Spring 2001 - Methods Demos

The following demonstrations were presented by the Spring 2001 SCED 441 - Secondary Science Methods Class at UNC.

1. Effect Of Pressure On The Size Of A Balloon - Beth Kochevar
2. Investigating Limiting Reactants - Mica Deike
3. Food Calories: - Ethan Emery
4. Osmosis and Eggs - Laura Sanches
5. How Massive? - April Griffo
6. Magic "Floating" Coin - Ryan Evans
7. The Egg Trick - Steve Ottmer
8. What Happens When Air Is Heated - Mishon Reps
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11. Grape Balls Of Fire - Nikki Turner
12. A Magnetic Torsion Pendulum - David Lloyd

1. Effect of pressure on the size of a balloon - Beth Kochevar

The purpose of this demo is to relate the ideal gas law to what the students observe. Start by clamping a 4 L filter flask to a ring stand. Blow up a balloon so the sides become rigid but it should still fit through the neck of the flask. Tie the balloon closed and insert into the flask. Seal the flask with the stopper and attach one piece of vacuum tubing to the flask. Connect the other end of the tubing to a stopcock a second piece of tubing the stopcock and an aspirator. Turn on the aspirator and slowly open the stopcock. The balloon will increase in size. When the stopcock is closed and unattached from the aspirator the balloon will shrink again. If this demo is done around Easter the marshmallows bunnies will work in place of the balloon but they will only work once because the air is not in the pockets of the marshmallow after it is deflated. Try to have the students relate their observations to the ideal gas law and determine what is changing and what variables are remaining constant.

2. Investigating Limiting Reactants - Mica Deike

Materials Needed:

Household vinegar (5% acetic acid, $HC_2H_3O_2$), 100mL
Sodium bicarbonate, $NaHCO_3$ (baking soda), 5g
Funnel
5 party balloons, 12” round
5 Test-tubes, 18 x 150 mm

Procedure:

1. Add 11.5 mL of 5% household vinegar to each of the six test tubes.
2. Add the following amounts of baking soda to the five 12" party balloons:
   0.2g, 0.4g, 0.8g, 1.6g, and 3.6g
3. Make sure the baking soda is sitting on the bottom of the balloon and not near the opening of the balloon.

4. Attach the five balloons to the five test tubes containing vinegar. Make sure the contents of the balloon do not mix with contents of the test tubes and that all the air has been squeezed out of the balloons.
5. After all the balloons are securely fastened to the test tubes, one at a time lift the balloons allowing mixing of the balloon and test tubes contents.
6. Record observations of each test in the table in the inquiry section.

Results:

The first three balloons should increase in size as more baking soda is added to the vinegar. However the last two will end up about the same size as the middle balloon. While the first three test tubes should only contain a clear liquid when finished, the last two balloons should have a lot of undissolved baking soda. The first two test tubes are limited in their reaction by the amount of baking soda present while the last two are limited by the amount of vinegar present. In this demo, only the middle test tube contains exactly the right amount of baking soda to react with all the vinegar so that there is no unreacted material of any kind present at the end.

3. Food Calories: - Ethan Emery

Food Calories:

-Place 25 ml of water (25 g) in a small beaker and measure the temperature in degrees Celsius.
-Measure the mass of a high fat nut (Brazil nuts, cashews and even peanuts work well).
-Stick a long pin through a cork and place the nut on the point of the pin.
-Ignite the nut. This may take a couple of tries.
-Hold the beaker above the burning nut so that the flame will heat the water.
-When the flame goes out, measure the final temperature of the water.
-Use the data to calculate the number of food calories in the nut.

$$\text{Food calories} = \left(\frac{\text{mass of } H_2O \text{ in grams} \times \text{change in temperature}}{1000}\right)$$

-Find the accepted value for the calories of your type of nut and compare the experimental value to the theoretical value.

