum and Newton's third law, the momentum backwards on the gas is equaled and negated by a forward momentum imparted to the bottle. It is important that students understand that this phenomenon is only because of the motion and forces between the gas and bottle, and not because the gas is pushing on a wall or air or anything like that. This is a common misconception, and if a rocket required something to "push against", it wouldn't work in space!

SAFETY:

As with any demonstration involving flammable substances, it is important to have the demonstration area cleared of any potentially flammable objects. As well, make sure students are out of the path of both the traveling bottle and the alcohol flame. Finally, make sure that the demonstrator has gloves and goggles on, and that a fire extinguisher is nearby in case of any accidents

Vacuum Power!

Aaron Adamson – Physics Senior

MATERIALS:

Vacuum (Hand vacuum, upright vacuum, Shopvac – anything that has a tube)
3' x 4' Plywood
Drill and Holesaw
Weatherstripping
Rope
Hot glue

SETUP:

1. Obtain your vacuum. This vacuum won't need to be destroyed. Measure the diameter of the tube attachment – this is how you will connect your vacuum to the suction apparatus.
2. Get a piece of plywood, approximately 3 feet by 4 feet. It should be large enough to have quite a bit of surface area, but small enough to be easily manageable in a car, classroom, etc.
3. Attach weatherstripping on one side of the plywood around the entire perimeter. This will be used to seal the plywood when it is placed against a wall.
4. Create two straps for handling the plywood by drilling holes, inserting the rope through the holes, and securing it with knots. Place these such that a person can easily hold both straps at once.
5. Drill a hole in the center of the plywood that matches the diameter of your vacuum tube. Get this as close as you can. 6. Insert the vacuum tube in the hole.
6. Use hot glue and/or weatherstripping to make sure that all holes are sealed as well as possible.

PROCEDURE:

Find any smooth, flat surface, like a ceiling, wall, refrigerator or whiteboard. Turn the vacuum on and place your apparatus against the surface. The suction of the vacuum will cause the panel to stick strongly, and depending on the seal and the strength of the vacuum, you could hang substantial amounts of weight from the two attachment straps, or even yourself!

EXPLANATION:

We don't typically think of home vacuums as being strong enough to lift a person or any other substantial weight. However, vacuums create a pressure differential, and the force due to pressure increases according to surface area. The plywood suction board greatly increases the surface area affected by the vacuum, so a vacuum that can normally only lift dust or a small marble can now lift much heavier objects.

Polarizer Tank

Josh Leckman Physics Senior

MATERIALS:

Aquarium (One that can hold water)
3d glasses that utilize polarizers
A 3rd polarizer
Wooden Dowel (2 pieces)
Hot Glue
Water
Coffee Creamer
Green Laser (Red should work too)
Cardboard/Something to attach the dowels to

SETUP:

Any polarizer will work for this setup, but it is more fun to go see a 3d movie and get the polarizer's as a bonus. Cut the 3d glasses (utilizing proper safety practices) at the bridge remove the folding arms as well. Being careful to align the polarizer's so they are at opposing angles, glue/attach them to the ends of your dowel rod. (I used the arms of the glasses themselves to make the other end of the dowel look fancy) When doing this, make sure that they will be at the same level in the tank. If you have enough helpers, you can just have somebody hold the two polarizer's, otherwise a piece of cardboard with slits cut in it will help you hold them up while you talk and use the laser. I drilled a hole through the arms big enough to stick another piece of dowel through to keep them from falling in. Fill the tank with enough water to cover the polarizer's and position them far enough apart that you can stick in the third polarizer in between them. Now add just a dash of coffee creamer to better enable beam visibility.

PROCEDURE:

Show the students the nifty tank of water that you can see a beam of light in. Now show them that each polarizer can diminish the beam's intensity by half. By passing the light through both polarizer's, the beam all but disappears after the second polarizer.Now, ask the students what would happen if a third polarizer was placed between them. After gathering ideas, show that by putting a third polarizer in, the light can actually pass through the last polarizer.

TIPS:

Go easy on the coffee creamer, not much is needed to cloud the water. Also, make sure that the two original polarizer's are actually in opposition with each other. And DO NOT leave the polarizer assembly soaking in water. The glue will weaken and it will fall apart.

EXPLANATION:

Light travels in waves. When light passes through a polarizer, the polarizer has "slats" much like a fence. Waves that are travelling in the direction of the slats (think up and down) will continue through while the others are blocked. When these waves than crash into a horizontal (left to right) polarizer, the waves can't go through. Now when a third polarizer is put in between them at a 45 degree angle, the waves that travel through the first polarizer are reduced, but the ones that make it through are manipulated into a new orientation, allowing them to pass through the last polarizer.

The Copper Pipe Remix

Josh Leckman Physics Senior

MATERIALS:

Copper pipe
Powerful magnet
Wooden Dowel
Stem Tube (Think floral department)
Hot Glue/ Masking Tape

ROCEDURE:

In an original version of this demo, you show the class a copper pipe and a magnet. Demonstrating that the pipe itself is not magnetic (by touching the pipe to the copper), you then have a volunteer hold the pipe and watch as a magnet is dropped down the inside. The magnet will fall very slowly and the only person who really gets to see it fall is the teacher and the student. Now, this demo involves dropping a long stick with a magnet on the end down the copper pipe. This demo rehash allows for the demo to be shown to multiple people at once (as opposed to one person at a time) and also allows for students to pull the magnet through the tube and feel the opposing force (great for students who have vision problems or students who learn better through touch.)

TIPS

Make your assembly smaller than the diameter of your tube, but make sure your magnet is big/powerful enough to create resistance. Also, marking the dowel makes its speed easier to see. (Like marks, or swirls)

EXPLANATION:

Lenz's Law explains (in general) how a magnet passing by a conductive material can induce a current, which will generate a magnetic field. When the magnet passes through the tube, current is generated and an opposing magnetic field slows the descent of the magnet.

Inseparable Phone Books
Alex Bajorek Senior Earth Science Major

MATERIALS:
2 Phone books (any size works)

PROCEDURE:
Page by page, interweave the phone books so they are effectively "shuffled" together.

EXPLANATION:
The frictional force acting on each page of recycled paper is fairly small. However multiplying this force by ~600 pages makes the force resisting trying to pull the phonebooks apart very great.

SNELL'S BENDY LASER
Damien Gapinski – Senior – Physics Major

MATERIALS:
An obstacle
A target
A glass prism
A plane mirror
A piece of plastic
A laser

PROCEDURE:
Create the setup by placing the laser, the obstacle, and the target in a straight line (so that the laser cannot hit the target). Now place the prism between the laser and the obstacle so that the light refracts/reflects beyond one side of the obstacle. Place the plane mirror in the path of the laser so that the light bends towards the target area. Lastly, place the piece of plastic in the path of the laser and rotate until it's oriented so that the laser hits your target.

TIPS:
It's easier to make quick adjustments when the laser and the target are equidistant from the obstacle and the mirror is place perpendicular to the laser/obstacle/target line. You can add more obstacles and more light manipulatives (mirrors, prisms, etc.) to make the demo more flashy. You can also outline different objectives for students to try and achieve by moving around the target and limiting the regions where the manipulatives can be placed.

EXPLANATION:
Snell's Law is used to determine the direction of light rays when refractive media have varying indices of refraction. The law is most commonly written as $n1\sin\theta = n2\sin\theta$ where n is the refractive index of the material and theta is the angle of incidence with respect to the perpendicular of the medium interface. When light travels from air to water, the refractive index (n) changes from 1 to 1.3 and requires a change in theta, the refraction of light. This is why fish are not where they appear to be when trying to catch them. There is also the case of the critical angle which results in reflection. In the case of the plane mirror, all angles can be considered critical angles and light will be reflected.

Laser Radiation Tester

Damien Gapinski – Senior – Physics Major

MATERIALS:

2 water pouring jugs
Water
A laser

PROCEDURE:

Fill one jug up about halfway with water, preferably the one that pours more easily. Place the other jug, empty, next to filled jug. Tell your audience that you have discovered a way to tell if water is radioactive. Explain that by shooting a laser through the flowing water, it should pass through if it was clean. However, if the water is radioactive, the radioactive particles will absorb the energy from the laser and emits a glow. (Of course this is just the background story to engage the students and later you will explain the real reason for the glow.) Now fire your laser at a high angle of incidence into constant flow of water being poured from the filled jug to the empty jug. Depending on the angle, the stream of water should give off a glow.

TIPS:

You may want an extra jug of water to help demonstrate the difference of how the angle you fire the laser matters. If you fire perpendicular to the flow of the pour, the laser should pass through with some refraction. If you fire the laser near parallel, it is easier to get the desired glow effect. A constant flow is important, so it may be easier to have a volunteer/helper pour the water for you.

EXPLANATION:

The flow of water acts as fiber optic tube when the flow is near constant. This means that when a laser is fired into the tube at the appropriate range of angles, the light goes through total internal reflection all the way down the stream. This is mostly due to Snell's Law ($n_1 \sin\theta = n_2 \sin\theta$) and finding the critical angle. The critical angle is the minimum angle at which total internal reflection occurs and light fails to leave its medium and enter another one (for example, trapped in a flow of water). Fiber optics allows us to transmit information around the world at nearly the speed of light, which is pretty darn fast and cool.

“Cartesian Diver”
Scott Beckley – Post Graduate – Chemistry

DESCRIPTION:
The Cartesian diver experiment is set up by placing a "diver"—a small, rigid tube, open at one end, such as an eyedropper – in a much larger container with some flexible component; for example, a 2-L soft drink bottle. The "diving" occurs when the flexible part of the larger container is pressed inward, causing the "diver" to sink to the bottom until the pressure is released, when it rises back to the surface.

MATERIALS:
Large plastic container with lid, e.g., a 2-L soft drink bottle, and an eyedropper

RATIONALE:
This is a demonstration that takes about two minutes to prepare and really helps students visualize the concepts of buoyancy and how pressure can change an objects density.

PROCEDURE:
The large container is filled with water and must be airtight when closed. The “diver”, eyedropper, is partially filled with water (the exact amount of water to be added will be determined experimentally as it depends on the size of the eyedropper). Stand the bottle on its base, and drop the “diver” into the bottle. Have the “diver” float on the top of the water, but still being almost completely submerged, by finding the balance of air to water to become buoyant. Once this is accomplished, place the lid on the bottle. To make the “diver” sink, squeeze the plastic container. The “diver” will sink when the container is squeezed and will rise back to the surface when the container is no longer squeezed.

EXPLANATION:
There is just enough air in the diver to make it positively buoyant and the diver floats on the water's surface. In accordance with Pascal’s Law, when the pressure is increased by squeezing the container, the pressure on the water also increases and this compresses the diver, allowing more water to enter. The diver becomes less buoyant due to its increased weight so becomes negatively buoyant and sinks. When the pressure on the container is released, the air expands, reducing the weight of the diver, which becomes positively buoyant and floats.

Are You Left or Right Sighted?
Krista Van Allen

MATERIALS:

1. Two blank sheets of white paper.
2. A pencil

PROCEDURE:

1. Make a hole in the center of one sheet of paper with a pencil.
2. Draw a black dot in the center of the other sheet of paper the size of a penny, and place this about 40 cm in front of you on the table.
3. With both eyes open, hold the sheet with the hole between your face and the sheet with the dot, and move the sheet about until the black dot can be seen through the hole.
4. While holding this sheet steady (while seeing the dot), close first your left eye and then your right. When does the dot disappear?

EXPLANATION:

For most people, the dot will disappear when closing the right eye. This indicates that most people are right sighted. It means that most people prefer to use their right eye over the left, if they are confronted with the option of using only one. In this case it means that those people can see the dot with both eyes open or with only the right eye open, but not with only the left eye. In other words, when both eyes are open, the left eye does no work. There is probably a connection between this phenomenon and the right handedness of most people, although it would be hard to say which is the cause is and which is the effect.

Energy Demonstration
Marquelle Sanchez

LESSON OBJECTIVES:

1. Students will learn that energy is not lost just changed into usable and unusable forms.
2. Students will apply Newton's laws in real examples

MATERIALS:

Empty Aluminum pop can   Bucket with water String/ fishing line Nail ¼"

METHOD:

Place four holes in the aluminum can equally spaced apart with a nail, near the bottom of the can. Make an angle of the hole with the nail by pushing the nail threw and turning it sideways. Tie a string to the pop tab and submerge the can into the bucket of water. As the can is lifted out of the water, the potential energy is turned into kinetic energy and causes the can to spin until the water is drained out. The water streaming out creates a force.

Students can use the scientific method to make a hypothesis (what will happen as the experimental can is raised out of the water?) They will change one variable at a time to determine the maximum amount of energy released. Variables include changing the size of the holes, increasing the number of holes, placing the holes at different heights on the pop can. They will determine the energy by counting the number of spins the pop can creates.

Lava Lamp Density Demonstration
Arnold, Tamara   Senior-Biology

TOPIC:
Density- This demonstration shows how the density properties of different materials affect a system.

MATERIALS:
- Clear container
- Water
- Vegetable oil
- Table salt

PROCEDURE:
To create the system, fill container with water to desired level. Carefully add vegetable oil into container. Wait for oil and water to separate. (Brief discussion of oil and water densities/properties could be inserted here.) After the two layers separate, sprinkle table salt on top of oil. Watch as oil and salt move to the due to change in density.

EXPLANATION:
Oil floats on water because a drop of oil is lighter than a drop of water the same size. Another way of saying this is to say that water is denser than oil. Density is a measurement of how much a given volume of something weighs. Things that are less dense than water will float in water. Things that are more dense than water will sink. Salt is heavier than water, so when you pour salt on the oil, it sinks to the bottom of the mixture, carrying a blob of oil with it. In the water, the salt starts to dissolve. As it dissolves, the salt releases the oil, which floats back up to the top of the water.

SAFETY:
Be mindful of liquid materials as they might spill.

