COOL SCIENCE DEMO'S

FROM THE

I.C.E.

WORKSHOPS

In 1987 the University of Northern Colorado became a field center for the Institute of Chemical Education. Summer I.C.E. workshops for teachers have been presented each summer since. The following are a number of the most popular simple demonstrations from those workshops. We hope that you find them useful and that your students enjoy them.

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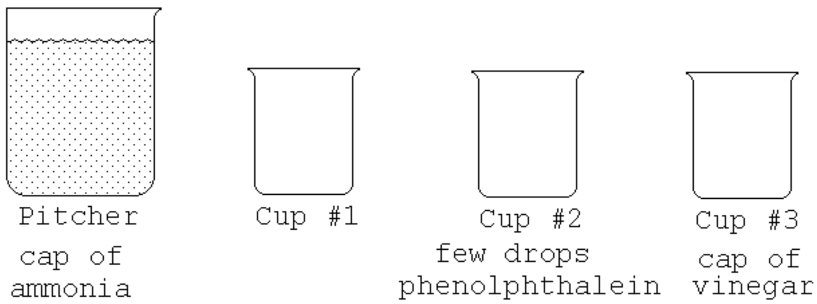
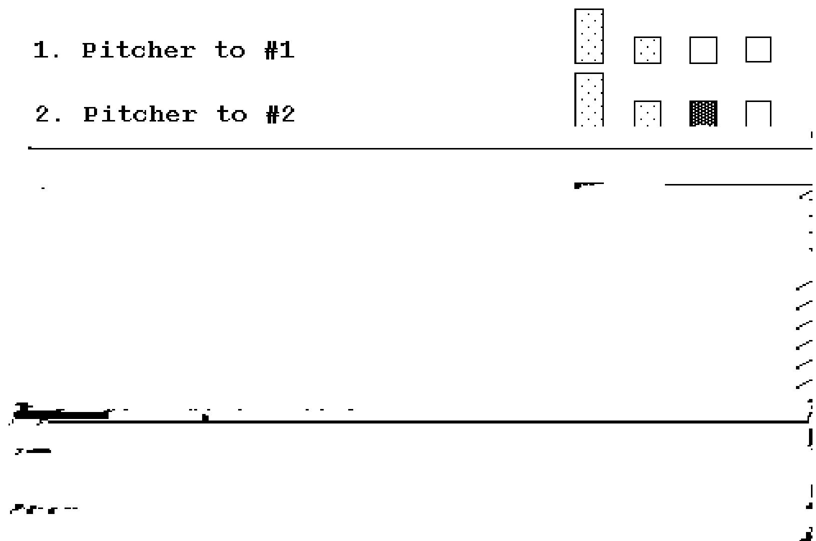
1. ACIDS and BASES

A. Water to Wine



The phenolphthalein solution can be made by dissolving 3 or 4 Non-chocolate Exlax tablets in a bottle of denatured alcohol. Cup #3 should contain a bit more vinegar that the pitcher has ammonia.

A clear liquid from a pitcher is poured into cup #1 but becomes pink when poured into cup #2. The contents of cups #1 and #2 are poured back into the pitcher. The liquid in the pitcher is now pink. The pink liquid is poured into cups #1 and #2 but turns clear when poured into cup #3. The contents of all three cups are poured back into the pitcher. The liquid in the pitcher becomes clear and the clear liquid is poured into all three cups.



B. Magic signs

Phenolphthalein solution is clear when neutral or acidic but turns pink when basic. This allows a white piece of paper to be painted with phenolphthalein solution and allowed to dry. When the previously prepared paper is sprayed with a weak ammonia solution or Windex, a message magically appears. The message will also magically disappear as the ammonia escapes into the air.

C. Acid/Base Paper

The easiest way to test for acids and bases is to use something already available. Real golden rod paper is colored with a natural acid/base indicator. it is golden when exposed to an acid and pink when exposed to a base. It is usually best to have both the normal golden paper as well as pink available. To make the pink dissolve a tablespoon of baking soda in a cup of water. The baking soda solution can be "painted on" to a normal golden sheet and then left to dry. I prefer to make a pink strip using a cheap foam brush to apply the baking soda on a normal golden sheet and have students make all their tests on one sheet. The next page is an example of a sheet which can be printed off on golden rod paper with one row of boxes painted with baking soda solution.

D. Learning Liquids

For each liquid, use a Q-Tip cotton swab to transfer enough of the liquid to wet both squares. Use a **NEW** Q-tip for each liquid. Observe the results and record your observations.

OBSERVATIONS

☐ ☐ 1. Lemon Juice ______________________________

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☐ ☐ 2. Vinegar ______________________________

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☐ ☐ 3. Liquid Cleaner ______________________________

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☐ ☐ 4. Water ______________________________

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☐ ☐ 5. Baking Soda in Water ______________________________

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☐ ☐ 6. Soapy Water ______________________________

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☐ ☐ 7. Orange Juice ______________________________

____

☐ ☐ 8. Ammonia ______________________________

____

Other substances of your own choice.

☐ ☐ 9. (____________________) ______________________________
name of substance

____

☐ ☐ 10.(____________________) ______________________________
name of substance

____

E. Cabbage pH paper

Traditionally a substance can be tested as an acid or base with a piece of litmus paper. If the litmus paper strips are allowed to dry after use they may be used again several times. However, a better acid/base test paper can be formed by soaking coffee filters in red cabbage juice, allowing the

3. HOT AIR

A. Candle in a Jar

One of the demonstrations that is most commonly miss-explained involves lighting a candle which sticks above some water in a shallow trough. If a beaker (or jar) is inverted over the top of the candle, water will gradually partially fill the beaker. This is commonly miss-explained as being due to the candle using up the oxygen as it burns in the confined air of the beaker. The correct explanation is that the candle heats up the air. The air expands and some leaves the jar. When the air inside the jar begins to cool, it contracts and water begins to fill the beaker.

