Dr. Bill M. Brent

STRING MAZE

Purpose: To challenge students' observation skills.
Materials: A one and one-half meter long piece of string or yarn.
Procedure: Tie the string into a loop. While holding the loop in front of you with one hand, pass the other hand through the loop from the front. Then you...... and then...., you really have to experience this first hand.
Principle involved: Students have to observe very carefully to detect the motion that produces the desired results.

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 aluminum 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.

INERTIA RINGS

Purpose: To show that objects at rest tend to stay at rest.
Materials: A ring cut from a four or six inch PVC pipe (the ring should be approximately 1/2 in wide), a bean or small dense object, a glass soda bottle.
Procedure: Balance the ring upright on the top of the bottle. Place a small object (bean) on top of the ring directly

BALANCE BALLS

Purpose: To demonstrate a center of gravity device and to show the principle of inertia.
Materials: A wire clothes hanger, two tennis balls or rubber balls, and a wire pliers.
Procedure involved: Open up the hanger and bend into the shape of a "M" with a twist in the center to keep the two parts from separating. The ends should be much lower than the center. Stick tennis balls or other similar objects on each end. To final appearance should be as diagrammed below.
The center of the hanger can now be balanced on your finger. Better yet, it can be balanced on your head. You now can demonstrate inertia by spinning the balls while you remain still or by pirouetting while the balls remain still.
Principle involved: The mass of the balls on the end is lower than the balance point and as the balls spin and turn the center of mass stays lower than the balance point.

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, sprinkle 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.

LASER ACTIVITIES

Purpose: To demonstrate a variety of properties of light.
Materials: A laser (an inexpensive laser pointer works well), color filters (colored report covers do a good job. Make sure one is green), Polaroid lens (use old lens from Polaroid sun glasses), Chalk dust, and candle.
Procedures:

1. In a darkened room, place the laser where the light from it can not be seen. Clap two chalk board erasers together near the beam. The reflected beam can then be seen.
2. Aim the laser at a white surface. Put a Polaroid lens in the beam and observe the results. Put a second lens in the beam and turn observing the results.
3. Aim the laser at a white surface. Pass the beam through red, blue, and yellow filters. Observe the results. Put a green filter in the beam and observe.
4. Aim the beam at a white surface. Hold the flame of a lit candle directly under the beam near the laser and move it back and forth under the beam. Observe the results.

Principle involved:

1. A beam of light cannot be seen unless it inters the eyes directly or reflects off something. The beam will not reflect off the molecules in the air but will off the dust particles.
2. The beam will pass through the parallel lines of the Polaroid lens. When a second lens is placed in the beam, the light will still pass through both if the parallel lines of both lens run in the same direction. If the lenses are placed so that the lines are 90 degrees with respect to one another, the light will be blocked.
3. The red light of the laser passes through all colors except the complimentary color of red which is green. The green filter will block more light than the others.
4. The heat changes the density of the air in the beam. Light rays passing through gases with different densities is bent. The effect is to make the beam appear to flicker. This is why the light from stars and planets appear to flicker as it passes through the atmosphere.

Safety Precautions: All of these activities can be carried out with low power pointer lasers. However, make sure that the laser beam is never directed into anyone’s eye.

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 will 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.

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ELECTROMAGNETIC INDUCTION

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Students often have difficulty understanding the concept of electromagnetic induction. One problem is that induction is often demonstrated using apparatus that is foreign to students' everyday life. The common demonstrations also usually lack excitement since they only involve watching a meter attached to a coil of wire as electrical current is varied in another coil near by. The following demonstration of electromagnetic induction is simple in concept but very effective in the classroom. It also has the added benefits of using familiar equipment and involving more than just the sense of sight.

Students in high school usually have had a lot of experience using cassette recorders. They

<u>CENTER OF MASS</u>

One of the most commonly encountered concepts in elementary physics is that of center of mass. Center of mass is commonly taken to be that point where the entire mass of an object can be considered to be concentrated. Center of mass is encountered in stability problems, gravitational problems, and motion problems.

There is a common method for finding the center of mass of an irregularly shaped object. If an object in hung from several points and a plumb line in dropped from each of the supporting points, the plumb lines will all cross at the center of mass. If the object is displaced to one side or the other it will always reposition itself so that the center of mass is in a vertical line with respect to the point of support,

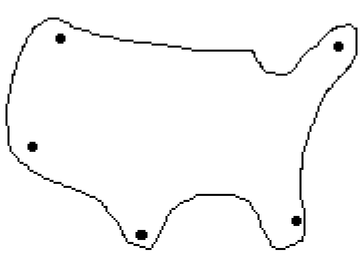
The most important property of the center of mass in the one most commonly overlooked. Using the concept of center of mass simplifies the motion of complex objects. The center of mass will move with the most simple motion while the motion of the other parts of the object might be very complex. This can be strikingly shown using a very simple apparatus.