Homopolar Motor
Travis Steele

MATERIALS:
1.5v battery (AAA-D)
Copper Wire (shielding/insulation removed for alternate setup)
Cylindrical Conductive Magnet (Neodymium works well)
Nail or Screw

PROCEDURE:
1. Place magnet on nail head
2. Use magnetic field to stick nail to one battery terminal
3. Touch one end of wire to open terminal of magnet
4. Touch other end of wire to side of cylindrical magnet

PROCEDURE (ALTERNATE):
1. Attach magnet to hard surface
2. Place battery on magnet
3. Make an "M" shaped frame of wire with center point touching upper terminal
4. Bend wire so that "legs" each touch (wrap) the sides of the magnet

EXPLANATION:
A magnetic field is produced by the electrical current moving through the circuit (this is why the magnet must be conductive). Another magnetic field is produced by the magnet. Since the magnetic flow from the current is also passing through the magnet, which has its own magnetic field, the magnetic fields want to repel from each other, causing torque to turn the magnet (standard setup) or wire (alternate).

Bernoulli's Ping Pong Ball
Travis Steele

MATERIALS:
Ping Pong Ball String or Fishing Line
Any ONE of the Following: Super glue/ Hot glue/ Epoxy/ Scotch or Duct Tape
Source of Running Water
Basin
Ring Stand (optional)

PROCEDURE:
1. Attach ping pong ball to end of string in whatever fashion works best (keep in mind the ball will get wet).
2. Start current of running water (must be run a fairly high rate)
3. Holding opposite end of string from ball (or have it tied to ring stand), swing ball back and forth towards stream of water.
4. When ball enters stream and sticks keep the string taught without pulling the ball from the stream.

EXPLANATION:
Bernoulli's principle states that pressure of a fluid is inversely proportional to the speed at which it is moving. In this demonstration, the fluids in question are the air and the water. Since the water is moving at a high rate, the pressure within the water stream is lower than that of the atmosphere. When the ping pong ball enters the flow of water, it is entering a low pressure region that keeps it suspended within the stream.

Gravity Defying Marble
Corey Johnson

DESCRIPTION:
This demonstration is used to illustrate centripetal force

MATERIALS:
Glass jar
Marble

PROCEDURE:
Place a normal sized marble on a flat tabletop. Turn an empty glass jar upside down over the marble. Announce that the marble can be moved to another part of the room without tipping the jar right side up. Make fast circular movements with the jar, which causes the marble to make revolution inside the jar. Continue making this movement to transfer the marble to a new location.

EXPLANATION:
Centripetal force moves the marble against the inner wall of the jar. Also, the narrowing of the glass jar at its mouth prevents the marble from dropping out as you lift it from the table

Balancing 6 nails on the head of 1 nail
Jennifer O'Patchen

A. WILL NEED
1. 7 nails
2. Block of wood

B. SET UP/ STEPS
1. Begin with one nail already hammered into the block of wood
2. The challenge is to balance the remaining 6 nails on the head of the standing nail
3. Rules: none can touch the block or table and no additional objects can be used

C. CONCEPT
1. Center of gravity

Candle and Air Pressure Demonstration
Shannon Swanson Senior Biology Major

MATERIALS

1. Tea candle
2. A clear glass container
3. Shallow dish
4. Water

PROCEDURE

1. Pour water into a shallow plastic dish with lit tea candle in the middle.
2. Place the glass container over the candle.
3. Allow the candle to burn until it uses up the oxygen and burns out.
4. Observe the water level rise.

EXPLANATION

The water level in the glass changes due to a pressure difference between the inside of the glass and the outside of the glass. This is due to the heating of the air in the glass as the candle burns (this could also be done using a source other than a candle that also heats the glass.) After the glass is heated and the candle burns out the glass begins to cool. This creates a high to low pressure gradient that causes the water to move from the dish into the glass and cause a change in water levels. The water will rise until the pressure inside the glass and outside the glass are equal. You can also use ice to cool the glass down further and cause the water to rise even higher. This can be used to explain convection in the atmosphere. As air is heated near the surface of the earth due to solar radiation it begins to rise, and the cooler air of the upper atmosphere is more dense and sinks back to the surface where it can be heated and the cycle repeats. This vertical exchange of heat in the atmosphere is known as convection.

The Bernoulli Effect
Tony Grabau

The Bernoulli effect is showing that when air moves faster pressure drops. This is how planes are able to fly.

MATERIALS

- 2 ping pong balls
- string
- tape or glue
- drinking straw

METHOD

Place the two ping pong balls about 2cm apart using string. Take the straw and blow in between the two balls. The fast air will drop the pressure between the two balls causing them to swing together. This demo shows how pressure drops when air moves faster between two objects.

PURPOSE

This is a good demo when talking about pressure systems and showing how when air move faster than the surrounding air, it causes a lower pressure. This can be tied into describing how planes fly using jet engines and the pressure of the surrounding air.

Steady Flow
Tony Grabau

PURPOSE

The purpose is to demonstrate how different air pressures work together. The hair dryer represents high air flow with low pressure to the surrounding air.

MATERIALS

- Hair Dryer
- Ping pong ball

METHOD

Turn hair dryer on and place ping pong ball in the center. The ping pong ball will float in the middle of the air stream because that is where the air pressure is the lowest. When the ball moves to the side of the air flow it will quickly move back to the center because that is where the air pressure is at its lowest. This is another demo of the Bernoulli Effect.

2009 CSC demos

Sage Andorka – Senior – Physics Major

BERNOULLI'S TOILET PAPER

Materials:

- a helper
- piece of PVC
- roll of toilet paper
- leaf blower
- piece of paper

Procedure:

Begin the demo by blowing over the paper and making it "levitate" up. (OOHHH AAAHHHHHH) That's cute.

Now, slide the toilet paper over the PVC pipe. The paper should be placed so that the end wraps up and points down over the roll. Have your helper hold the roll horizontally. Turn on the leaf blower. Blow the air over just over the top of the toilet paper.

Tips:

Turn on the blower above the paper and slowly lower it down onto the paper to find the optimal spot. The steeper the angle, the higher it goes.

Explanation:

Bernoulli's Principle states that the faster a fluid moves, the less pressure it exerts on its surroundings. The most common example of this is an airplane wing. The faster moving air on the top of the wing is pushing down on the wing far less than the slow moving air pushing up under the wing. The same situation applies here. The fast moving air from the leaf blower exerts less pressure on the toilet paper than the slow air below it. This phenomenon creates lift.

Kelsey Destree – Senior – Earth Sciences Major

CORIOLIS EFFECT DEMONSTRATION

Materials:

*Phonograph/record player (something that turns such as a lazy susan might also work)
*Paper
*Ruler
*Marker
*Record (optional, only needed if you want to trace the record so that your circle fits nicely on the record player, also fun to play music later)

What to do:

Before you begin make sure that the phonograph works (most are pretty old) and cut out a circle of paper to place on top of the phonograph. You can use a record to trace on paper so that it is the correct size. Turn on the phonograph. While it is spinning, hold your ruler so that one end is in the center of the paper and the other end is on an edge, usually towards you is easiest. Starting at the center draw a line along the ruler out toward the edge making sure your marker follow the ruler. The slower you draw the larger the curve you will get. This shows students that even though you drew along a flat/straight surface you got a curved line because rotation was involved.

DC MOTOR DEMONSTRATION

Learning objectives:

The motor demonstration is a great visual and hands on experiment. By designing the motor with parts the students recognize and use commonly it provides students with an experimental atmosphere, making them start thinking creatively about the world around them. The DC lantern battery supplies power safely and steadily making the experiment fun and safe, note the contact points between the magnetic loop and the safety pins may get hot. Try not to touch these points once the battery is connected. This lab provides students with a visualization of a DC motor and exemplifies the idea of Faradays laws, and Maxwell's laws of electromagnetism.

Materials/Quantity:

Alligator wires QTY:2
Permanent Magnetic QTY:1-6
Magnetic wire winding with Enamel Coating
Safety pins QTY:2 (Or paper clips QTY:2)
6 Volt Lantern Battery QTY:1
Cup or Base QTY:1
Duct Tape ½ feet
Weight for base change

Resources/Tools:

Leatherman tool
Sand paper, and a knife scissors, or wire striper
Whiteout bottle or film canister

Bulletin Summary of pre-lab

- Before using this lab in a classroom test it at least once.
- Have a working model present with the students to show them.
- Have several wound coils pre-enamel stripped for the students to test with.
- Make sure the loop can rotate easily by tapping it before attempting to complete the circuit and providing current from the battery.
- Never test this experiment with ac power supply.

Procedure:

Pre-lab (Teachers assembly)

1. The magnetic wire winding needs to be wound with a minimum of 15-20 turns. This is tricky because the size of the radius depends highly on what base you are having the motor rotate.
   - Wind around a whiteout bottle or circular surface that once wound can be pulled off without reducing its form.
   - Tie off two ends of the wire on the loop to keep the wires form. Make sure that both tied ends are symmetrically tied from the center of the winding and the knot is centered so the loop rotates and does not wobble.
2. After the loop is tied off from both sides cut the wire so that enough wire is remaining to hold the loop between the gap of the cup on each safety pin.
   - Cut to a length of 2 inches.
   - Cut off the excess wire left after the trial of the experiment.
   - Leave 1-3" excess wire left on each side to serve as conductor
3. On the excess wire supporting the wound loop **strip the enamel on only one side**

Lab assembly (For patient students or instructor)

1. Place the cup with the magnet centered in cup. If they have a lamp, or paper weight or change add it and secure the magnet in the center.
2. Place the two safety pins down with the pin down into the cup at symmetrical positions allowing the magnetic loop to be able to rotate.
3. Place the pre-wound magnetic loop in the eye of the safety pin loops. There should be excess wire on both sides. It should spin with a simple tap.

4. Center the magnetic loop under the permanent magnet.
5. Tape the safety pins down.
6. Clip the first alligator wire to the negative terminal of the 6 volt lantern battery and to one end of the safety pin. This makes the safety pin the conductor.
7. Clip the second alligator to the positive terminal of the 6 volt lantern battery and clip the other end to the second safety pin.

The motor should start running, if not tap the center of the loop. It should start up.

Tessie Myers – Post Graduate – Biology

AIR PRESSURE DEMO: RISING WATER DUE TO HEATING OF AIR

Principles

- Air pressure and the pressure gradient
- Expansion of air as it heats
- Vertical transfer of heat energy in the atmosphere.

Materials

- Tea candle
- shallow plastic dish
- clear drinking glass
- matches/lighter
- water
- food coloring to color water (optional)

Procedure

Pour water in to the shallow plastic dish with the tea candle in the center of the dish. Light the tea candle and then place the clear glass over the burning candle. Wait for candle to burn off the oxygen and the flame extinguished. Watch the water level rise up into the glass.

Science behind the Demo:

The water level rises due to a pressure gradient between the air pressure inside the glass and the air pressure outside of the glass. As the candle burns out, the air inside the glass heats up and expands the pressure inside of the glass is less than the pressure outside of the glass. Because of the pressure gradient between high and low pressure water will rush into the glass. The concept explains convection in the atmosphere.

Convection occurring in the atmosphere is due to the ability of earth's surface to absorb solar radiation and heat up. The air molecules next to the surface will gain extra energy due to conduction, the direct contact between the surface and the air molecules. The heated air near the surface expands becomes less dense and rises transferring heat up into the atmosphere. Cooler air is heavier and flows towards the earth's surface replacing the rising air. This cool air will then heat up due to conduction and the cycle repeats. In terms of meteorology, the vertical exchange of heat is known as convection.

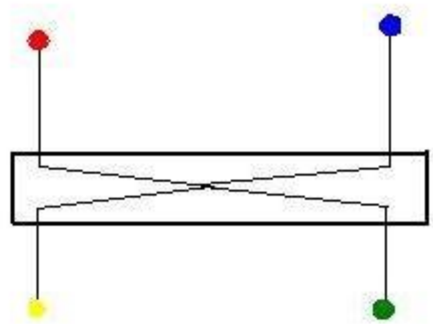
THINK TUBE

Materials:

Cardboard mailing tube, 45cm/18” long, with end caps
Two pieces of string, each about 1m/39” long
Four colored beads, for example blue, red, green, and yellow

Rationale:

Scientists frequently have to use the scientific method to make educated guesses about things that cannot be seen directly. Students can be given an introduction to this by having to think about what must be inside the mysterious tube to account for the motion of the beads.



Procedure:

A cross-section of the assembled tube looks something like the diagram at right.

The blue and green beads are on the same piece of string, and the red and yellow beads are on the other string. The secret is to loop them together!

Set the tube to its **starting position** by pulling the green and yellow beads so that the **red and blue beads are both in contact with the tube**, and the yellow and green strings are about the same length. Hold the left end of the tube and **place very light pressure on the yellow string with your thumb**. Now pull the blue bead and the green string will shorten as the blue string lengthens, showing that green and blue are connected.

Reset the tube to its starting position. Once again, the thumb of the left hand is resisting any movement of the yellow string. This time, pull the red bead and the green string will shorten as the red string lengthens, showing that green and red are also connected.

Reset the tube to its starting position. This time, pull the green string and the yellow string will shorten as the green string lengthens, showing that green and yellow are connected.

Thus, the green bead is connected to all three of the others. Any bead can be shown to be connected to each of the other three. How very mysterious. Ask students to draw what they think the interior of the tube looks like.

Nathan Kirkley – Post Graduate – Biology Major

FLOATING PAPER CLIP

Objective: To show that water has a surface tension that allows some objects to float upon the surface, which examples of these could be leaves, water striders and other long, flat lightweight material.

Materials:

1. 1 paper clip
2. Glass of water
3. 1 dinner fork
4. Bottle of dish soap

Procedure: Get a glass full of water, then take paper clip and place it upon fork. Carefully place the paper clip, as level as possible on the surface of the water. Once it has been floating and everyone has seen it float, then add one drop of dish soap and watch the clip fall to the bottom of the dish.

Rationale: This is an example of surface tension of water. The water molecules have an attraction to each other that creates a skin like surface to the water. Adding the soap to the container disrupts this attraction and the paper clip no longer floats on the surface, but instead sinks to the bottom of the container.

MYCHAL CINOTTO – SENIOR – PHYSICS MAJOR

2-BIT PROJECTILE MOTION DEMONSTRATION

Materials Needed:

- Stick with a ledge cut out at one end
- Two quarters

The Demo: Before doing the demonstration, ask the students to watch the first time and observe what happens. Then do the demo a second time and have them explain what happened and why. To do this demo, set the stick at the edge of a table so that the end with the ledge is sticking out away from the table. Place one quarter on the ledge and one between the edge of the table and the stick. In one swift motion, flick the stick so that the quarter placed on the stick will fall straight down and the quarter on the table will be projected from the movement of the stick. Both quarters will fall at the same time. This works best with tile floor because the students can hear and see that the two quarters will fall simultaneously. You can talk with the students about how everything falls at a constant rate.

