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.

Jessica Cihiwsky – Senior Biology Major

HYDROPHOBIC VS HYDROPHILIC FORCES AS OBSERVED ON GRAPES

Materials

- one peeled grape
- one unpeeled grape
- 7-up soda.
- A cup

The teacher pours non-flat soda into one cup. The two grapes are dropped at the same time. The presence of the hydrophobic skin is observed by seeing the unpeeled grape rise to the top of the cup while the peeled grape remains at the bottom. The reason for the increased altitude for the unpeeled grape is that the skin has hydrophobic interactions to the upward escaping carbon dioxide gas. This experiment can be done at as many student locations the teacher deems necessary as it is very cost effective and very safe for the students to handle.

INFLATING A BALLOON WITHOUT A BREATH!

Materials: bottle, vinegar, small piece of paper towel, baking soda, and a balloon.

Steps: 1. fill bottle with vinegar (enough to cover bottom of bottle)

2. pour baking soda onto small piece of paper towel (paper towel is used to delay reation so that you can get balloon on bottle)

3. put paper towel with baking soda into bottle

4. cover opening of bottle with balloon (hold onto balloon, so that the gas does not blow away the balloon)

5. enjoy the show

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.

Chris Schaumberger – Post Graduate – Physics

LUNG DEMONSTRATION

This demonstration is a great visualization of the respiratory system; it demonstrates how the diaphragm works and how as we breathe we inhale and exhale air through our lungs. The air fills and empties our lungs by changes in the diaphragm. This can be incorporated with discussions about our lungs and body. It can also serve as an introduction to pressure differences and a discussion about vacuums.

Materials/ Quantity:

Gatorade 32FL OZ or larger QTY:1
Rubber Band QTY:4
Balloons QTY:3
Tube Tee Nylon 3/8" X 3/8" x 3/8" QTY:1
Vinyl tubing ½" OD 3/8" ID

Resources/tools:

Drill
Scissors

Procedure:

Pre-Lab (Teachers assembly)

1. Drill a hole at the center of the cap of the Gatorade bottle sized to fit ¼" radius ½" diameter.
2. Cut the bottom of the Gatorade bottle with scissors. Make sure that when you cut you keep the edge really smooth. (A sharp edge could be a safety hazard!)

Lab Assembly (For the students in class**)**

1. Cut tubing to approximately a ½ foot length.
2. Take one rubber band, wrap it around the tubing at the top ¾ of the tubing length from bottom, to serve as seal tent and placeholder for the lungs.
3. At the long end push the center of the tubing tee in to the vinyl tube, ¼" is sufficient. The remaining tee ends of the tubing tee place balloons over the ends. To keep them in place wrap the rubber bands around the balloon and seal them to the tee end four loops around the balloon will suffice.
4. Put the nylon tubing through the Gatorade bottle without the cap on.

5. Push the cap with the pre-drilled hole though the vinyl tubing and twist the Gatorade cap on the bottle. (Try to keep the rubber band right under the cap as a sealant, note it may improve the demonstration)
6. Cut the last balloon across just above the largest part of the balloon's diameter.
7. Stretch the balloon out, pull it across the bottom diameter of the Gatorade bottle.
8. (This is the most challenging step -it may require two people, one student should hold the Gatorade bottle and the other should stretch the balloon.)
9. Once the balloon is on put the last rubber band on the diaphragm to keep it in place.

DC MOTOR DEMONSTRATION

<u>Learning objectives:</u>

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.

<u>Materials/Quantity:</u>

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

<u>Resources/Tools:</u>

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

Jordan Kaufmann – Senior – Biology Major

BIODIVERSITY

Materials

10 small wooden/plastic sticks

Procedure

Take all 10 sticks and place them randomly on top of each other to make a “mixture” of sticks

Attempt to remove one of the sticks (probably one near the middle or bottom of the pile) without moving any of the surrounding sticks

Explanation

One main idea in biodiversity is that everything is connected. This demo demonstrates that you cannot physically remove one stick from the pile without affecting the surrounding sticks. If a species is removed from an ecosystem, then many other species that depend on that species’ existence for food, protection, spatial area, etc. will also be affected. It may help to use multi-colored sticks in order to represent a sample of species diversity.

NATURAL SELECTION

Materials

10 different colored 8 x 11” pieces of paper (can be construction paper and 5 pieces have to be red, 2 have to be green, 2 have to be yellow, 1 has to be brown)

A large roll of twine, string, or tape

Scissors

Procedure

Use the roll of twine, string, or tape to create a large circle with a diameter that is roughly 10 feet across

Have 10 students obtain 1 of the 10 pieces of paper

Instruct each student to create a paper airplane and fashion it in a different way from their peers

Once the paper airplanes have been made, have the students form a circle around the circle you made on the ground (but have them at least 5 feet from the perimeter)

Students will then be told to launch their paper airplanes towards the inside of the circle and have some students use different speeds and angles in their throwing technique

After this action, some airplanes will be inside the circle and some will be outside. Some may even be on the perimeter itself (you can place these airplanes inside the circle).

