A COLLECTION OF DISCREPANT EVENTS – NSTA 1999

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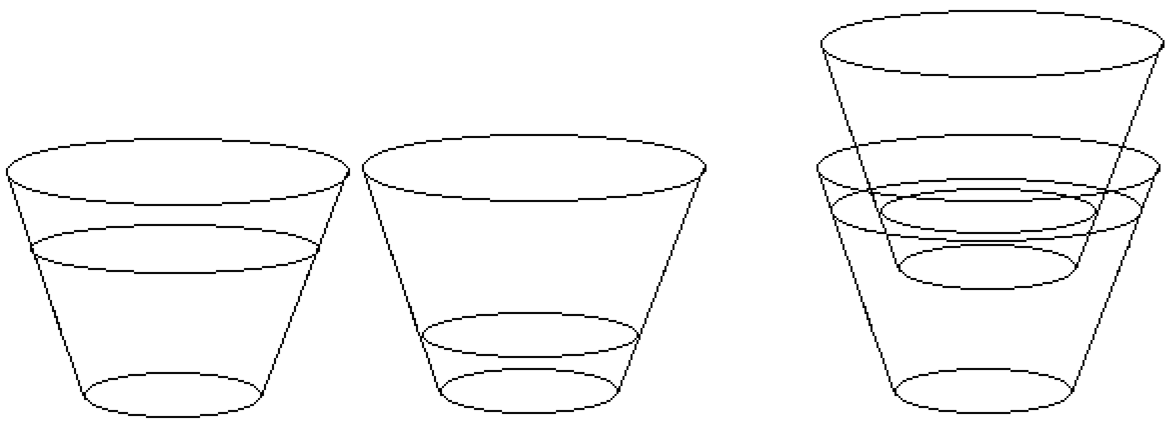
ARCHIMEDES' PRINCIPLE

The formal statement of Archimedes' Principle 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.

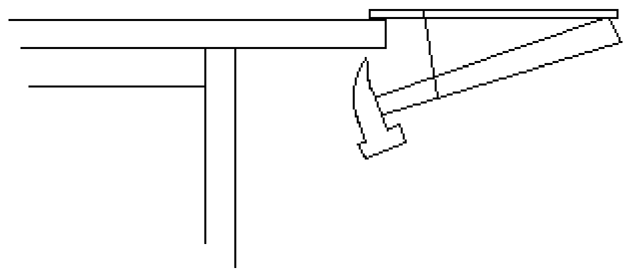
This is a good vivid example that floating objects are buoyed up with a force equal to the weight of the water that they displace. Since the disposable tumblers are nearly weightless compared to the water that we are working with, the weight of the floating object is equal to the weight of water it contains. 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.

ANTI-GRAVITY?

This demonstration will seem to "defy gravity" while at the same time illustrating the concept of center of mass.

Materials Needed:
- A 16 oz carpenter's hammer
- A wooden 12 inch ruler
- About 10 inches of string
- Small piece of tape (any kind)

Make a small loop with about 10 inches of string that is strong enough to hold the weight of the hammer. Slip this loop around the handle of the hammer (if the handle is polished, you may need to tape the string in place around the handle to prevent sliding). Next, slide the ruler through this same loop. Put the "head" of the hammer towards the 1" mark end on the ruler. Depending on the size of your hammer, the string should rest between the 3" and 5" mark on the ruler. The edge of the handle should rest against the wooden ruler. The ruler and handle should form an angle of about 30 to 45 degrees. It is important that the head of the hammer extends beyond the edge of the ruler... an inch beyond the edge of the ruler should be more than enough. Now you should be able to carefully balance the device off the edge of a table. The hammerhead should be under the table surface that the ruler is resting on. With a little practice, you will be able to balance this heavy, seemingly awkward device with only one 16th of an inch... or less in contact with the table.



This works because the center of mass (somewhere near the hammerhead) is under the supporting end of the ruler on the tabletop. It looks impressive because the majority of the ruler and handle is suspended off the edge of the table.