SCATTERING OF LIGHT

Materials Needed:

- Physics Egg
- Light source

The Demo: Why is the sky blue? Many students have misconceptions about this question and using this demo will clear any of them up. Talk with the students about why the sky is blue while showing them with the egg the scattering effect. Hold the light source up to the egg and show how the egg appears blue when it's right next to the light. You can also explain why sunsets are orange and red by showing the part of the egg farthest from the light. A similar effect can be demonstrated with dilute skim milk and a strong flashlight.

Rebecca Orcutt - Senior - Chemistry and Physics Major (double)

DRY ICE DEMOS

1. **Dry ice in a film canister**
   a. Instructions
      i. Place a small amount of crushed dry ice in a film canister
      ii. Place the lid on the canister
      iii. Place the canister upside down on a table
      iv. Stand back and wait
   b. Discussion
      i. As the dry ice turns back into CO_2 gas it expands and increases the pressure. When the pressure gets to high the lid is shot off and the canister is launched. This demo is good to explain gas laws.
2. **Dry ice in water vs. dry ice in soapy water**
   a. Instructions
      i. Fill two clear containers water. Add dish soap to one of the containers
      ii. Place a moderate amount of dry ice in each container.
      iii. Observe how soap affect the smoke
   b. Discussion
      i. This demo is good for showing the effect of contaminates in water. This demo can also be used to discuss why the water appears to boil when the dry ice is added.

Balloon - Pressure Demo

Introduction:

This demonstration helps students to understand pressure. Using a water balloon resting on top of a glass jar, students will understand the forces that makes the balloon move into a glass jar.

Materials:

Glass Jar with a medium sized mouth
Water balloon
Small piece of paper
Lighter

Procedure:

- Light a small piece of paper on fire
- Drop the piece of paper in the glass jar
- Quickly place the water balloon on the mouth of the glass jar
- Stand back and watch as the water balloon gets sucked into the glass jar

Discussion:

This demonstration shows pressure. It demonstrates that the pressure outside of the jar is so great, that it pushes the water balloon into the jar.

Golden Red Sunrises and Sunsets

Purpose: To show students why the sky is blue and sunrises and sunsets are orangey/yellow.
Materials:
Large glass jar Overhead Projector Flashlight
Creamer
Procedure:

Fill large glass jar halfway with warm water, set on top of an overhead projector. Show how the water is clear and the light reflected on the screen is white (clear – all the wavelengths of light are passing through the water).

Add a small pinch of creamer and stir. Point out that the water in the jar is turning a grey/blue and the light on the screen is beginning to turn yellow/orange.

Add a second small pinch of creamer stir. Point out that the water in the jar is even more bluish/grey and the light on the screen is more orangey/yellow.

Last, turn off the lights, shine a flashlight at your audience and point out that the light is white.

Next, shine the flashlight through the jar with the beam of light towards your audience. Point out how it is now yellow (the water is bluish/grey still).

Why?

Blue wavelengths are smaller than yellow/orange/red. The water represents the air, the creamer represents the pollution in the atmosphere, and the overhead light and the flashlight represent the sun. The sun emits all wavelengths of the visible spectrum. That light is white. However, when it passes through our atmosphere the pollutants scatter the blue wavelengths since they are small and allow the loner wavelengths, yellow, orange, red to pass through. So when we look through the atmosphere at the sun (at sunrise or sunset) the sun appears orange and the sky is a faint blue.

Hartung, Cody
Senior – Biology

Needle Through a Balloon

Concept: To show the characteristics of polymers, using the balloon as an example of large polymer chains.

Materials: Two Balloons
One Skewers or sharpened piece of coat hanger or sharpened knitting needle
Cooking Oil
Q-tip

Directions: Inflate both balloons and tie them off. Do not blow them up too big. Use one balloon for first part but keep the other one on the side. Dip the tip of one skewer in cooking oil and use a q-tip to spread oil up and down the skewer. Using a gentle twisting motion push the skewer into the nipple end of the balloon (the rubber is thickest here). Keep twisting the skewer until it comes out the tied end. If possible use yellow or clear balloons. The students can see the skewer going in and so can you. After the skewer comes out, show students that it went all the way through. Then pick up the second balloon and skewer. Pierce the other balloon on its side and the balloon will pop. Note: if two skewers are not available, you can use one. The balloon might loose a little air when you take the skewer out to pierce the side.

Introduction: How many of you have ever popped a balloon? It doesn't take much to pop it; a needle or something sharp does the trick. Well, today I am going to show you a way to get a sharp object through a balloon without popping it.

Explanation: The word poly- means many of something. A polymer means molecules with many atoms. A balloon is made up of lots of polymer chains. These polymer rubber chains are may exist isn random loose clups in the unstretched state. The reason I was able to get the skewer through the balloon had to do with where I put it in. At the nipple end of the balloon, there is lots of rubber and therefore many, many polymer chains - still loosely coiled. These chains are very close together. They can be pierced without popping the balloon because the the chains can still be stretched. This is because they allow the skewer in between the chains without breaking the chains or the bonds that connect them. But on the sides of the balloon, these chains are stretched almost to their limit and very far apart. The piercing is too much for the stretched chains and they break apart., and the balloon pops.

Safety: Don't pop balloons near children faces.

Waste: Throw balloons away and wash off skewer cleanly.

Surface Tension Boat Racing

Objective: Help students understand surface tension of different substances and the effect of a surfactant.

Materials: 3 “Race tracks”

Water

Vegetable oil

Rubbing alcohol

Dish soap

Syringes or pipette

Boats (cardboard bottom wrapped with plastic wrap or laminated)

Procedure: Fill each track with about 2 cm of liquid (1 oil, 1 water, 1 alcohol).

Place boats about 3 cm from the back of the race track (enough room to drop soap).
Ask 3 people to each fuel a boat.

Give them a pre loaded syringe or pipette with dish soap.

Have them drop the soap behind their boat on the count of three.

Wtch the race!

Results: The surface tension of oil is not affected at all by the surfactant and that boat will not move. The rubbing alcohol, although it is partially water, does not have a very high surface tension and the boat may even start to sink. There will be little movement from this boat too. The water boat will quickly shoot down the track. The surfactant has a hydrophilic and hydrophobic end. This causes it to break the surface tension and send the boat on its way.

Hogan, Emily

Senior – Biology

Teabag Thermal

Materials: teabag(s), matches, saucer/plate, water/wet towel (for safety)

Procedure: 1) Empty contents of teabag. 2)Open bag up so that it can stand upright on the plate. 3)Light the bag and allow it to burn down.

What happens: When the tea bag is being burned, the heat is being released which creates a narrow column of warm rising air. This is a miniature thermal current. When the bag burns down enough, it becomes light enough to be lifted up by the thermal current.

Marble Gravitron

Materials: A glass that is narrower at the top (ex. wine glasses), marble

Procedure: 1) Trap a marble under the glass on a smooth surface. 2) Wiggle the glass so that the marble will start rolling around and eventually the marble will roll up the sides a bit. 3) When the marble is really rolling, lift up the glass and the marble will be rolling on the sides for atleast a few seconds

What happens: The reason the marble is able to stay in the glass when it is lifted up is because centripetal force is being applied. This is the "sideways force" that pushes one sideways in a car when going around a sharp corner. An object in motion tends to stay in a straight line motion unless something else is acting upon it. The marble wants to keep going in a straight line but the curve of the glass makes it change direction. This results in the marble pushing against the glass.

Kipf, Rebecca
Senior – Earth sciences

False Lift

Materials: 1 latex balloon filled with helium, ballast (quarter and paperclip), yarn, 2 drinking straws

Procedure: Fill the balloon and attach the yarn to the balloon and then to the quarter using the paperclip. The balloon should be almost buoyant but unable to lift the quarter.
For the demonstration use the straws to blow on the upper area of the balloon. The wind you create should move over the top of the balloon and cause the balloon to lift.

Explanation: This is an example of Bernoulli's principle and how the air going over an aircraft wing causes the lift that allows the plane to fly. In hot-air ballooning this is referred to incorrectly as false lift because it is not lift created by the pilot. Once the balloon reaches the speed of the wind this lifting force is no longer created and unless the pilot compensates for it, the balloon will descend.

Powder Glove

Materials: 600ml Beaker
Baby Powder

Method: Fill the 600ml beaker about ¾ of the way full. Then sprinkle a small layer of baby power on the top of the water. Push three fingers into the powder, and wiggle around a bit so everyone can see, and pull them straight out. There will be powder on your finger, but no water. To prove this snap your fingers and watch the dust fly.

Explanation: The baby power will not mix with the water because it is hydrophobic or water hating. Actually the water is polar, and the powder is nonpolar. These properties mean that the two substances will not dissolve or mix with each other. The molecules of the powder try to stay away from the molecules of the water. In addition, the powder is mostly less dense than the water and will float on the top.

When you stick your hand into the powder and water, the force of your hand makes the powder particles stick to your fingers and push the molecules of the water away, therefore the powder is like a water repellent. **NOTE:** This works better with a more nonpolar powder like Lycopodium powder

Peoples, Andrew
Senior – Physics

The Returning Can

Materials: One coffee can, some rubber bands, a couple of paper clips and a weight with a hole in it.

Demonstration: This is a demo to show stored or potential energy to a group. The can is constructed by puncing a hole in the middle of the I demonstrator rolls the can across a table and the can returns to him or her. To show the audience that the table is level, the demonstrator turns the can around and rolls it the other direction and the can still returns to the demonstrator. To help the can move along, it is a good idea to turn the can one or twice before rolling it.

The Science: As the can rolls, the weight causes the rubber band to wind itself up, thus storing energy for the return trip. The can comes toa stop, and the rubber band releases that energy which causes the can to roll in the opposite direction. Analogies that could be used to describe what is going on is the charging of a battery or the winding of a clock.

The "Heavy Newspaper"

Materials: Paint stirrer sticks, a table and a couple of sheets of newspaper.

Demonstration: This is a demo to show the audience the awesome power of pressure. The demonstrator will place 1/2 of the wooden sticks hanging off the edge of a table. He or she will place one or two sheets of newspaper to cover the half on the table. Be sure to spread the paper down in order to make sure there is no air under the sheets. The presenter then may proceed to bread the stick in half by hitting the hanging edge downward hard. The paper should stay in place while the stick breaks.

The Science: The force acting on an object is equal to the area of the surface times the pressure. The surface area of the sticks are very small when compared to the surface area of the newspaper. Then the newspaper is spread out and the air underneath it is removed, the only other force from pressure is exerted on the top of it. When the stick is hit quickly enough, there is not enough time for air to enter the underside of the newspaper and the forces being exerted on the stick is enough to break it in two.

Travis, Cheryl

Senior – Biology

Rainbow in a Jar

Materials: (1) Qt. **Glass Jar or** beaker

(1) Small bottle **White Karo Syrup** (approx. 16 oz.)

(2) **Polarized Plastic Sheets**

(1) **Overhead Projector** or comparable light source

Procedure: Place the overhead projector on a sturdy, flat surface and plug in. Pour Karo Syrup into glass jar until approximately 3-4" deep. Place one polarizing sheet on the overhead projector. Turn on light source. Now place the jar filled with the karo syrup on top of this polarized sheet. Next, place the second polarized sheet on top of the glass jar rim. Experiment by moving the top sheet in different directions to observe visual changes. Now try rotating the top sheet in a clockwise direction (the bottom sheet stays stationary). You'll notice all of the colors of the rainbow appear.

Why this works: Glucose (Karo Syrup) is a very large sugar molecule. By allowing the light to pass through the polarized sheets, the wavelengths are broken as they pass through the syrup. The colors of the visible light spectrum can thus be observed.

Source: Front Range Community College Science Demonstration Dr. Shashi Unnithan

<u>Demonstration by Morgan Baines</u>

<u>Biology Major</u>

#4. BUOYANCY

Principles:

Water displacement, Buoyancy

Materials:

Two identical pieces of clay

Tub of water (preferably clear)

Procedure:

Take one of the pieces of clay and shape into a ball. Take the other and shape into a flat boat shape. Place both pieces of clay into the water and watch as the ball sinks and the other pieces of clay floats. The reason for this is that the total area of the object that makes contact with the water is large enough that the object floats due to the object displacing an equivalent amount of water as to its volume. The object is placing a downward force on the water, and the water is placing an upward force on the object. The amount of water displaced must be equivalent to the weight of the object. Since the ball doesn't have as much volume, then it doesn't displace enough water to stay afloat.

Demonstrations by William Berry

Biology (Post Bach.)

#5. RACING THE DINOSAURS: USING TRACKWAYS TO ESTIMATE VELOCITIES

Materials:

A Meter Stick

A Stop Watch

Procedure:

1. Have students walk (or run) down a length of track.
2. Calculate student velocities by using a stopwatch and by determining how long (in seconds) it takes a student to go the length of the track (velocity is in meters/second).
3. Use Alexander's equation:

$$V = 0.25(\text{avg. stride length})^{1.67}(\text{hip height})^{-1.17}(\text{gravitational constant})^{0.5}$$

to find the student's estimated velocity using their stride length (the average distance between two successive tracks made by the same foot), their hip height (from the floor to their acetabulum—i.e., top of their femur), and the gravitational constant (9.8 m/s^2).

Since the velocity values found in (2) and (3) should be similar (in some replicates, I've found a Chi-Square Goodness-of-Fit of > 99% between Alexander's values and actual velocity values), discuss how Alexander's equation can be used to find the velocities of extinct animals from their trackways. Discuss how this relates to behavioral analyses of extinct animals.

Resources: Alexander, R. (1989) Dynamics of Dinosaurs and Other Extinct Giants. Columbia University Press, New York.

Rocky Mountain Dinosaur Resource Center (www.RMDRC.com)

#6. WEIGHING A DINOSAUR (OR OTHER VERTEBRATE) USING ONLY 1 OR 2 BONES

Materials:

Long Bones (Femur for Biped / Humerus + Femur for Quadruped)

Discussion:

As a science teacher, it is important to give students an appreciation for the antiquity of the Earth and its diversity. If the history of life on Earth were a best-selling novel, it would be a murder mystery. Paleontologists estimate that more than 99% of all species that have lived on the Earth are now extinct (Prothero, 1998). For vertebrates in particular, all that we usually find of these extinct organisms is one or two fragmented bones, and it can be very difficult to tell what extinct organism such bones came from, particularly if there are few if any diagnostic characteristics on the bone (e.g., skeletal synapomorphies, etc.). So, if we do find such a bone, what *can* it tell us?