Repeat the throwing steps with only the airplanes that made it inside the circle

Keep doing it until one color is the only one left inside

Explanation

Natural selection is a biological process that "selects" the fittest species to survive and the less fit to become extinct. This activity shows that each color symbolized a "species." Certain species were more numerous than others (red is the dominant species in terms of species number). The 10 ft. circle on the ground represented the threshold for survival in a particular environment. As each student was instructed to throw their airplanes, some students used a slower velocity when throwing their planes while others launched their airplanes at different angles above the horizontal. This diversity of launching techniques is supposed to resemble the different strategies used by different species to survive in their environment. Some airplanes made it into the center of the circle and some did not. The planes that made it "survived" and the ones that did not make it became "extinct." The surviving airplanes were then thrown multiple times in order to "weed-out" the less fit species until only one species dominated. The teacher can then explain what strategies were the best in having their airplanes make it into the circle and what ones did not work. Other questions related to how a species' number plays a role in surviving a disturbance may also be asked.

Nicole Bobian – Senior – Biology Major

COMPONENTS OF BLOOD

Objective: Students will identify the four components of blood and their relative amounts.

Materials:

1 clear container at least 1 Liter in size

Candy red hots

Corn syrup

Small marshmallow or white jelly beans

Candy sprinkles

Stir stick

Procedure:

1. Explain the four components of blood.
   -Red blood cells (candy red hots): 44% of blood volume, 1 ½ cups
   -Plasma (corn syrup): 55% of blood volume, 2 cups
   -White blood cells (marshmallows): 0.5% of blood volume, small handful
   -Platelets (candy sprinkles): 0.5% of blood volume, 1 tablespoon
2. Measure and combine all four components and mix the candy "blood"
3. Optional: Dispense "blood" into small cups and pass out one cup to each student with spoons so that the students can eat the candy if they desire.

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.

Kaitlin Griffin – Senior – Earth Sciences Major

POP BOTTLE BAROMETER

Subject Area: Physical and Earth Science

Concepts Addressed: Meteorology- air pressure and weather phenomena.

Materials Required:

- Empty pop bottle
- Glass measuring cup with a spout
- Colored water

Procedure:

1. Turn the empty pop bottle upside down into the measuring cup containing the colored water. Make sure the bottle fits tight into the cup so that the lip of the bottle does not touch the bottom of the glass.
2. Mark a line on the cup to indicate the water level within the pop bottle.
3. Reexamine the water level as the weather changes.

Rationale:

The amount of air within the bottle is fixed at whatever the atmospheric pressure was on the day you turned the bottle upside down during the initial demo. 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. As the weather becomes wetter pressure decreases and water in the bottle will lower. This can be used in a meteorology unit where students can observe and predict weather patterns by keeping an eye on the barometer. Students can decide weather temperature has anything to do with air pressure and explore what force is acting on the water in the bottle.

Nicole Poling – Post graduate - Biology

ICE ON A STRING

Science Concept Demonstrated: NaCl (table salt) lowers the melting point of water.

Materials:

1 piece of thin string
1 large ice cube
NaCl (table salt)
small cup of water
plate

Directions:

Place the ice cube on the plate. Dip the end of the string into the cup of water, making sure at least an inch of the string is wet. Lay the string on top of the ice cube. Sprinkle salt over the string, making sure to cover all of the string that is touching the ice cube.

Wait 10-20 seconds. Pick the string up- the ice cube should lift up with it.

Introduction:

"Have you ever wanted to put some ice cubes into your drink but you didn't want to get your fingers wet and cold? Well, I know how to do it! I can pick up this ice cube without getting my hands cold or wet. Just watch!"

Explanation:

Salt has the ability to make the melting point of water or ice lower than it usually is. When salt is poured on the ice, it causes the melting point of the ice to lower slightly. This allows the string on top of the ice cube to sink into the ice cube slightly. The water re-freezes itself around the string fairly quickly, almost as if the string were a part of the ice cube all along. The ice cube then lifts up easily. We use this in winter- salt is sprinkled on the sidewalk in order to keep the ice from forming. The salt lowers the melting point of the ice and it doesn't ice up the streets.

Important Note: Make sure to sprinkle enough salt over the string and wait for a few seconds or else the ice cube won't lift up with the string...

Waste Disposal: Dump ice cube in a sink so it will melt into water and can then be washed away.

Jill Legualt – Senior – Biology Major

VANILLA, CHOCOLATE OR COLORS

Objective: To denature the milk solution to see how weak bounds between lipids and proteins break apart and travel all over the plate. This happens because the detergent denatures the bounds and the food coloring allows students to watch the proteins and lipids as they travel across the plate because they are no longer attached and happy. The liquid soap also works to destroy the surface tension of the milk because milk is a lot like water and has surface tension which would allow the food coloring to stay put, but when you denature it, it allows the food coloring to go all over the place helping to cause the color explosions.

Materials: milk (any type available will work)
food coloring
plate
liquid detergent
cotton swabs
elmo (for this demo, in classroom not really necessary)

Procedure:

1. Pour the milk into plate to cover the bottom
2. Add four drops of food coloring, each a different food coloring in the center, but not touching each other
3. Take cotton swab and add a drop of liquid detergent to the tip of one end, place in the center of the food coloring drops in the milk, watch the explosion of color

4. Continue to do this with different cotton swabs and detergent on the end in various places in the plate. You may also use water in this experiment to see how that reacts to liquid detergent denaturing the water properties. Follow same procedure, just use water instead of milk.

Melissa Haag – Senior – Biology Major

SOLID WATER

Science Concept:
A polymer absorbs a large amount of water by the process called osmosis.

