Hands-on Demonstrations and Activities That Mix Some Thrills in with the Skills!

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Acknowledgements

The Idea for Stark Raven Mad About Science originated with the Kivalliq Science Committee of the Nunavut High School Project. This committee wanted to put together an entertaining Science Workshop for the 1997 Kivalliq Teachers' conference in Rankin Inlet.

Activities and demonstrations were selected, developed and originally presented by:

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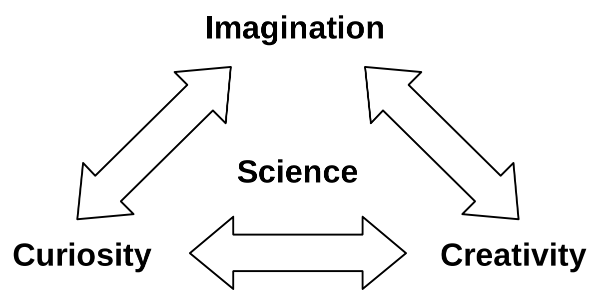
The presentation was an equivocal success, which is to say we all had a blast and lived to talk about it. Members of the committee came and went but variations of the workshop lived on, primarily as an annual public science show at the Kivalliq Regional Science Fair.

"Stark Raven Mad About Science" is divided into three sections, Earth, Air, and Water. The section on Fire has been removed and now form the basis for the Workshop entitled *"Science With a Bang!"*. Each activity in this workshop is outlined with objectives, materials required, the procedure and an explanation. The activities worked very well in the Science Show format but obviously they could be used on their own in the classroom as a demonstration or student activity.

Students learn best when they are able to see science in action. A well-planned demonstration can ignite the natural curiosity in students and feed their imagination and, hopefully, nourish their creativity. Curiosity, imagination, and creativity form the foundations of science.



Regardless of how these activities are used, teachers must consider the following points for developing a dynamic demonstration or activity:

1. Capture student attention by using interesting and discrepant activities and modeling enthusiasm, excitement and humour.
2. Make sure all the participants can see the demonstration properly.
3. Engage students and make them participants and not just spectators.
4. Check your classes' concept understanding through appropriate questioning.
5. Make safety a priority, establish familiarity the apparatus and materials (read the MSDSs).

Safety pointers are included in the demonstrations that can be dangerous. Teachers are advised to exercise their good judgment and caution when attempting any of the activities. Practice before you demonstrate an activity to your class.

Jim Kreuger
Baker Lake, January 22, 2008

Table of Contents

Inuit Qaujimajatuqangit and Science

Inuit Qaujimajatuqangit (IQ) Principles are common essential leanings or core values of Inuit culture. The IQ Principles were developed by elders and adopted by the Nunavut Government as guiding principles. Science lessons and activities should be structured to promote as many of the eight IQ principles as possible. Some suggestions are given below:

1. *Innuqatigiitsiarniq*- the concept respecting others, relationships and caring for people. Group work and having fun together should be part of your science class. The SET Challenge, "What's your Theory?" and other group problem solving activities are popular with students because they promote working and having fun together.
2. *Tunnganarniq*- the concept of fostering good spirit by being open, welcoming and inclusive. The creation of an inclusive and welcoming environment will encourage students to take risks. Creating an accepting and inclusive climate will give students the confidence to risk being wrong and state what he or she thinks. This confidence is absolutely necessary for students to formulate an hypothesis and reach a conclusion.
3. *Piliriqatigiingniq*- the concept of developing a collaborative relationships and working together for a common purpose. Group work and collaboration are an important part of any science program. Lab work, theory construction, and Science Olympics all depend on collaboration.
4. *Avatimik kamattiarniq*- the concept of environmental stewardship stresses the key relationship Inuit have with their environment and with the world in which they live. The environment and our impact on it is a thread that weaves through our entire curriculum.
5. *Pilimmaksarniq*- the concept of skills and knowledge acquisition and capacity building is central to the success of Inuit in a challenging environment. Learning by doing is a pedagogical technique that brings the traditional into the contemporary and is essential to the knowledge construction that occurs is a science class. Careful observation is as key to science as it is to survival on the land.
6. *Qanuqtuurniq*- the concept of being resourceful to seek solutions by maximizing utilization of limited resources and improvising when and where necessary. Resourcefulness is probably one of the strongest IQ value embedded in a science program. Necessity and curiousity are powerful engines of resourcefulness and creativity.
7. *Aajiqatigiingniq*- the concept of consensus decision-making relies on strong communication skills and a strong belief in shared goals. Group work and team problem solving challenges give students the opportunity practice consensus decision-making.
8. *Pijitsirarniq*- the concept of serving and community as opposed to pure self-interest. Science classes should strive to help students see beyond themselves and begin to understand the complex, interdependent world we live in. Role-playing activities like "Chocolate Chip Cookie Mining" allow students see many of the issues that make up a human enterprise.

The Primordial Elements

"THE PERIODIC TABLE."

Earth

Mass Appeal

Introduction:
All matter has mass; here are two demonstrations that show how to distribute the load for some surprising results.

Rise Up!

Objective:
To lift a person using only two fingers (and five friends).

Materials:
• one medium sized person who is wearing shoes (the "liftee")
• five lifter people

Procedure:
1. Have the liftee stand up straight and tall with his/her arms bent at right angles at the side.
2. Each of the lifters will use two fingers on either the elbows, feet, or chin.
3. On the count of three they should be able to lift the person off the ground at least for a few seconds.

Explanation:
If a 150 pound person is being lifted, each of the five lifters will have about 30 pounds of weight to raise. This is a reasonable amount to lift with two fingers. This also proves the adage that many hands make light work.

Balloon Bed

Objective:
To make a bed of balloons--it's safer and more comfortable than a bed of nails!

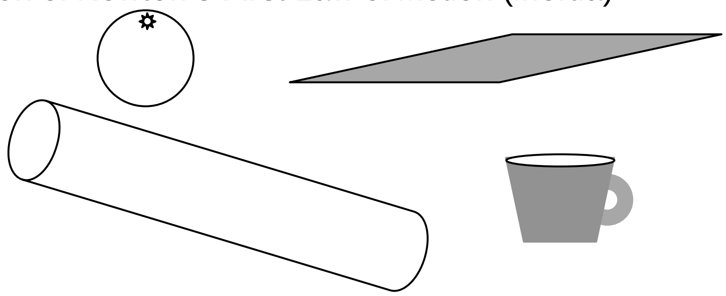
Materials:
• Ten to fifteen balloons
• Piece of string
• One desk or small table
• One student

Procedure:
1. Ask a student to blow up a balloon and tie it.
2. Now ask the student to sit on the balloon. The balloon breaks.
3. Pass out ten balloons and ask your class to blow them up and tie them. It is important that they all blow them up to approximately the same size.
4. Tie the balloons together so they do not float away and turn a table up-side down and lay it on the balloons.
5. Now let a student stand on the up-side down table. How many students can stand on the table before the balloons break?