Procedure:

1. It is a general rule of thumb (or toe) that the larger a vertebrate is the bulkier its bones must be to support its weight. In fact, the circumference of long bones relative to the mass of the animal follows a predictable, linear trend. Thus, the mass of an animal (in kg) can be found using the circumference (in mm) of its femur (C_f) and/or its humerus (C_h):

For quadrupeds:

$$\text{Mass in kg} = 8.4\text{x}10^{-5}(C_f + C_h)^{2.73}$$

For bipeds:

$$\text{Mass in kg} = 1.6\text{x}10^{-4}(C_f)^{2.73}$$

2. For my demonstration, I will be using a fossil bone fragment that I found in Southeastern Colorado. I will be seeking to answer the question: What is this bone from?

(a) I found this fragment in fluvial (river) channel deposits dumped into the Western Interior Seaway (overlying and intergrading with the Pierre Shale). This suggests it was from a terrestrial rather than a marine animal, and its age is roughly 70 million years old (My). At this time and in this environment, the only creatures large enough to leave behind such a bone were, of course, the dinosaurs.

(b) At the end of the Cretaceous 70 Mya, the most common dinosaurs were the hadrosaurs and their relatives ("duckbilled" dinosaurs), the ceratopsians (e.g., *Triceratops*), and the large carnivores (e.g., *Tyrannosaurus*). Is it possible to distinguish between these alternatives using only this bone fragment?

(c) Given the bone's relative size and "bulk," it is clearly a fragment of a long bone. It is badly abraded (as expected from its depositional environment), but its relative size and shape is consistent with this hypothesis.

(d) It is possible to distinguish between the alternative dinosaurs based on total body mass, but I must first decide whether this bone represents a quadruped or a biped.

(e) Ceratopsians are unique in that they represent (in all of Earth's history) the animals with the largest heads. Because of this, they had particularly stout forelimbs that were slightly sprawled, and the circumference of the humerus and the femur are approximately equal. Thus, I can determine whether this bone is from a ceratopsid by using the equation

$$\text{Mass in kg} = 8.4\text{x}10^{-5}(2C_f)^{2.73} .$$

(f) If my mass is reasonable (within the range of expected values for a ceratopsid dinosaur), then I can conclude that this bone may have been from a ceratopsid.

(g) Here I run into a slight problem. I only have a fragment of the bone. I do, however, have an outer edge (arc) of the bone preserved. By picking two points along this arc and drawing two lines tangent to each of these points, I can find a line perpendicular to each of these tangent lines. Incidentally, where these perpendicular lines intersect is the radius of my bone. Or, alternatively, I can use the angle created by these intersecting lines and the arc length (distance between my two points along the arc) to solve for the radius (r) using the equation: Arc Length = $r\theta$ (where θ is in radians).

(h) By using this radius (82.55 mm), I can find the circumference ($2\pi r$).

(i) Plugging this into the equation given in Step (2e), I find my mass to be about 14.4 metric tons (to find metric tons, multiply kg by $1\text{x}10^{-3}$). This is much too massive to be a ceratopsid (ceratopsids are roughly 6 – 10 metric tons).

(j) Since I have eliminated the hypothesis that this bone is from a quadruped, I now plug C_f into the biped equation. This is roughly 4.1 metric tons, the mass of a largish hadrosaur or a typical *Tyrannosaur*.

Resources: Alexander, R. (1989) Dynamics of Dinosaurs and Other Extinct Giants. Columbia University Press, New York.

Prothero, D. (1998) Bringing Fossils to Life: An Introduction to Paleobiology. McGraw-Hill, New York.

Demonstrations by Christina Gasaway

Biology and Chemistry Major (double)

#11. CONSERVATION OF MASS

Purpose: Students need for it to be proven to them the concept of conservation of mass. The Law of Conservation of Mass states that matter cannot be created nor destroyed. And if you start with a specific amount of mass, the mass might change forms, but it will not be lost.

Supplies:

Analytical balance, or a balance that will not be affected by buoyancy.

Carbonates soda

Balloon

Sodium bicarbonate

Method

1. Obtain the mass of unopened soda pop can
2. Obtain the mass of the sodium bicarbonate, including the mass of the balloon holding the sodium bicarbonate
3. Place the unopened can in the analytical balance, and open.

The challenge is to be able to maintain the mass contained in the soda including the gas put the sodium bicarbonate in the in the pop can using the balloon for delivery obtain the mass following the experiment

this is easier said then done because there is a tendency to lose with because of the inability to get a weight without being affected by the buoyancy.

#12. PROPERTIES OF CHARGES

Purpose: Students will be able to grasp the concept of like charges repel and opposite charges attract in this sun experiment that can be done by the instructor, individual students, or small groups. Properties of Electron and Protons are essential in the mastery of the concepts concerned with matter, and the elements that make up the matter.

Supplies

Balloon(s) minimum two

Light weight string

Method

1. Blow up both balloons and tie them

2. Tie the light weight string onto one of the balloons

3. Take the untied balloon and rub it on anything, cloths, walls, floor

4. Take and approach the untied balloon with the tied balloon, and if the charged are alike the balloon on the string will go away, and if the charges are opposite, the balloon on the string will be attracted to the untied balloon. (Generally a rubber balloon rubbed with a paper towel becomes + charged while an overhead acetate rubbed with a paper towel becomes – charged)

Demonstrations by Heather Parker

Biology Major

#13. MIRACLE THAW

Materials- Miracle Thaw or any cast iron pan

Many ice cubes

Procedure- Place ice cube on Miracle Thaw and at the same time place an ice cube on another surface close to the Miracle Thaw. Observe how quickly the ice melts on the Miracle Thaw compared to the other surface. Use many ice cubes to demonstrate that more than one cube can be melted quicker on the Miracle Thaw than on the other surface.

Why it works- The ice melts quicker on the Miracle Thaw because of conduction. Metals are great conductors because the metallic bonds have free-moving electrons and they form a crystalline structure, which aids in the transfer of the heat. Heat is always moving from areas of high temperature to areas of low temperature, which is why the ice cube melts. The surrounding temperature of air is higher than the metal which inturn is higher than the ice cube so the heat travels from the air, to the metal, to the melting the ice cube.

#16. SURFACE TENSION

Materials: Aluminum Coins (1 yen coins)

Bowl

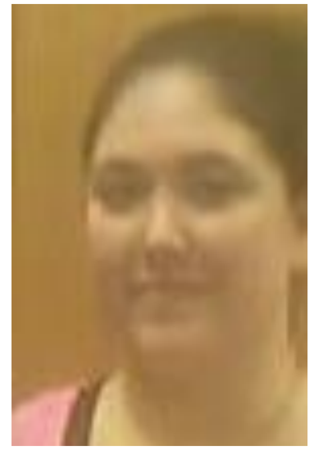
Water

Paper clip

Procedure: Bend the paper clip in the middle so there is a ninety degree angle in it. Use the paper clip to slowly lower the coins (or other paper clips) onto the water. Watch the coins rest on the surface (they do not "float").

This is when I will ask the students some questions like: Why is the metal paper clip resting there? What mechanism is allowing this? After discussing the possibilities is when you place a single drop of dish soap into the water. Immediately the clip should sink because there is a distraction to the surface tension. This brings up another round of questions. Why does the soap cause the paper clip to sink? Could this be done with a larger object? What could a different object be?

Explanation: This demo will show students that surface tension exists. After explaining the properties of water molecules and their attraction to each other, we can prove that there is a layer on the surface that is almost skin- like. Adding something like dish soap disrupts this attraction and makes the clip sink. A real life example of a living organism that uses surface tension would be a Water Strider (little insects). This could be used in chemistry, biology and science in general.



#19. SHRINKING AND EXPANDING MARSHMALLOWS

Scientific Principles: Effects of Pressure

How levels of pressure can be effected by volume

Materials: A large (needle less) syringe

2 or 3 mini marshmallows

Procedure:
1. Place marshmallows into the syringe.
2. Replace the plunger.
3. Push the plunger all the way down to the marshmallows, getting as close as you can without squashing them.
4. Place a finger or your thumb on the open end of the syringe creating an air tight seal.
5. Slowly pull plunger out, stopping before you reach the end of the syringe.
6. Notice as the plunger is being pulled; the marshmallows begin to expand, because you are significantly decreasing the amount of pressure inside the syringe, by increasing the volume within the enclosed space.
7. Release your thumb or finger to equalize the pressure again.
8. Pull the plunger to the end of the syringe just before it loses its air tight seal.
9. Again place your thumb or finger over the open end of the syringe, creating an air tight seal.
10. Slowly push the plunger toward the marshmallows
11. Notice that the marshmallows are shrinking. This is due to the fact that the level of pressure within the enclosed syringe has increased greatly by the decrease in volume with in the syringe.

When to use this:

This is a great visual for students to wrap their minds around how pressure affects matter, and how volume plays into the whole equation. Pressure levels can be a very abstract thought process, and by showing the children this visualization, they will have a better understanding of what happens as different factors are changed or introduced.

Demonstration by Rob Liebman

Biology Major

#29 BLOOD SPATTER

Materials: poster board

simulated blood (one recipe to follow)

markers

meter stick

ruler

calculators

Procedure: After teacher preps simulated blood, the students will separate their poster boards into sections containing elevation from which blood is dropped and a section for low angle impact. The simple way to reenact low angle impact, tilt the poster board to approximately 30 degrees and drop blood on to it rather than trying to fling blood at an angle onto board. After doing angled impact students can then drop blood from predetermined heights onto their respective sections. Suggested heights would include 0.5m – 1.0m – and maybe one more substantial height. At the bottom of the board leave a section for calculations. Students will measure length and width of angled spatter and perform calculation that follows. They will also measure diameter of regular impact and calculate average diameter for each height to compare effects of gravity on blood drop diameters.

Calculations:

For low angle impact trigonometry will be used.

sin (impact angle) = width/length

inverse sin (width/length) = angle of impact

Blood Recipe:

200 mL water

5 tablespoons corn starch

300 mL corn syrup

2 tablespoons cream or whole milk

5 tablespoons red food coloring

3-4 drops green food coloring

Mix water and corn starch thoroughly before adding remaining ingredients.

#31. The Woozle

Purpose: Some time it is hard using inductive reasoning to discover simple meachanisms.

Materials:

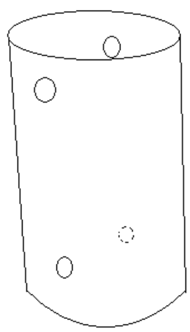
Hollow cardboard Cylinder

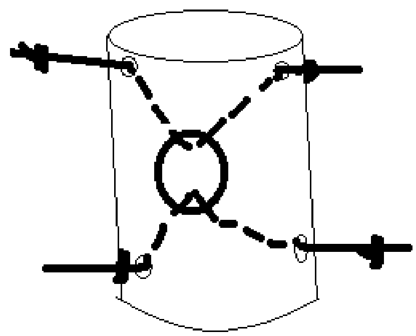
String preferably something thick like yarn or hemp

A key ring (for smaller cylinders smaller key rings work better)

Make a Woozle:

1) Poke 4 holes in cylinder [see below]





2) Cut string into two equal lengths approx. 4” longer than the diameter of the cylinder, thread string through the key ring.

3) Tread string through the holes in the cylinder. Tie knots at each end so that sting can slide entirely through but can move back and forth. [See below]

4) Seal both ends of the cylinder. Have students in groups try to figure out the mechanism behind this remarkable contraption.

Demonstrations by Hannah Wilson

Junior – Elementary Education (Physics)

"Sympathetic Resonance"

If you blow air across the top of one empty bottle (making a lovely sound) another bottle (also empty) of the same kind located near the first bottle will also vibrate. This is because of resonance.

"Burning Candle in a Jar"

Principles

air pressure

expansion of air as it heats

exothermic reaction of burning

Materials

-clear shallow dish

-two clear drinking glasses

-candles

-matches

-water

-something to color the water with

-rubber band

Procedure

Pour water into the shallow dish. Place the candle in the dish. Light the candle and place the drinking glass upside down over the candle. Before it burns out, the candle will heat the air inside the glass causing it to expand and bubble out of the drinking glass. The candle will eventually burn out due to lack of oxygen. After the air in the drinking glass cools (and contracts) the pressure in the glass will be less than the pressure outside of the glass. Therefore water will be pushed into the glass. This should be repeated with more than one candle lit. To do this, rubber band several candles together and repeat the experiment. Because there are more candles, the air will get warmer forcing more to escape the glass. This will cause a greater pressure difference and more water will be pushed into the glass. This also shows that the result is due to the heating of the air rather than the candle "burning-up" the oxygen in the glass. If it was due to the "burning-up" of the oxygen then the water level should be the same no matter the number of candles.

Demonstrations by Amanda Bauldridge

Senior – Biology

"Invisible Test Tube"

It's a test tube leaning in a beaker of corn oil. The tube is actually "invisible" in the oil! Put any amount of **corn oil** in a beaker. Place three clean Pyrex test tubes into the beaker. Fill one will corn oil, one with water, one with whatever substance (I used yellow die in water so it would look the same as the corn oil). You should see the following: The two without the corn oil will look bent, and the one with the corn oil will be invisible. How come? The index of refraction of the Pyrex tube is virtually the same as that of corn oil and they make the light bend by the same amount so there is no "boundary"" between the tube and oil!

Original Source: http://www.darylscience.com/Demos/InvisibleTT.html

"The Fireproof Balloon"

Balloons are rather fragile things. They need to be kept away from sharp objects and flames. However in this experiment you can hold a flame directly under a balloon without it breaking. Inflate a balloon and tie it shut. In a second balloon fill it (not inflated) with water, and then blow it up about the same size as the first balloon and tie it shut. Hold a match directly under the first balloon. What happens? The balloon breaks. Light another hold it under the second balloon. What happens? It doesn't break.

Why does the balloon with water in it resist breaking in the flame? When water inside the balloon is placed in the flame, the water absorbs most of the heat from the flame. Therefore, neither the air in the balloon, nor the rubber gets hot enough to weaken and break the balloon. Water is good heat absorber. It takes a lot of heat to change the temperature of water.

