Science Demonstrations

The following science demonstrations were prepared and presented by the teacher candidates in the University of Northern Colorado's SCED 441/541 (Methods in Teaching Secondary School Science) in Fall 2011. Dr. Rob Reinsvold was the instructor for the course. Most of the demonstrations were presented at the 2011 Colorado Science Conference.

Although each demonstration was tested by the teacher candidates, you are encouraged to test it yourself before using it for instruction. Often a slight change in materials can affect the success of the demo. Also, even though some safety considerations are mentioned, please use additional caution with any of the demos, especially if students will be using the demos.

You are free to use these demos if you like.

Table of Contents

Egg in a Bottle: Pressure Differentials

Alice Arbogast

MATERIALS:

1 glass bottle (old milk bottle, Erlenmeyer flask etc)
1 hard-boiled egg
Match or lighter
Paper (to burn; newspaper works well)

SETUP:

Make sure there is fire extinguishing equipment nearby as a safety precaution.

PROCEDURE:

Place the egg on the opening of the bottle to show that it does not fall through and would not easily be pushed through. Remove the egg, then use your match or lighter to light the paper on fire and drop it in the bottle. Quickly replace the egg on the bottle opening. The egg will fall into the bottle.

TIPS:

Make sure the size of egg you buy is suitable for the container you are using. Let the flame burn for a second or two before you put it in the bottle

EXPLANATION:

When you place the lit paper in the bottle, the air inside the bottle heats up and expands. When the flame goes out, the air inside the bottle begins to cool. As it does so it contracts, or reduces in volume. This lowers the pressure of the air inside the bottle. The pressure differential between the outside atmosphere and the inside of the bottle causes the egg to fall into the bottle.

SAFETY:

A fire extinguisher should be present in any experiment involving fire.

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.

Hot Pack

Amy Bekins – Chemistry Post Bac

MATERIALS:

Vinegar
Steel Wool
Ziploc Bags

PROCEDURE:

1. Put steel wool in the Ziploc bag
2. Add Vinegar.
3. Shut bag and enjoy the heat.

TIPS:

Do not get watered down vinegar.
Make sure that you do not get a thin bag, needs to be thick enough so the steel wool does not cut through the bag.

EXPLANATION:

Steel wool and vinegar create a chemical reaction that is exothermic. Thus producing an observable heat, and creating the heat associated with a hot pack.

SAFETY:

Steel wool can cut you.

Dissolving Chalk

Amy Bekins- Chemistry Post- Bac

MATERIALS:
Something for the reaction to occur in (a cup or a Ziploc bag)
Vinegar
Lemon Juice
Chalk

PROCEDURE:
1. Place chalk in the container where you want the reaction to occur.
2. Put in enough lemon juice to cover part of the chalk.
3. Put in enough vinegar to completely submerge the chalk
4. Watch reaction occur.

TIPS:
The chalk may not fully dissolve this does not mean the reaction isn't occurring. You will still hear sizzling and see bubbles. If you have a small class you might be able to pass it around and let them see.

EXPLANATION:
The vinegar and the lemon juice react with the chalk to dissolve the components of the chalk. You can use this to talk about chemical reactions for the chemical reaction is easy to see. You can also use it to show the production of a gas because a gas is being produced.

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.

Sediment Sorting

Matt Nolen –Biology

MATERIALS:
Large, clear container with sealable cap
Water
Gravel
Pea-gravel
Sand
Silt,
Clay

SETUP:

Place some of the gravel, pea-gravel, sand, silt, and clay into the container. Then add water to the container leaving just a little air space at the top to help when shaking it up. Seal the container with the lid.

PROCEDURE:

Shake the container and its contents so that they are all in suspension and then let it sit undisturbed so that the contents can fall out of suspension.

TIPS:

Vary the particle sizes enough to ensure that they will fall out of suspension at different rates in order to be observed.

EXPLANATION:

Rivers and streams have the ability to transport a variety of differently sized sediments. However, these sediments will be transported varying distances based on stream velocity and particle size. This demonstration shows that the larger sediments will fall out of the water column before the finer sediments. Therefore, larger sediments such as rocks and gravel will not travel as far as finer sediments such as sand, silt, or clay.

This demonstration may also allow the presenter to discuss the effects of erosion and how it affects water quality.

SAFETY:

Choose a container strong enough to withstand the abuse of rocks being shook inside of it.

Diffusion

Matt Nolen –Biology

MATERIALS:
3 large beakers
water to put in beakers
food dye
hot plate or stove
large bowl of ice or freezer

SETUP:
Before the demonstration fill the three beakers with water. Place one of them in the freezer or ice to lower the water temperature. Leave one out to stabilize are room temperature and place the 3rd beaker on the hot plate or stove. The water in the beaker on the hot plate does not need to be brought to a boil. It simply needs to be heated to reach a temperature above room temperature.

PROCEDURE:
Place three beakers on a table or desk in order of temperature. Then add food dye to the water and observe the rate of diffusion.

TIPS:
I have found that food dyes are generally darker and easier to observe than iodine or methyl blue. Don't be afraid to add LOTS of dye.

EXPLANATION:
This demo allows students to see something actually diffuse, or move from an area of high concentration to an area of low concentration and become equally dispersed throughout a container. The cold water results in a slower rate of diffusion while the hot water has a very fast rate of diffusion. You may also use this demonstration to show how catalysts function.

SAFETY:
Be careful using the hot plate or stove and then when moving the hot water from the hot plate/stove to the demonstration area. Take proper precautions to protect yourself from burning your hands during transport. Students should be shown which beaker contains the hot water is they are allowed to move in to view the demo close up.

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 (1

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:

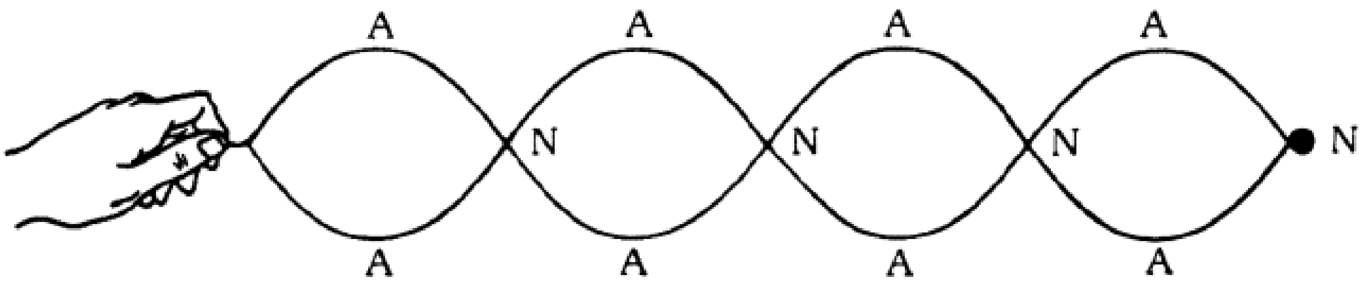
Try the demo beforehand to calibrate the strobe frequency to the string frequency. Bigger guitar strings are easier to see because of their lower frequencies.

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).