Explanation:
One balloon is not strong enough to support a student, but 10 balloons certainly are. The mass of the table and student when spread over ten balloons is equivalent to 5 to 10 kgs per balloon.

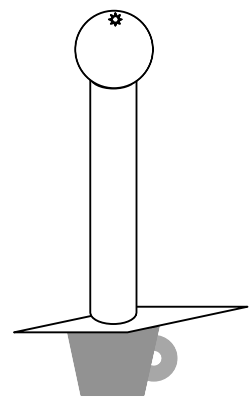
Orange Catch

This demonstration is an amazing illustration of Newton's First Law of Motion (inertia).



Materials:
- Orange, grapefruit, or rubber ball
- Paper towel or toilet paper tube
- Heavy mug
- Stiff card board or masonite
- Broom (optional)

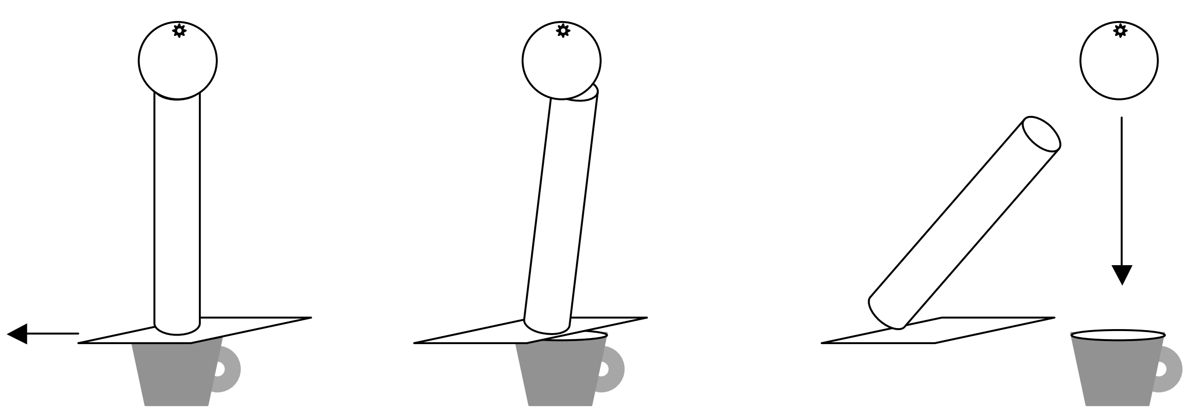
Procedure:



1. Place a stiff piece of cardboard or masonite on top of a large, heavy coffee mug with about an inch protruding over the edge of the mug.
2. Put the mug at the edge of a desk so that the masonite protrudes over the edge of the table but the cup does not.
3. Place a paper towel tube on top of the board and directly above the mug.
4. Carefully balance an orange on top of the paper towel tube.
5. Your challenge is to quickly push or pull the masonite board off the top of the mug so that the orange falls directly into the mug.
6. A quite tug on the board will work but it is more impressive to wack the edge of masonite with broom handle or metre stick.

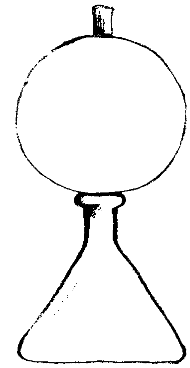
Explanation:
Newton's First Law of Motion states that a system will remain at rest unless acted upon by an unbalanced force. Once set up, the system is in equilibrium and at rest. Pushing or pulling the masonite causes it to move. The mug is heavy and the friction between it and the masonite is not enough to move the mug. However the friction does move the bottom of the tube off the top of the mug and this cause the orange to be unstable and to fall. Gravity pulls the orange straight down into the mug. This trick requires a quick push or pull. If you are too slow, the top of the tube will topple over and take the orange with it.

If you master this trick you can up the ante by filling the mug with water and replacing the orange with an egg.



Hoop-la

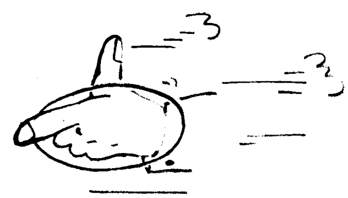
(Shootin' with Newton)



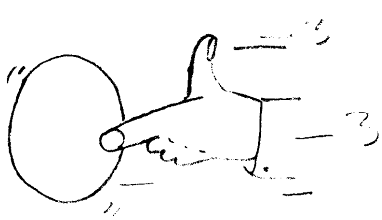
This inertia trick is even more impressive than the Orange Catch and can be used to teach to value of careful observation. Only those who pay extremely close attention will be able to replicate this feat.

Materials:
- One large needle point hoop
- One cork or rubber stopper (small enough to fit inside the flask)
- One cylinder or flask
- One sleight of hand

Procedure:
1. Place the hoop on top of the flask and balance the cork on top of the hoop as illustrated in the adjacent diagram. Be sure the cork is directly above the opening to the flask.
2. Set up the demonstration by telling your class to watch closely because sometimes our eyes can trick us.
3. When the class is watching closely, extend one finger and move it towards the hoop quickly, stopping just before you hit the outside. Repeat this motion a number of times to establish the impression that you are going to hit the outside of the hoop.
4. When you are ready to perform the feat, in a quick fluid motion, strike the hoop on the inside and follow through so the hoop flies off the top of the cylinder. The cork should drop directly down into the cylinder.



Explanation:
Striking the hoop on the inside allows you to pull the hoop away from the cork and cylinder. Friction is minimal, so the cork obeys the law of gravity and falls straight down into the cylinder. Striking the inside of the hoop also deforms the hoop slightly down as your finger pulls the hoop to the side. This also helps reduce the friction and increase your success. This is a great example of Newton's 1st Law of Motion or Inertia. The system remains at rest until a force is applied to remove the hoop. The force of gravity then pulls the cork down into the flask.



If your students did not watch closely they will think that you hit the hoop on the outside. When asked to duplicate your feat, they can't because hitting the outside causes the hoop to deform slightly up, pushing the cork and increasing the friction. Instead of falling straight down, the cork arcs through the air in the same direction as the hoop.