This demonstration can be performed will less formal apparatus if necessary. A pop can with the lid cut off will transmit the heat better than the glass beaker. The thermometer can be dispensed with if ice is melted rather than water heated. Fill the can about half full of ice. Hold the can over the burning nut and melt the ice. When the ice goes out, measure the volume in mL or water produced (ice melted). Since it takes 80 calories to melt 1 mL of ice, the number of food calories can easily be calculated.

$$\text{Food calories} = \left(\frac{80 \times \text{volume of ice that melted in mL}}{1000}\right)$$

4. Osmosis and Eggs - Laura Sanches

Take regular eggs that you can buy at the store. Cover them with vinegar until the whole egg is covered. Let this sit for at least 24 hours. It really works well after 48 hours. This will allow the shell to come right off. In case the shell is hard to get off, hold it under running water while rubbing. Be very gentle because it is easy to break the egg.

Put the eggs into different solutions to show movement across a membrane (osmosis) and observe the results. It is a good idea to keep the eggs in the solution for 24 hours to have best results. This is a good demo to explain hypotonic and hypertonic. Two solutions that are good to use are water (regular tap water works fine) and corn syrup (a strong brine solution should also work). The egg will become hypotonic after it has been in water (water will have moved into the egg), and corn syrup works well to show hypertonic (water moving out of the egg). Other solutions would work also, and I suggest playing around with it for a while to see what else would work.

5. How Massive? - April Griffo

How much of the solar system's mass is contained in the sun? Where's all the matter in the solar system?

There are nine planets, 65 moons, and billions of smaller objects in the solar system. But almost all of the matter in the solar system is contained in one object, namely the sun. Imagine you have a basket containing 100 potatoes. Those 100 potatoes represent the whole mass, or amount of matter, in the solar system. Take one potato out of the basket and cut it in to seven equal pieces. Put six of these pieces back into the basket. Those 99 potatoes plus the extra six pieces of the cut-up apple stand for the mass of the sun!

The one piece of potato left over stands for the mass of the rest of the solar system. Cut that piece in 10 equal parts. Seven of these parts are for Jupiter, the largest planet. Two of these parts stand for Saturn, the second-largest planet.

Most of the remaining part of the potato can be divided among the other seven planets. Cut the remaining part in half. Those two pieces stand for Neptune and Uranus. The small specks of potato left on the knife represent Earth, Venus, Mars, Pluto, and Mercury. Some of the microscopic particles of the potato would make up the 65 moons, the comets, the asteroids, and the meteoroids that are also part of the solar system.

The basket of potatoes gives you a model for understanding how mass is distributed in the solar system.

Compare the mass of each planet to the mass of the Earth.

6. Magic "Floating" Coin - Ryan Evans

Take a coin made of aluminum, such as a Chinese 1 yen coin, and rest it on the surface of the water. You can use a bent paper clip or a fork to carefully place the coin on the water's surface. It is held there by the surface tension of the water. This tension is caused by the polar hydrogen bonds between water molecules and is similar to an elastic rubber membrane or balloon. If you look closely you can see the "skin" bending, and sagging under the weight of the coin.

Next, try to rest a coin with a thin film of soap on it. This task should be more difficult because soap breaks down the surface tension of the water. This demonstrates why we use soap for washing. It allows water to get into the cracks and surround dirt particles so they can be washed away.

7. The Egg Trick - Steve Ottmer

<u>Concepts:</u> convection and air pressure

<u>Materials:</u> wide mouth glass bottle, candle, matches and a hard boiled peeled egg.

<u>Method:</u> Place the candle inside the bottle and light it with a burning piece of paper. Place the egg lightly over the top of the bottle. The air inside of the bottle is heated from the candle, thus making it expand and pass over the outside of the egg. Eventually the fire will extinguish itself because all the oxygen is used up and all that is left is carbon dioxide. Once the flame goes out the temperature will cool thus creating a lower air pressure inside of the bottle. This increase in temperature pulls the egg into the bottle.

To get the egg out, turn the bottle upside down so the egg is at the mouth. Cool the bottle slowly then invert the bottle in a warm temperature bath. The change in temperature changes the pressure again thus pushing the egg back out. Or if you don't mind a little egg on your face, blow hard into the bottle while you hold it upside down.
Warning: After repeated attempts the bottle may eventually break!