Evaporative Cooling

Ross Kononen – Earth Science Graduate Student

MATERIALS:

Sling Psycrometer
Misting Spray Bottle
Water
Hollowed-out Shoelace

PROCEDURE:

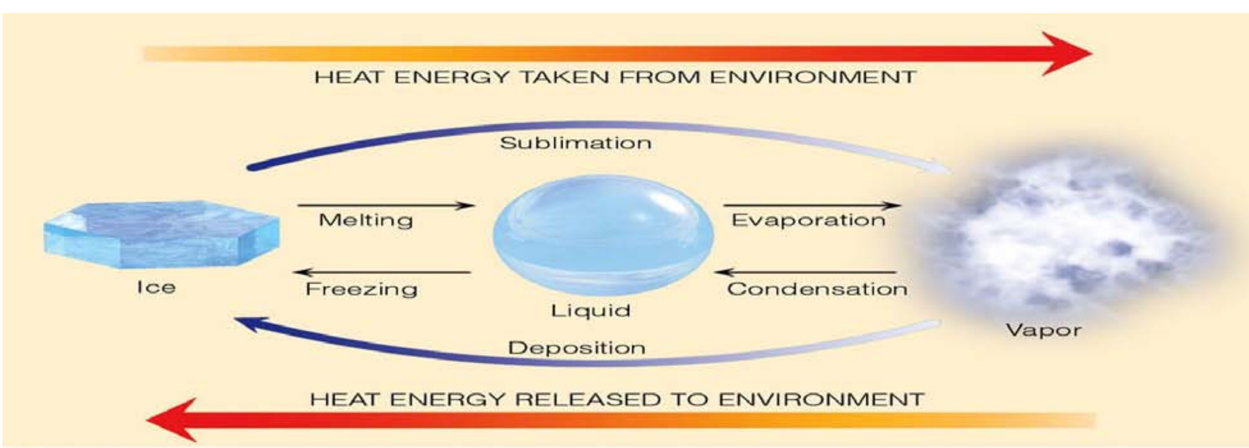
1. Dampen shoelace until saturated with room temperature water (not dripping)
2. Slide shoelace over wet-bulb thermometer
3. Note both temperature readings (should be approximately equal)
4. One hand: Spray a fine mist of water with the spray bottle
   Other hand: Spin the sling psycrometer through the air that is being misted for ~10 seconds
5. Note the wet-bulb and dry-bulb temperatures
6. Repeat steps 4 & 5 as many times as you like

TIPS:

Have sling psycrometer out several minutes before demo to allow the thermometers to adjust to room temperature. Pre-dampening the shoelace is also recommended.

EXPLANATION:

When matter changes phases there will be an energy effect on the environment. In this case, liquid water is being misted into the air. Due to its surface area and the humidity (or lack there of) indoors, some of the water will evaporate into water vapor. This phase change will require energy, in the form of heat, to be taken from the environment. The thermometers on the sling psychrometer will show that less heat is present where the liquid mist is changing into water vapor.



Enzymatic Breakdown by Lactase

Deidra Shutte - Biology Senior

MATERIALS:

Plastic cups
Nonfat milk
Lactaid caplets
Pestle and mortar
Stirrer
Glucose test strips (Diabetic test strips)

PROCEDURE:

1. Pour nonfat milk into plastic cup.
2. Use glucose test strip to determine if glucose is present in milk.
3. Use pestle and mortar to grind one Lactaid caplet.
4. Mix Lactaid into milk with stir bar.
5. Use a new glucose test strip to determine if glucose is now present in milk.

PROCEDURE: (ALTERNATE)

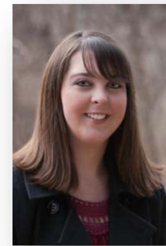
1. Begin with the procedure listed above.
2. Use the same procedure as above for water.
3. Use the same procedure as above for soy milk.

EXPLANATION:

The enzyme lactase, breaks down the disaccharide lactose into two constituent monomers, galactose and glucose. Lactose is present in nonfat milk and has not yet been broken down to galactose or glucose. When a glucose test strip is added to whole milk, the indicator should show neutral, or no glucose present. When the Lactaid caplet is added to the milk, lactase works at breaking down lactose. When a new glucose test strip is used, traces of glucose should be detected by the strip. Doing the same test to water shows there is no glucose present in the Lactaid caplet itself because both glucose test strips show no traces of glucose present in water before or after the caplet is added. Doing the same test to soy milk shows there is no sugar present in the milk. Both test strips will show no traces of glucose present because the Lactaid caplet has no sugar to break down.

SAFETY:

Do not consume anything used in demo.



Pop Bottle Barometer

Deidra Shutte - Biology Senior

MATERIALS:

Glass measuring cup with spout, or glass vase
Empty, clear pop bottle
Food Coloring
Water
Marker

PROCEDURE:

1. Pour water in glass container.
2. Add a couple drops of food coloring and mix well.
3. Turn empty pop bottle upside down into the glass container. Make sure the bottle fits tight into the container so that the bottle does not touch the bottom of the glass.
4. Mark a line on the cup to indicate the water level within the pop bottle.
5. Reexamine the water level as the weather changes.

EXPLANATION:

The amount of air within the bottle is fixed at whatever the atmospheric pressure is on day one. The pressure on the surface of the water depends on the current air pressure. As the weather becomes drier, the air pressure increases, forcing the water to rise in the bottle.

Ping Pong Lipid Bilayer

Deidra Shutte - Biology Senior

MATERIALS:

Glass Bowl
Ping Pong Balls
Water
Colored Sand (i.e. bath salt)
Colored Pebbles

PROCEDURE:

1. Pour water in a clear, glass bowl.
2. Layer ping pong balls on the surface of the water.
3. Pour colored sand over the ping pong balls. It will "diffuse" through the layer of ping pong balls.
4. Pour colored pebbles over the ping pong balls. They are too big to move past the layer of ping pong balls.

TIPS:

Carefully place the colored pebbles on the ping pong balls. Dropping them on the ping pong balls moves the layer enough, the pebbles sink into the water.

EXPLANATION:

The ping pong balls represent the lipid bilayer of the cell membrane. Colored sand passing through the ping pong balls represents diffusion of small particles into the cell. Colored pebbles represent the larger molecules that are not able to simply diffuse through the cell membrane.

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.

The Incredible, Transforming Liquid Served at the School Dance

Keri Bowling – Post-baccalaureate Teaching Candidate – Secondary Science

MATERIALS:

Opaque pitcher or extra-large opaque cup
4 clear cups
Phenolphthalein
Water
Vinegar (acid)
Ammonia, Sodium hydroxide or milk of magnesia (base)

SETUP:

1. In the pitcher, mix 2 Tablespoons of Phenolphthalein into ½ gallon of water.
2. Line up all four cups in front of you
   - leave the first cup empty
   - put a few drops of ammonia in the 2nd and 3rd cups
   - put a teaspoon of vinegar in the 4th cup

PROCEDURE:

1. As you pour the phenolphthalein-water mixture into the first cup, you explain that you are serving free drinks at the school dance and the first student that comes up to the drink station wants water. (liquid in cup is clear)
2. As you pour the phenolphthalein-water mixture into the second cup, you explain that the second student decides to order strawberry juice. (liquid in cup is pink)
3. As you pour the phenolphthalein-water mixture into the third cup, you explain that the third student saw how delicious the strawberry cool-aid looked, and also ordered strawberry cool-aid. . (liquid in cup is pink)
4. The next student that comes to the drink station started to order and then the DJ starts to play their favorite song and the student quickly leaves to go dance without ordering anything! (looks like the cup is empty)
5. The first three students come back to the drink station and say that they would all like strawberry juice this time, so you pour the three cups back into the pitcher and re-pour the phenolphthalein-water mixture into all three of the cups. (Liquid in all three cups is pink)
6. Finally, after their song is over, the fourth student comes back to the drink station and orders water. So, you pour the phenolphthalein-water mixture into the fourth cup. Pour slowly so the audience can see that a pink liquid is coming from the pitcher, but the liquid turns clear once it enters the cup!