Teacher Note:
For this demonstration practice makes perfect. Keep repeating this demonstration through out the year until a sharp-eyed student sees what you are actually doing. Then let the student demonstrate. You may also make the same apparatus from a bottle, paper loop, and a small piece of chalk. A section of a plastic pop bottle also makes a great loop.

More Inertia Tricks

The following tricks are all based primarily on Newton's First Law of Motion (Inertia)

Coin in the Cup
Place a coin on a playing card placed over the mouth of an empty cup. Flick the card away quickly with your finger. The coin falls into the cup. The coin does not move sideways because the card is smooth and friction is very small. The coin stays at rest until the force of gravity pulls it straight down into the cup.

Tower of Books
Build a tower of books. Grab the book at the bottom of the tower and pull very quickly. You can remove this bottom book without upsetting the pile because of the inertia of the books above it. The heavy mass of the tower requires a substantial force to move it. The force of friction is not enough, but the force of gravity is.

Coin Crasher
Make a pile of coins or checkers. Strike the bottom coin sharply with a ruler to dislodge it without the pile falling over. Now try to flick a coin at a pile of coins. If hit just right, the bottom coin will be dislodged and replaced by the flicked coin.

Hammer Pull
Place a hammer on end on top of a piece of cardboard to which a piece of string is attached. Quickly jerk the string and the cardboard comes out but the hammer does not fall.

Golf Ball Drop
Drop a golf ball while walking slowly across a room. The golf ball follows you across the room.

Hanger Helper
Fashion a metal coat hanger into V shape with long side arms. Suspend heavy masses from the end of each side arm. Place the V on your head and rapidly turn around. The coat hanger/mass system will not move.

String Fling
Suspend a heavy mass from string with a second string hanging down from the mass. If the bottom string is pulled with a sharp jerk, the bottom string will break. If the bottom string is pulled with a slow, steady force, the top string will break.

Tablecloth Trick
Put a piece of chart paper on a smooth desk so that the one edge of the paper hangs over the edge of the desk. Place a mug, half filled with water, on the middle of the paper. (Make sure the paper and the outside of the mug are dry.) With a sharp jerk, pull the paper (on a slight downward angle) away from the table. The mug and the water should stay put. Practice this one. The paper must be jerked quickly and with no upward motion. If you master this version of the trick, try setting a simple table on a smooth cloth.

Explanation:
The force that holds an object in place is called "inertia." The mass of the object needs to receive enough kinetic energy (that's energy in motion) to cause it to start moving. Everything has inertia, and the more massive an object is, the more inertia it has.

There are four forces that affect how well these demonstrations work. They are: inertia of the object, gravity, friction, and the kinetic force that you apply. We already talked about inertia, so let's look at the others.

Gravity pulls everything towards the earth. All of the objects in the demonstrations are affected by gravity. Gravity pulls the stacked objects into each other, affecting the amount of friction between the different surfaces.

Friction is the force that is caused by the contact of the two surfaces. To move one object out from under another, you must overcome the friction between them.

The last force is the one that you provide, the push or pull (the kinetic force). When you pulled the paper you had to overcome the inertia of the paper, the friction between the paper and the table, and the friction between the paper and the cup. Since the paper has very little mass, it is easy to overcome its inertia. The faster you pull the paper, the easier it is to overcome the friction. In fact, if you didn't pull the paper fast enough, the demonstration would fail.

Once you overcome the friction, the paper moved easily. Because of the inertia of the cup, it didn't want to move, and tried to stay right where it was. The other demonstrations basically worked basically worked the same way.

Take a Spin!

Objective:
Here's a cool way to show how the Earth started rotating

Materials:
• rotating chair or stool
• two heavy masses(two hefty science books will do as long as they can be supported at arms length for a short period)

Procedure:
1. Sit in the rotating chair with the masses one in each hand and arms outstretched.
2. Get your partner to start turning you slowly around.
3. Have your partner let go and move back.
4. Quickly pull your arms in and you will spin faster. Watch out! You may spin very quickly and be dizzy when you stand. It might be a good idea to have your partner nearby to assist you.

Explanation: Once something starts spinning it will keep on spinning until something slows it down. This is called rotational inertia. Our planet is way bigger than someone on a stool so it has way more inertia. The earth began as some gas and space (dust left over from the Big Bang) that started to rotate due to all the energy zoomin' around in space at the time. As the dust clumped more and more together gravity pulled yet more dust together to form a primordial ball. As the ball became more tightly packed, it began to spin faster. The earth has been spinning ever since.

The speed at which a body spins is a bit more complex than a body that is travelling in a straight line. The speed at which a body spins depends on its velocity and its moment of inertia. The latter depends on the mass and how the mass is distributed. The further away the mass is from the center the slower the spin. Vice versa for when the mass is closer to the center.

Water Wheelie

Introduction:
Defy the law of gravity without fear of reprisal. This trick takes a little practice to master but impresses even the most jaded student. May the force (centripetal) be with you!

Materials:
- 30 x 30 cm piece of plywood
- two 1 m lengths of strong cord
- unbreakable glass
- water

Procedure:
1. Using a small knot attach the ends of the string to the corners of the plywood to produce a hanging platform. Be sure to make each length of string equal.
2. Place the empty cup on the center of the platform and try to swing the platform in a full circle without letting the cup fall off.
3. If you're really brave, try the same trick with the cup full of water. The cup will be more stable if you spin the platform more quickly.

Explanation:
Objects in motion want to continue moving in a straight line. This is called "inertia". An object moving in a circle is being pulled inward. This is called "centripetal force". As you start swinging the platform, the cup and water want to fly away from you. Centripetal force keeps the water in the cup and the cup on the platform when you spin the platform. The centripetal force exerted by the platform counteracts the cup of water's inertia and forces it to keep rotating in a circle.

Meet Me at the Centre!

Intoduction:
Centre of mass (center of gravity) is also known as the balance point since it must be supported for an object to be stable or balanced. This demonstration helps lay the groundwork to understanding this concept.

Materials:
- Meter stick
- Plasticine lump
- Hammer

Procedure:
1. Ask your class to predict where the center of mass is on a metre stick. They will most likely suggest it is at the 50 cm mark.

2. Balance the metre stick on your two index fingers and slowly move your fingers towards each other. As if by magic, your fingers will meet at the 50 cm mark and the metre stick will stay balanced.