SUNKEN ICE CUBES

Kids tend to jump to conclusions when things appear to be identical. Fill one beaker with plain water. In another beaker, place alcohol (rubbing alcohol from the drug store is fine but any other alcohol will work). The beakers will look essentially identical. Place an ice cube in each beaker. The ice will float in the water because its density (≈ 0.9 g/cm^3) is less than the density of water (≈ 1 g/cm^3). The ice will sink in the alcohol because the density of the ice is more than the density of alcohol (≈ 0.8 g/cm^3). This is a great demo to introduce density because it really surprises the students and gets them to think.

DISAPPEARING INK

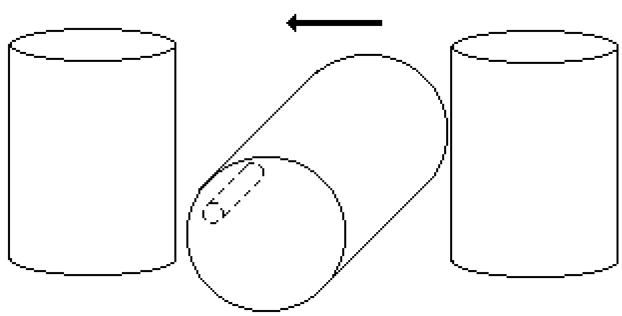
In a beaker combine 50 mL of 95% ethyl alcohol, a few drops of thymolphthalein indicator, and just enough sodium hydroxide solution (a few drops of 1M NaOH) to produce a deep blue color. Put the solution in a squirt bottle and enjoy! When squirted on a piece of cloth the blue ink will gradually disappear. The reason the ink disappears is because the sodium hydroxide in the solution is a base. As carbon dioxide from the air dissolves into the solution it forms an acid which reacts with the base to form a more neutral solution. The indicator is blue when in a basic solution with a high pH but it loses its color when the pH drops below about 9.5 as the CO^2 makes the solution more and more acidic.

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 predict 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 upright cans faces one way and the other faces the opposite way. Put the third can down and let them see that it does not move in any direction.

Ask the students to develop a theory as to why the can moves the way it does. Ask then to think of some other experiments that might be helpful in figuring it out. Try some of then if you have time. After the students have some hypothesis as to how things are working, give them the hint: "It is battery operated." See if some students have to change their minds.

Explain to students that this is really the scientific process. Scientists make (1) observations of things. They try and figure out what is happening. They try and make several other observations. From these observations they try and (2) predict what is going to happen. After they have taken a number of observations they try and (3) form a theory to explain their observations. Finally they (4) test the theories. Your students may have developed more than one theory as to how things are working (although I think most will be convinced that magnets are involved some how). Scientists also often develop more than one theory to explain what has been observed. (PS. Scientists test their theories to see if they are WRONG. Scientists do NOT prove things correct, they try and disprove things.)



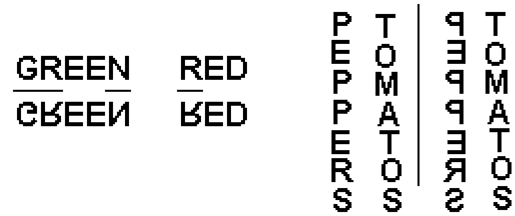
How do scientists choose between theories? The one that best explains what has been observed is generally the accepted one. If two or more theories explain the observations equally well then Ockham's Razor is used. This is the idea that if two, theories equally explain the facts then the simplest theory 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 an 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.

IS WHITE WHITE?

Cut a rectangle about 1" by 2" from the center of a white index card or even a simple V will do. Hold this card in front of a second index card so that you can see the second card through the hole. If you turn one of the cards up or down, the two cards seem to change color. One gets whiter and one gets grayer as different amounts of light fall on them.

CYLINDRICAL LENSES

Why do letters printed in one color turn upside down while letters in another color do not? Try printing the following words on a sheet of paper. Print the normal letters in green and the underlined letters in red.

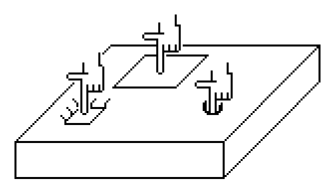


If the cylindrical lens (pop bottle filled with water) is held close to the words, everything looks normal. However, when the cylindrical lens is held about 2 to 3 inches above the paper, the red letters turn upside down while the green ones do not! Actually, the green ones also turn upside down but because they are symmetrical they appear to read the same. This same effect can also be shown vertically by having two signs with words written vertically. The word PEPPERS written in green letters will appear to be reversed but the word TOMATOS written in red ones can be read normally.