EXPLANATION:

Phenolphthalein is an indicator of acids (in this case vinegar), which will become or stay colorless, and bases (in this case ammonia), which will become pink when it comes into contact with phenolphthalein. When Phenolphthalein is added to water, the mixture is clear because the pH is neutral. When Phenolphthalein and water are added to ammonia, the hydroxide ions increase and the hydrogen ions decrease, pH increases and the mixture turns pink. When Phenolphthalein and water are added to vinegar the hydrogen ions increase and the hydroxide ions decrease, pH decreases and the mixture turns clear.

SAFETY:

All mixtures in this lab are not safe to drink.

Eggshell Fire Extinguisher

Keri Bowling – Post-baccalaureate Teaching Candidate – Secondary Science

MATERIALS:
Eggshell
Vinegar
Deep container (beaker works well)
Candle
Candle holder – can be a bowl with sand to hold the candle upright
Matches

PROCEDURE:
1. Put 3 teaspoons of vinegar in a deep container (beaker)
2. Place small pieces of eggshell into the beaker
3. Light the candle (completing this step here will allow the gas from the vinegar and eggshell to build up)
4. Pour the gas (NOT the liquid) from the beaker onto the lit candle
5. The flame on the candle will go out

EXPLANATION:
The acetic acid in vinegar reacts with the calcium carbonate in the eggshell, making carbon dioxide gas. The carbon dioxide gas smoothers the fire and extinguishes the flame.

SAFETY:
Use caution with matches and the lit candle. Make sure to tie back long hair and keep all items out of the reach of the flame from the candle.

Thermal Grill – Sensory Confusion

Shawn Murphy – Biology Postbac

MATERIALS:

10, 12” pieces of ½” copper pipe
Hot glue gun
12” X 15” piece of wood
Warm water
Cold Water

SETUP:

Each piece of copper pipe in closed off using a hot glue gun to seal the end and make it water tight. Half the tubes are then filled with ice water (0 degrees Celcius) and the other half are filled with warm water (40 degrees Celcius). The water filled pipes are then placed on the piece of wood on an incline, so the water does not drain out. Small pieces of wood can be attached to the bottom of the board and the sides to secure the pipes in place.

PROCEDURE:

When placing your hand on the alternating cold and warm water pipes, there is a feeling that the pipes are red hot and one is inclined to move their hand away quickly.

TIPS:

The water begins to cool down and warm up quickly so this will only be an effective demonstration for a few minutes.

EXPLANATION:

The demonstration shows how contradictory stimulation of cold and warm receptors generates the feeling of burning pain in an individual. A burning sensation is generated by the combination of hot and cold nerve impulses and the inhibition of the cold impulses.

SAFETY:

None.

Effects of Pressure on Volume- Boyle's Law

Shawn Murphy – Biology Postbac

MATERIALS:

Pressure pot
SCUBA air cylinder
SCUBA regulator
Balloon
Styrofoam cup

SETUP:

A pressure pot is a device that is used by dive shops to simulate the pressure at depth underwater for testing dive gauges and other equipment. A SCUBA cylinder and regulator are attached to the pressure pot to apply pressure. A balloon or Styrofoam cup can be placed inside the device.

PROCEDURE:

When an inflated balloon is placed inside the pressure pot and the pressure is increased, the volume of the balloon will begin to decrease. The more pressure that is applied, the smaller the volume of the balloon will become. When the pressure is lowered the balloon will revert to its original size. When a Styrofoam cup is placed in the device and pressure is applied, the air spaces in the cup will be decreases in a similar fashion to what occurred in the balloon but when the pressure is decreased, the cup will not revert to its original size and will appear much smaller.

TIPS:

This demo takes some time to setup and should be done prior to any teaching activity.

EXPLANATION:

The demonstration shows the inverse relationship between pressure and volume. As the pressure is increased to 2 ATMs, the volume of the balloon will be decreased by one half of the original volume. As the pressure is increased to 3 ATMs, the volume will be decreased by 1/3 of the original volume. As the pressure is increased to 4 ATMs, the volume will be decreased by 1/4 of its original volume. This relationship is demonstrated in the Boyle's Law equation, PV=nRT. As pressure increases on a gas, the volume must decrease when the temperature is held constant.

SAFETY:

Proper training on the pressure pot is necessary prior to use.

CO_2 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.

Halocline

Shawn Murphy – Biology Postbac

MATERIALS:

Salt
Water
Food coloring
Clear glass

SETUP:

Three tablespoons of salt is placed into 16 ounces of water and stirred until dissolved food coloring is added to this mixture. A different food coloring is added to 16 ounces of fresh water.

PROCEDURE:

The salt water mixture is first placed into a clear glass, filling it half way. The fresh water mixture is then slowing placed in the glass by pouring it down the side of the glass to prevent the two solutions from mixing. The two mixtures will layer in the glass with the salt water mixture on top.

TIPS:

Warmer fresh water can help keep these solutions from mixing but this is cheating a little. The salt water solution can be super saturated by heating a larger amount of salt and water and then cooling it.

EXPLANATION:

The demonstration shows how different densities of water will layer. The salt water is more dense, layers on the bottom. This is seen where fresh water rivers empty into the ocean. A clear halocline is seen in these areas as the water layers. This is also an issue in coastal areas where the water table is being depleted and salt water from the ocean seeps in.

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

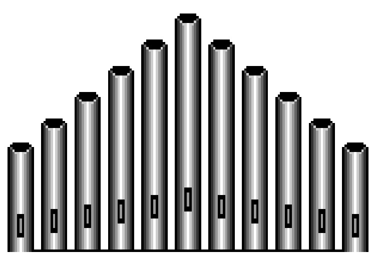
SETUP:
It is important to have the pipes measured correctly so the proper sounds will resonate through each pipe. If possible, arrange the pipes that resemble an organ type instrument.

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:

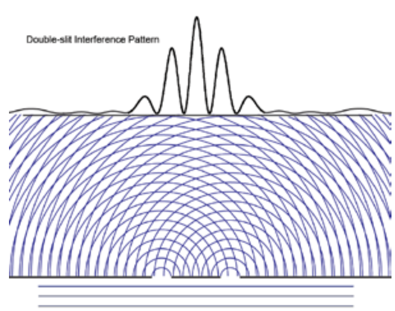
If possible, turn the lights down or off in order to view the interference pattern with clarity. It is important to make the interference pattern visible to everyone in the audience by moving the screen or laser accordingly.

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)

Shell Be Gone!

Benito D. Espinoza

MATERIALS:

• a few eggs
• white vinegar
• a container big enough to hold all your eggs and a cover for the container
• a big spoon

PROCEDURE:

1. Place your eggs in the container so that they are not touching.
2. Add enough vinegar to cover the eggs. Notice that bubbles form on the eggs. Cover the container, put it in the refrigerator, and let the eggs sit in the vinegar for 24 hours.
3. Use your big spoon to scoop the eggs out of the vinegar. Be careful—since the eggshell has been dissolving, the egg membrane may be the only thing holding the egg together. The membrane is not as durable as the shell.
4. Carefully dump out the vinegar. Put the eggs back in the container and cover them with fresh vinegar. Leave the eggs in the refrigerator for another 24 hours.
5. Scoop the eggs out again and rinse them carefully. If any of the membranes have broken, letting the egg ooze out, throw those eggs away.
6. When you're done, you'll have an egg without a shell. It looks like an egg, but it's translucent—and the membrane flexes when you squeeze it.