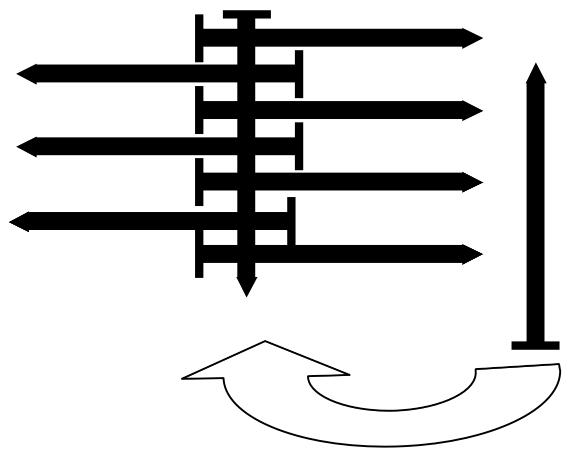
3. Now add a small lump of plasticine to one end of the metre stick and repeat the demonstration. This time your fingers will not meet at the 50 cm mark, but rather at some point closer to the plasticine. However, the point where your fingers do meet is the balance point or center of mass because the system is balanced.

Explanation:
As one finger slides towards the center of mass (lets say the left), it begins to support more mass than the right finger. This increased mass, increases the friction between the left finger and the stick and so the left finger stops moving and the right finger begins to slide. The right finger continues to slide until it is closer to the center of mass than the left finger and friction stops it. This back and forth sliding continues until your two fingers meet at the center of mass, which is not always the middle.

Balancing Nails

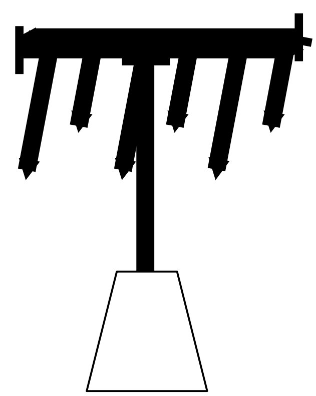
Materials:
- 10 long nails with flat heads (all the same size)
- Cork or wood base

Procedure:
1. Push a nail into a cork, or drive it into a piece of wood so that it stands upright.
2. Lay one of the nails on a flat and steady surface and then lay seven on top of the nail as shown in the diagram
3. Lay the ninth nail on top of the seven.
4. Carefully hold the ends of the bottom nail (the first one you laid down) and lift slowly.
5. As you lift, the seven nails you laid across the bottom nail should slide closer together until their heads should lock against the top (ninth) nail.
6. You can now balance the nine nails on top of the upright nail.



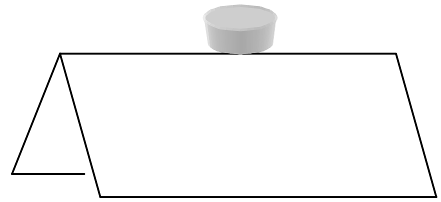
Explanation:
The centre of gravity is the point at which an object balances (its balance point). For example a metre stick has its center of mass at the 50 cm mark, right in the middle. You can balance a metre stick on one finger at this point. This is because the meter stick is uniform in its mass and so equal masses are on both sides of the 50 cm mark. A hammer is a different story. It is not uniform; the metal head has more mass than the wooden handle and so its center of mass is not in the middle but much closer to the metal head

So the centre of gravity depends on how the weight of an object is distributed. Now an object is balancing if its centre of gravity is above its point, or points of support. When you stand, you're balancing because your centre of gravity is above your feet. If an object's centre of gravity is below the point of support, it is hanging.



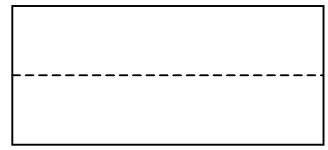
Now have another look at the arrangement of the 'balanced' nails. Can you see most of them are hanging well below the head of the tenth nail? The centre of gravity of this arrangement is well below the point of support. So you see, it's isn't really a balancing trick after all – the nails are hanging.

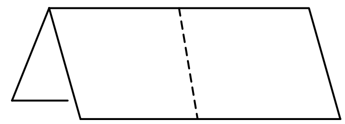
Impossible Coin Balance Trick



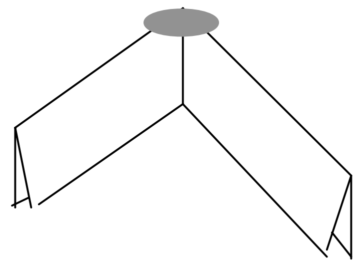
Materials:
- A quarter
- A $10 bill or similar

Procedure:

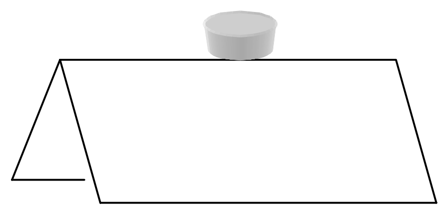




1. Challenge your class to balance a quarter on the edge of a folded $10 bill.
2. After they have grown tired of trying, ask if you can have a go.
3. Fold your bill in half both ways and bring the two opposite ends together, to form a “V” shape.
4. Place the coin on top of the vertex of the “V”, as shown below.
5. Carefully take hold of the top corners of the two ends of the bill and slowly pull them apart to straighten out the bill.
6. Miraculously, the coin will stay balanced on the edge of the folded bill.



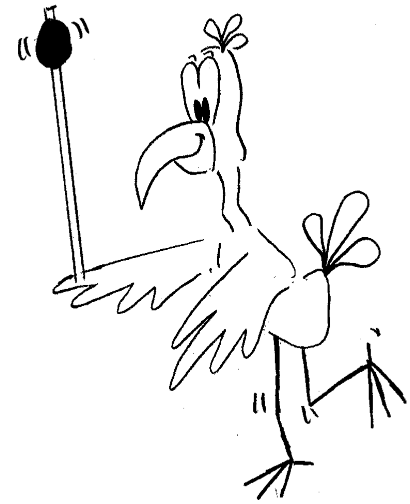
Explanation:
The explanation for this trick is very similar to the explanation for the *Meet Me at the Center*. As you pull the corners apart, the coin finds its center of balance and will align itself accordingly. This is because the friction between the coin and the bill pulls and pushes the coin until it is in an equilibrium position. Once you get the bill straight, continue to gently pull the bill in opposite directions so the coin continues to balance. This trick takes some practice, but can be mastered with some patience.



Which End is Up?

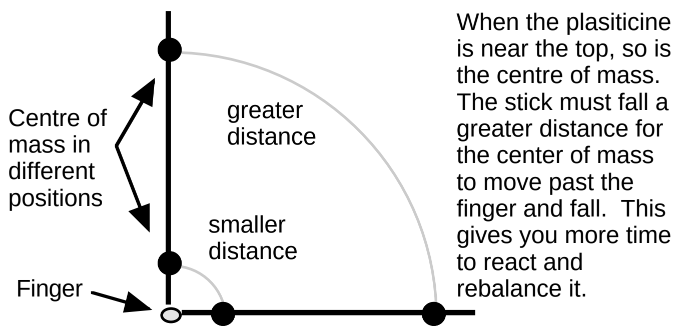
(Is it a matter of fact or a fact of matter?)