Original Source: http://scifun.chem.wisc.edu/homeexpts/FIREBALLOON.html

"Marker on a hoop"

Scientific principle:

This demo illustrates the force of gravity as well as Newton's first second law of motion. The marker is the object at rest that tends to stay at rest. When the hoop is removed, the marker "falls" as the force of gravity takes over. The hoop is the object in motion that tends to stay in motion (forward moving). When this demo does not work, 1) the hoop is pulled too slowly or in a crooked fashion so as to "pull" the marker into a forward motion or 2) the marker or coin is too large or not aligned with the bottle hole.

Materials:

Embroidery hoop

Bottle

A marker or coin that has a smaller diameter than the opening of the bottle

Procedure:

Place the embroidery hoop on the opening of the bottle. Stand the marker or lay the coin on the top of the hoop. (Hint: Align the object so it is placed directly over the opening of the bottle.) Pull (snap!) the hoop away and the marker will drop in the bottle.

Demonstrations by Lindsay Eklund

Senior – Biology

"The Collapsing Can "

Materials

1. One empty aluminum can (354 ml)
2. A Hot plate or burner
3. Large bowl of water
4. Tongs to hold pop can

Procedure

1. Put about 5 ml of water in the pop can (just enough to cover the bottom).
2. Heat the can over the hot plate or burner.
3. Let the water boil vigorously.
4. In a single motion, remove the pop can from the burner and INVERT it in the bowl of water.
5. Submerge the opening to the pop can in to the water. The can will IMPLODE instantly.

Questions

1. What was in the can besides water?
2. What happens when water is boiled?
3. What do you think will happen if the can is inverted in the bowl of water?
4. What happens to the air in the can as water vapor is formed?
5. What force is working on the outside of the can?

Rationale

Before heating, the can was filled with water and air. By boiling the water, it changes states, from liquid to gas (water vapor). The water vapor (steam) pushes the air that was inside, out of the can. By inverting the can in water, we are cooling the vapor very quickly and constraining the potential for rapid flow of air back into the can. The cooling condenses the water vapor back to water. All of the vapor, which originally took up the interior space of the can, is now turned into a few drops of water, which take up much less space. This causes the pressure to drop and the atmospheric pressure is therefore pushing on the can and crushing it.

The total force working on the outside of the can is the total of the can's surface area in square inches multiplied by atmospheric pressure (about 14.7 pounds/in^2).

Demonstrations by Nikki Smith

Senior – Biology

"Natural Life Jackets"

Materials:

2 oranges, 1 clear container of water

Directions:

Peel one orange ahead of time allowing as much of the peel as possible to remain in one piece.

Safety Concerns: None.

Questions:

Does an orange float or sink? Does the peeled fruit float or sink? Does the peel float or sink? What explanations can you offer? Concepts: The fruit is denser than the peel. The air in the peel

actually buoys the fruit up. Some people think this is why life jackets are orange.

<u>Demonstrations by Cynthia Arnett</u>

Additional Baccalaureate – Biology

"Balloon Rocket"

Balloons can be use to demonstrate Newton's third law:

for every action there is an equal and opposite reaction.

Supplies needed:

Balloons (straight balloons work better than other shapes)

Drinking straw

String

Tape

Procedure

Blow up a balloon and hold it without letting air out.

Ask the students what will happen if you let go of the balloon neck while holding the neck.

Most students will answer that the air will come out. Ask them why?

The atmospheric pressure outside the balloon is applying force to the sides of the balloon. The force exerted on the balloon is squeezing the air out. The force of you holding the balloon is preventing it from moving.

Blow up the balloon again. Ask what will happen if you let go of the balloon. They will answer the balloon will fly away. Why? Have two students hold a string taunt across the room. Thread the straw onto the string. Tape the blown up balloon to the straw. Let go. The balloon will travel from one end of the string to the other.

Probe the students with questions about what happened and why.

Why did the balloon move?

Why did the balloon move in the direction it did?

What were the forces involved?

Which of Newton's law apply?

The air pushes against the sides of the balloon, the sides push back. The air is forced out of the balloon the balloon is forced in the opposite direction. Newton's Third law. This is how rockets work.

Variation.

Place the straw with the attached balloon in a bottle to make a bottle rocket.

For more information and variations visit:

http://www.brown.edu/Departments/Swearer_Center/Projects/PSO/Lessons/balloonrockets.htm

http://www.iit.edu/~smile/ph9608.html

http://www.at-bristol.org.uk/Newton/experiment.htm

http://www.intel.com/education/projects/wildride/learning/sciencelabs.htm

http://swift.sonoma.edu/education/newton/newton_3/html/newton3.html

http://www.brown.edu/Departments/Swearer_Center/Projects/PSO/Lessons/balloonrockets.htm

<u>Demonstrations by Dash Almedia</u>

Senior Physics

"Fun with angular momentum"

Supplies needed:

filled bicycle tire

string.

Procedure:

For this demonstration its more about playing with the tire than a structured routine however it is helpful to first play with the tire yourself so you know what does and doesn't work, things you can show are how a top works, or that a spinning tire will rotate not drop when held with one hand.

Background information:

The unusual effects are due to the fact that angular motion involves three dimensional vectors. Angular momentum is a vector along the axle of the tire and gravity produces a torque in the horizontal plane. Since the torque changes the angular momentum, the tire moves in a circle rather than falling down.

Demonstrations by Elizabeth Meece

Junior – Elementary Education (Physics)

"Convection Rocket"

Materials Needed:

Scissors

Tea Bags

Matches

What to do:

Cut off the top off of the tea bag.

Dump the tea leaves.

Open and place the tea bag standing up on a table.

Light the top of the tea bag with a match and watch it go!

Background information:

The burning paper forms a small convection current near the burning paper. Since the air is hot near the paper it rises and carries with it the very light ash of the burned paper.

GOOD CONDUCTORS

Andrea Lambrecht - IDLA-Chemistry Concentration - Elementary

PURPOSE: Find out which material is the best conductor.

If possible, include spoons made of various materials in your experiment.

MATERIALS: Plastic, metal, and wooden spoons

- Butter
- Bowl of hot water
- Colored Candy

PROCEDURE: Stand the spoons in the hot water with their handles resting on the edge of the bowl.

- Use a pat of butter to stick one piece of candy to the top of each spoon.
- Heat will be conducted up the spoons and melt the butter so that the candy drops off. The best conductor will lose its candy first!

RESULTS: Most of the 80 metals on Earth are good conductors. This means that heat and electricity can pass through them easily. Many of them can be shaped by beating, pulling, or melting. Metals are shiny when cut. Some metals, such as gold, do not react easily with our substances. This means that they do not tarnish and are good for making coins and jewelry.

RISING WATER

Sara Cleaves - Earth Science Concentration - IDLA (Elementary Teacher)

Materials: Clear glass pie pan or other clear container, clay or playdough, candles, matches or lighter, jar, food coloring, and water.

Set-up: Place a piece of clay in the middle of the pan. Put a candle in the middle of the clay. Put a few drops of food coloring into the water and pour the water into the pan so that it touches the very bottom of the candle. Light the candle and then place the jar over the top of the candle and the clay (make sure it is placed around the clay not on it and that the candle does not touch the bottom of the jar). The candle will burn out and the water will quickly rise into the jar.

Science: As the candle burns, the air in the jar is heated, begins to expand, and then starts to escape from the jar. When the candle uses all of the oxygen in the jar, it goes out. The pressure then becomes lower in the jar than on the outside, which causes the water to be pushed into the jar by the higher pressure outside.

THE FLOUR BOMB

M. Travis O'Hair - Biology

Purpose: The classic high school flour bomb demonstration shows the explosive power of flammable powders under the right circumstances, which is dictated by surface area.

Materials:

- 500g coffee tin with lid (not too stiff a fit).
- Funnel with bottom edge flat to put flour in - can be made from plastic and paper.
- Single hole bung to put funnel through.
- Small candle.
- Bulb-type pipette filler.
- One spatula of dry flour (does not work as well if damp).
- Splint and matches.

Safety:

- Apparatus should be enclosed in safety screens.
- Everybody should wear safety goggles.
- Coffee tin needs to be wrapped in sticky back plastic or sellotape.
- Pupils and staff to stand at least 2 metres back.
- When lighting the candle and placing the lid on the coffee tin keep your head out the way.
- Do not use a glass funnel.

Procedure:

1. First, demonstrate to the students how a pile of flour (on a table) is not flammable by placing a lit match to it.
2. Next, make a hole in the coffee tin the same size as your bung at approximately the same height as the center of the flame of the candle.
3. Push the funnel into narrow end of the bung as far as it will go, then insert this into the hole in your coffee tin (funnel on the inside). Attach the pipette bulb to the narrow end of the funnel. This needs to make a tight seal.
4. Put a spatula of flour (cornflour, custard powder, etc. will do very well) into the funnel, blocking the tube from the pipette bulb.
5. Put the candle inside the coffee tin (approximately in the center).
6. Light the candle carefully using the splint (making sure not to light the funnel).
7. Fit the lid securely, without too much force, and then quickly give the pipette bulb a rapid squeeze.

Principal involved: The large surface area of the carbohydrate (flour) means that it is rapidly oxidised. There is a loud WHOOMP and the lid flies off (normally vertically) about 4 feet up. Given a large enough suspension of combustible flour or grain dust in the air, a significant explosion can occur. For example, the 1998 explosion of the DeBruce grain elevator in Wichita, Kansas which killed 7 people.

TRICK COFFEE CAN RAMP

Joshua Cooper - Physics

This demonstration is easy to perform, but requires a bit of set up to begin with. Materials required are 2 coffee cans, a board to serve as an inclined plane, a large lump of modeling clay, and enough sand, sugar, or some other grainy substance to fill one quarter of the volume of a coffee can. Affix the modeling clay to one side of a coffee can, so that when laid on its side the can rocks back and forth. Put the sand, sugar, etc into the other coffee can, and replace the lids on both. Set up the board into a small angle inclined plane, making certain that the cans will not slide down the plane due to gravity. While throwing in as much theatrics as you wish, set up both cans close to the top of the ramp. Make sure the can with the clay has the heavy end facing off the back of the ramp. When released, the clay-can will rock backward and fall off the back of the ramp, while the sand-can stays firmly in place. For added effect, a third coffee can, empty, can be allowed to roll down the ramp freely. The clay-can rolls backward because the center-of-mass of the can is housed within the mass of clay, which will cause the can to rotate backward until the clay is at the bottom of the can. The sand-can stays put because the center of mass is housed within the sand. Because the location of the center of mass relative to the can is comparatively more fluid, the can will not roll down the ramp of its own volition. The center of mass will always be near the bottom of the can, with will not allow for any rotational motion.

FARADAY CAGE

Joshua Cooper - Physics

This demo requires a small handheld radio, a metal container large enough to contain the radio, a glass beaker large enough to contain the radio, and a wire mesh barrel capable of completely surrounding the radio. Using the radio, find the signal from a nearby radio station. When the radio is placed in the metal container, the signal drops out. The reason for this is that when an electric field, like that of radio waves, is incident on a metal container, the electrons in the metal arrange themselves in such as way so that there is no electric field inside the closed space. To prove that this is phenomenon is due to the metal of the container; put the radio into the glass beaker. The radio will continue to pick up its signal. Next, put the radio into the wire mesh. You will find the same phenomenon you observed with the metal container. This wire mesh is called a “Faraday Cage”, after Michael Faraday, who created the first one in 1836. Faraday found that an electric field incident on a metal surface causes that surface to have the same electric potential on all parts. Therefore, because the electric potential is the same, Gauss’ law states that the electric field within such an enclosed space would be zero. Faraday showed that the same effect can be produced with a wire mesh cage as with a solid metal one. This electric field cancellation effect is the reason why cell phone and radios tend to have trouble working in large building made of concrete reinforced by a mesh of re-bar. The whole building works as a Faraday cage. Yet, the same effect does not occur within houses since most houses are made of wood timber, not reinforced concrete

FALLING PAPER

Erica Engels – Earth Sciences

(Found on nerds.unl.edu)

Objective: To show air resistance and how that effects how things fall.

Materials: Notebook (or computer paper) and a book that is about the same size as the paper.

Procedure: Take one sheet of paper and crumple into a ball. Take the paper and crumpled paper, hold them side by side and drop them. Discuss why the paper didn't fall the same. Then put the paper on top of the book and drop them again. Discuss why they then both fall the same.

Explanation: Air resistance is the reason the paper floated to the ground. When you add the book underneath the paper, the book blocks the air resistance.

FALLING OBJECT

Brian Unrein - Physics

Procedure: I will rest one quarter on my hand and pull my hand away quickly and then catch the quarter, asking the audience to help me decide the distance the quarter falls. I will then rest two quarters on my hand ask the audience, if I catch one quarter like before and then catch the other quarter in approximately the same amount of time how far will the second free- falling quarter fall. (Most students will think twice as far, but you know better).

Explanation: For every second a free falling object falls, it can be squared to find the difference in distance. The second quarter will fall four times as far as the second quarter since it has averaged twice the speed for twice the time.

BERNOULLI'S PRINCIPLE

Brian Unrein - Physics

Procedure: Using a hair dryer and a ping-pong ball I will demonstrate Bernoulli's Principle. The ping-pong ball will float a distance above the hair dryer's air current. The ball will not fall to the ground. It will stay suspended as long as the angle from the hair blower and the ball is not too drastic.

Explanation: The air that is pushed from the hair blower will create a low pressure and the ball will stay in the middle of the air stream.

UPSIDE-DOWN GLASS OF WATER/ATMOSPHERIC PRESSURE DEMONSTRATION

Scott Brungardt - Biology

I will do a demonstration that is great for showing that although the air all around us is colorless, odorless, and tasteless, it does have properties that can be tested and proven to exist. The atmosphere exerts a force on every object that exists within it. At sea level, the air exerts a pressure of about 14.7 lb/in^2 on all objects including the human body. Rationale for this demonstration includes two concepts. When the cup is completely filled with water, there is no air left in the cup and thus no air pressure. The inverted cup can therefore hold the water up, because the atmospheric pressure is working against the under-side of the cup. An application of these concepts is apparent while drinking a full can of pop; without allowing air to enter the container, you cannot drink it.

The procedure for this demonstration is not complex; the steps are as follows: 1. fill a glass container (use a container that is transparent and has a smooth and uniform lip) completely to the top with water, 2. place an index card or stiff piece of paper on top of the container and press down along the edges to form a tight seal, 3. carefully turn the water-filled contain upside-down over a basin while holding the index card securely in place, 4. gently remove your hand from the index card, 5. observe results. Again, the air pressure acting upwards against the index card will support the weight of the water and prevent it from spilling out.