Materials:
- two - 400 mL beakers
- sodium polyacrylate (This same experiment may be performed by using the stuffing found in the seat of baby diapers as a replacement for the pure chemical)
- table salt
- water
- food coloring
- stirring rod

Directions:
1. Measure 300 mL of water in one of the 400 mL beakers.
2. Add a few drops of food coloring to the water.
3. Measure out 5 -7 grams of the sodium polyacrylate and pour into the other 400 mL beaker.
4. Pour the water quickly into the beaker containing the sodium polyacrylate from a height of about 12 inches with a lot of vigorous splashing. This is to ensure good mixing as stirring after the addition of the water does not work properly.
5. Turn the beaker upside down to demonstrate how it has become solid.
6. Measure out about 10 grams of table salt.
7. Pour the salt onto the solid water gel and stir until the mixture becomes a liquid again.
8. Pour the liquid back into the first beaker again to demonstrate that it is a liquid again.

Jacqueline Medford – Senior – Physics and Earth Sciences Major

CLOUD FORMATION

Procedure:
1. Remove the label from your cloud bottle and rinse it thoroughly. Do not use soap and do not dry the inside.
2. Add a small amount of very warm water to your cloud bottle. Replace the cap and shake it up so that water droplets are sticking to the inside of the bottle. Pour out the excess water.
3. Carefully light a match and drop it into the bottle. Shake it up so the match burns out. The smoke adds one of the key ingredients for cloud formation **dust**.
4. Immediately replace the cap and shake it back and forth 2-3 times. You now have the second ingredient **water**.
5. Using both hands, squeeze the center of your cloud bottle as hard as you can. Then, release both hands evenly and very quickly. You are now simulating the third ingredient **temperature and pressure changes**.
6. After several squeezes you should see a cloud that appears when you release your hands. If you don't see a cloud, try placing the bottle near a dark background for contrast.

Tips:

1. **Explanation:**
    - Clouds require key atmospheric ingredients to form.
        - water
        - dust particles
        - temperature or pressure changes
2. **Advanced:** Use a bicycle pump to change the pressure and see even more clouds. Watch Steve Spangler perform the cloud experiment live at a local news channel.
3. **Going further:** Try using other sizes of dust particles. Design an experiment to determine the best size of dust particles to use. You could also test different water temperatures. (These are things I'm still working on)

Materials:

- A clear plastic bottle with a screw on cap
- Matches
- Warm water

Andy Russell – Post Graduate – Biology

"WHOOSH" TUBE

Materials:

Large plastic container, e.g. a 5-gallon water cooler bottle
Small volume of 95% denatured ethyl alcohol (at most, 50ml)
Splint (paper, preferably)
Source of fire (lighter, match, etc.)

Rationale:

This is a demonstration that takes about 30 seconds to prepare and is always a crowd-pleaser. Even the most disengaged student will no longer be able to claim that chemistry is boring.

Procedure:

Pour the ethyl alcohol into the large bottle and swirl it around until the insides of the container are coated in a thin layer. Stand the bottle on its base, light the splint, and drop it into the bottle. Try not to jump backwards.

Safety:

The "whoosh" is fairly loud, but not going to hurt anyone. The ethyl alcohol needs to be stored in a locked cabinet. A little goes a long way.

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

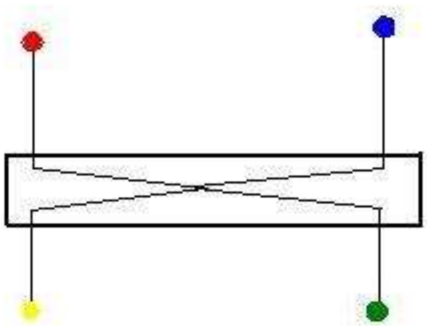
Rationale:

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.

Sarah Butler – Senior- Chemistry

MACRO REPRESENTATION OF CHROMATOGRAPHY:

Materials:

- Seed beads of varying sized
- Clear plastic tube that becomes narrow at one end (a 16 fl oz water bottle works well)
- Ping- pong balls (enough to fill the clear tube)
- Funnel
- Small catch tube (should be narrow enough that mixing will not occur as the beads drop in and have a closed end)

Set- up:

Before class: If using a water bottle the larger end should be cut off, but only cut off enough to have that end open enough to get the ping- pong balls in. The larger plastic tube is placed over the funnel and the funnel is placed in the smaller catch tube. The large plastic tube is packed with ping- pong balls. The seed beads should be mixed so that they are uniformly distributed.

In class: Place the set up on a table in front of the class so everyone can see. Show the class the mixture of seed beads and have them hypothesize how long it will take to separate the beads out by size. Then pour the beads through the apparatus. They should separate by size so that the smallest ones come out first.

Explanation:

The mixture of beads represents a liquid or gas mixture that we put through chromatography. The beads take longer to go through based on size because larger beads spend more time in contact with the ping- pong balls, slowing them down. This is how chromatography works. The different molecules come out at different times based on their size and how they interact with the stationary phase.