Objective:
To discover the easiest way to balance a vertical stick



Materials:
• metre stick
• lump of plasticine (size of your fist)

Procedure:
1. Place the ball of plasticine 15 cm from the end of the stick.
2. Balance the stick on the tip of your finger, putting your finger under the end that's near the plasticine.
3. Now turn the stick over and balance it with the plasticine at the top.
4. Discuss why it is easier to balance the stick when the plasticine is at the top.



Explanation
An object will balance when its center of mass (center of gravity, balance point) is supported. Attaching a heavy lump of plasticine to a metre stick displaces the center of mass from the 50 cm mark to a point closer to the lump of plasticine. When the lump is on the bottom of the stick, the center of mass is close to your finger and when the lump is on top of the stick, the center of mass is farther from your finger. Balancing requires you to keep the support (your finger) underneath the center of mass. The stick is out of control and falls when its center of mass moves below your finger. When the center of mass is near the top of the stick, it must move a greater distance to fall past your finger than it does when the center of mass is near the bottom of the stick. To fall this greater distance takes more time and therefore you have more time to react and move your finger to rebalance the stick.

Teacher Note: Do not do the demonstration or give background in advance. Give the materials to the group and challenge them to see who can balance the stick longest or have them stand two sticks on the floor to see which falls first. This activity works well for “Whats your Theory?”

Hammer Time!

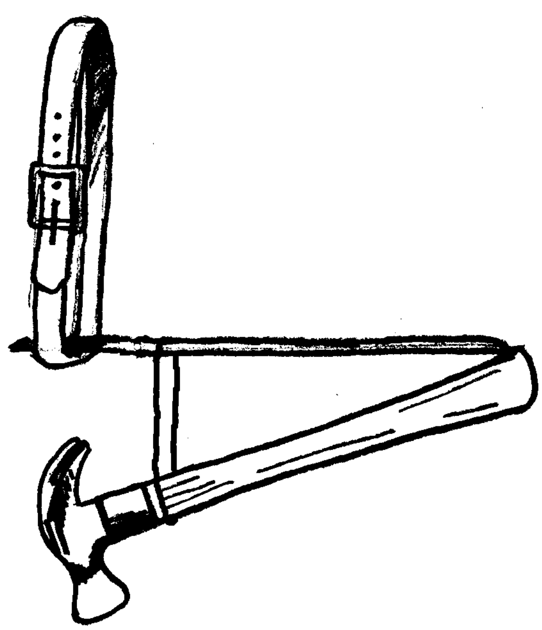
Objective:
To demonstrate a balanced system.

Materials: (may vary)
- Hammer
- String about 30cm
- 30cm ruler
- One belt

Procedure:
1. Take off belt (hold on to pants) and fasten to make a loop.
2. Tie string to form a loop.
3. Place hammer handle and ruler in loop of string. The handle end should be even with the end of the ruler.
4. Put the opposite end of the ruler in the belt loop. Shift the looped string on the ruler and hammer until the entire system is balanced.

Explanation:
The system looks unnatural and unstable because the hammer is so lop sidedly heavy on one end. The center of mass is the balance point and it is positioned directly under the support that is the belt. This set up is the basis for many balancing toys and executive desk ornaments. Look closely and you will see an object that has most of its mass concentrated in one spot.

Teacher Note:
Practice this demonstration or wear steel-toed boots. You can enhance the demonstration tying your belt to string hanging from the ceiling and leave this unlikely mobile hanging for a while.



Balancing Act

(Center of Mass and the Human Body)

Introduction

Balancing is also a human phenomena that requires us to keep our center of mass over our support. These three demonstrations all deal with our center of mass and the human body.

Stand By Me?

Objective:

To determine where our center of mass is located

Materials:

- Two students
- Two large paper dots

Procedure

1. Ask two students to stand side by side so that their hips touch and then challenge them to lift their outside legs at the same time.
2. Try as they might, they cannot do it. Each one pushes the other over as their body tries to achieve a stable position with their center of mass over one supporting leg.
3. Explain to your class that their centers of mass are located close to their belly buttons and tape a large paper dot on each volunteer to mark their center of mass.
4. Ask each student to stand on one foot and point out how they position their center of mass over their supporting leg.

Explanation

When the two students are side-by-side, they can not position their center of mass over their supporting leg and so they become unstable (unbalanced) and fall over.

Under My Thumb!

Introduction:

This demonstration is especially amazing if you get a small student to restrain a larger student.

Objective:

To force a student to stay sitting, using only your thumb.

Materials:

- One or two students
- One chair
- One thumb

Procedure

1. Ask a student to sit in a chair at the front of the room.
2. Ensure that feet are in front and not under the chair and that the volunteer is sitting erect with back straight at the back of the chair.

3. Place your thumb on the middle of the volunteer's forehead and ask him/her to stand up.
4. As the student tries to stand, push down and back with even sustained pressure. The students is powerless to stand.

Explanation
When trying to stand from the sitting position, we must move our center of mass from the chair seat to a position over our legs. To achieve this we lean forward using our back muscles. Pushing down on a person's forehead prevents them from leaning forward and moving their center of mass. Most people do not have strong enough back muscles to overcome the force of the thumb and so they cannot get into a stable standing position.

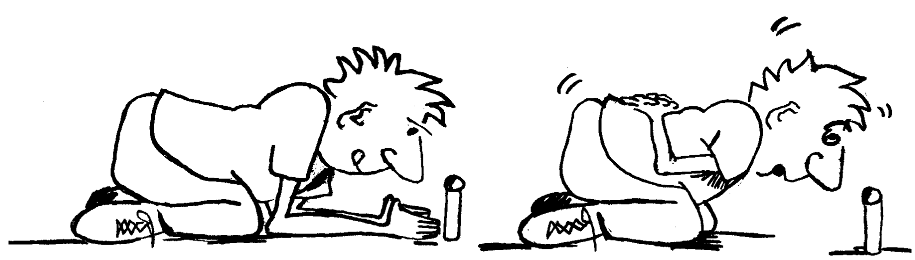
Woman Nose Best!

Introduction:
This demonstration draws attention to the differences in centers of mass for males and females.

Objective:
To determine who can reach the farthest with their nose and not fall over.