PRESSURE

It is always difficult to try and introduce students to ratio concepts such as density, velocity and pressure. Students often tend to associate the concept with the numerator and pass up the denominator. When discussing density for example students' generally associate it with mass (or weight) and forget about volume. Try asking students which weighs more lead or Styrofoam. You will seldom get the answer, "It depends on how much of each you have." Pressure is one of these ratio concepts that can be easily demonstrated. All you need is a piece of foam rubber about the size of a seat cushion and a couple of squares of wood.

Have a student come forward and ask them to take their index finger and very gently press down on the foam rubber. It will compress only slightly. Next, have them press as hard as possible on the foam rubber. This time they will be able to press nearly all the way to the table. Have them observe that the harder they push, the further down the foam compresses. Then, because their finger may be getting tired, offer to help them out by giving them a small piece square of wood about 2" (5 cm) on a side. Point out that gravity will pull down on the wood so they will not have to push as hard. When they try it, they will find that they can only push down about half way. You can then offer to give them a much bigger and heavier square of wood about 6" (15 cm) on a side. This piece will weigh nearly 10 times as much as the smaller one. When the student pushes down, the wood will hardly dent the foam. You might even say that they can start any time they want when it is obvious that they are already pushing down very hard. This should be a good place to start talking about what things affect how far down the foam will compress. The compression has a direct relationship with force BUT an indirect relationship with area. Now is the time to introduce the formal concept of:



$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$

The following discrepant events were presented at the NSTA National Convention in Boston. They were scanned into the computer from the materials prepared by Bill Brent. There may be some scanning errors present.

DIME IN A PLATE

Purpose: To show the force that can be exerted upon an object by reducing the air pressure on one side of it.

Materials: One dime and a plate

Procedure- Place the plate on a table with the edge of the plate about 12 cm from the edge of the table. Put the dime about 4 cm from the table edge, position your mouth to blow OVER the dime and toward the plate. Do not blow down on the dime. Use a quick hard puff and the dime would end up in the plate.

Principle involved: By blowing over the dime, the air pressure on top of the dime is reduced. The dime will then be pushed up into the stream of air by the pressure underneath it. The stream of air from your breath should blow the dime into the plate. Practice!!

BERNOULLI'S PRINCIPLE #1

Purpose: Bernoulli's principle is a way to reduce air pressure by rapid air flow over a surface. This shows how to suspend a ball in mid air by applying air flow to the surface.

Materials: A hair dryer, Styrofoam ball or ping pong ball, a flexible straw.

Procedure: Turn the hair dryer on to full speed and place a compressed Styrofoam ball or ping pong ball into the air flow. When the ball suspends, you can tip the hair dryer to the side and the ball" I remain suspended in the air flow. Blowing in a flexible straw bent in an "L" shape should suspend the ping pong ball also.

Principle involved: The air stream moving around the ball reduces the pressure immediately above the ball. The greater pressure underneath will keep it suspended.

HOVERING HALO

Purpose: To demonstrate the repulsion by objects with like charges.

Materials: A styrofoam block, an aluminum pie pan. a styrofoam or plastic cup, a wool cloth, thin aluminum Christmas tree tinsel, glue (preferably a glue gun and glue stick).

Procedure: 1) Glue the cup to the inside bottom of the pie pan.
2) Make a circle with the tinsel and glue the ends together. The ends can be tied if no glue is available.
3) Charge the styrofoam block with the wool. The first time the styrofoam is charged may requires several minutes of rubbing.
4) Place the pie pan assembly on the styrofoam and touch the pan with your finger. You should receive a slight electrostatic shock
5) Pick the plate up by the cup and drop the halo onto the plate from a distance.
6) The halo should then be repelled from the plate. Some practice may be required to balance the halo above the plate.
7) If the halo approaches anything neutral, it will be attracted to it.

Principle involved: Rubbing the styrofoam imparts a negative charge to it by rubbing electrons onto it from the wool. When the pie pan is placed on the styrofoam, the electrons in the aluminun are repelled to the outer edge of the plate. Some of these electrons will jump to your finger when you touch the plate. The plate now has a positive charge. When the tinsel hits the plate, it picks up the same charge as the plate (positive). Like charges repel.