EXPLANATION:

When you submerge an egg in vinegar, the shell dissolves. Vinegar contains acetic acid, which breaks apart the solid calcium carbonate crystals that make up the eggshell into their calcium and carbonate parts. The calcium ions float free (calcium ions are atoms that are missing electrons), while the carbonate goes to make carbon dioxide—the bubbles that you see.
(http://www.exploratorium.edu/cooking/eggs/activity-naked.html)

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

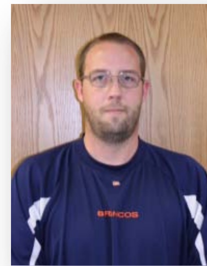
SETUP:
No advance setup necessary

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.

Soaking Spuds

Sandra Pike – Biology, Post Bac

MATERIALS:
1 small potato cut into several flat pieces
2 containers or bowls
Water
Salt (about 2 tablespoons)

SETUP:
Label one container with "Water" and the other container "Salt Water".

PROCEDURE:
Place half the sliced potatoes in one container and the other half in the second container. Fill both containers with water. Add salt to the container labeled as "Salt Water". Allow the potatoes to soak for 15 minutes before observing and comparing.

EXPLANATION:
This demonstrates osmosis and how water moves from an area of low salt concentration to an area of high salt concentration. The water inside the potatoes that are soaking in the salt water solution will move to the higher concentration of salt which is outside the potatoes. This will cause the potato slice to become less stiff than the potato slice in just water.

This could also be done by the students themselves. The students can cut the potatoes into cubic centimeters and measure the difference in the potatoes that were soaked in salted water and regular water. The salt water potatoes will shrink in size.

"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:

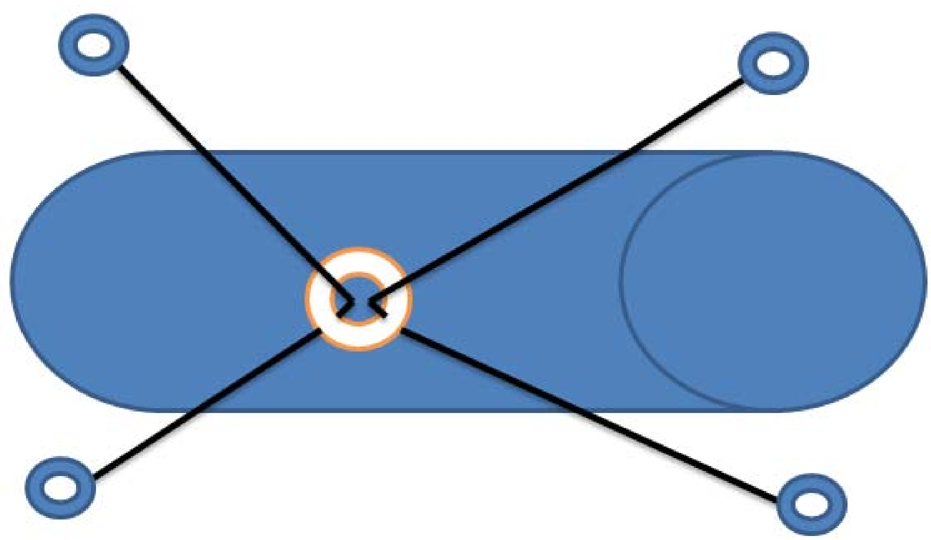
Drill two holes opposite each other in each end of the tube. Thread a rope through one hole, then through a washer, and through the hole opposite the first one. Thread the other rope through the other end, through the same washer, and through the hole opposite the first. Tie the other four washers to 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.



Oscillating Iodine Clock Reaction

Eric Leeper- Earth Science Secondary education

MATERIALS:

3 test tubes- pre-measured
Erlenmeyer flask with rubber top
Goggles
Hot plate- if you want to make it go faster
Small graduated cylinder
Large graduated cylinder
Chemicals:
Solution 1: 3.6 M hydrogen peroxide. To get this dilute 204 mL 30% hydrogen peroxide to 500 mL water.
Solution 2: .2 M Potassium Iodate, .16 M Perchloric acid, To get this dissolve 21.4 g of potassium Iodate in about 400 mL of hot water, then get 11.2 mL of 70% Perchloric acid and dilute to 500 L with water to complete the second solution.
Solution 3: .15 M malonic acid, .04 M Manganese sulfate, .04% starch, To get this dissolve .2 g of soluble starch in 100 mL of boiling water, let cool for 10 minutes off of the hot plate then put back on the hot plate and add 15.6 g malonic acid and 3.4 g of Manganese sulfate monohydrate, diluted to 500 mL.

PROCEDURE:

Get equal amounts of each solution 1, 2, 3 and place into one large graduated cylinder and observe what happens.

TIPS:

Concentrations must be fairly equal for reaction to work.

EXPLANATION:

In the demonstration once the solutions are mixed the unstable chemical reaction will continuously change colors between clear, blue and gold. The specific principle is the difference between a chemical and a physical change.

SAFETY:

Lab attire: Close toed shoes, pants, goggles, gloves and apron.
30% Hydrogen peroxide-Eye contact: Immediately flush the eye with plenty of water. Continue for at least ten minutes and call for medical help without delay. Skin contact: Wash off with plenty of water. Remove any contaminated clothing. If the skin reddens or appears damaged, call for medical aid. If swallowed: Wash out the mouth with water if the person is conscious; call for immediate medical help. Potassium iodate-Harmful if swallowed. May be harmful by inhalation or through skin absorption, Irritant. ***Perchloric acid- It is highly corrosive to all tissues and reacts violently with many oxidizable substances***. Fire/explosive hazard if shocked. Malonic acid-Harmful if swallowed, inhaled or absorbed through the skin. Manganese sulfate- Manganese sulfate is harmful if you swallow or inhale it, and may be harmful in contact with the skin.

50 Plus 50 Doesn't Always equal 100, Water vs. Alcohol

Eric Leeper, Earth Science- Secondary Education

MATERIALS:
Water
91% Isopropyl Alcohol
2 test tubes- pre- measured
Burette
2 graduated cylinders
Erlenmeyer flask
Metal stand plus clamps
Funnel

SETUP:
Metal stand will be on the table with clamps on it that will hold the burette up in the air.

PROCEDURE:
First 100 mL of water is poured into the burette and marked, then poured out. Then, Equal amounts of 50 mL water and 50 mL of alcohol will be poured into the burette.

TIPS:
Higher the concentration of isopropyl alcohol the better- it contains less water

EXPLANATION:
There is an active rearranging of molecules that are attracted to one another that result in the final volume change. This is great when discussing volumes and specific formulas for compounds.

SAFETY:
Goggles must be worn
Isopropyl alcohol- Can irritate skin, should not be drank, very flammable, evaporates quickly producing noxious fumes, if spilt clean immediately.