Reference:

Journal of Chemical Education, Volume 63, 1986, page 715

Dr. Brandon Murry - Senior – Biology Major

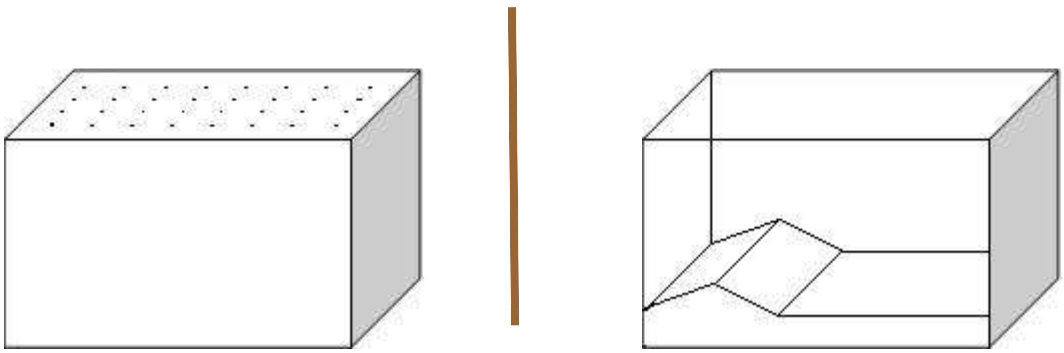
MAPPING THE OCEAN FLOOR

<u>Materials</u>:

- Box with holes in top (holes are equidistance creating a grid type pattern)
- Rows and Columns must be differentiated for data entry (We used: Rows A,B,C… & Column 1,2,3,,,)
- Dowel rod (if too short it falls into the box) marked with numbered hash lines representing distance

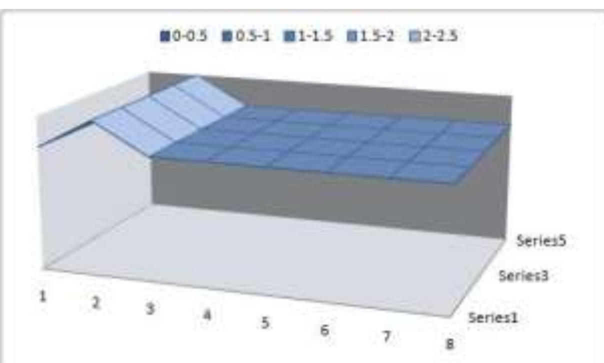
- Create the bottom of the ocean with paper mache or foam overlaid with strapping tape (remember students will push the rod through the material if it's not tough enough to resist) foam comes in a spray can called *Great Stuff*
- Log sheet
- Excel or other spread sheet program

Students will replicate the in-class version of the seismic mapping process using a dowel rod. The student slides the dowel rod down each hole in the surface of the box (holding it perpendicular to the surface of the box) and when it touches the bottom the depth (numbered hash mark on the dowel) is recorded on a log sheet. After all measurements have been taken the data is then entered into an Excel (or similar) program and the computer produces a graphical representation of the bottom of the ocean represented by the data. We used 6 boxes; each box containing a different ocean floor shapes (i. e., oceanic plate separation, ocean-ocean convergence, ocean continent convergence, mid-ocean ridge transform fault…). Each student actively participate in mapping the ocean floor and contemplating what caused that structure; was it plate convergence or plate divergence, or was it due to volcanic activity or earthquake activity or some combination of these factors. Be prepared for those students that try to look inside; however the unknown builds the anticipation.



The Box as the student sees it The Shape inside the Box

An example of the computer printout and the data table from Excel provided below.



Oceanic Depth Measurements Data Chart

	A	B	C	D	E	F	G	H
1	2	2.5	2	2	2	2	2	2
2	2	2.5	2	2	2	2	2	2
3	2	2.5	2	2	2	2	2	2
4	2	2.5	2	2	2	2	2	2
5	2	2.5	2	2	2	2	2	2

MALODOROUS BALLOONS – DIFFUSION THROUGH A MEMBRANE

Materials:

- Balloons, large, latex, various colors
- Flavor extracts, various — coconut, peppermint, vanilla, lemon, etc.
- Beral-type pipette, one for each extract
- String is optional for tying the balloon closed – you may choose to just tie a knot in the balloon

Nothing tricky here, this demonstration is quite simple. You want to deposit about 2 ml of a flavor extract into a balloon. Make sure you insert the pipette well into the inside of the balloon before squeezing the bulb and depositing the extract. If you get the extract on the outside of the balloon the demonstration is somewhat worthless. By using different colored balloons your students can easily reference that specific balloon when they comment about the smell. "The red balloon smelled like maple syrup, and the yellow balloon smelled like peppermint." Pass the balloons around and have students record the odor of each balloon and talk about how the smell gets out of the balloon.

The balloon is a selectively permeable membrane that allows passage of selected molecules. If molecules are small enough they will be able to pass through small holes in the balloon and into the air surrounding us or into the balloon if conditions are appropriate. The flavor extracts contain molecules small enough to diffuse through the balloon membrane and into the room. Eventually these molecules make their way to the olfactory receptors located in the superior part of the nasal cavity and these receptors send signals to the brain. Interestingly enough olfactory sensations are the only sensations that reach the cerebral cortex without first synapsing with the thalamus. Most people can recognize about 10,000 different odors.

Tips and tricks

Use latex verses Mylar balloons. Try blowing up the balloons a few times before you use them, the stretching seems to help the diffusion. You may want to fill one balloon up with nothing but air to act as a control.

THE LYNX AND THE HARE: PREDATOR – PREY – POPULATION GROWTH

(The source for this demo is the website at Flinn Scientific Inc. Publication Number 10109)
http://www.flinnsci.com/Documents/demoPDFs/Biology/BF10109.pdf
I have made minor modifications.