B. Egg in a Bottle

The same principle is at work in TV's Mr. Wizard's (Don Herbert) favorite demonstration of all time. This demonstration is commonly called the "egg in a bottle" demonstration. A burning strip of paper is put into a glass bottle with a mouth slightly smaller than a hard boiled egg. An old fashioned milk bottle is commonly used but a glass cranberry juice jar will also work. When a peeled hard boiled egg, or a water balloon of about the same size, is placed on the jar's mouth, the egg will pop into the bottle. Again this is often miss-explained by saying that the fire was using up the oxygen while the correct explanation is the same an above. The air is heated by the fire and expands therefore some air leaves the bottle. When the air cools, the pressure inside drops and the egg is pushed into the bottle by the normal air pressure. To get the egg out, turn the bottle upside down and blow very hard. You may end up with a black mustache but the kids will love it.

C. Dancing Quarter

Another fascinating experiment that involves the expansion of heated air involves placing a wetted quarter on the mouth of a narrow mouth glass bottle such as a pop bottle or vinegar bottle. If a pair of hands are clasped around the bottle, the warm air in the bottle will expand and gently "burp" the quarter on the mouth of the jar a few times.

D. Balloon in a Bottle

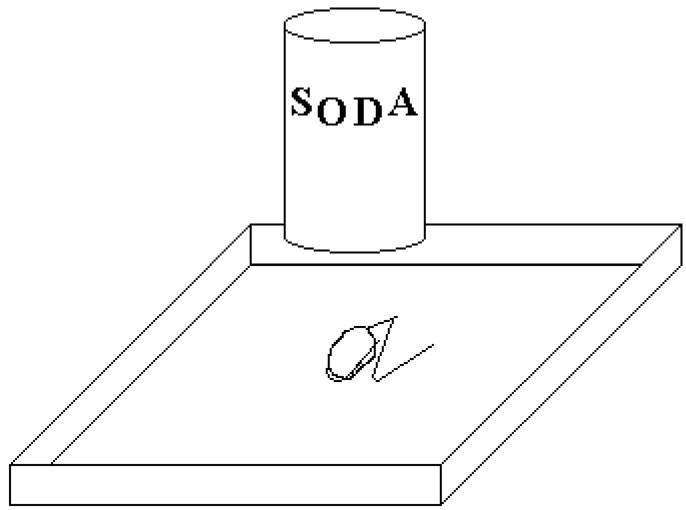
A 300 ml florence flask or a glass soda pop bottle can be gently heated with about 25 ml of water in the bottom until the water boils. If a rubber balloon is then quickly fitted to the top, the pressure inside will decrease as the water vapor inside gradually cools down and the balloon will be forced inside the flask due to the air pressure in the room. If done carefully, you will end up with a balloon blown up inside the flask. If students are first shown the balloon in the flask and asked how it was done, they will soon discover that it is not a simple task and will be very receptive to find out how it was done. The explanation is very simple. As the water was boiled, steam forced most of the air in the flask out. After the balloon is placed on the top, the air cannot reenter. So, as the temperature in the flask begins to drop, the steam condenses back into water leaving a lower pressure inside the flask than out. This is what causes the balloon to be pushed into the flask.

4. THE BURNING PEANUT

In this experiment you will measure the energy given off when a peanut burns. Since it takes 80 calories to melt 1 gram (1 ml) of ice, we will only have to measure the amount of ice that melts while the peanut burns to get a measure of the thermal energy. It is interesting to note that most of the food we eat is burned in our bodies to keep us warm rather than to give us energy to allow us to move around.

Lay a sheet of aluminum foil on the table top to protect the surface. Turn up the edges to make a shallow tray. If the peanut falls off the stand, the edges should keep it from failing on the floor. Fill the "SODA" can about 1/4 full of ice.

Set the peanut on a paper clip stand as shown above. You will then need to light the peanut. The match should be held directly below the peanut to get it started. It might take a couple of matches to get the peanut burning. As someone tries to light the peanut another person should pour off any excess water that has collected. There should be as little water in the can as possible when the peanut starts to burn. As soon as the peanut starts to burn by itself, the match should be removed and the "SODA' can held about 5 centimeters (2 in.) above the peanut.



Hold the can above the flame and gently swirl as long as the peanut continues to burn (if your peanut goes out prematurely you will have to relight it). When the peanut has burned as completely as it is going to, measure the volume of water that was melted by the flame.

On the back of this instruction sheet:

1. Calculate the heat required to melt your water by multiplying the volume in ml by 80.

2. Determine the heat given off by the peanut in both calories and food Calories (1 food Calorie - 1,000 calories).

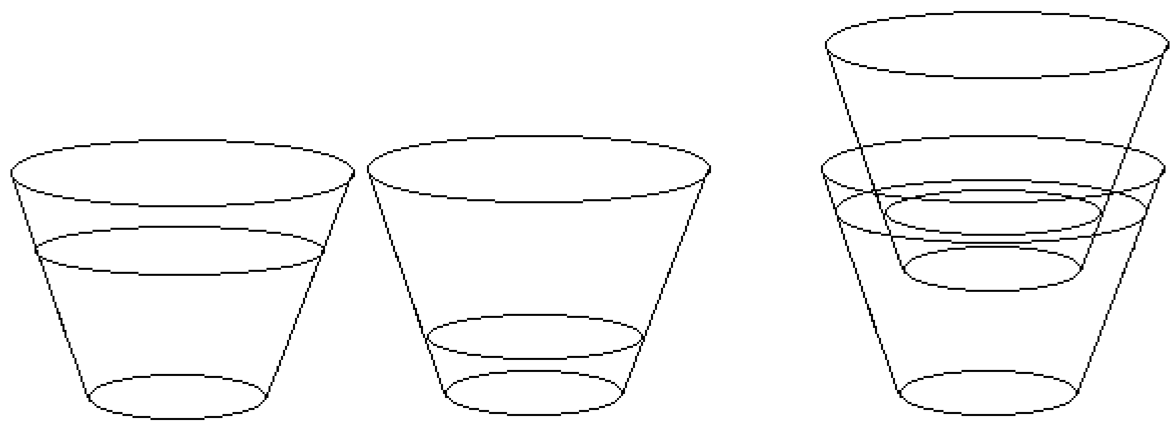
3. There are about 40 average peanuts in a one ounce serving. How many calories would there be in an average serving? How many food Calories?

4. How does your value of food Calories per serving size compare to the class average? How does the class average compare to the label? Why do you think the class average is different from the label?

NOTE: This experiment usually gives about half the value given on the libel because of all the lost heat, but it is still amazing to see how long the peanut burns. Many other foods will also work instead of peanuts. For example you could try the same experiment with Cheetos.

5. ARCHIMEDES' PRINCIPLE

The formal statement of Archimedes, usually means very little to students who are learning science and why things float or sink. The following demo is a nifty way to catch students attention. Start with two clear plastic disposable tumblers. Fill one nearly to the top then ask the students if they think that the empty second glass will float in the first glass filled with water. Most will agree that it can and will be pleased that they were correct when you demonstrate it to them. Then pour about 1/3 of the water into the second glass and repeat the question again. Will the glass I/3rd filled float in the glass that is 2/3rds filled? Again, most will agree that it will. When it is demonstrated, the cup does float as expected. Finally, pour another third of the first cup into the second and repeat the question. Will the second cup which is now 2/3rds filled be able to float in the first cup that is now only 1/3rd filled? Most of the students will agree that it will not but watch the surprise on their faces when you actually try it!



This demonstration can really help with an understanding of Archimedes' principle if a line is drawn at the starting level of the water in the first cup. Because the disposable tumblers are so light no appreciable water will be displaced when the second empty tumbler is placed on top of the water and floated. Therefore, the water level remains basically in the same place. During the second try when the second cup is 1/3rd filled, students should be able to observe that the water in the first cup is displaced (rises) to its original position AND that the second cup will sink until its water level is essentially equal to the original mark and the water in the first cup. Finally, when the second cup is filled with 2/3rds of the original water, students should notice again that the water in the first cup will rise to its original level and the second cup should sink until its water level is even with the water level in the first cup.

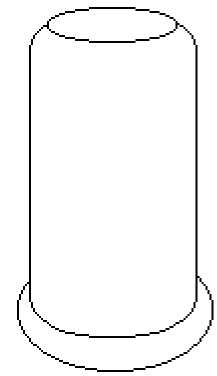
This is a good vivid example that floating objects are buoyed up with a force equal to the weight of the water that they displace. Since the disposable tumblers are nearly weightless compared to the water that we are working with, the weight of the floating object is equal to the weight of water it contains. Therefore, it always floats so that the water level inside is equal to the water level outside. Since the volume of water that has been removed from the first cup is the difference between the present water level and the original mark, the water will always rise to its original level when the other glass is floated on top.

6. CARBON DIOXIDE

One of the easiest and safest chemical reactions to demonstrate is the reaction of baking soda with vinegar to produce carbon dioxide. This reaction can be demonstrated a number of ways for spectacular effects.

A. Pouring CO_2

The simplest method is to pour some vinegar into the bottom or a 2 liter soda pop bottle that has had the neck cut off to form a simple beaker as shown in the diagram. A few table spoons of baking soda can then be dropped into the beaker and students can observe the reaction and see the formation of the bubbles. To show that carbon dioxide is really the gas produced, the beaker can be gently tipped over a burning candle. Students can observe that the candle is extinguished by the CO_2 gas.



B. Rising CO_2

If an old aquarium is available, a similar but even more dramatic demonstration can be preformed. Put a thin layer (1/4 inch) of vinegar in the bottom of the container. Then stand 3 or 4 candles of different height in the bottom of the aquarium. If you don't have candles of different heights, you can stand the candles on object of different heights. By adding a few tablespoons of baking soda the reaction will begin. As the aquarium begins to fill with CO_2 the candles will go out one at a time starting with the lowest candle first.

C. Popping a Cork

Students seen to like explosions while teachers are usually a bit more cautious. The following is a simple way to show an explosion without fire. Put some vinegar into a regular 2 liter soda pop bottle. Wrap about 2 tablespoons full of baking soda loosely in a small tube of aluminum foil. The tube needs to be small enough to fit through the mouth of the bottle. Gently insert the tube into the bottle; then close the mouth with a cork. When the bottle is shaken, the vinegar and baking soda will mix and $C0_2$ will build up pressure inside the bottle and eventually blow the cork off. caution: the cork can be expelled with considerable velocity. Make sure the bottle is not pointed at anyone.