THE GLOWING PICKLE/CONDUCTIVITY & ENERGY STATES

Scott Brungardt - Biology

I will do a demonstration that shows the conductibility of an ionic solution and the color of visible light given off by NaCl when the its electrons are excited. The pickle will get hot and glow when an electrode is placed in each end of the pickle because the salt (NaCl) and vinegar (acetic acid) in the pickle's juice allows the electrons to flow; thus, the pickle is a conductor. Energy is also being added to the electrons in the pickle as the sodium ions attach electrons from the flowing current. These ions are neutralized electrically, which forms excited sodium atoms. Since each atom of all elements is different, any given atom will emit a different color of visible when excited. The Na in the pickle's salty juice emits yellow-orange visible light at a wavelength of 589 nm when it is glowing; this is the same color that is observed with Na in a flame test.

After attaching an electrode (ford, copper wire, etc.) to each wire os a two-conductor extension cord (cut off the female end), the demonstration can be completed with the following steps: 1. set up ring stands with clamps about one foot apart, 2. put the electrodes onto the stand with the clamps, 3. put the pickle in position by inserting (3-4cm) an electrode into each end of the pickle (make sure the probes are not touching each other inside the pickle), 4. plug in the extension cord attached to the probes. It will take a while before anything happens. The pickle will begin dripping, then it will hiss and smoke, and finally it should begin to glow.

Workshop on Electricity and Magnetism
2002 Colorado science Convention

Presented by Dr. Willis's Seminar in Teaching Physics Class @ UNC
Class web site: http://physics.unco.edu/sced441

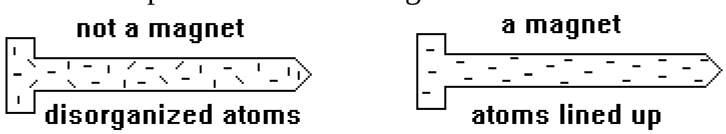
Kelly Johnson, Veronica McMullin, Brain Firooz, and Philip Harrison

The following are activities and investigations which can be used to develop concepts in electricity and magnetism.

NORTH AND SOUTH

Ever wonder why a magnet attracts some things but not others? Or why some metals are magnetic? Magnetism is one of the topics you will be exploring today.

Magnets work because the atoms that make up the material are all lined up in a particular way. It is believed that atoms have a north and south pole, like the earth. In a magnet, when the atoms are lined up, the poles are also lined up. This creates strong attractions at the ends of the magnet.



1

A. THE MAGIC OF MAGNETS?

What kinds of materials are attracted by a magnet? You probably think of metals, but all metals? What about metals that are chemically combined with other materials--like metal salts. An example is sodium chloride, NaCl, commonly known as table salt.

Get a magnet, some iron filings, a piece of copper wire, a piece of aluminum foil, and some table salt. Put the table salt and the iron filings in a ziploc baggie.

Will the magnet attract the aluminum foil? How about the copper wire?

Hold the magnet next to the baggie of salt and filings. Describe what happens.

Why do you think the magnet attracts the iron filings but not the other materials?

Can you use a magnet to make another magnet? Think for a minute--have you ever noticed that sometimes scissors will attract pins or nails will attract other nails?

Get a large nail and a couple of small nails. Try to pick up the smaller nails with the larger nail. What happens?

Now rub the nail against the magnet 10-15 times. Start at the head and rub the magnet from the head to the tip. It is best to rub the nail in one direction. Try to pick up the small nail. What happens?

Why do you think the large nail picked up the small nail?

You are right. Rubbing the nail with the magnet caused some of the atoms in the large nail to line up, so the nail now acts like a magnet. But is this a permanent change?

Hit the large nail with a hammer a couple of times and try to pick up the small nail. What happens?

Chances are, the large nail either didn't pick up the small nail or it had trouble picking up the small nail. When you pounded on the large nail, some of the lined-up atoms moved around and got all jumbled up. So the nail "lost" some of its magnetism. Some of the atoms are still lined up, but not enough to attract another nail.

Get a second magnet. See if the magnets always attract each other, no matter which ends you put together. What happens when you do this?

What you have found is that your magnets have a north and a south pole, and that the poles attract when north meets south. When north meets north or south meets south, the poles repel each other.

B. HOW DO I KNOW WHERE I'M GOING?

Compasses are useful for helping us navigate on a hike. They also help pilots fly planes. Your magnet acts as a compass--all you need is some string!

Get a piece of thread and tie it around the center of the magnet. Hold the other end of the string and let the magnet hang down.

What happens when you try to twist the magnet so the ends point towards different directions?

You probably noticed that one end of the magnet always moved so that it points in the same direction. The north seeking pole of a magnet tries to point towards the earth's north pole. The magnet's south seeking pole points towards the earth's south pole.

A compass works in much the same way. In a compass, the magnet sits on a pin so it can move easily.

You can make a compass out of a sewing needle (or nail or paper clip) and a stryofoam raft cut from the bottom of a styrofoam cup. Get a sewing needle, a stryofoam raft, a magnet, a compass and a container of water.

Magnetize the sewing needle by rubbing the magnet along the needle (do this in one direction--like the nail you did earlier).

Lay the needle into the top of the styrofoam. Now float the styrofoam in the water so that the needle is parallel to the water.

2

Compare the position of the needle in your cork compass to the needle of the "real" compass. What happens to the needle on each one when you move them?

C. HOW STRONG IS YOUR MAGNET?

Can magnets attract things they are not touching? How far away can a magnet and an object get before the magnet can't pull it any more?

Get a magnet, some nails, and a ruler. Put the nail on the table and place the ruler next to it. See how close you can slide the magnet towards the nail before they are attracted. How close can you get?

See if your magnet will attract a nail through different materials. Try paper, a book, glass, plastic, wood, whatever you can find. Describe your discoveries in the space below.

D. WHY DO WE NEED MAGNETISM?

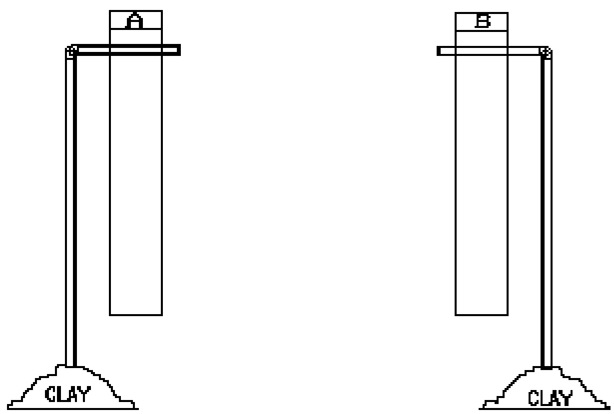
Magnets are pretty useful for a lot of things other than compasses and holding papers to your refrigerator. Running electricity through some metals makes an electromagnet, and these can be very strong. They can be used to lift heavy machinery. Magnets also allow us to listen to a cassette tape!

> Look inside of the tape recorder. You will see a little silver box-shaped piece. Push "play" and this silver piece (among others) will move out.

When a tape is playing, the tape part moves across this silver piece. The silver piece is an electromagnet. A cassette tape has music recorded on it as magnetic patterns--tiny particles on the tape get arranged in certain patterns when the tape is made. When the tape is played, the electromagnet responds to the patterns on the tape and sends electrical signals which correspond to the sounds you hear.

INVESTIGATING STATIC ELECTRICITY

1. To start this investigation you will first need to stick a flexible straw in each of two small pieces of modeling clay to form inverted "L"s. These will serve as holders for the test strips that you will make next (see diagram below).
2. To prepare a pair of test strips, first obtain a strip of "Scotch Brand: Magic Mending Tape" about 12 to 13 cm long. Fold over about .5 cm of tape at one end to form a non-sticky tab. Stick this strip of tape to the tabletop and use a pencil to mark an "A" on the non-sticky tab. Next, prepare a second strip of tape in exactly the same manner. Stick the second strip of tape directly on top of the first piece of tape and mark a "B" on its non-sticky tab.
3. Stick the strip of tape marked "A" on one of the flexible straw holders you mad in step 1 and the strip marked "B" on the other holder.



4. Prepare a second set of test strips exactly the way you did in step 2. Remove both strips of tape from the table together. Then, using the non-sticky tabs, separate the two strips of tape. Bring the strip marked "A" near the hanging strip marked "A". Write your observations in the table below. Bring the strip marked "A" near the hanging strip marked "B". What do you observe? Next, bring the strip marked "B" near each of the hanging strips. Record your observation in the following table.

	Strip "A"	Strip "B"
Hanging Strip "A"		
Hanging Strip "B"		

5. If an object has an electrical charge it will have to behave as either "A" or "B" in the table above. Write a general statement of this behavior.

6. If an object was attracted to both strips “A” and “B” could you determine whether or not it has an electrical charge?

7. At your table you will find a number of objects. Try rubbing each of the objects with a cloth or paper towel. First bring the object near hanging strip “A” then near hanging strip “B”. **<u>THERE ARE SPACES PROVIDED FOR YOU TO TRY SOME OBJECTS OF YOUR OWN</u>**. Record your observations in the table below. If your charged strips seem to lose charge, you can recharge them by repeating step #3 above.

	“A” strip“	B” strip
plastic plumbing pipe:		
Plexiglas:		
plastic silverware:		
wood:		
glass test tube:		
plastic test tube:		
rubber balloon:		
overhead transparency:		
metal nail:		
name tag holder:		
Styrofoam:		

8. Which of the above items did NOT give a definite indication that it had been electrically charged after it was rubbed with cloth? EXPLAIN

9. The phenomenon you have just observed was first recorded by Thales of Miletus nearly 2500 years ago in ancient Greece. He observed that pieces of amber when rubbed with fur would attract feathers and dried leaves. During the middle ages, it was noted that a glass rubbed with silk or cotton would behave similarly. It remained just an interesting phenomenon until about 1600 when Sir William Gilbert made the first systematic study of the phenomenon. He called the phenomenon 'electricity' after 'electron', the Greek word for amber. In 1747, Benjamin Franklin became America's first internationally known scientist after publishing his studies on electricity. Besides flying his kite in a thunderstorm, and inventing the lighting rod, Franklin was the first to name the two types of electricity plus and minus. After it had been rubbed with cloth, Franklin named the kind of electricity found on glass 'plus' or 'positive' electricity. Even though some of Franklin's original ideas of electricity have now been replaced, people have continued calling the two types of electrical charge 'plus' and 'minus' (positive and negative). Use this information to determine the type of electrical charge found on the objects in part 3. Be ready to defend your choices.

	Charge
plastic plumbing pipe:	
Plexiglas:	
plastic silverware:	
wood:	
glass test tube:	
plastic test tube:	
rubber balloon:	
overhead transparency:	
metal nail:	
name tag holder:	
Styrofoam:	

SUMMARY AND APPLICATIONS:

10. Does an object have to have an electrical charge to be attracted to an electrical charge? Give an example.

11. (a) Below, list the procedure you would use to determine the charge on an unknown rubbed rod based on the information you have gained thus far.

(b) Set up your apparatus as described in your procedure and ask the instructor test a rod of unknown charge. Describe the results below and indicate the charge of the rod.

12. The question : Is a thin stream of water charged? If so, what is its charge? Plan a procedure you and your students could perform to find out. Now perform the necessary investigation to answer the question. Write your procedure, data and conclusion below.

TRIBOELECTRIC SERIES

Courtney W. Willis, Physics Department, University of Northern Colorado, Greeley, CO 80639

When two materials on this list are rubbed together, the material higher on the list will become positively charged while the material lower on the list will become negatively charged.

I	P	+++	Air
n	o		Acetate (for overhead projectors)
c	s		Human hands
r	i		Acrylic plastic (Plexiglas)
e	t		Asbestos
a	i		Rabbit fur
s	v		Glass
i	e		Mica
n		++	Human hair
g			Nylon
l			Wool
y			Cat Fur
			Lead
		+	Silk
			Aluminum
			Paper
	Neutral		Cotton
			Steel
			Wood
			Amber
		-	Sealing wax
			Hard rubber
			Nickel, copper
I	N		Gold, platinum
n	e		Sulfur
c	g		Acetate, Rayon
r	i		Polyester
e	t	--	Celluloid
a	i		Orlon Saran
s	v		Polyurethane
i	e		Polyethylene
n			Polypropylene
g			PVC (vinyl)
l			Silicon
y			
		---	Teflon

FALLING MAGNETS - ELECTROMAGNETIC INDUCTION

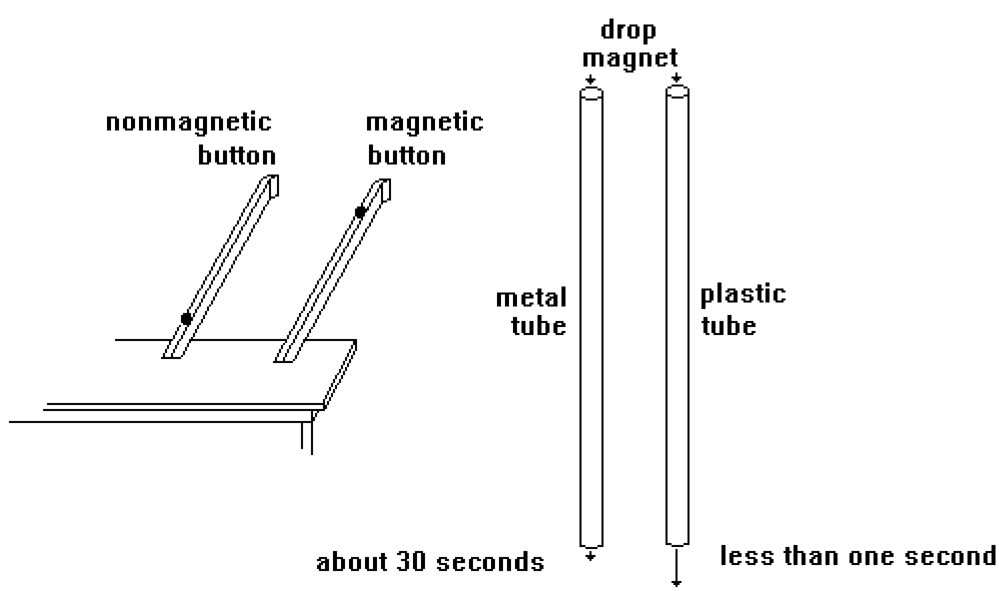
Moving electric charge (electric current) produces magnetic fields and moving magnets produce electric fields. This dynamic relationship between Electricity and Magnetism can be used to demonstrate some very interesting phenomena.