Materials: (for each group)

- Flat surface (about 4 square feet)
- Tape or ribbon (something to mark the area for the study)
- Prey (300 paper squares ~ 1 inch: snowshoe hares)
- Predator (1 cardboard square ~ 3 inch: Lynx)
- Population Data Table
- Graph paper

Procedure

1. Begin the simulation by populating the habitat with three hares—spatially dispersed within the square.
2. Establish a reasonable distance for the Lynx 'tosser' to stand from the square. Toss the cardboard lynx into the square in an effort to capture (i.e., land on any portion of) as many hares as possible. In order to survive and reproduce, the lynx must capture at least three hares when tossed. With the hare population at this stage, lynx survival is virtually impossible. Remove any hares captured and enter the tallies for the first generation.
3. The hare population doubles between generations—multiply *Hares Remaining* by two and enter the resulting number in the "Number of Hares" column for the second generation. Place the required number of hares in the square. If no lynx survived the previous generation another moves into the area. Toss the newly recruited lynx—repeating step 2. Remove any captured hares and enter the new tallies.
4. By generation 5 the lynx should be able to capture three hares when tossed. If successful, the lynx survives until the next generation and also produces offspring—(one per each three hares captured.) Toss the lynx square once for each lynx.
5. As the population builds it is important to separately tally each lynx's kills, removing captured hares after each lynx is tossed. Determine lynx survival and reproduction using individual lynx capture numbers. Remember, lynx produce one offspring for each three hares captured. If a lynx captures seven hares, three lynx enter the next generation—the original lynx and two offspring. Individual lynx capture numbers should be tallied on a separate sheet of paper and only totals entered in the table.
6. Between generations 9 and 11, the populations will probably crash back to, or near, zero. If and when this happens be sure to begin subsequent generations with at least three hares. Carry the simulation through 18–20 generations, by which time the cycle will be well on its way to repeating and the next few generations can be (relatively accurately) predicted.

Generation of Hares	Number of Hares	Number of Lynx	Hares Eaten (total)	Hares Remaining	Lynx Starved	Lynx Surviving	Lynx Offspring
1	3	1					
2							

Discussion

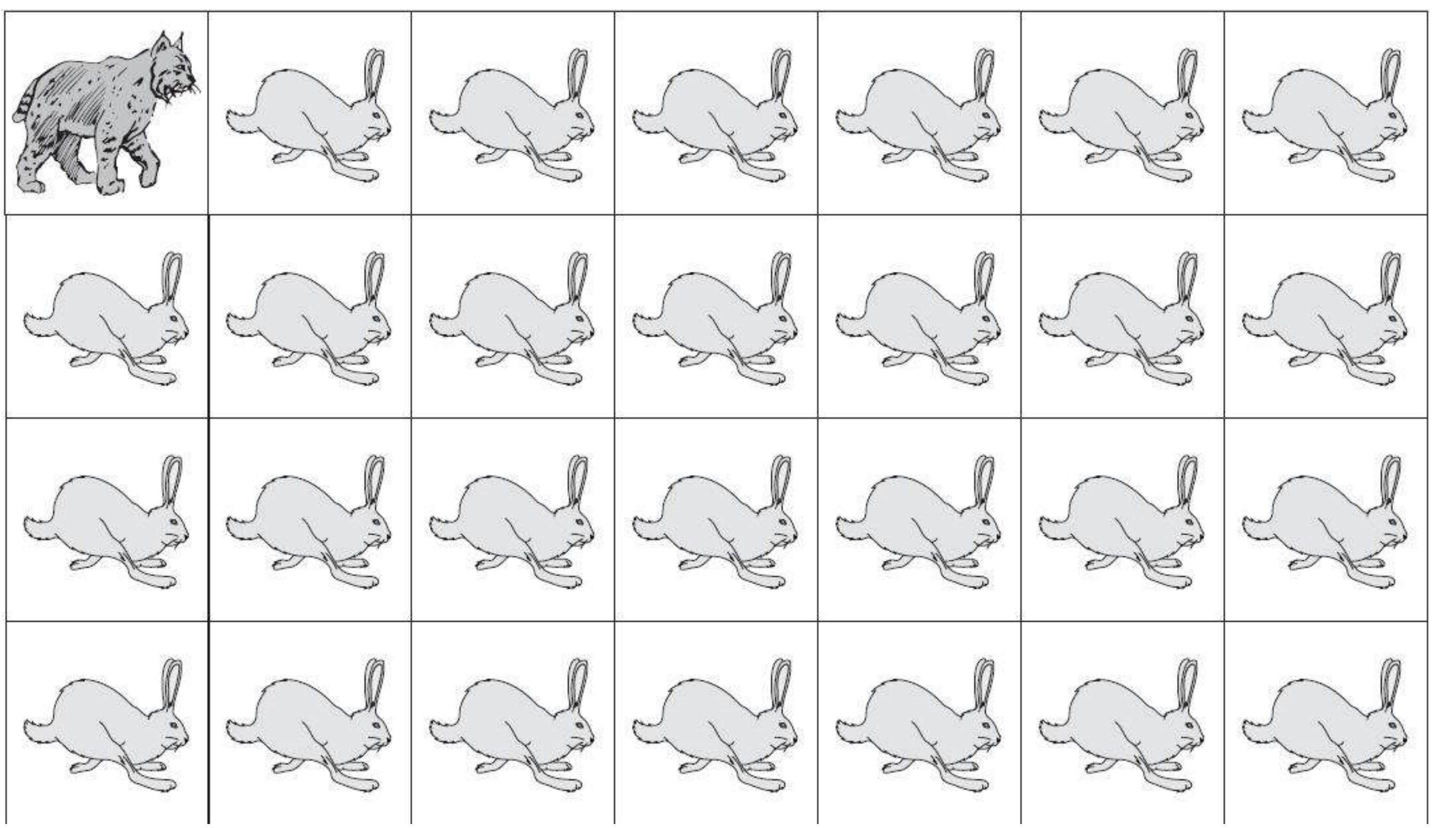
The data is best analyzed graphically. For each animal make a plot of population totals (the first two columns) versus generation number. By plotting the hare population and the lynx population side by side on the same graph, the relationship between the two becomes abundantly clear.