PICTURE IN SPACE

Purpose: To generate a complete picture by seeing small portions of it very rapidly.

Materials: An overhead projector **or** slide projector, a transparency or slide, and a pointer

Procedure: Focus the overhead for a few feet and to the point that the transparency is not clear on any surface. Lower the lights and hold the pointer at the focal length. Move the pointer rapidly up and down to generate the complete picture.

Principle involved: As the pointer moves up and down, various portions of the transparency reflects off of it. If done rapidly enough the image of each part persists long enough to create a total picture. The principle of focal length of a lines can also be covered.

ALTERNATING CURRENT

Purpose: To demonstrate that a rapidly blinking light can appear to be a steady light and to show the effect of alternating current.

Materials: A high brightness red neon lamp (#272-712 at Radio Shack), an electric cord without the female plug (cords from broken electrical appliances work well), and electric tape or heat shrink tubing.

Procedure: Attach the neon lamp to the cord (soldering is recommended) using electrical tape or heat shrink tubing. Plug in the apparatus and have students observe that the lamp does not appear to blink.
Move the lamp back and forth rapidly or swirl in a circle. The path will appear alternately red and dark.

Principle involved: House current is 60 cycle which means it changes direction 120 times in a second.
The bulb will light at any the peak (and trough) as the current alternates. The time that the bulb is off is too short for the eye to respond so the lamp appears to glow constantly, unless the position of the lamp is changed rapidly.

DIRECT AND ALTERNATING CURRENT

Purpose: To demonstrate the difference between direct and alternating current.

Materials: Two bi-color LEDs (Radio Shack #276-012), 4 ft extension cord with plug and no outlet attached (can be cut off inoperative electrical equipment). electrical cord (2wire), 1000 **ohm** resistor, 9 volt battery, 22 K ohm resistor, electrical tape, solder and soldering gun, and 9 volt battery clip.

Procedure: The DC demonstration
1) Solder the 1000 ohm resistor to one prong of a LED.
2) Solder one wire of the electrical cord to the resistor and the other wire to the other prong from the LED. 3) Attach the battery clip to the other end of the electrical cord. Tape all exposed wiring.
The AC demonstration
1) Using the extension cord with the plug, solder the resistor to one wire of the cord and the other prong from the LED to the other wire on the cord.
2) Solder the 22 K ohm resistor to one prong from the LED. Tape all exposed wiring.

Demonstrating the difference:
1) Hook a 9 volt battery to the clip. Either a red or a green light should show on the bulb. 2) Reverse the contacts on the battery and the other color should light.
3) Plug the extension cord from the AC demonstration into an AC outlet. Both colors should show 4) Swirl the bulb and alternating red and green light should show with a dark space in between.

Principle involved: When the current in the DC demonstrator is going one direction, the bulb will glow red. If the current direction is reversed, the bulb will glow green. Since the current in the AC demonstrator is giving both directions, both colors show. Each color should show 60 times per second in 60 cycle current (the normal frequency of house current) as the current reveres.

BLOWING UP A PLASTIC TUBE

Purpose: To show the amount of air that can be moved using Bernoulli's Principle. To estimate the volume of air contained in one breath.

Materials: Large (30 gal) lightweight plastic bags, glue dot adheres to plastic, a seal-a-meal-heater, or 2" clear packaging tape.

Procedure:
Preparing the Tube: Cut the plastic bag down each side. Leave the bottom attached. When unfolded, the resulting plastic sheet will be twice as long as before (approx. 6 ft.). If a larger tube is desired, a three foot section can be glued on. Trim the sheet to approximately 24 inches in width. Fold lengthwise, leaving about a one inch overlap. Seal the edges and seal the bottom of the tube closed. If you have a seal-a- meal, you may be able to heat seal instead of gluing. Prepare 2 such tubes.

Presenting the activity:
1) Have a student hold the closed end of the tube. Squeeze the air out of the tube toward another student. Have the second student blow a breath of air into the tube. Squeeze the breath from the second student toward the closed end. Estimate or measure the trapped volume of air and predict the number of breaths necessary to fill the tube.
2) Challenge the students to a race to **fill** a second tube with air. Have students hold the closed ends. On the count, blow your breath into the tube while holding the tube a few inches from your mouth. The tube should **fill** with & quickly.