If a falling magnet is surrounded by metal, the electric field produced by the moving magnet will induce an electric current in the metal. The magnetic field produced by the induced electric current opposes the fall of the magnet according to Lentz's law. If the magnet is strong enough, the induced electric current can produce a magnetic field strong enough to appreciably slow the fall of the magnet. This is also an interesting example of the conservation of energy. As the falling magnet loses potential energy it induces an electric current which in turn is converted to heat. An interesting example of this can be seen as the "fail safe" brake on free fall rides in amusement parks.

This can be demonstrated two ways:

1. A neodymium button magnet about 1 cm in diameter can be rolled down a piece of Aluminum channel. The motion of the magnetic can be compared to the motion of a similar non-magnetic button. The non-magnetic button will accelerate unimpeded down the channel while the magnetic button will roll slowly down the channel with a constant velocity.

2. A neodymium button magnetic can also be dropped down a vertical piece of copper or aluminum tubing about 1/2 inch in diameter. A similar non-magnetic button will accelerated down the tube with an acceleration nearly that of "g". The magnetic button will move through the tube very slowly taking 5 or 10 seconds to fall a meter. If the button magnetic is dropped through a piece of PVC tubing it will fall with the same acceleration as the non-magnetic button. The falling buttons can be heard as they move through the tubing as they bump against the walls during the fall.



FLASHING - ELECTROMAGNETIC INDUCTION

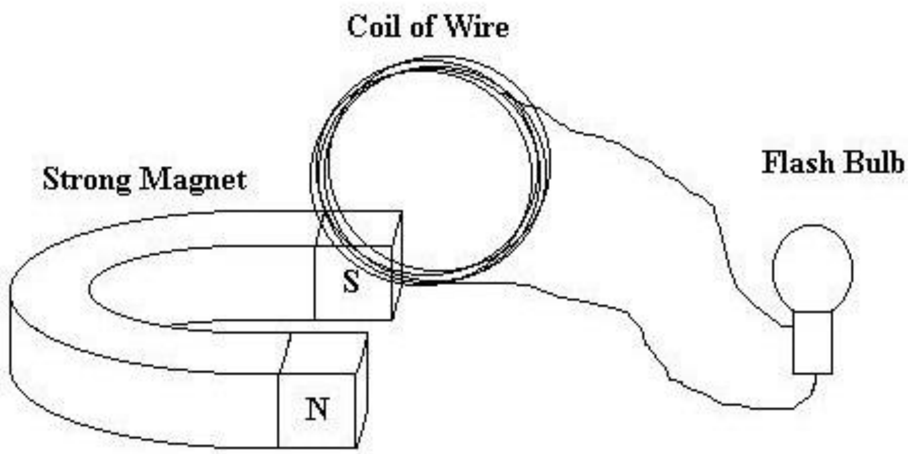
The idea that moving electric current produces a perpendicular surrounding magnetic field is relatively easy to demonstrate with a compass needle and a long straight wire. The concept of a changing magnetic field can produce an electric current is a bit harder to demonstrate to a large group. One of the easiest and most attention getting demonstrations is to use a conventional flash bulb.

If a conventional flash bulb (it can be a single bulb or flash cube, it can not be a Magic X cube) is attached by wires about 1 meter long to a coil of wire (20 to 50 turns, 10 cm. in diameter), when the coil is quickly moved through a strong magnetic field the resulting current will set off the flash bulb. This is usually quite convincing to students since most students understand that it take electric current to excite a flash bulb.

The magnet that produces the field must be quite strong. It can be a large horse shoe magnetic or two of the neodymium super magnets (about 2 cm. cubed) held two to three centimeters apart.

Flash bulbs and cubes are getting harder to find but some times show up in reasonable quantities at reasonable prices at Goodwill Stores or garage sales.

The demonstration works because as the coil of wire is moved the magnetic flux passing inside the coil changes. This changing magnetic flux produces a current in the wire which in turn flashes the bulb.



BATTERIES AND BULBS

In this activity you will extend your knowledge of electricity through an activity on electricity in motion (electrodynamics). The procedure follows.

1. You will first be given a flashlight battery which you are to investigate and write answers to the following questions regarding the battery.

(a) Voltage is an electrical term which is related to electrical energy but it can give an indication of the amount of "push" available to charges. It is more rigorously referred to as the electrical potential or the electrical potential difference. Its SI unit is the Volt. What is the voltage of your battery?

(b) Chemical reactions are occurring within the battery and as a result of this chemistry, the battery has a negative and a positive terminal. Identify these two terminals on your battery.

(c) What has to happen for the negative terminal to become negatively charge? the positive terminal to become positively charged?

(d) Apply the above information to give a scientifically sound reason how a battery goes dead?

(e) If you were to connect a conducting wire between the two terminals, why would you expect a flow of electrons to pass through the wire?

This flow of electrons is non-rigorously defined as current. Electrical current is operationally defined as the number of charges passing a given point per unit time. The SI unit of current is the Ampere, most often referred to as "amp." Although most everyone tends to want to concentrate on voltage it is the effects of **CURRENT** that people can most easily observe. **CURRENT** is what makes things happen.

2. You will now be given two insulated wires (called leads) and a flashlight bulb (you can unscrew one from the circuit board if you do not have a free bulb).

CAUTION: Do not connect the two terminals using only a conducting wire. This is called a short circuit and it can cause excessive heating and produce a dead battery in short order.

(a) Problem: Using the two leads (the two leads cannot be connected together), light the free bulb with the battery. Show in a sketch below the electrical circuit that accomplished the task.

(b) Study the bulb and draw a sketch of it below, showing the path of the electrons as they pass through the bulb when it is lit. *(i.e. where can the current enter and leave the bulb?)*

(c) Question: Can you light the bulb by using only one lead? Show how you accomplished this below.

3. In order to establish a qualitative measurement in future work, you will first connect one bulb across single battery, then across two batteries, three batteries and finally all four batteries. The batteries in the case are connected in series (plus to minus, plus to minus, etc.) and the voltages are additive. From this investigation, fill in the table on the following page.

No. of Batteries	Effect on Brightness	Effect on Current

Since voltage is related to "push", to increasing the current it is necessary to _________________ the voltage.

Thus, the brightness of the bulb indicates both the the amount of _____________________ flowing through and the _____________________ across the bulb.

4. Using all four batteries in the battery case and the necessary leads, make the following connections.

(a) First, two bulbs connected across the batteries such that **<u>all the electrons (current) flow through each bulb</u>**.
(b) Second, three bulbs connected across the batteries such that **<u>all the electrons (current) flow through each bulb</u>**.

What happened to the brightness of the bulbs as you added more bulbs to your circuit?

What happened to the total current as you added more bulbs to this circuit?

Unscrew one bulb and note what happens.

These bulbs are said to be connected in series, i.e., one after the other, with the total current passing through each bulb. Can you think of any common circuit which is wired in series?

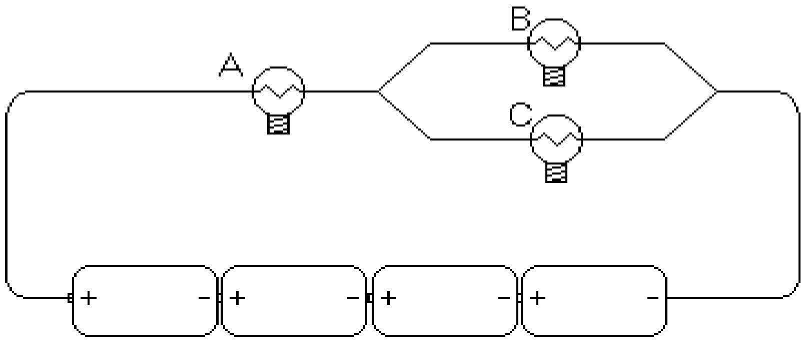
5. Using all four batteries in the battery case and the necessary leads, make the following connections. (a) First, two bulbs connected across the batteries such that t**<u>he total electrons (current) are divided between the two bulbs</u>**.
(b) Second, three bulbs connected across the batteries such that **<u>the total electrons are divided among the three bulbs</u>**.

What happened to the brightness of the bulbs as you added more bulbs to your circuit?

How does the current through each bulb compare in this type of circuit? How does it compare to the total current coming out of the battery?

These bulbs are said to be connected in parallel. The total current is divided among each of the bulbs. Question: Is a household wired in series or in parallel? Use the information you have gained in Nos. 4 and 5 above to give two pieces of evidence for your choice of answer.

6. Problem: Shown below is a schematic of a circuit which involves three bulbs and four batteries. Wire this circuit using your bulb board and four batteries in series.



(a) After you have finished wiring the circuit, how could you readily tell whether it is correctly wired?

(b) Compare the currents in the A, B, and C bulbs and give an explanation for the degrees of brightness, based on the information you gained from Nos. 4 & 5 above.

7. Electricity travels through many materials. These materials are called conductors. Electricity does not travel as well through other materials. These are called insulators.

(a) How could you use a battery, wires, and a bulb as a tester for conductors and insulators in an elementary classroom? Draw a diagram of your tester.

(b) If you were given a wire, a strip of paper, a key, a paperclip, a twig, a penny, a piece of yarn, a pencil with both ends sharpened, a plastic button, some steel wool, and a piece of aluminum foil, how would you determine which were insulators and which were conductors of electricity? Give your own predictions for the above material (are they insulators or conductors?).

Workshop on Electricity and Magnetism
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Web based resources for classroom and lab instruction in Science and Physics

Brought to you by Dr. Willis's Seminar in Teaching Physics Class @ UNC
Class web site: http://physics.unco.edu/sced441
Kelly Johnson, Veronica McMullin, Brain Firooz, and Philip Harrison

Graphics and Layout by Computer Assistance & Instruction--CAI (jnoa4@aol.com)




To visualize various concepts in math and physics
http://falstad.com/mathphysics.html

Pre-lab Exercise for Ohm's Law
http://webphysics.davidson.edu/physlet_resources/bu_prelabs/index.htm
l

The Hands-On Technology Program
http://www.galaxy.net/~k12/index.shtml

Teacher Electricity Tools
http://nsc10.nscdiscovery.org/TeacherResources/SearchItems/ThemeLookup.cfm?ThemeID=3&Start=
0

HyperPhysics
http://hyperphysics.phy-astr.gsu.edu/hphys.html

Electricity and Magnetism
http://edtech.kennesaw.edu/web/electric.html

Physics Lessons
http://www.sciencejoywagon.com/physicszone/lesson/default.ht
m

How Stuff Works
http://www.howstuffworks.com/

Magnetism and Electricity Science Links on the World Wide Web
http://www.cssd11.k12.co.us/science/4magnet/links.htm

Teaching Physics
http://webphysics.davidson.edu/physlet_resources/
Physlets, Physics Applets, are small flexible Java applets designed for science education. You do not need to become a Java expert in order to use Physlets.
http://webphysics.davidson.edu/Applets/Applets.html

Electricity and Magnetism!
http://ippex.pppl.gov/interactive/electricity/

Misc. Sites http://scitec.uwichill.edu.bb/cmp/online/P10D/p10D.htm
http://www.thinkquest.org/library/
http://whs.dist214.k12.il.us/www/academics/ms/s/physics/physicslinks.html

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Tech. Notes: via WEB

Depending on you computer and software (particularly the Browser) you will probably need to install various browser plugins or software such as java, shockwave etc.

The "Shockwave" Plug-in is required to use this module. You can get the Plug-in from the Macromedia Web site.

This archive contains JavaScript and Java Applets that may not run on all browsers. Please make sure you have a Java 1.1 capable browser. All exercises have been tested on Netscape Communicator version 4.7, Netscape Navigator 4.08, and Internet Explorer version 5.0 for Windows.

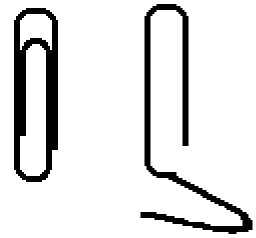
Windows users: Version 4.08 of Netscape Navigator is available on this CD in a subdirectory named Netscape. Netscape Navigator 4.08 is a smaller version of the full-featured browser package Netscape Communicator version 4.7.

Mac users: Currently, Physlet Problems **will not run** on a Macintosh Power PC. Mac browsers do not support both Java 1.1 and Java to JavaScript communication. Hopefully, this will change when version 5.0 browsers are released in 2000.

Errata: View the errata page to for a list of post-production corrections. Please report problems not listed on this page to the authors: wochristian@davidson.edu and mabelloni@davidson.edu

Surface Tension **Guinevere Kulyan**

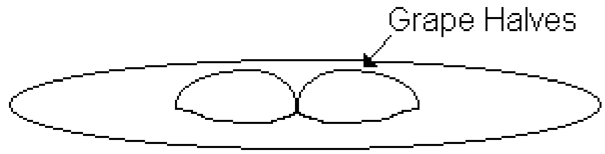
Materials: One large paperclip, one small paperclip, a plastic or glass container, water.



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.

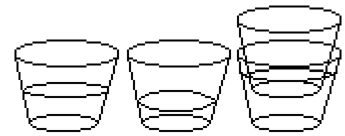
Grape Balls of Fire **Sarah Bieber**

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.)

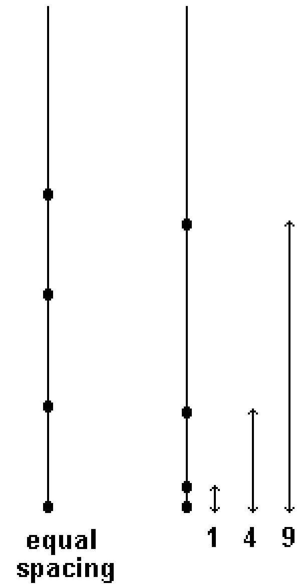


Archimedes Principal **Marshall Hahn**

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.