The most evident pattern is the near exponential initial increase in the prey (hare) population followed by a proportional increase in the predator (lynx) population. Students should note the lag time between the two populations. The predator population responds directly to fluctuations in the prey population—recovery follows recovery and crash follows crash.

Students should keep in mind that, as in any simulation (even sophisticated computer models), certain assumptions are made and many variables overlooked. Natural populations are subject to myriad pressures and disturbances such as immigration, emigration, overgrazing, disease, floods, droughts, fires, and extreme cold spells—to name a few. Many of these factors compound each other. Disease spreads more easily as population density increases. Hares intensively competing for food in overpopulated areas will be less able to resist droughts or freezes. The enormous complexity of a relatively simple system is mind-boggling.

If several groups are conducting the simulation, you may wish to introduce other variables. Disease or fire could reduce the hare population at any stage in the cycle. Human hunting or trapping activity could impact either population. Ask the students to imagine the outcome if the lynx were exterminated. Note the well-known impact on deer populations throughout North America—populations no longer regulated by natural predators. Studies have shown that natural predation pressure maintains the overall health and size of prey populations at optimal levels.

Graphics for the Lynx and snowshoe hares are below:



Sarah Butheres – Senior – Biology

BLOWING UP A BALLOON WITH A CHEMICAL REACTION

Materials

Vinegar
Baking Soda
Water Bottle
Funnel

Procedure:

Pour the vinegar into the bottle so 1/3 of it is full. Place 3 teaspoons of baking soda into a balloon. Vary carefully attach the balloon onto the top of the water bottle without mixing the vinegar and baking soda. To start the reaction tip the balloon upwards so the baking soda falls into the vinegar. The balloon will inflate.

Why:

Combining vinegar and baking soda is an example of an acid base reaction and a decomposition reaction. When the two ingredients are mixed, hydrogen ions (H+) from the vinegar react with the bicarbonate ions (HCO3-) from the baking soda to form a new chemical called carbonic acid (H2CO3).

$$H^+ + HCO_3^- \text{--->} H_2CO_3$$

The carbonic acid thus formed then immediately decomposes into carbon dioxide gas (CO2)and water (H2O).

$$H_2CO_3 \text{--->} H_2O + CO_2$$

It's this carbon dioxide gas that you see bubbling and foaming as soon as you mix baking soda and vinegar together. Using the molecular structures of only the components involved, the chemical reaction can be written: baking soda and vinegar reaction The overall reaction however, is often written as follows:

$$NaHCO_3\ (aq) + CH_3COOH\ (aq) \text{---->} CO_2\ (g) + H_2O\ (l) + CH_3COONa\ (aq)$$

CORNSTARCH AND WATER

Materials:

Cornstarch
Water
Bowl

Directions:

1. Pour approximately 1/4 of the box (about 4 oz.) of cornstarch into the mixing bowl and slowly add about a half a cup of water. Stir. Sometimes it is easier to mix the cornstarch and water with your bare hands (of course, this only adds to the fun).
2. Continue adding cornstarch and water in small amounts until you get a mixture that has the consistency of honey. It may take a little work to get the consistency just right, but you will eventually end up mixing one box of cornstarch with roughly 1 to 2 cups of water. Notice that the mixture gets thicker or more viscous as you add more cornstarch.
3. Sink your hand into the bowl and notice its unusual consistency. Compare what it feels like to move your hand around slowly and then very fast. Sink you entire hand into the goo and try to grab the fluid and pull it up.

Purpose:

The cornstarch and water stirred together create a mixture. When the solid grains of cornstarch are evenly spaced apart in the water, the starch grains slide easily past one another, as liquids do. When the mixture is squeezed, the grains are pushed together. This pressure makes the starch molecules stick together in a different way, so the mixture acts like a solid. When the pressure stops, the molecules come unstuck again, returning the mixture to liquid form.

All fluids have a property known as viscosity - the measurable thickness or resistance to flow in a fluid. Honey and ketchup are liquids that have a high resistance to flow. Water has a low viscosity. Newton said that viscosity is a function of temperature. The cornstarch and water mixture is an examples of non-Newtonian fluids because their viscosity changes when stress or a force is applied.

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.

SOLUBILITY

Materials:

1. One can of soda.
2. A glass container
3. Table salt
4. Teaspoon
5. Basin (to catch the overflow)

Procedure:

1. Pour the soda into the glass. Try to tip the glass and pour along the side so that the pop doesn't fizz too much. Then pour about one teaspoon or more salt into the glass with soda. This extra solute should make the soda fizz, which relates to gas being released due to excess solute and only a certain amount able to be dissolved by the soda.

Rationale:

Salt is very soluble in water. Air dissolves in water, but not very well, especially compared to salt. In a solution, the solvent (the water in this case) can only hold so much solute (stuff like salt, sugar, air, etc.) When the salt is added to the water, the water can't hold as much dissolved air in it, so the air escapes and we see the fizz.