D. Alka-Seltzer Rocket

A variation on the experiment above is to put some water into a film canister (the clear ones are the only ones I can get to work). Break an Alka-Seltzer tablet into quarters and drop into the water. Quickly put on the top and turn upside down. When the pressure builds up sufficiently the film canister will "take off." Since the water creates quite a bit of mess You would probably want to do this outside.

7. SIPHONS

Most kids are fascinated by siphons. Siphons work because of the unequal pressure set up in the two unequal sides Of the tubing.

A. Simple Siphon

A very simple siphon can be set up with a short piece of plastic tubing in a cup of water. If the siphon is draining onto the ground, it will continue until the cup is dry or the water level is equal to the bottom of the free end. If the siphon is draining into another cup it will continue until the water level is equal in both cups.

B. Twisted tissue

There are several additional examples of unusual siphons. A piece of twisted tissue can be set into a cup full of water. The water will gradually climb up the tissue by capillary action and then be pulled down the other side by gravity until the first cup is empty or the two levels are equal.

C. Automatic Siphon

An automatic siphon can be made by taking a small piece of tubing and forming a V or a W. When one end is quickly thrust into a full cup of water, inertia will allow the water to reach the top of the V and allow the siphoning action to begin.

D. Tantalus Cup

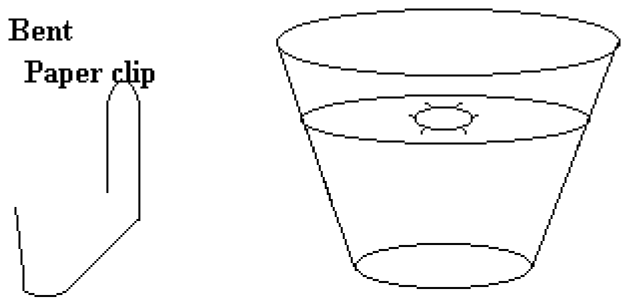
In Greek mythology, Tantalus was the son of Zeus (Jupiter in Roman mythology) and the

<u>8. SURFACE TENSION</u>

Molecules Of a substance have a tendency to attract other molecules of the same substance. This property is called cohesion and makes the surfaces of liquids behave as if they were covered by a flexible Plastic membrane. This property of liquid surfaces is called surface tension and is responsible for a number of interesting phenomena.

<u>A. "Floating" Coin</u>

A paper clip, pin, or Japanese one yen piece can be gently placed on the surface of water. This is most easily accomplished by bending a paper clip as shown, placing the object on the horizontal portion, and slowly dipping the paper clip in water. If the object is carefully observed as it rests on the surface of the water, It can be seen that the surface is pushed down but that the object does not enter the water. The top of the object is often even below the surface of the surrounding water.



<u>B. Drops on a Penny</u>

Ask students how many water drops can be placed on top of a penny before the water runs off. Have then try it. They will usually predict something less than 10, but they are usually able to place well over 20 drops on the penny. The surface tension of the water will allow a relative large amount of water to pile up before it bursts like a bubble. A variation of this is to fill a glass with water until the surface of the water is level with the top of the glass. Then ask students how many pennies, paper clips, or nails can be put into the glass before it' overflows. Again the estimates are usually far under the actual number.

<u>C. Peanut Butter Jars</u>

The mouth of two peanut jars can be covered with screen door screening. Water can be poured into the jars and back and forth as if nothing was on top of the jars. However, if your hand is placed over the mouth of one jar and the jar inverted, the water will be held inside without leaking until the jar is tipped. When tipped, the water will quickly drain out.

<u>D. “Floating” Fruit Baskets</u>

A plastic fruit basket from the grocery store like the kind that often contain strawberries, raspberries, or blue berries can also be used to demonstrate surface tension. When gently placed on the surface of some water in a tray, the basket will rest on the surface of the water and appear to 'float." A couple of coins can even be placed in the basket without sinking. The action of soap and detergent on surface tension can be observed by dropping a couple of drops of soap in the middle if the basket boat. The basket will immediately sink as the detergent breaks the surface tension.

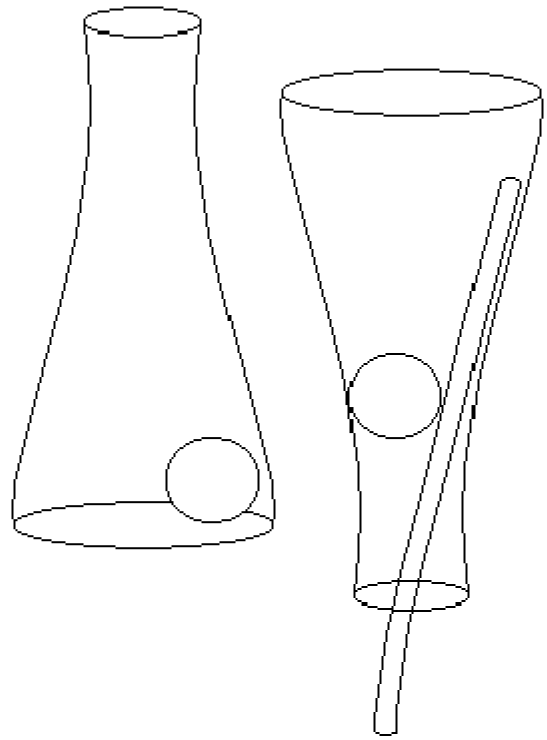
9. BATTERY OPERATED CANS

This is a great demonstration that provides a chance for teachers to talk about science and the way that it works. All you need is three coffee cans (or similar round cans) with tops to keep students from seeing inside. Mark the outsides of two of the cans with a strip of tape running from top to bottom and place them about 50 cm apart. Ask the students to observe what happens when you place the third can on its side midway between the other two. When you put it down, it rolls towards one of the cans. Next ask the Students to c what will happen when you turn both of the original upright cans around 180 degrees. Then put the third can down and let them observe it roll in the opposite direction. Ask them to predict what might happen if one of the two upip EVpendeg

How do scientists choose between theories? The one that best explains what has been observed is generally the accepted one. If two or more theories explain the observations equally well then Ockham's Razor is used. This is the idea that if two, theories equally explain the facts then the simplest theory is generally more likely valid. Ask student if there might be an even simpler explanation of their observations. Then perform the ultimate experiment and take the lid off the can that has rolled back and forth and show them how things have worked. Inside have a AAA battery (thus battery operated) glued to one side. The teacher has simply set the can down so that the battery inside has made the can roll in a desired direction.