Principle involved: The flow of breath into the tube will cause a region of reduced air pressure which will cause a greater flow of outside air into the bag. This is an application of Bernoulli's Principle.

BOILING WATER IN A SYRINGE

Purpose: To show how to boil water by reducing the pressure.

Procedure: Large plastic syringe (100 ml or 60 ml), nail, hot water (over 60 degrees C), removable plug for the syringe, thermometers.

Materials: Pull the plunger on the syringe to the highest mark. Heat a nail and push it through the plunger so that the plunger can be stopped from sliding back into the syringe. Create a plug for the nozzle of the syringe. A short piece of rubber tubing plugged at one end with a piece of glass rod works well.
Remove the nail from the plunger and push into the syringe. Draw up approximately 20 ml of hot water. Plug the nozzle and pull the plunger out to the 100 ml mark and insert the nail to through the plunger. The water should start to boil. If it does not, check for a leak around the plug and/or use hotter water.

Principle: The boiling point is pressure dependent. When the plunger is pulled out, the pressure is reduced and the boiling point lowered.

MYSTERY PAPER

Purpose: To demonstrate the pressure that can be exerted by a lever (scissors).

Materials: Strips of newspaper, rubber cement, talcum powder, and scissors.

Procedure: Coat one side of the paper with a thin coat of rubber cement. Allow to dry and put on another coat. When dry, sp6nkle talcum powder on the rubber cement and blow off excess. Fold the paper and cut with the scissors. The cut will, re-seal.

Principle involved: the pressure of the scissors (a lever) will break through the powder coating and bring the glued portions in contact.

AIR PRESSURE AND SMOKE RINGS

Purpose: To demonstrate the force that air can exert.

Materials: One cardboard box, a plastic bag or plastic sheet, (a source of smoke is optional), tape.

Procedure: Cut the box so that one end is cut loose and is still hinged on the top. Cut a 3 to 4 inch hole out of the opposite end. cover the hinged end with the plastic and tape to the body of the box. Aim the hole at a target (person) and tap the hinged end. If a source of smoke is placed inside the box and the hinged end is tapped, smoke rings "I be blown.

Principle involved: Tapping the hinged end will increase the pressure inside the box which will then be forced out of the small hole.

FOG FORMATION IN A 2 LITER BOTTLE

Purpose: To illustrate how fog forms.

Materials: A 2 liter bottle, water, and a match.

Procedure: Put a very small quantity of water in the bottle. Light a match and drop into the bottle to create a small amount of smoke. Cap the bottle tightly and squeeze and release rapidly and repeatedly until fog appears in the bottle when released.

Principle involved: The air inside the bottle is saturated with water vapor. The smoke provides a nucleus upon which the water droplets can form. The droplets will form on the smoke particles at the lower pressure.

IRON IN CEREAL

Purpose: To remove the metallic iron from various cereals.

Materials: Total cereal, petri dish, cow magnet 1/2" ceramic disk magnet, water, plastic bag, overhead projector, and white spray paint.

Procedure (a): Crush 1/2 cup of the cereal in a plastic bag and add enough water to make a slurry. Spray the small ceramic magnet with white paint. When dry, place the magnet in the bag and knead vigorously. Remove the magnet and rinse gently in water and examine it for iron filings.

Procedure (b): Place a petri dish containing water on an overhead projector. Float a small piece of cereal on the water. Hold a cow magnet close to the cereal to see if it attracts.

Principle involved: Most iron contained in fool is in the form of a compound and does not interact with a magnet. In many cases, the iron is present as very **fine** metal particles and is attracted to a magnet.

FLYING TEACHER

Purpose: To demonstrate how a mirror can produce an unusual optical effect and to show that teachers can do "anything".

Materials: Mirror (24 to 26 " in height and over 30 " in length) obtainable from most glass and mirror shops for free. For use around small children I recommend mirrored Plexiglas, and a stand (can be made by grooving a 2" x 12" board or an old **mirror** stand).

Procedure: Set the mirror in the stand. Straddle the mirror. Lift your foot that is on the mirrored side while going through a flying motion (using the balance balls turning on your head, you resemble a helicopter).

Principle involved: The reflection of your foot and leg gives the illusion of seeing two feet, both of which are off the ground to anyone in front of the mirror