Density Column

Alicyn Roberson - Chemistry Senior

MATERIALS:

Honey
Pancake Syrup or corn syrup
Liquid Dishwashing Soap
Water (with food coloring)
Vegetable Oil
Rubbing Alcohol (with food coloring)
Container to pour all materials
Spoon
Containers to mix the food coloring and materials

PROCEDURE:

1. For timing purposes:
   a. Mix the substances with food coloring in a separate container before class.
2. Carefully pour the liquids over the back of the spoon into the clear container from most dense to least dense. The most dense is honey and the least dense is rubbing alcohol. The order given in the materials is from most dense to least dense. (See Figure 1.1)

Figure 1.1

TIPS:

1. Substances must be poured from most dense to least dense
2. Avoid the sides of the container and pour slowly so the substances do not mix
3. Pour the less viscous liquids slower and closer to the other substances

EXPLANATION:

The density column allows the students to see density with many different household items. Using the demonstration, many Chemistry vocabulary terms can be brought in. Some of the substances have a high viscosity. The more viscous solutions fall to the bottom due to density. Emulsion occurs when two or more substances mixed together without mixing together. This occurs often in the density column when the rubbing alcohol is added. It created emulsion with the vegetable oil Figure 1.2.

SAFETY:

The rubbing alcohol is highly flammable and also has a noticeable smell that is overpowering, use only in a ventilated area.

Figure 1.2

Boyle's Law

Alicyn Roberson - Chemistry Senior

MATERIALS:

Two Plastic Gallon Jugs
Two Regular Balloons
Scissors or sharp knife

SETUP:

1. Cut a hole in the bottom or side of one container. (1 inch by 2 inches is fine)
2. Place one balloon into the neck of the gallon jug and stretch the balloon over the mouth of the jug.(Figure 1.1)

PROCEDURE:

1. Try to blow up the balloon in the jug without the hole in the side.
2. Try to blow up the balloon in the jug with the hole in the side.
3. Discuss the properties of gas and pressure related to volume.

TIPS:

1. For timing, having the balloon already in place will limit the time necessary for the demonstration.

EXPLANATION:

Boyle's Law states that $P_1V_1=P_2V_2$, where P is pressure and V is volume. In this demonstration, the air inside the plastic jug cannot expand outside the bounds of the containers flexibility. Once the capacity for air pressure is reached, the balloon will cease inflating and will force air out of the balloon. When there is a hole in the side of the plastic jug, the gas in the plastic jug continues to exit as air enters the balloon and the balloon will fill until it cannot expand anymore.

SAFETY:

Watch for students with latex allergies. Scissors and knife will be sharp, exercise caution when cutting the plastic jug.

Figure 1.1: Balloon in the neck of the gallon jug

Sinking Eggs

Alicyn Roberson - Chemistry Senior

Materials:

Two raw eggs
Two clear glasses/ plastic cups
Salt
Water
Food coloring if desired

Setup:

1. Pour water into both cups until it is 2/3 full.
2. Stir salt into one cup until it is saturated (I found that in about 1 cup of water, I needed about a half cup of salt to saturate the solution).
3. Add food coloring if desired.

Procedure:

1. Add one raw egg to the cup with only water.
2. Demonstrate that it sinks and explain density.
3. Add the other raw egg to the cup with water and salt.
4. Explain why the egg floats.

Tips:

1. Test this to make sure the egg will float in your container and with the right amount of salt

Explanation:

The density of a raw egg is slightly higher than water, which is why it sinks in water. The salt raises the density of the water and the egg will float on the water. Research has shown that an average egg has an approximate density of 1.06 g/mL and the density of 25% salt water is 1.25 g/mL. Using this knowledge, the density of the egg is less than the density of salt and will therefore float in salt water.

Safety:

Spoiled eggs may smell and have a slightly lower density than fresher eggs.

Water on a Penny

Brianne Wold – Biology Major

MATERIALS:

Penny
Dropper
Water supply
Soapy water (or ethanol)
Paper towel

SETUP:

Set up the penny and water supply on a paper towel, possibly on a document cam so that the whole class can see what is happening.

PROCEDURE:

Drop water onto a penny one drop at a time. Do not touch the water on the penny with the dropper.

Count how many drops fit on it.

Do the same thing with soapy water. You should get a lower number of drops.

EXPLANATION:

The number of drops that fit on the penny before the bubble breaks should be higher than compared to the soapy water or ethanol because they do not have the same properties as water. Adhesion, cohesion, surface tension, and hydrogen bonding adds to the higher number of drops that fit on the penny.

SAFETY:

If you use a doc cam, be aware that you are using water around electricity. Ethanol might also be used and can injury your eyes if there is contact.

Acids and Bases

Brianne Wold

MATERIALS**:**
Chopped red cabbage
Acidic solution (lemon juice or white vinegar)
Basic solution (ammonia)
3-4 glass beakers
Dropper
Homemade pH strips (optional)

PROCEDURE**:**

1. Chop some of the red cabbage in a food processor. Add water to it, and chop more.
2. Drain the purple juice into a large beaker. Try not to get any chunks. If it is a really dark purple color, just add some more water.
3. Pour samples into two other beakers. To one, add lemon juice one drop at a time and swirl. Wait for the acidity to turn the pH indicator (cabbage juice) pink.
4. To the other beaker, add ammonia the same way using a dropper. Swirl and wait for it to turn turquoise.
5. You can make homemade pH strips by soaking paper in cabbage juice and letting it dry. Then cut it up and dip the ends into various pH solutions.

EXPLANATION**:**
The cabbage juice is a pH indicator. When you add the acid or base to it, only after a few drops, the color will change. Acids turn pink and bases turn turquoise. You can also make homemade pH strips by using the cabbage juice to soak a normal piece up paper. When you dip the strips into an acid or base, it will turn either a pink or turquoise color again.

SAFETY:
Be careful when using a food chopper for the cabbage. Use caution when dealing with the acids or bases. Ammonia has a pH of 11, which is relatively strong. Its fumes are also strong and overwhelming. Do not inhale vapors directly.
When disposing of acids and bases you will want to neutralize the pH. You can add both of your solutions including the cabbage juice together and the pH will be neutralized.

Floating Paperclip

Brianne Wold

MATERIALS:

2 beakers, one full of plain water, one full of soapy water
Two paperclips (plain metal, not any plastic coverings on them)
Dropper

PROCEDURE:

Unfold one paperclip and use it as a hook to lower a normal paperclip onto the surface of the water beaker. Get it to float. Use the dropper to put soapy water onto the floating paper clip. This will disrupt the hydrogen bonding and break the surface tension and the paperclip will sink.

EXPLANATION:

The properties of water like surface tension, cohesion, and adhesion allow the low mass paperclip float on the surface. But when the soapy water is added, the hydrogen bonds are disrupted and the paperclip cannot be supported by surface tension and will sink.

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:

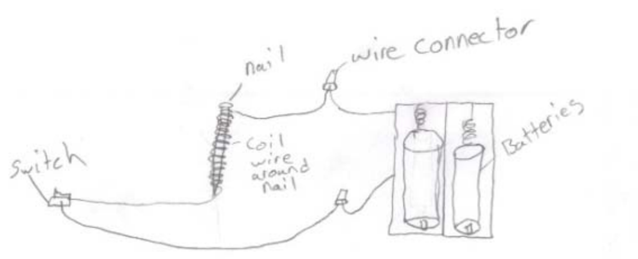
I placed a piece of electrical tape at the end of the coil on the nail to hold the coil in place.