10. GENIE IN THE BOTTLE

This is a version of an old magic trick that can still be purchased at magic stores. It is a good example to use when talking about how science works. From a thrift store or garage sale obtain an opaque glass vase similar to the one shown. Carefully use a knife to cut a piece of cork (cork stopper or wine cork) in to a small ball just small enough so that it can be forced through the neck of the bottle and into the bottom of the vase.



To use, show the students that a rope (or piece of plastic tubing) can be inserted and removed as would be expected. However, at certain times the "genie" inside the bottle will grab on and hold the rope tight but you can convince the genie to let go whenever you wish.

To have the "genie' grab hold of the rope turn the vase upside down and gently pull on the rope. This will wedge the cork ball between the rope and the side of the vase and hold it secure. The vase can easily be lifted with the rope without falling off. To get the “genie" to let go, simply hold the vase upright and gently push down on the rope. This will dislodge the cork ball and allow it to fall to the bottom of the vase. Don't tell the students how this works, have them use their imagination and design a way for it to work.

11. NON-BURNING DOLLAR BILL

This is an old chestnut that is often used in magic shows as well as Chemistry demonstrations. It can be easily demonstrated that alcohol burns in air by putting a few mls in an evaporating dish and lighting it. All students know that water puts out fires. A solution of half water and half alcohol however has some interesting properties. If a dollar bill is soaked in a 50/50 solution and then ignited by a match, the dollar bill will catch fire but will not burn. This is because a 50/50 mixture still has enough alcohol to burn but there is enough water in the solution to wet the bill and keep it from catching fire. if you only have 70% denatured rubbing alcohol available, try mixing l00 ml of the alcohol with 50 ml of water. This should be close to the correct proportions.

PS. Make sure you try this one first. Once, when I was just moving into a new school, I found a charred dollar bill in the back room. Obviously someone had not tested the demo first!

12. SOUND

A. Sound is Vibrations

A simple way to show that sound is a vibration is to hold a ruler flat against the top of a table with only about 5 cm touching the table and the rest sticking out off the edge of the table (12 inch rulers work but 18 inch wooden rulers are best). It the ruler is set vibrating a sound can be heard. The pitch of this sound increases if the ruler is slowly turned so there is less and less ruler sticking out over the edge of the table. Students can also see that the ruler vibrates faster as the amount hanging out over the edge gets shorter and shorter. Thus, the rate of the vibrations determines the pitch of the sound.

B. Music Box

Another nice example of sound being produced by vibrations is a simple music box movement. A music box movement has a number of small lengths of metal reed that vibrate at different rates and produce the different musical notes. Because they are so small, they can not excite much air and thus it produces little sound. However, when placed on a large flat surface, the small vibrating reeds will also cause the surface to vibrate exciting a great deal of air and producing a much louder sound.

C. Singing Rods

E. Diffraction of sound

A loudspeaker actually produces sound from both sides of the speaker's cone. The difference is that if there is a high pressure in the front of the cone because it is moving forward, there is a low pressure produce in the rear of the cone. Scientists say these two sound waves are out of --phase" and if they come together, the high and low pressures will cancel one another. If we play a small 2" loudspeaker out in the free air, it sounds very "tinny-" This is because high frequency (short waves) move in nearly straight lines while the low frequencies (long wavelengths) bend or diffract easily, letting the sound from the front and back bend around and cancel each other. If the speaker is held at a small hole (2" dia.) in the middle of a large cardboard (20" x 200) baffle, the sound produced is much richer and more base can be heard because the baffle makes it harder for the long base waves to bend around and cancel one another. This is why stereo speakers are put in a box. It keeps the sound from the rear of the speaker from canceling the sounds coming from the front.

13. BOILING WATER IN PAPER CUP

Another old chestnut is boiling water in a paper cup. Actually, I prefer to make my own container rather than use a real paper cup. Real paper cups often have wax coatings which seem to cause problems at times. I prefer to make my own container by taking a 7 inch square of typing paper

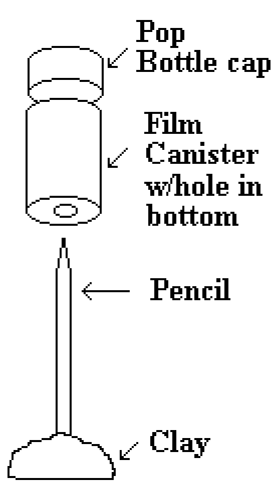
15. ELECTROSTATIC FORCES

Nearly every student knows that when two different materials are rubbed together static electric charges are produced. Traditional glass and hard rubber rods work, but there are several modern plastics that do a much better job. PVC tubing, such as that used for plumbing, will produce a strong NEGATIVE charge when rubbed with cotton. Acrylic plastics such as Plexiglas will produce a strong POSITIVE charge when rubbed with cotton. An extension to this activity is to try rubbing together a wide variety of materials in pairs to determine which material ends up with a negative charge and which ends up with a positive charge. A triboelectric chart can then be set up similar to the one below.