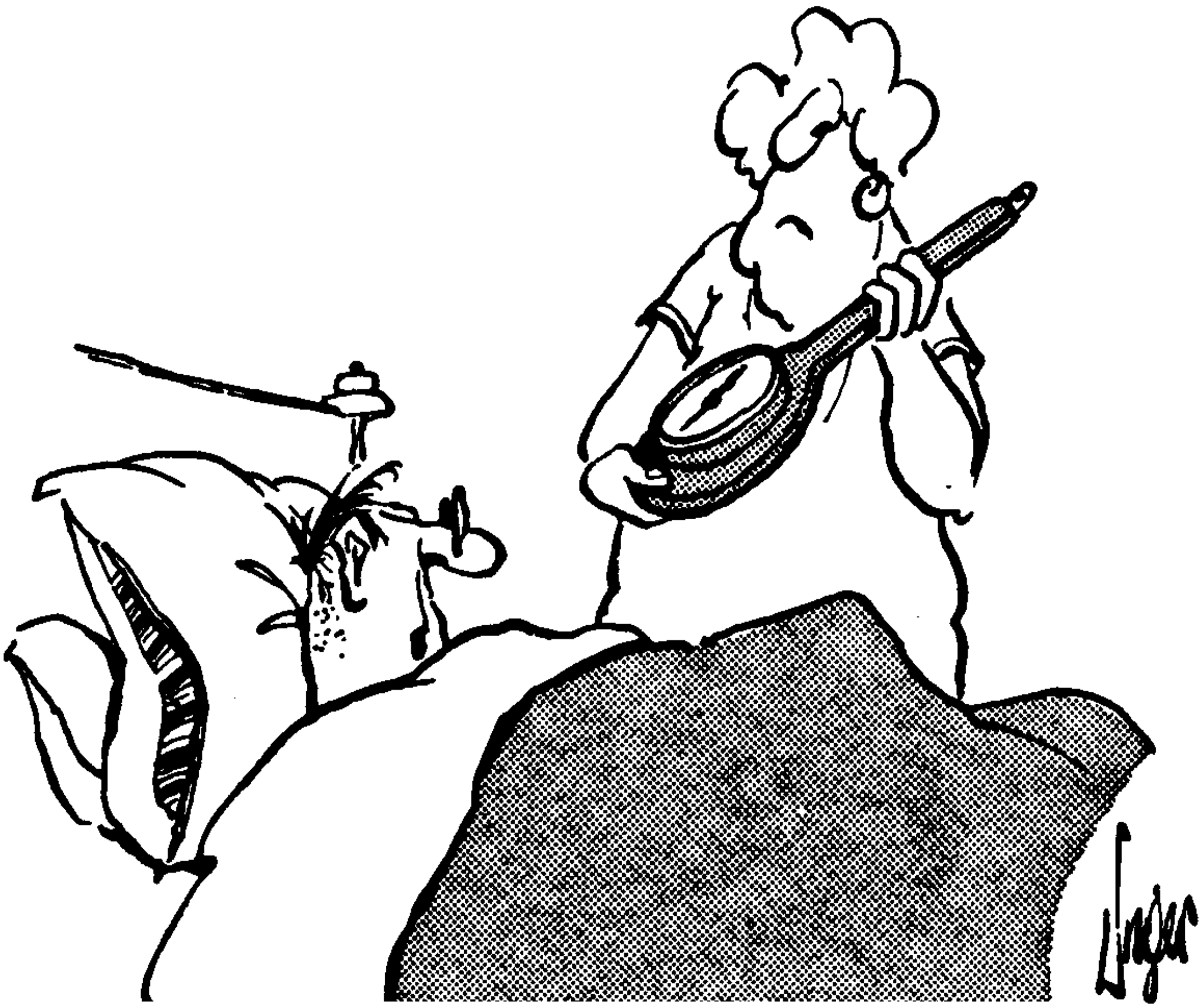
Materials:
- One glue stick
- One ping pong ball
- One male student
- One female student

Procedure
1. Ask a student to kneel, bend over and put their elbows on the floor touching their knees and their arms and fingers extended away from their body.
2. Place a glue stick so that it just touches the student's extended fingers and balance a ping pong ball on top of the glue stick.
3. Now ask the student to straighten up on their knees and with their hands behind their back, challenge them to lean forward and knock the ping pong ball off the glue stick (without losing their balance and falling over). Amazingly most girls can do this trick and most boys can't.



Explanation:
The center of mass on the human body is located quite close to your belly button. For men it is generally a little higher and for women it is a little lower. This gender difference is due to men having more mass concentrated around their arms and chest and women more around their hips. This demonstration works best with adolescents and adults. Children who have not reached puberty have their center of mass in the same place regardless of gender and so are not ideal for this demonstration.

Air



"Are you sure he told you to stick a barometer in my mouth?"

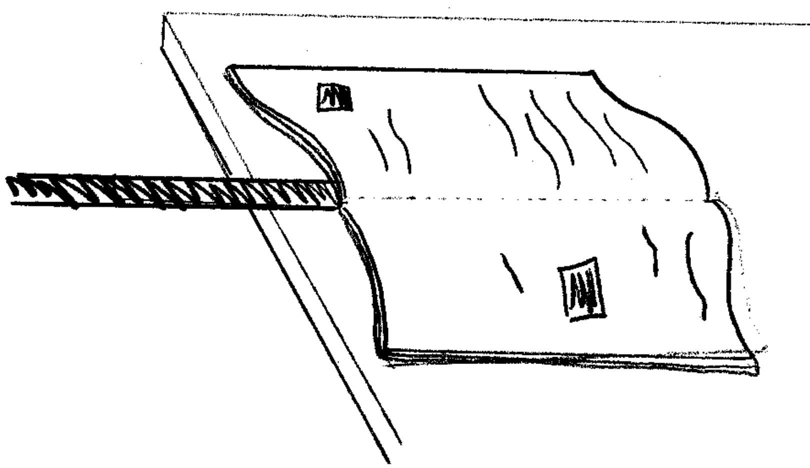
Karate Kid

Introduction:
In this activity you will demonstrate what the force of a thin layer of air can do. The air pressure under a newspaper is strong enough to break wood.

Materials:
- Newspaper or flip chart paper
- Wooden ruler or wooden slat
- Large flat desk
- "Karate Chop Action"

Procedure:
1. Place the wooden stick on the edge of a desk so that it balances.
2. Cover the wooden stick with 2 sheets of newspaper.
3. Raise your hand over the part of the stick that is hanging out of the paper in a Karate Chop motion. Ask the class what they think will happen or how far they think the stick will fly.
4. Karate chop the wood in an attempt to break it. If the stars are aligned, the stick will break.
5. Fold the newpaper in half, 3 or 4 times. Now repeat the demonstration. The mass of the paper is the same, but why won't it break the stick this time?