8. What Happens When Air Is Heated - Mishon Reps
Materials: A yard stick, paper lunch bags, a folding chair, masking tape, a candle, and matches.
Procedure: Tape a paper bag to each end of the yard stick on the same side(facing down). Then, balance the yard stick on the back of the chair like a teeter-totter. When it is completely balanced, light the candle and place it under one bag. The yard stick will then teeter (go down) on the cooler side because the bag with the candle under it will act like a hot air balloon. Hot air is lighter than cool air, because it has less mass per unit volume. The gas laws dealing with temperature and volume explain the affect on density of a gas when conditions are changed.

9. Endothermic and Exothermic Reactions - Jeff Stephens

Chemical changes are usually accompanied by a change in heat. If heat is absorbed in a reaction, the reaction is said to be endothermic. The products are higher in heat content than the reactants. A reaction in which heat is given off is exothermic. In this case, the products are lower in heat than the reactants. The amount the temperature increases or decreases in a given reaction can be measured by placing a thermometer in the reaction vessel.

This experiment uses a half a cup of Ammonium Nitrate (NH_4NO_3) and a half a cup of Calcium Chloride ($CaCl_2$). They are in plastic Ziploc bags and are mixed with a half a cup of water. When mixed with water one will release hit and the other becomes cold, absorbing heat.

The majority of students should be familiar with instant cold packs and heat packs. Most students have seen the heat packs or cold packs that instantly turn cold or hot.

10. Water Distribution Demonstration - Chad Unrein

This demonstration is designed to show students the amount of useable water the earth contains. It also will show students the percentages of the amount of water contained in the oceans, icecaps and glaciers, ground water, surface water, and air and soil.

97.2% Oceans (saltwater)
2.8% Freshwater

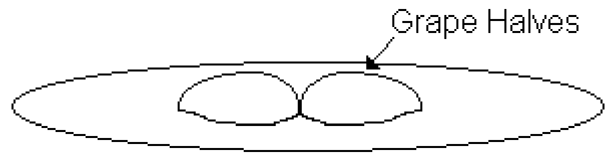
Freshwater
2.38% Icecaps, glaciers
0.397 Ground water
0.022% Surface water
0.0001% Air and soil

To start this Demonstration you will fill up a jug with 1000 ml of water this represents all the water on earth. Next you will pour out 972 ml of water in separate jug to represent the ocean waters. The remaining 28 ml of water represents the freshwater. Next you will pour out 23 ml to represent the amount of water contained in the Icecaps and Glaciers; then 4 ml to represent ground water. Next you will take your eye-dropper and use 2 drops for surface water and 1 drop for the water in the air and soil.

11. Grape Balls Of Fire - Nikki Turner

This demo can be used as an introduction to scientific investigation and experiment design.

Materials: seedless green grapes
microwave
microwave-safe dish
knife or other cutting utensil



Procedure: Cut a grape nearly in half length-wise. Place the grape (still attached by a thin bit of the outer skin) face down in the center of the dish. Put the whole she-bang in the microwave. Set the timer for 30 seconds on high power. Press "start".

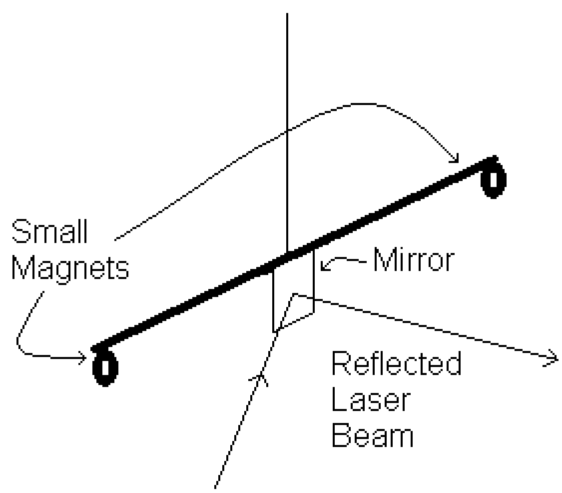
Observe: After watching this demonstration, students would be asked to design their own experiment using the same materials to try to explain how an experiment is run, what variables are important, what a control is for, etc.

12. A Magnetic Torsion Pendulum - David Lloyd

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

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

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



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