A good example of this is pressure and fish or scuba divers. The deeper you go the higher the pressure gets and when there is higher pressure, the more solute that can be dissolved in a solution. So if a fish were to be brought up quickly or even a scuba diver swam up to quickly, the air would be released from the blood too quickly, potentially being fatal. It is necessary to understand that the higher in water you get or even the atmosphere, the pressure decreases and thus the amount of solute that can be dissolved also decreases. Gas is the easiest to dissipate from a solution, which is why you usually see a release of gas, thus the fizzing in the soda can.

Ed Mathews – Senior – Biology Major

Demo:

I have not written it up yet but I will be doing a demo to demonstrate polymers and I will be placing a balloon on a skewer like magic. I will send more later just wanted to reserve my spot.

Sarah Groth- Senior-Biology Education

CELL MEMBRANES FROM EGGS:

Materials:

- Water
- Oil
- Egg
- 150-200 mLFlask
- Eye dropper
- Small dish

Procedure:

1. Explain to students that we are made up of cells and that I will be doing a demonstration about cell membranes. Explain what a cell membrane is.
2. Obtain your flask and add 100 mL of water to the flask.
3. Then add 25 mL of oil to the flask.
4. Shake and then let separate. Explain how a type of membrane is formed so that the water and oil can not mix. This is how a cell membrane works. The cell membrane keeps the outside environment out of the cell to protect it. Ask: If all cells are made from preexisting cells, how does a cell membrane split and multiply?
5. Then, crack open the egg and put it into a small dish.
6. Using an eye dropper suck out some of the yolk and squirt drops into the oil and water mixture.
7. Wait for the reaction of the egg and the surrounding water and oil to form cells. This will demonstrate how a cell membrane can split and multiply.

Discussion:

Ask: Why is it important for a cell to have a cell membrane? Students will learn from this demo that cells keep themselves together using cell membranes. Students will also learn about the importance of a cell membrane for the cell and how it replicates.

SMALL CELLS RULE!

Materials:

- 1 large potato
- Knife
- A dark colored food coloring (blue is best) or iodine
- 2 beakers

Procedure:

1. Take the large potato and cut it into 2 cubes. On cube will be 1 cm3 and the other should be about 3 cm3
2. Soak both cubes in the iodine or food coloring solution for 4-6 minutes. The iodine will react with the starch to form a dark blue color in the potato (the same thing will happen with the food coloring)
3. As the potato absorbs the solution, the color will travel further into the potato.
4. Remove the cubes after 4-6 minutes.
5. Cut both cubes in ½
6. Compare the traveling of the blue color (the smaller cube should be almost completely blue, while the larger cube should have a slightly white center.

Discussion:

This experiment will demonstrate why it is advantageous for cells to be small in size. Because volume increases at an exponential rate when surface area increases, smaller cells will have a greater surface-area-to-volume ratio. The smaller size allows the cell to absorb nutrients at a higher efficiency than larger cells.

Preston Stafford – Junior - Biology Major

MARTIN GARDNER'S HEXAPAWN FOR TEACHING EVOLUTION

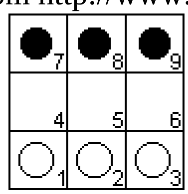
In a 1963 *Scientific American* article, Martin Gardner proposed the game of Hexapawn as a game that a simple machine could learn to play. Hexapawn is played with three white and three black pawns on a 3x3 square board. A player wins when either: one of their pawns reaches the other side or the other player has no legal move when their turn comes. The player who goes first in Hexapawn will always lose if she is playing against a knowledgeable player. Martin Gardner thought this was a game that could be learned by a very simple computing machine. There are now Hexapawn programs written in Basic, for the HP 41C calculator and the iPhone.

What I propose is a variation of what Mr. Gardner originally proposed: 24 index cards showing each of the possible positions and 24 containers. Each container contains a colored M&M for each of the possible "computer" moves.

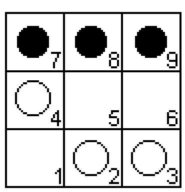
The rules are:

1. Each pawn can only move one square at a time
2. Capturing is done diagonally, just like in chess
3. You cannot move through a piece
4. If you can't move when your turn comes, you lose
5. If your piece reaches the other side of the board you win

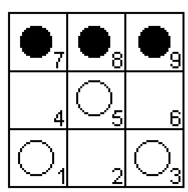
Your first six boxes will look like this: (taken from http://www.hpmuseum.org/software/41td/hexpawn.htm)



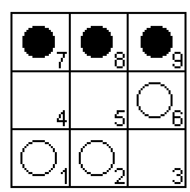
Leads to three possible positions after White's first move:



1 to 4



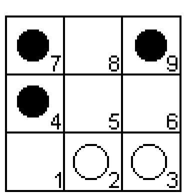
2 to 5



3 to 6

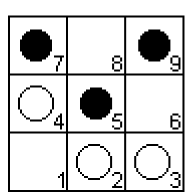
Let's say the human chooses the 1 to 4 position. The "computer" has three possible moves. Each move gets its own M&M. The student randomly chooses an M&M from the 1 to 4 container and makes the "computer" move to match the picture.

Red



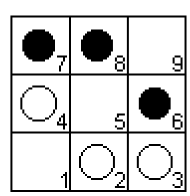
8 to 4

Blue



8 to 5

Green



9 to 6

At first, the moves are simply random and the "computer" will lose most of the time. Every time the "computer" loses, the M&M for the last move the "computer" made gets eaten removing that choice from the available choices. Anytime the "computer" wins the M&M is put back into the container for that position.

It won't be long before the computer wins all the time in accordance with Mr. Gardner's prediction.