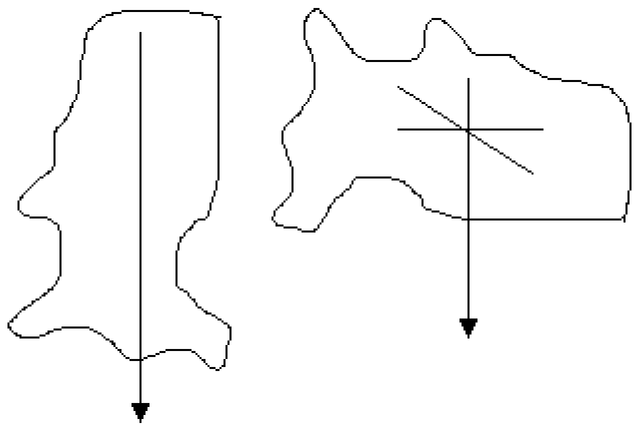


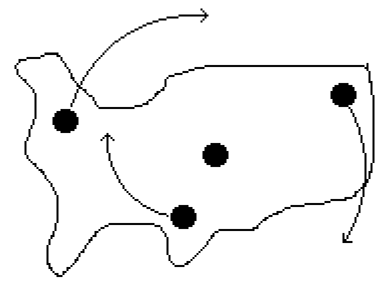
On the Level? Marshall Hahn

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.

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. Whenever 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.





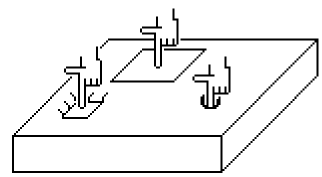
The center of gravity is important for another reason that can easily be demonstrated. On the reverse side of the object place a colored dot at the center of gravity and a few other arbitrary points. Throw the object with a spinning motion. All the dots will blur except for the dot at center of gravity. 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.

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.

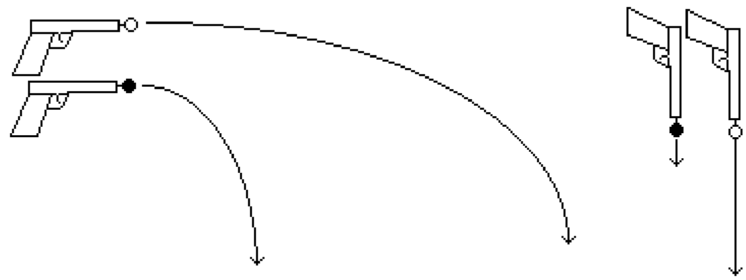
Have a student come forward and ask them to take their index finger and very gently press down on the foam rubber. It will compress only slightly. Next, have them press as hard as possible on the foam rubber. This time they will be able to press nearly all the way to the table. Have them observe that 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:



Pressure = Force/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:

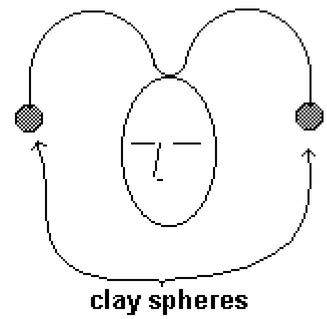
Science Fun Talking Cups
11 Marion Road
Westport, CT 06880
(203) 226-4938

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.

12. A Magnetic Torsion Pendulum - David Lloyd

This is a demonstration of a device that has been used to measure very small forces. It has been used to measure forces created by static charges, and even the gravitational attraction between small weights. The device is called a torsion pendulum, and it is quite easy to make one that can measure very small magnetic forces.

One was made using a small dowel about 4 feet long. A small ceramic magnet was glued to each end. Make sure that the north and south poles of each magnet face opposite directions. Find the balance point in the middle of the dowel, and glue a small mirror (a stainless steel camping mirror works great) to it. About three feet of dental floss was tied to the middle of the dowel so that it balanced horizontally.

Hang the torsion pendulum by the string and let it hang until it stops moving. This can take up to an hour. After the pendulum is no longer turning aim a laser pointer at the mirror. Steady the laser on a solid object and have someone hold down the button. The laser will reflect off of the mirror and onto the wall. If you have given the torsion pendulum enough time to settle down the laser should remain nearly still. If you bring a small magnet within a few feet of the pendulum the laser will start to move. It will take some experimentation to figure out how far the magnets can be from the pendulum in order to cause a noticeable effect. In a first test of the pendulum it was able to register magnetic forces from weak magnets 8 feet away.

This demonstration is very effective for showing that very small forces are measurable. It would be difficult to use this device in class to figure out how forces change with distance between magnets. The pendulum has inertia that keeps it moving for a long time once it has started to move. Since it takes so long for the pendulum to settle down only a couple measurements could be recorded during a class period.

3. THE COLLAPSING CAN

Purpose: To demonstrate the effects of air pressure differences on an aluminum can

Materials: A clean pop can (not a large mouthed can like Mountain Dew) ** the best can for this is a Ruby Red Squirt® pop can or a can made of thin aluminum., One Tablespoon of water, Hot plate, Clear pan filled with cold tap water, Hot pad, gloves, or tongs

Methods: Place one tablespoon of water in the empty pop can. Put the pop can directly on the hot plate. Allow the water to come to a boil (steam should be rising from the mouth of the can). Don't boil for too long or the paint on the can will begin to melt. Once the water has boiled for about 15 to 30 seconds (listen for a popping sound), quickly turn the can upside down into the pan of cold water using a hot pad or tongs. The can should collapse with a "pop" sound due to the difference in pressures. The pressure difference is due to the steam from the boiling water pushing the air out of the can. When the can is put upside down into the cool water, the steam condenses which quickly decreases the pressure within the can. The air pressure on the exterior of the can will now be greater than that within the can and the can will collapse.

4. THE EGG TRICK

Purpose: To demonstrate the differences of air pressure on the system (this could be used in a lesson explaining how lungs work).

Materials: Large egg (hard boiled),Large mouthed jar (an Oceanspray® juice jar is great for this), Paper (2 or 3 tissues or lens papers work best), Matches

Methods: Place a small pile of paper into the bottom of the clean jar. Twist another piece into a wick. Light the wick and as soon as it starts to burn tip the jar sideways and ignite the paper in the bottle (the hotter the fire, the better the results). Once the fire gets going (be sure not to wait too long so that it doesn't use up all of the oxygen in the bottle), quickly place the hard boiled egg over the opening of the jar with the pointy end of the egg facing into the jar. The egg will be pushed down into the jar due to a difference in pressures. When the paper is lit within the jar, the air expands because it is heated and is pushed out of the jar. After the egg is placed on the jar, the fire goes out and the air inside the jar cools. Cooler air will condense in the bottle and the air pressure will decrease. Because the pressure inside the bottle is less than that outside of the bottle, the egg is forced in.

** For a more dramatic effect, place the bottle into a tub of ice water after the egg is placed on top. The quick cooling of the air will cause the egg to be pushed down into the bottle with more force and at a quicker speed.

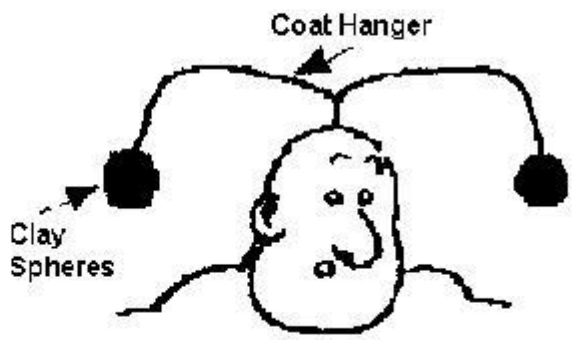
Alan Nall

15. NEWTONIAN HEADGEAR

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.



Alan Nall

16. CONVECTION AMONG FRIENDS

Scientific Principle: This demonstration is helpful in demonstrating how heat energy moves from one mass to another through convection.

Demonstration: Have the audience form groups of two. Next, have one member of each group hold their hands out with their palms facing up. The other group member then places their hands with palm down over their partner's hands. Have the partners slowly move their hands closer together and farther apart. The partners should be able to notice a temperature difference. If the students do not notice a difference, have one of the partners rub their hands together briskly to generate extra heat. The magnitude of felt difference should also increase, as the hands become closer together.

Further: Conduction can also be quickly demonstrated by having the partners touch hands.

Catherine Bowles

26. JINGLE ALL THE WAY?

Materials: 1 jingle bell, glass bottle with lid, hot plate, some super glue

Preparation: Use a large glass bottle with a metal lid. Using a jingle bell that will fit through the mouth of the bottle glue the bell by some string to the lid. When the lid is on the bottle the bell should dangle down into the bottle.

Demonstration:

1. Shake the bottle to hear the bell. Remove the lid, put about 20 ml of water into the bottle, and heat it with the hot plate. Let it boil for at least one minute.
2. Carefully and quickly, put the lid onto the bottle. (CAUTION: the bottle will be HOT! Use a towel or hot pad.) Remove the bottle from the heat and cool. Shake again to hear the bell. Can you hear the bell as clearly?

A partial vacuum is created the much lower air pressure inside the bottle does not carry the sound well. Since air carries the sound vibration, the smaller amount of air in the bottle carries less sound.

If a perfect vacuum could be produced, no sound would be heard.

HOW TO FILL A BOTTLE WITH WATER USING A CANDLE (John Erdkamp)

This experiment is truly a classic but unfortunately it is often misexplained. Place a small lump of clay (or "Playdough", etc.) in the center of a plate or shallow pan to serve as a candle holder. Place one candle into the clay. Pour about 1" of water into your pan with the candle and clay base. Light the candle. Quickly cover the burning candle with an inverted glass jar or beaker, making sure the entire rim of the glass is under water. As expected, after a few seconds, the candle will go out as the oxygen inside the jar is consumed. At the same time, water will rise and partially fill the inverted glass jar.

MATERIALS: Several small candles, Lump of clay (1" to 2" cube), Plate or shallow pan, water, glass jar or beaker (glass cranberry juice jar)

Somehow, the pressure inside the inverted glass jar was reduced, and water was pushed inside by outside atmospheric pressure. Did this reduction in pressure really occur because the oxygen was consumed by the candle?

Do the experiment again, this time using 3 candles burning at once. After all candles go out from lack of oxygen, notice how much water was pulled into the jar this time. You will see that 2 to 3 times as much water was pulled into the jar. Both times, the jar held the same amount of oxygen. Both times, the same amount of oxygen was consumed, but the water level was higher the second time. Why?

As the candle burned, the air above the candle and then the jar was heated. The hot air expanded and left the jar. Soon the candle went out, the air cooled, and contracted. Water from the pan entered the jar to take the place of the air that escaped. More candles made the air in the jar warmer than only one candle, thus creating a more dramatic result when the air cooled.

THE BURNING CANDLE (Nicholas F Barnes)

This is a simple demo that I like to use to allow students to make hypothesis and observations about a common item that is readily used. This demo can be modified to fit many levels of difficulty. The materials used are a candle, match, holder, and piece of paper for the wax to drip. Some questions that might be asked are: What is the color of the flame? Does it smell? What did the candle look like before and after it was ignited?

VISCOSITY (Noah Oyler)

Liquids of different viscosities are sealed inside clear of plastic bottles along with a couple of dark marbles. When turned upside down the students can clearly see the difference in viscosities by the rate of decent of the marbles. Some possible liquids might be: water, vegetable oil, rubbing alcohol, and corn syrup.

ANTI-GRAVITY? (John Erdkamp)

This demonstration will seem to "defy gravity" while at the same time illustrating the concept of center of mass.

Materials Needed: A 16 oz carpenter's hammer, A wooden 12 inch ruler, About 10 inches of string, Small piece of tape (any kind)

Make a small loop with about 10 inches of string that is strong enough to hold the weight of the hammer. Slip this loop around the handle of the hammer (if the handle is polished, you may need to tape the string in place around the handle to prevent sliding). Next, slide the ruler through this same loop. Put the "head" of the hammer towards the 1" mark end on the ruler.

Depending on the size of your hammer, the string should rest between the 3" and 5" mark on the ruler. The edge of the handle should rest against the wooden ruler. The ruler and handle should form an angle of about 30 to 45 degrees. It is important that the head of the hammer extends beyond the edge of the ruler... an inch beyond the edge of the ruler should be more than enough. Now you should be able to carefully balance the device off the edge of a table. The hammer head should be under the table surface that the ruler is resting on. With a little practice, you will be able to balance this heavy, seemingly awkward device with only one 16th of an inch... or less in contact with the table.

This works because the center of mass (somewhere near the hammer head) is under the supporting end of the ruler on the table top. It looks impressive because the majority of the ruler and handle is suspended off the edge of the table.

DISAPPEARING PENNY (Karen James)

This will demonstrate the principles of refraction and total internal reflection. Put a penny underneath a clear plastic tumbler. Show that the penny can be seen from the side even when a piece of cardboard covers the top of the tumbler. Then fill the tumbler with water to the very top and again cover the top with a piece of cardboard. The penny will have seemed to have disappeared. Explain that the light from the penny is being refracted as it enters the bottom of the tumbler. When it hits the side of the tumbler it strikes at such an angle that it undergoes total internal reflection and can only exit the water at the top surface. This is really the principle of fiber optics. Light enters one end of the fiber and can only exit at the other end.

THE BURPING JAR (Courtney W. Willis)
A simple but very convincing demonstration that air expands when heated can be done with just a glass bottle and a coin that just rests over the mouth of the bottle.

Wet the coin and place it over the mouth of the bottle. The water helps provide a good seal. Gently wrap your hands around the bottle so that the warmth of your hands will gradually warm the air of the bottle. As the air is warmed the pressure inside will rise until it is great enough to push the coin up and allow some of the air to escape. This will usually happen several times. A quarter works well on a typical pint vinegar bottle or a half dollar on a fruit drink bottle.

WEIGHING A FINGER (Meg Chaloupka)

Place a hexagonal pencil on a flat surface. Place a 12 inch ruler on the pencil so that is is balanced and not touching the table on either side (like a teeter-totter). Place a clear plastic glass at each end of the ruler. Fill one glass to within 1/2 inch of the top with water. Slowly pour water into the second glass until it is just slightly heavier than the first glass. Ask your students what they think will happen when you put your finger in the glass that is slightly lighter. Demonstrate the reaction by putting one finger into the lighter glass of water. Be careful not to touch the rim of the glass. Ask your students if they can explain why the balance tips. By sticking your finger in the lighter glass you increase the volume that the glass is holding by an amount equal to the volume of your finger. The increase in volume makes the glass heavier and it tips the balance to that side. Now ask what will happen when you remove your finger!