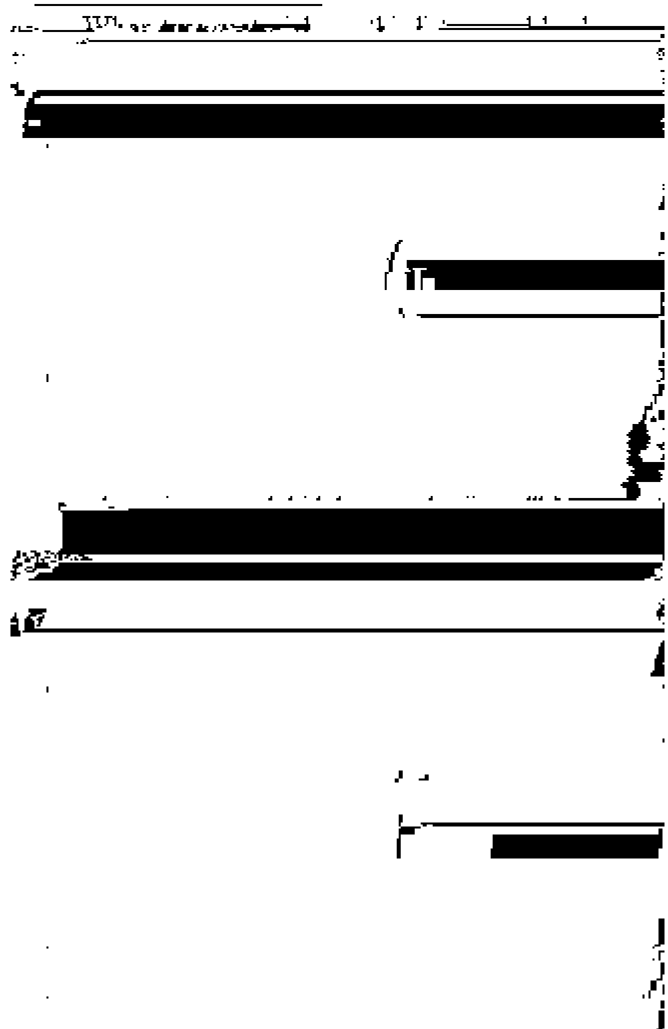
A. A Simple Electroscope

An electroscope is a device for investigating electrical charges. There are many kinds but the simplest and easiest to understand can be easily constructed in the classroom.

Stick a sharpened pencil, point up, in a small piece of clay. Drill hole in the bottom of a film canister slightly larger than the diameter of the pencil. Use small diameter drill bit to make a small dimple in the underside center of a pop bottle cap and then insert the cap into the film canister. Stick the film canister over the pencil and adjust it so that the point of the pencil is resting In the dimple. This will make a "spinner" on which you can place an object with a known charge. When a unknown object is brought near by, the spinner will either show attraction by turning towards the unknown object or repulsion by turning away.



B. Triboelectric Series



C. A Sensitive Electroscope

Although traditional electroscopes can be used to show electrical charge, they are not particularly sensitive. Also, many students have difficulty explaining their operation. Therefore, students tend to treat the operation of an electroscope as a blackbox rather than the consequence of simple electrical phenomena. A very simple and at the same time very sensitive electroscope can easily be constructed.

Tape a 12 oz soda pop can an top of an upside-down foam cup. The foam cup will serve to insulate the can from its surroundings. Tape a 12-13 cm piece of magnetic audio cassette tape, shiny side up, to the top of the pop can so that the remainder hangs about half-way down the side of the soda pop can. See figure 1 below.

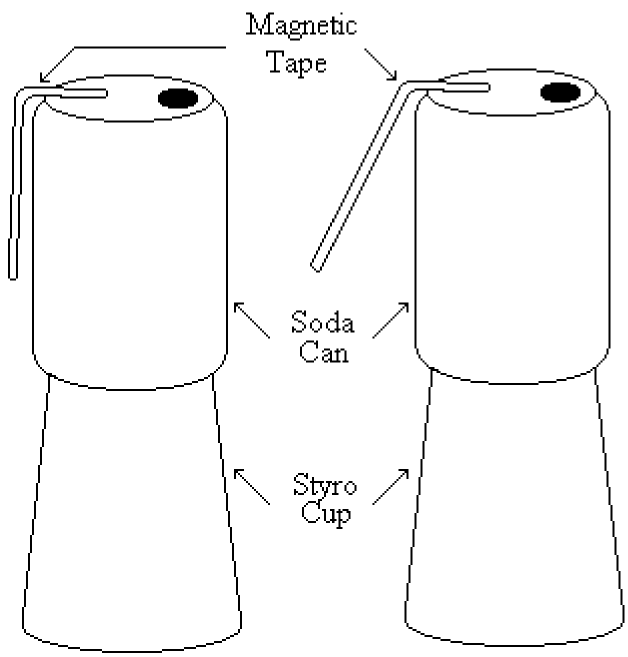


Fig. 1 Fig. 2

When the soda pop can is touched with a charged object, the magnetic tape will be repelled from the can and stand away from its side (fig. 2). If the can is grounded by touching the can with a finger, the magnetic tape will again fall along the can's side. The electroscope works because the magnetic tape is a conductor of electricity and not because of the tape's magnetic properties.