This can be used to teach the power of the Theory of Evolution. Random variation (picking the M&M) and selection (eating the M&M for the last unsuccessful move) allows the “computer” to evolve into an unbeatable opponent.

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.

Sean Scribbick – Senior – Biology Major

BURNING MONEY CHEMISTRY DEMONSTRATION

Scientific Concept behind Burning Money

A combustion reaction occurs between alcohol and oxygen, producing heat and light (energy) and carbon dioxide and water.

$$C_2H_5OH + 4\ O_2 \rightarrow 2\ CO_2 + 3\ H_2O + \text{energy}$$

When the bill is soaked an alcohol-water solution, the alcohol has a high vapor pressure and is mainly on the outside of the material (a bill is more like fabric than paper, which is nice, if you've ever accidentally washed one). When the bill is lit, the alcohol is what actually burns. The temperature at which the alcohol burns is not high enough to evaporate the water, which has a high specific heat, so the bill remains wet and isn't able to catch fire on its own. After the alcohol has burned, the flame goes out, leaving a slightly damp dollar bill.

Materials:

Here is what you need to perform the burning money demonstration:

- dollar bill (higher denomination if you're brave)
- tongs
- matches or a lighter
- salt (or one of these chemicals if you want a colored flame)
- solution of 50% alcohol and 50% water (you can mix 95% alcohol with water in a 1:1 ratio, if desired)

Performing the Experiment

- Prepare the alcohol and water solution. You can mix 50 ml of water with 50 ml of 95-100% alcohol.
- Add a pinch salt or other colorant to the alcohol/water solution, to help produce a visible flame.
- Soak a dollar bill in the alcohol/water solution so that it is thoroughly wet.
- Use tongs to pick up the bill. Allow any excess liquid to drain. Move the damp bill away from the alcohol-water solution.
- Light the bill on fire and allow it to burn until the flame goes out.

Safety!!!

This is an experiment involving fire. Have a source to extinguish the fire in case of an emergency occurs.

Sources:
http://chemistry.about.com/od/demonstrationsexperiments/ss/burnmoney_3.htm

Brooks Williamson - Post Graduate – Chemistry

GAS-PHASE ACID-BASE REACTION

Materials:
2 flasks
2 rubber stoppers
conc. HCl
conc. NH_3

Place both vessels on a dark surface (or in front of a dark backdrop). Unstopper vessels. What appears to be vapors is in fact the product of an acid-base reaction occuring in the gas phase:

$HCl\ (g) + NH_3\ (g) \rightarrow NH_4Cl\ (s)$

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.

Misty Rains (Kintzley) - Post Graduate – Biology

ATP ENERGY JAR

Teaching the order of phosphorylation in the ATP/ADP cycle can be confusing, and students may struggle with the order of events. This example is a visual representation of when energy is lost and needed in the system

Materials:

- Jar with screw cap
- 4 strips of paper
- tape

1. Get a large jar with a screw top, such as a mayonnaise or canning jar.
2. Cut two strips of paper and fit them around the jar. Put a *P* on both of them.
3. Make a third strip of paper and fit it around the lid. Put another *P* on that strip.
4. Print the word *ENERGY* on a strip of paper and tape it so it hangs down the inside of the lid. **This jar represents a molecule of ATP.**
5. Remove the lid, and show how energy is released when a phosphate is removed.
6. Ask them what molecule remains, and they should say that it is ADP because of the two *P* s on the jar. When ADP is converted to ATP, a phosphate group is required, and it takes energy to phosphorylate the ATP.
7. Put the lid back on the jar, and show that the energy is now stored in the molecule.

Joyce Parrish - Senior - Biology Major

HOW THE LYTIC CYCLE AFFECTS NEIGHBORING CELLS?

Materials:

- Balloon
- Pin to pop the balloon
- Hole punch confetti

Procedure

- First put some hole punched paper (confetti) in the balloon
- Blow up the balloon
- Tell the students that each one of them is now a cell
- Go into the middle of the class and pop the balloon
- Ask the students how many of the cells are now effected

Explanation

This demo will emphasize why viruses are virulent. This will explain the lytic cycle of the viruses. When the cell lyses the viruses are expelled, free to affect other cells. So you can ask students surrounding the exploding balloon how many people (representing cells) are not infected by the virus.

MUSCLE CONTRACTION

Materials:

- Mousetrap

Procedure:

- Put the mouse trap together properly
- Explain that muscle contraction is like a mouse trap….all or nothing…set the mouse trap off, it goes all the way

Explanation

This demo will help explain the way muscle contraction works. It is either all or nothing, muscles don't work halfway. They receive a signal and contract. They need ATP in order to release, just like when you have to reset the mousetrap. You can also explain rigor mortis at this point as well.

EVOLUTION MOUSE TRAP THEORY

Materials:

- Mousetrap

Procedure:

- Take the mousetrap apart piece by piece
- At each point, hold a class discussion about how the mousetrap is affected. Is it still functional? Can it be used for something else?

Explanation

Evolution is usually discredited by the theory that complex structures cannot be simplified. They sometimes use a mousetrap to prove this. If you remove one aspect of the mousetrap it is no longer functional. Well, it is no longer functional as a mousetrap, but it could be used for other things. For example, the bottom wooden part can be used for kindling wood. It's no longer functioning as a mousetrap, but yet still functional as something totally different.

Chris Walker – Junior – Physics Major

OPTICAL MODEL OF SEISMIC WAVES