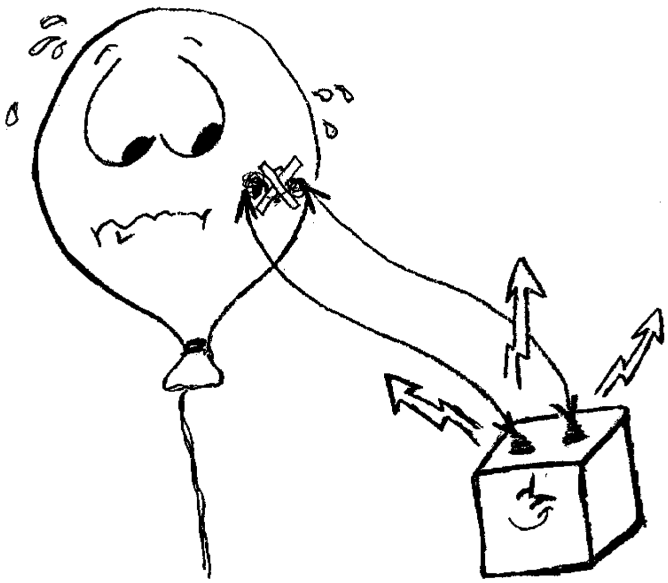
Explanation:
The wood should break in half while the newspaper stays in place. One would expect the wood and paper to go flying through the air, but this is not the case. Have your students attempt an explanation before you spill the beans.



It is the pressure of the air pushing downward on the newspaper that prevents the paper from rising and ultimately breaks the stick. Sitting on top of the paper is a column of air 400 kilometres high. This column exerts a force of 1 kg/cm^2 . A page from News North has an area of 2400 cm^2 , therefore the column of air pushing down on the news paper is equal to 2400 kg—that's the mass of more than eight Hondas. Our bodies are accustomed to this weight (pressure), but the air particles can be stubborn if we try to move them quickly. It takes a great deal of force to move air quickly and a small wooden stick or ruler is not strong enough to provide this force. The reverse of this is also true. That is, moving air has a great deal of force. A great mass of moving air (wind) has enough force to power large sailing ships, knock down houses or move tons of snow around the Kivalliq.

Smoothing down the newspaper with your hands prior to hitting the stick is a crucially important step. You want to make certain that there is no air under the newspaper that might help it to lift up when you strike the stick. When the newspaper is folded, its area is reduced and therefore does not have to move as much air.

Blow a Fuse



Introduction:
In this activity students will see that electricity moving through wires causes the wires to heat and that this principle is applied to the safety device called a fuse.

Materials:
- steel wool
- scissors
- tape
- balloon
- alligator clips (2)
- 6 or 9 Volt battery

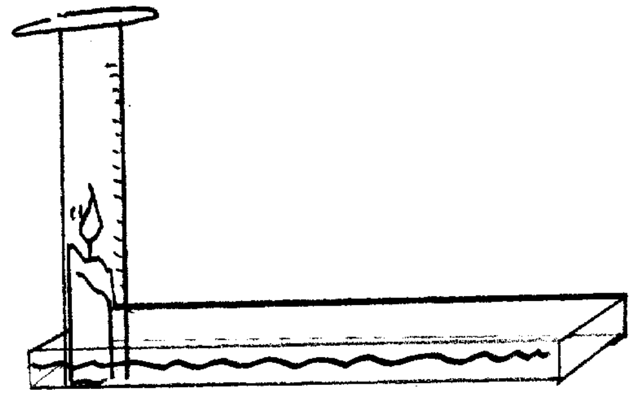
Procedure:
1. Inflate a balloon so that it is stretched to its near maximum capacity. This demonstration works best if the rubber is taut. Balloon may be tied to a retort stand or held by a volunteer.
2. Tape a 4 cm long strand of steel wool to the balloon so that both ends are accessible and not covered by the tape.
3. Attach an alligator clip to each end of the steel wool strand.
4. Attach one alligator clip to each of the terminals of the battery.

Brace yourself. The balloon should burst shortly after the circuit is completed.

Explanation
Current electricity is the flow of electrons along a wire. These moving electrons generate heat by rubbing against each other and against the atoms in the wire. Different materials conduct electricity differently; the better the conductor is the easier the electricity passes through it and the less heat that is generated. Copper is a very good conductor, but it can overheat if too much electricity is passed through it. When wires overheat, they melt their insulation and can start household fires. Fuses were designed to prevent this situation. A fuse is metal strand usually encased in glass that is part of the electrical circuit or an electrical appliance. It is designed to melt and break apart at a safe temperature. Once the fuse breaks, the electricity must stop and overheating is prevented.

In the case of the demonstration, the thin strand of steel wool acts as a fuse. When the circuit is completed, it becomes red hot and melts, thus breaking the circuit. The heat of the steel wool is enough to put a hole in the balloon. Your result is a popped balloon and a blown fuse.

Candle Power!



Materials: • candle • graduated cylinder, • matches • shallow dish • food colouring.

Procedure:
1. Place the candle in the dish.
2. Add coloured water to the dish until the water level is several centimetres high.
3. Light the candle.
4. Place the graduated cylinder over the candle for a couple of seconds and then make sure that the mouth of the cylinder is below the surface of the water.

The candle will slowly burn out, bubbles may appear in the dish and then water will rise up the graduated cylinder.

Explanation:
The volume of air inside the graduated cylinder expands when heated by the candle and some of the air leaves the cylinder. When the cylinder is placed over the candle, all of the remaining oxygen is consumed and the candle goes out. When the air cools, its pressure becomes less than that in the room. The room's air pressure pushes water into the cylinder until the pressure of its air space equals that of the room.

Needle Point!

Materials: • knitting needle/skewer
• large balloon

Procedure
1. Blow up the balloon.
2. Carefully place the needle through the end of the balloon where the rubber is thickest.
3. Carefully pull the needle out of the balloon. The balloon does not pop or seem to deflate.

Explanation:
When a balloon is inflated there are several forces that pull the rubber in all directions. A pin prick will weaken the rubber and a combination of the air pressure inside the balloon and the elastic properties of rubber pull and tear the balloon the sight of the pin prick. The result is that the balloon pops. The ends of a balloon are forced inwards or closed and the rubber is less stretched there and as a result it is thicker. When the hole is made by the needle there is not enough pressure to break the balloon. When the needle is pulled out, the rubber bounces back and seals the hole up.