To test whether an object is electrically charged, bring the object near the magnetic tape of a charged electroscope. If the object has a charge similar to that of the electroscope, the tape will be repelled. If the object has an opposite electrical charge, the magnetic tape will be attracted. Because the magnetic tape is very light, the electroscope is quite sensitive. This electroscope can be used to show that when two objects are rubbed together, one object becomes positive and the other becomes negative. This is a much more sensitive test than the “spinner" type electroscope.

The electroscope can also be used to examine whether a material is an electrical conductor or a nonconductor. If a foam cup or a plastic ruler is held to the top of an uncharged electroscope and a charged object is touched to the opposite end, the electroscope will not respond. This shows that the plastic does not conduct the electricity. To show a conductor, tape a soda pop can at right angles to a foam cup. Holding on to the cup, touch one end of the can to the top of the electroscope and touch the other end of the can with a charged object. The electroscope will immediately respond showing that the can is an electrical conductor.

D. Electrostatic Induction

One of the most difficult properties of electricity for most students to understand is the phenomena of electrostatic induction. Electrostatic induction involves the movement of electrical charge in a material because of another nearby electric charge. Induction can be well understood by students using the sensitive magnetic tape electroscope and a couple of tin cans taped perpendicularly to a couple of foam cups as shown in figure 1 below.

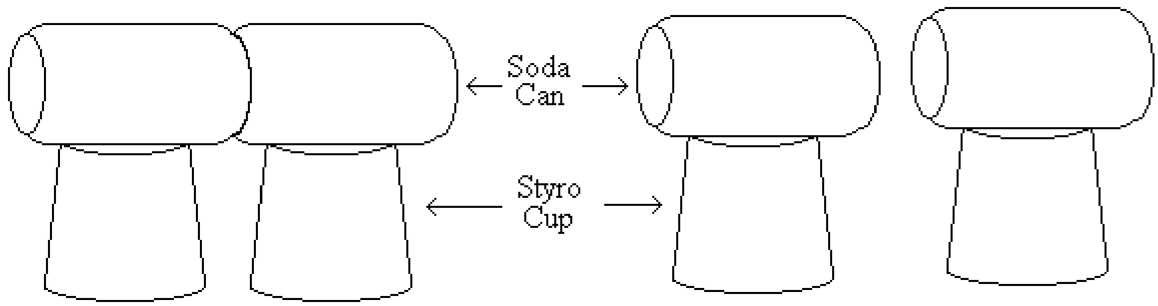
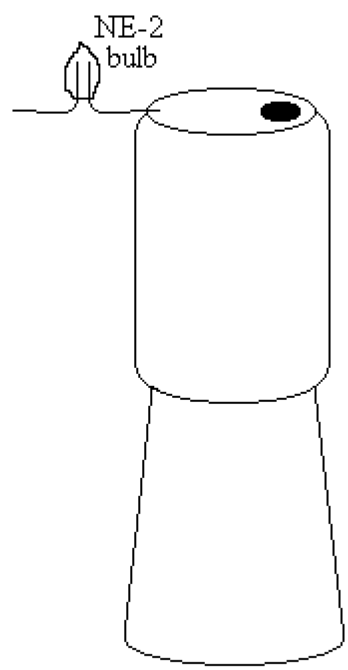


Fig. 1 Fig. 2

Set the cans on the table end to end touching one another. When a charged object is brought near one can, that can will become charged opposite to the charged object. At the same time, the far can will become charged similar to the charged object. However, when the charged object is removed, both cans will be neutral. This is because the opposite charges on the two cans will be attracted and cancel one another. If the experiment is repeated but the cans are separated while the charged object is still nearby, the charges will not be able to reunite (fig. 2). The two cans will show opposite charges when each is brought near the electroscope.

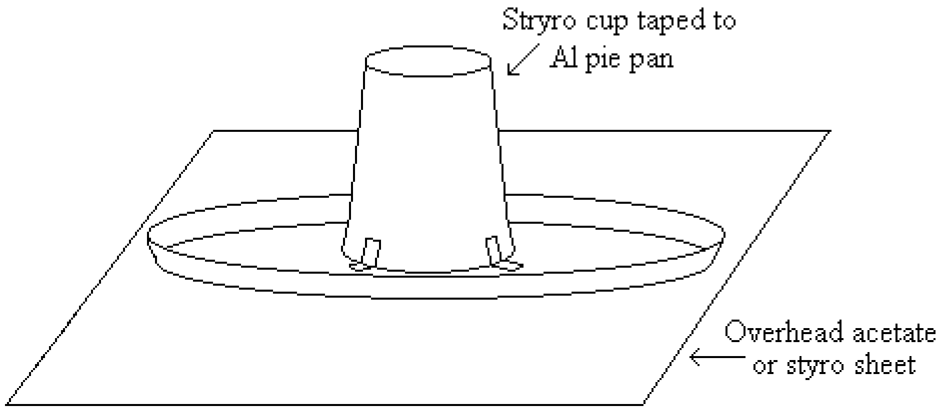
E. Flowing Electric Charges

A small ME-2 neon bulb from Radio Shack can be used to show the direction of flow of electric charge to or from the electroscope. An NE-2 bulb is just two electrodes inside a neon filled glass tube. When electricity flows through the NE-2 bulb, the negative terminal will glow with a neon orange light. If one wire of a NE-2 bulb is taped to the top of the electroscope and a charged PVC pipe is brought near the NE-2 bulb, the electrode closest to the PVC pipe will glow orange. When the negative electroscope is discharged through a nearby finger, the opposite electrode will glow orange.