Finding the Center of Mass

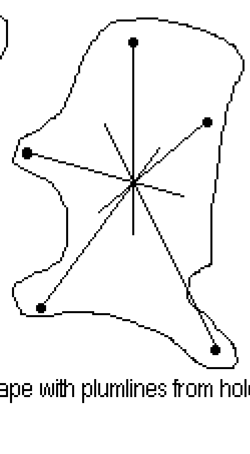
An irregularly shaped board is cut out of thin plywood (mine is a cut-out map of the United States on 1/8 inch plywood). A number of holes are randomly drilled near the perimeter. The board and a plumb bob are hung by a nail through one of the holes in the board. The line of the plumb bob is drawn on the board. The board and a plumb bob are then hung by a nail through a different hole and another line drawn. The lines of the plumb bob will all cross at the same point, the center of mass.

Motion of the Center of Mass

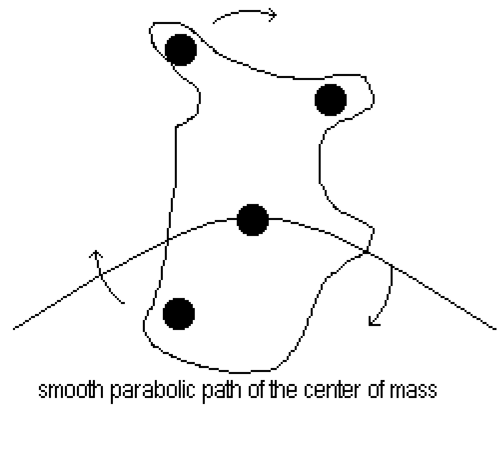
On the reverse side of the board I have stuck a colored circle at the center of mass and several other randomly locations. As the board is spun while throwing, it is easy to keep your eye on the circle at the center of mass but the other circles all blur.



Shape with random holes



Shape with plumlines from holes



smooth parabolic path of the center of mass

A number of physicists insist that all energy is either Kinetic Energy or Potentia
According to this concept thermal energy is really a form of Kinetic Energy while
in a stick of dynamite is really Potential Energy of the atoms in the dynamite. While this argument
might be true at the microscopic level, I think that it is a disservice to students to t
concept when they are just learning about energy in the first place. I prefer to tall
macroscopic forms of energy. These are the forms of energy we see around us every day.

- Mechanical Energy (of which can be either Kinetic Energy of Potential
- Chemical Energy
- Thermal Energy
- Light Energy
- Electromagnetic Energy
- Sound Energy
- Nuclear Energy

In this way we can talk about how different devices transform energy from o
another. For example a battery transforms chemical energy into electromagnetic
bulb transforms electromagnetic energy into thermal energy and light. Or people transform
chemical energy into thermal energy and a bit of motion. In this way students can

THE LEVER AND THE DOUBLE PAN BALANCE

Most students learn (often on their own and not in school) a little about levers. The heavy thing has to be close to the pivot to balance a light thing a long ways from the pivot. A balance looks very similar to a lever but does not work in the same way. An object on one side can be balanced by the same mass no matter where that mass is placed on the balance. This can bee easily demonstrated by constructing a simple model of a double pan balance similar to the one below.

Materials:

- 3 strips of 1/8 inch plywood about
  - 2 - should have 3 holed drilled (center and each end)
  - 1 should have 2 holes drilled (center and end)
- 2 triangles of 1/8 inch plywood about
  - Both should have holes drilled as shown in the diagram
- (actual size of the above pieces is not particularly important)
- 6 small bolts with nuts which fit easily through the holes

If the balance worked as a lever, then a mass placed at points **A**, **B**, **C**, or **D** could only**AB ,**

COLLIDING SPHERES
CONSERVATION OF ENERGY

In this demonstration you will look at the conservation of mechanical energy. While the conversion of mechanical kinetic energy to mechanical potential energy and back again is relatively easy to demonstrate it is often much harder to demonstrate the transfer of mechanical energy into other forms. This is an especially important concept to demonstrate and discuss, especially since it took so long to understand historically.

If a small rubber ball is dropped, it is easy to discuss the transfer of potential at the top into kinetic at the bottom. However, after a few bounces the ball will come to rest on the floor. It no longer is moving so it has no kinetic energy and it does not have a special position so it no longer has potential energy. Where has the energy gone has it disappeared? The answer of course is that it has been converted into thermal energy. The ball and the floor are a bit warmer at the end of the demonstration than they were at the beginning. While this is true, it is often hard to convince students of this since they cannot feel the increase in temperature.

This can be demonstrated by using two large steel ball bearings (4 to 6 cm. in diameter)* and some paper.
If thermal paper of the type used in FAX machines is available, the two balls can be smashed together with moderate amounts of energy and the thermal paper will leave behind a discolored mark where the two spheres collided showing the thermal energy was created in the collision. (The students will also be able to hear the collision showing that a bit of sound energy was also created) The demonstration can also be performed by forcefully smashing the two spheres together with a