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:

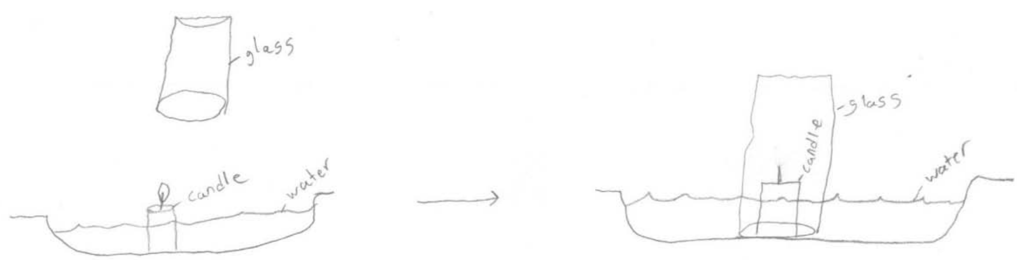
Pour water into the plate. Place the candle in the middle of the plate and on the water. Light the candle. Hold the glass over the candle for 1 to 2 minutes. Then place the glass completely over the candle. The candle should go out and after the candle is out the water will be sucked up into the glass.

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:

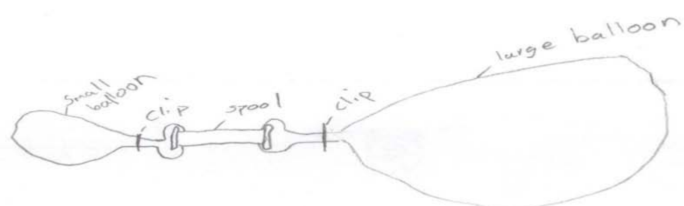
Present the balloons attached to the spool. Release the clips from both balloons and then let go of the ends to allow air transfer through the spool. The smaller balloon will deflate, inflating the larger balloon.

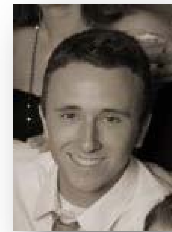
TIPS:

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.

Fireproof Balloon

David Conway – Chemistry Senior

MATERIALS:

2 large balloons
1 box of matches
1 bottle of water

SETUP:

Prior to the demonstration you will need to blow up both balloons. The first balloon will be blown up normally. The second balloon needs to be blown up but also needs a small amount of water to be added into the balloon (1/2 cup will be fine).

PROCEDURE:

Start off the demo by lighting a match and holding it under the balloon without water. The balloon will pop sometimes before the flame even touches it. Then light a match and hold it under the balloon with the ½ cup of water inside of it. Make sure the flame is under the portion of the balloon with the water. The balloon will not pop. Ask the students what characteristics of the balloon with water allowed it to not pop. Then ask students why water played such a pivotal role in the "strength" of the balloon.

TIPS:

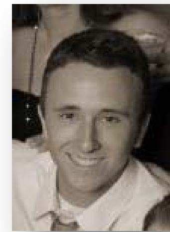
Be sure to use large balloons and do not blow them up too much. Do not overfill or under fill the balloon with water. When putting the match to the balloon with water be sure to hold it under the spot where the water is pooled.

EXPLANATION:

When heat is added to the balloons it heats up the rubber. Normally rubber has a small tolerance for change in heat and will quickly deform and pop as is seen with the first balloon. With the second balloon much of the heat from the flame is dispersed throughout the water. As we all know water is a great absorber of heat. It takes a large amount of heat to change the temperature of water.

SAFETY:

Be sure to wear safety goggles. Extra caution must be implemented anytime flames are present and in use.



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.

Transduction of sound wave energy

Nicholas Horianopoulos – Earth Science Education Graduate Student

MATERIALS:

Item 1: Stove Pipe/Drum with reflective mirror, mounted upon a tripod
Item 2: Laser, mounted upon a tripod
Item 3: Demonstration facility, 15m minimum

SETUP:

A 1' x 6" round stovepipe can be constructed as a drum with a cut latex glove. Rubber bands are used to mount the glove over one end of the pipe. Small machine screws should be threaded into the pipe near the latex to insure that the rubber bands will not slip over the end of the pipe, and a ¼" x 20 hole can be threaded into the body of the pipe in order to make it mountable to a standard tripod attachment. A 1" square of mirrored glass should be glued to the center of the glove with silicon. An inexpensive laser can be mounted to a riflescope mount, the mount threaded ¼" x 20, and an additional tripod can be used to mount the laser securely.

PROCEDURE:

The laser can be placed any distance from the Stove Pipe/Drum device, engaged, and aimed at the mirror. Then the beam reflected by the Stove Pipe/Drum device can be aimed at a distant surface. With the laser engaged, a person can yell into the Stove Pipe/Drum device, making the latex vibrate, wobbling the mirror, and showing that sound can be transduced into mechanical motion.

TIPS:

The longer the space you have to demonstrate the experiment, the greater the deflection of the beam, and the less you will have to shout to get apparent motion of the latex drumhead. Also, make sure your rubber bands are located beyond the screw heads so you can ensure they will retain their hold upon the latex. A balloon may offer better resilience against the metal of the stovepipe, and you may wish to sand the sharp edges to prevent the latex from tearing.

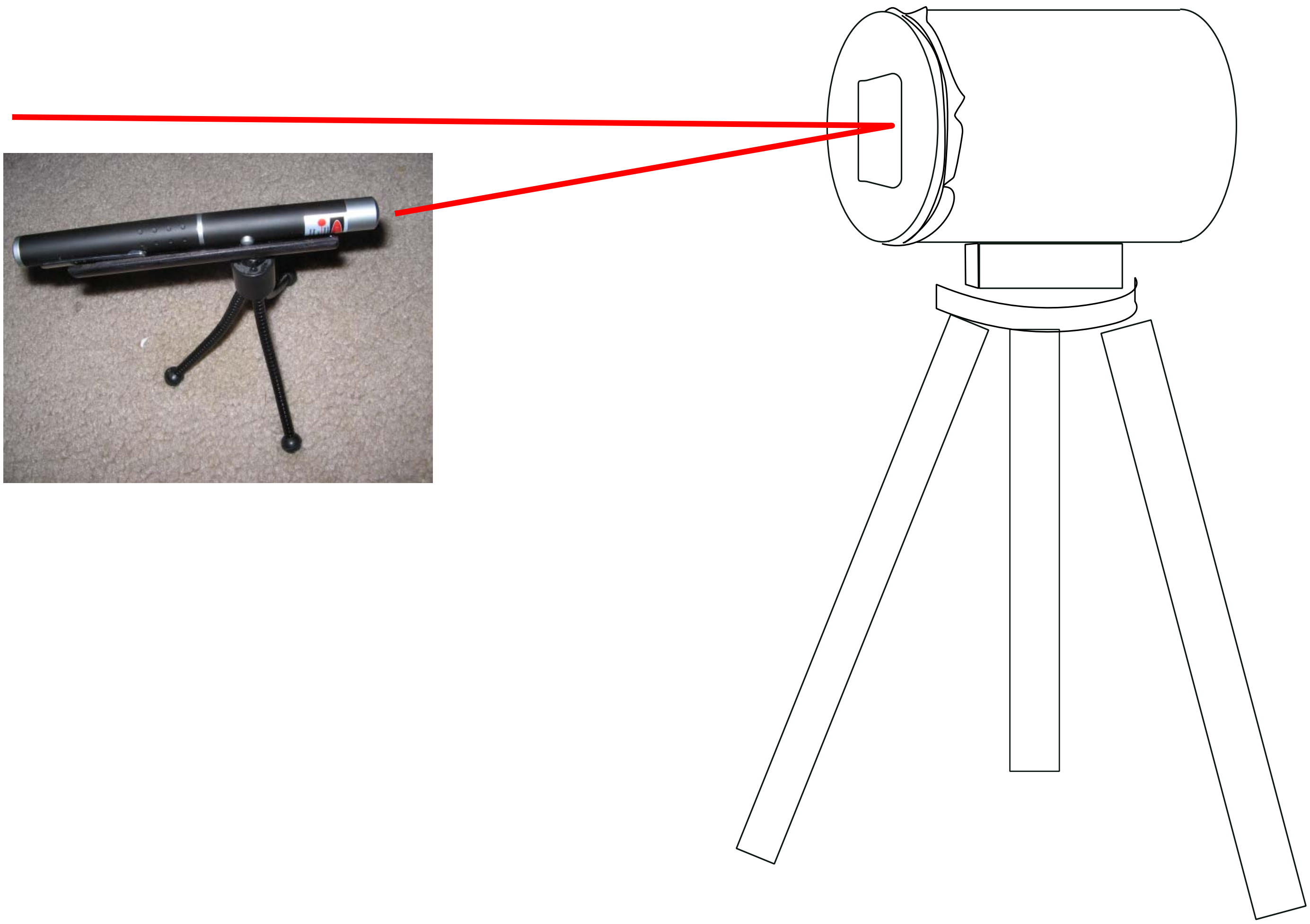
EXPLANATION:

Transduction of sound waves into mechanical energy is a natural occurrence in the Earth system. Creatures use this type of energy transfer to detect noise in the natural environment, and condenser microphones are similarly configured.

SAFETY:

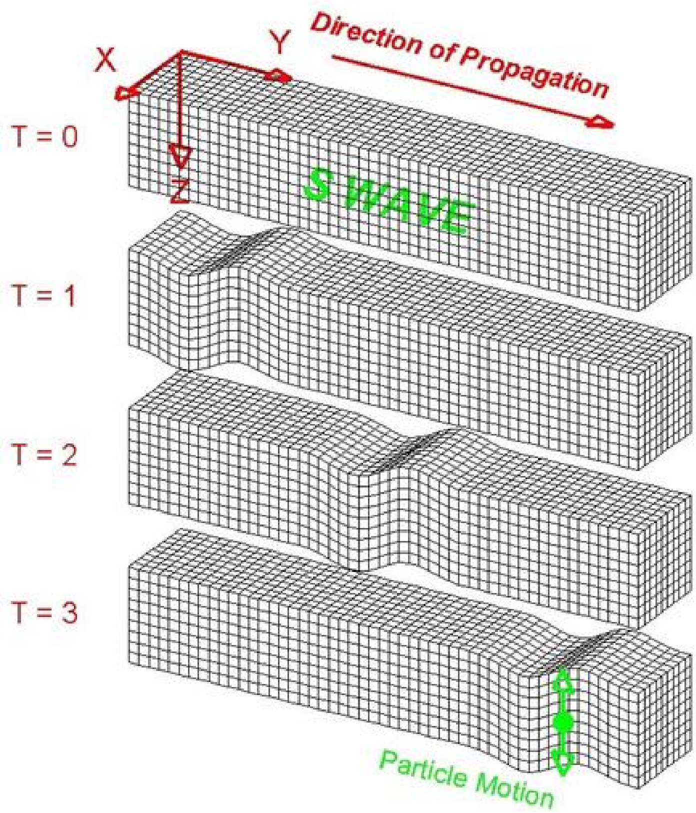
Participants should not look into the laser.

DIAGRAM



Body and Surface Waves in Earthquakes

Nicholas Horianopoulos – Earth Science Education Graduate Student



MATERIALS:

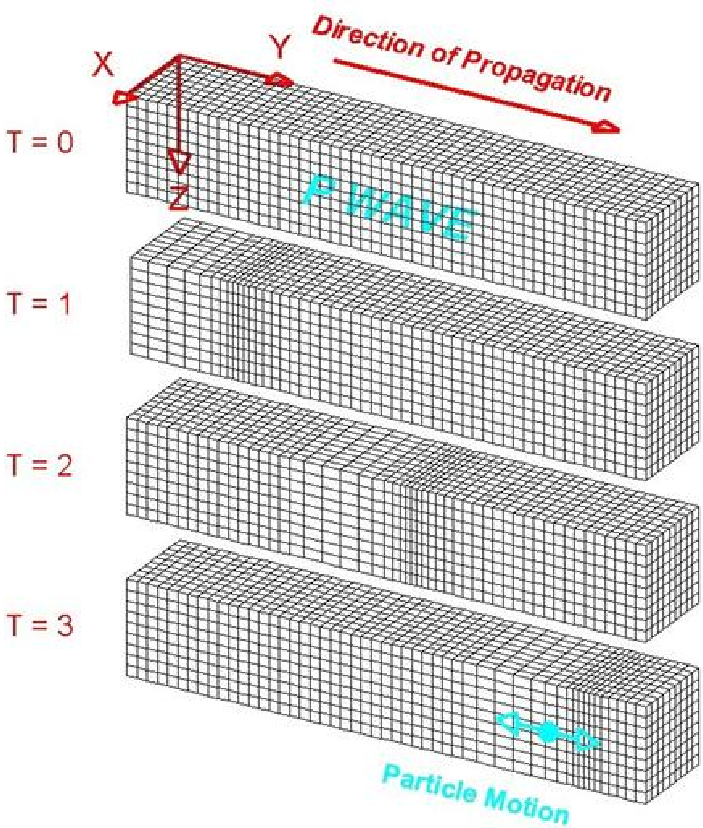
Item 1: Slinky x 4
Item 2: 3 volunteers

SETUP:

Volunteers will make the toy known as a "slinky" move to correspond with P-Waves, S-Waves, Rayleigh Waves and Love Waves, which are the four types of body and surface waves created by earthquakes.

PROCEDURE:

The instructor will create a "P-wave effect" with forward pulsations. Volunteers will create "S-Wave Effects," "Rayleigh Wave Effects," and "Love Wave Effects" when directed by the presenter.



TIPS:

Use a table top to manage motion so the effects of gravity don't disrupt your image of a wave.