F. Electrophorus

Induction can also explain the operation of an electrophorus. An electrophorus consists of a conductor with an insulating handle resting on top of a flat charged nonconductor. A simple electrophorus can be constructed using a foam plate or a blank overhead transparency sheet as the nonconductor - The conductor can be an aluminum pan with a foam cup taped in the middle as a handle as shown in the diagram below.



To use the home made electrophorus, charge up the flat nonconductor by rubbing it. Set the aluminum pan down on the nonconductor. If you do not touch the pan and just pick it up again it will not show an electric charge. if you repeat the experiment but momentarily touch the pan while it is resting on the nonconductor, the pan will show a charge when it is picked up by the insulated handle. An electroscope can show that the pan is charged differently than the flat nonconductor. The benefit of an electrophorus is that the nonconductor does not have to be continually charged to continually keep charging the pan. The electrophorus can also deliver a greater charge than most other objects. Induction can also be demonstrated with nonconductors. In nonconductors, the electric charge does not move from one side of the material to another, instead the atoms and molecules are polarized.

A simple Leyden jar can be used to store electrical charge. To construct a simple Leyden jar, wrap aluminum foil ,around the lower half of a small plastic cup half filled with salt water. Straighten out one end of a paper clip so that it can be attached to the top of the cup but still stick down into the water. An electrophorus can be used to charge the simple Leyden jar several times. To discharge the Leyden jar, touch the aluminum foil and paper clip at tile same time. CAUTION, do not make the Leyden jar too large or a severe can occur and it can become quite dangerous.

16. ELECTROMAGNETISM

A. Electromagnets

Electromagnetism is always fascinating I to observe. The easiest way to observe electromagnetism is to wrap several turns of magnet or insulated around a bolt or large nail and hook the ends of the wire to a battery. sort of simple electromagnet can then be used to pick up small magnetic materials such as nails or paper clips. When the wires are disconnected from battery the objects will fall off. This experiment is a good example of electric current producing a magnetic field.

B. Electromagnetic Induction

If a sensitive meter such as a galvanometer or multimeter is available it is possible to show that a magnet can produce an electric current. Make a loop of wire with about 100 turns. Hook the loop of wire to the meters most sensitive scale then move a strong magnet through the center of he loop. While the magnet is moving through the loop, a small current may e detected by a slight movement of the meter.

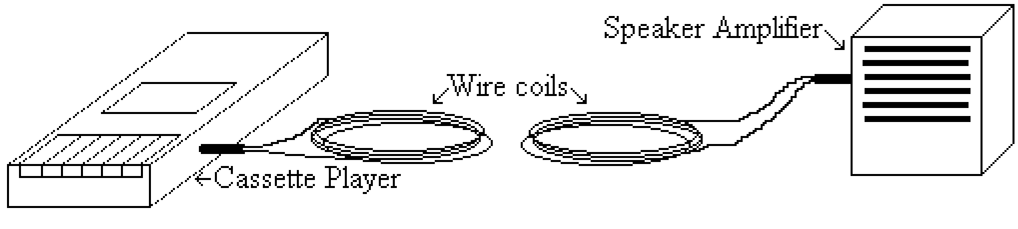
C. Magnetic Money

Although quarters are not made from magnetic material, it is possible for them to be influenced by a magnet if the coin or magnet is moving. A quarter rolling past a strong neodymium super magnet will be noticeably lowed down. If one of the Super magnets is quickly moved just above the op of a quarter resting on the table the quarter will be moved in the direction of motion. The physics of this demonstration involves Lentz's W. Electrical currents produced by a changing magnetic field produce opposing magnetic fields.

NOTE: Here is another nifty experiment that really does not involve electromagnetism but is just fun. If a neodymium super magnet is brought near one side of a dollar bill the bill will be attracted because bills are printed with magnetic ink.

D. Radio in the Classroom

A very Impressive demonstration of electric currents producing magnetic fields and magnetic fields producing electric currents can be made by first winding two coils of wire about 5 cm in diameter with a 50 turns each. (I used #26 wire but the size of the wire is not really important.) One loop should be connected to the earphone output of a cassette player and the second to the input of a small Radio Shack speaker-amplifier (#277-1008 about $12.00). When the play button is pushed, sound will not be heard from cassette player but will be heard from the speaker-amplifier even though there are no connecting wires between the two. As the two coils are moved farther from one another the sound gets weaker as they move closer the sound gets stronger. Polarization can even be shown by turning the coils at right angles to one another and having the sound disappear all together.



17. LIGHT AND COLOR

A study of light is very important in both physics and chemistry. The traditional method of making a spectrum of colors in a classroom is to use a prism. However, they are very difficult to work with as any teacher who has tried to use one in the classroom has learned. Perhaps the easiest way to produce a spectrum in the classroom is to fill a 600 ml beaker with water and setting it in the center of an overhead projector. A much more versatile way to produce a spectrum is to use a diffraction grating and make an overhead projector spectroscope.

A. Making the Overhead Spectroscope

1. Materials:
   - A. 2 1/2 inch square piece of 'STAR' diffraction grating (caution: this material is quite delicate and should be touched as little as possible.)
   - B. 5 inch square cut from a file folder
   - C. file Colder
   - D. filters

2. Take a strip of clear plastic (overhead transparency) about 2 1/2 inches by 5 inches. Fold it in half to produce a square about 2 1/2 inches on a side.
3. Insert the "STAR" diffraction grating inside the rolled plastic. Tape on each open side to secure grating inside plastic. The diffraction material is rather delicate and this will protect it from greasy fingers and the like.

When overhead is turned on, a bright white light is projected straight ahead with a fairly bright spectrum on both sides.