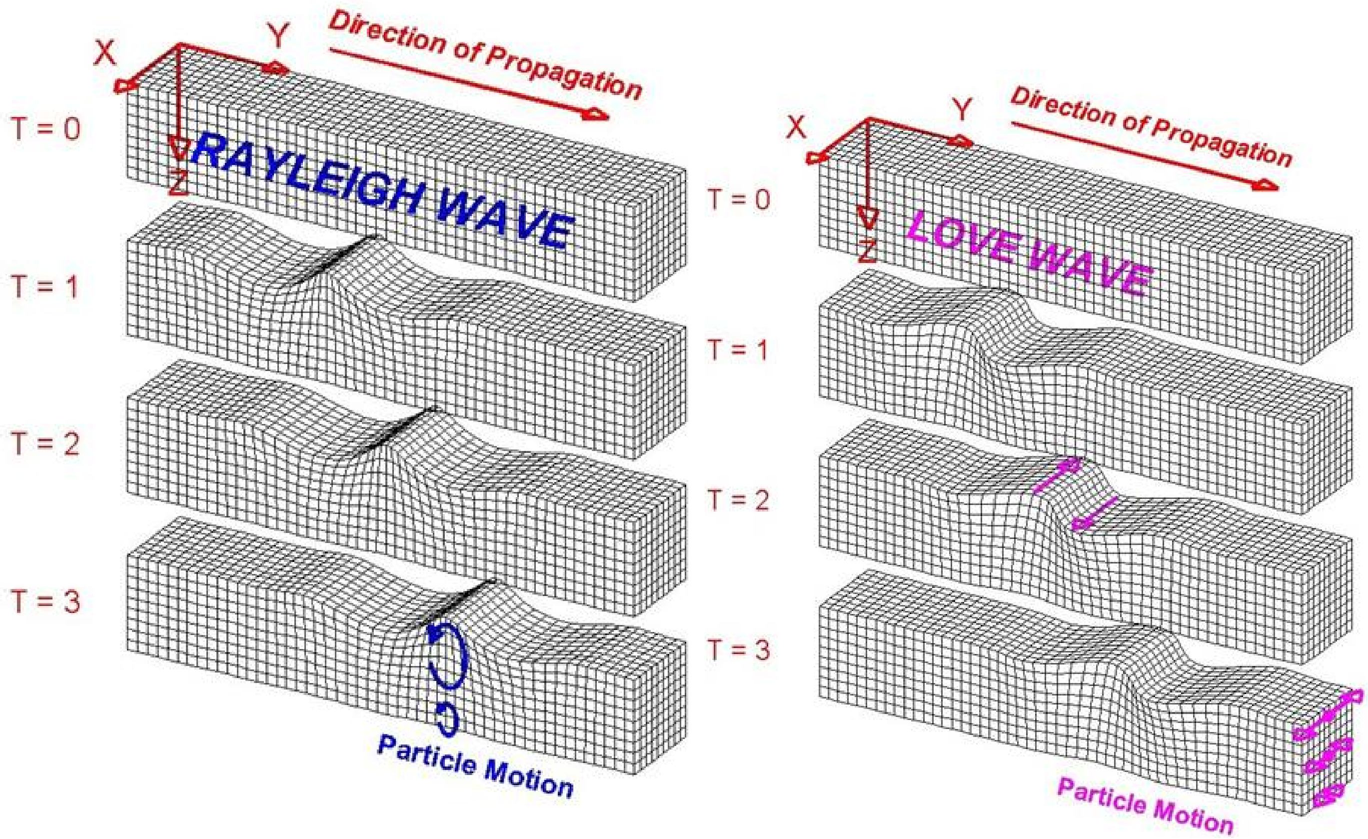
EXPLANATION:

Sound waves are propagated in rock at velocities in the neighborhood of 5000 m/s (for P-Waves). S-Waves, propagated 90 degrees to the direction of their travel, can travel 3000 m/s. Rayleigh and Love Waves travel even slower, and are transmitted on the surface of the planet. The slower arrival time of secondary and the surface waves can be used to locate earthquakes via triangulation.

SAFETY:

There should be no concerns with this experiment.

DIAGRAM



X
Y
Z
Direction of Propagation
T = 0
T = 1
T = 2
T = 3
RAYLEIGH WAVE
Particle Motion
X
Y
Z
Direction of Propagation
T = 0
T = 1
T = 2
T = 3
LOVE WAVE
Particle Motion

Rates of Diffusion

Jill Crookshanks - Biology

MATERIALS:

2 1000ml beakers (or larger)
1 container of food coloring
Cold water from tap
Hot water from tap (or you can use a hot plate to get the water very hot!)

PROCEDURE:

1. Get two 1000 ml beakers (or larger) with the same amount of water in each.
2. Put cold water from the tap in one beaker
3. Put hot water either from the tap or heat up the water on a hot plate in the other beaker
4. Put three drops of food coloring in each beaker

TIPS:

If using a hot plate you might want to heat up the hot plate and get both beakers of water set up before the demonstration.

EXPLANATION:

This demonstration will help clarify the topic of diffusion. Since diffusion describes the spread of particles through random motion from regions of higher concentration to regions of lower concentration. Also, this will show the difference that diffusion will happen more rapidly when in a warmer solution compared to a colder solution. Since water particles in the hot water have been energized by heat, this makes complete diffusion of the food coloring in the hot water much faster than how long complete diffusion takes the food coloring to be in equal concentrations throughout the entire beaker in the cold water.

SAFETY:
If using a hot plate be careful water can start boiling quickly!

Floating Water

Jill Crookshanks - Biology

MATERIALS:

Mason jar with lid (pint sized works best)
Fine mesh screen
Water
Overhead transparency (about the size of an index card)

PROCEDURE:

1. First replace the top part of the lid of the mason jar with the fine mesh screen
2. Put water from the tap in the mason jar and fill it as full as you can with water
3. Screw the lid (with the screen instead of the metal) on tight!
4. Place overhead transparency over the top of the lid
5. Flip the mason jar over and watch the transparency stick (as if by magic) to the mason jar
6. Remove the overhead transparency and watch how the water still stays in the mason jar
7. Finally to prove that there are really holes in the screen, tilt the mason jar to a 45 degree angle (over the sink) and the water will pour out

TIPS:

You are going to lose a little bit of water when you first flip it over and when you remove the overhead transparency so make sure to first flip the jar over a trashcan or the sink or if you don't can about getting a little water on the floor it is more dramatic especially if you bring in a mop.

EXPLANATION:

This demonstration will help illustrate some of the properties of water. This one demonstration actually will showcase waters cohesive, adhesive, and surface tension properties. The water will stick to the overhead transparency (adhesion) and the water will stick to itself and the screen holes (cohesive and surface tension). Since water has a high surface tension it will actually create a membrane at the lid of the mason jar even though there are tiny holes that when tilted will allow the water to pass through. The surface tension can be broken by uneven pressure of the water when it is tilted.

Enzyme/Substrate Reactions

Jill Crookshanks - Biology

MATERIALS:

Small cube of liver
A clear container to hold the liver in or a plate
Hydrogen peroxide
Disposable pipette

PROCEDURE:

1. First place a cube of liver on a plate or in a clear container
2. Get a disposable pipette full of hydrogen peroxide
3. Put about 1ml of hydrogen peroxide on the liver and watch it bubble!

TIPS:

It is better to use a clear plastic or glass container to avoid a mess with hydrogen peroxide spilling.

EXPLANATION:

This demonstration will help illustrate some of the properties enzymes and their substrates. The enzyme catalase found in the liver will break down harmful chemicals like hydrogen peroxide into oxygen gas and water (non-harmful). When this reaction occurs, you can see the oxygen bubbles escaping which causes the liver to sort of foam. This enzyme is specific too, if you were to denature the liver in any way (heat, acid, base) then no bubbles should form. You can use this demonstration to show students how the enzyme is working to transform the harmful hydrogen peroxide into non-harmful products of water and oxygen. Then you can elaborate from this demonstration and turn it into a lab. Have the students do the untreated liver and then have them come up with a treatment that they think will make the liver not function by what they know about enzymes.

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

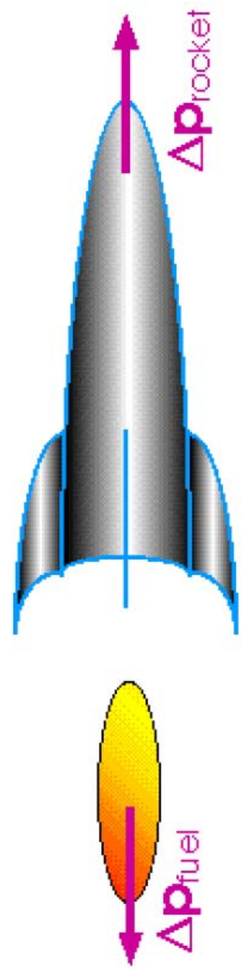
Aaron Adamson – Physics Senior

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.
7. 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.