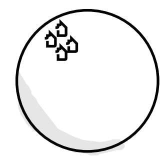
Patients on intravenous drips in hospitals are given medication by having it injected into a rubber septum on the drip tube. The needle punctures the rubber, but the rubber does not break and reseals itself when the needle is withdrawn.

Teacher Note: Practice this a number of times before demonstrating it to the class. It can be used to test the students observation skills. Challenge them to perform the demonstration.

Bubble Trouble

Here is a challenge for all K-8 classes. Using the instructions provided, produce bubbles big enough to enclose a student. Regardless of the outcome, it should be good clean fun!

Bubble Recipes
"Joy" is recommended by most books as the liquid detergent of choice. However, clear Ivory and green Dawn are good substitutes--all three products are made by Proctor and Gamble and must share some essential ingredient that makes hardy bubbles. If none of these fine products are available in your community, go with a good quality liquid detergent (i.e. expensive). For those of you that want to save some money and be environmentally conscious, old slivers of hand soap may be recycled and turned into a bubble mixture. Instructions for making this mixture are also included.



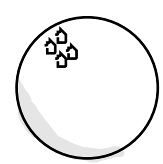
A Cheap Recycled Bubble Base
Have each student bring to school the slivers and leftover ends from bars of soap. Rinse them off and place them in a jar with just enough water to cover them. As time goes on, the contents of the jar will turn into a jelly-like mass of soap that can be used in place of liquid detergent in the following recipes.

Recipe 1--A Lasting Solution
- 2.21 litres liquid dish detergent or bubble base
- 22.57 litres of clean water
- 120 mL of glycerin
- makes 25 litres

Shaw, M. I., & Smith, G. (1995). Double bubble? No trouble!. Science and Children, 33(1), 24-27.

Recipe 2--Superbubbles
- 2 glasses liquid dish detergent or bubble base
- 6 glasses of clean water
- 1 to 4 glasses of glycerin (4 is best but since glycerin is expensive, you may want to use less)
- gently mix together
- makes 9-12 glasses

Ontario Science Centre. (1994). The jumbo book of Science. Toronto: Kids Can Press.



Recipe 3--Basic Bubbles
- 1 cup liquid dish detergent or bubble base
- 10 cups clean, cold water
- 3-4 tablespoons glycerin
- add water, detergent and glycerin in a clean pail and gently stir
- makes 11 cups

Cassidy, J. (1987). The unbelievable bubble book. Palo Alto, CA: Klutz Press.

Recipe 4--Mix Up Your Bubbles

- 60 mL liquid dish detergent or bubble base
- 200 mL clean water
- 1 tablespoon glycerin
- gently mix
- makes 1 cup

Kenda, M., & Williams, P.S. (1992). Science wizardry for kids. Hauppauge, NY: Barron's Educational

Bubble Secrets

Glycerin or Sugar

Soap and detergent reduce the attraction that water molecules have for each other. This allows water surfaces to be more flexible and to form spherical films called bubbles. Glycerin make the bubbles last longer. Table sugar may be substituted for glycerin, (1 tablespoon sugar = 1 tablespoon glycerin) in recipes 1, 3 and 4. In recipe #2, since such large amounts of glycerin are suggested, it would be wise to use less sugar so that it may dissolve.

Humidity

Bubbles love humidity but in most Kivalliq classrooms humidity is a scarce commodity. This makes it a challenge to make bubbles larger than 1 or 2 feet. Dry conditions cause the water in a soap bubble to evaporate quickly, bursting the bubble. A classroom's humidity can be increased using a humidifier or by leaving several basins of water out over night to evaporate. Another way to counter an arid classroom is to add more water to the bubble mixture. Up to 50% more water may be needed, but this should be determined through a trial and error approach.

Foam and Froth

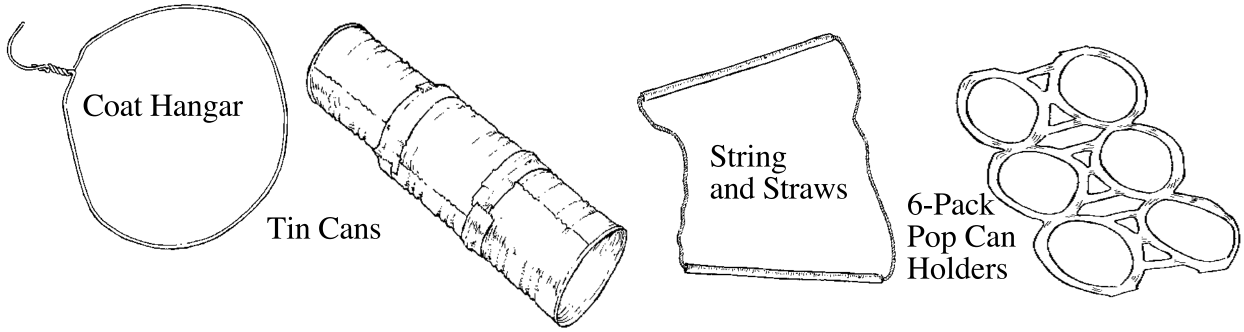
Whipping a bubble mixture into a thick froth does not help you achieve your goal of large bubbles. Suds and foam decrease a soap bubble's life span, so discourage students from splashing the bubble mixture. It is generally a good idea to let your bubble mixture settle for an hour after mixing it up.

Bubble Containers

Buckets and basins make excellent containers for your bubble mixture. If you want to try to make bubbles that engulf your students, then a large tub or small plastic swimming pool will be needed.

Bubble Makers

There is a large variety of everyday household things that can make great bubbles. Some examples are given below.



To make giant bubbles, capable of engulfing a student, a hula hoop is needed. (It may have to be cut and resized to be useful.) Wrapping the hoop in string or yarn allows it to soak up the bubble mixture and form longer lasting bubbles. To build a bubble around a student, you must have the student stand in the bubble mixture, either clad in rubber boots or on top of a wooden box or plastic pop/milk crate. A plastic swimming pool or large tub is recommended to hold the mixture. Place the hoop over the student and into the mixture, then with a quick upward motion, lift the hoop above the student.

Safety and Clean-Up
To prevent slippery messes, place several layers of newspaper on the floor where the bubble investigations will take place. If large bubbles are being attempted, clear desks out of the way so that there is room to maneuver. Since soap stings the eyes, let students wear sun glasses or goggles; it will add to the fun.

WindBags

Introduction:
In this activity students will see how air moving across an opening causes a low-pressure area. This is an application of Bernoulli's Principle

Materials:
- Two Windbags
- Two students with a lot of hot air

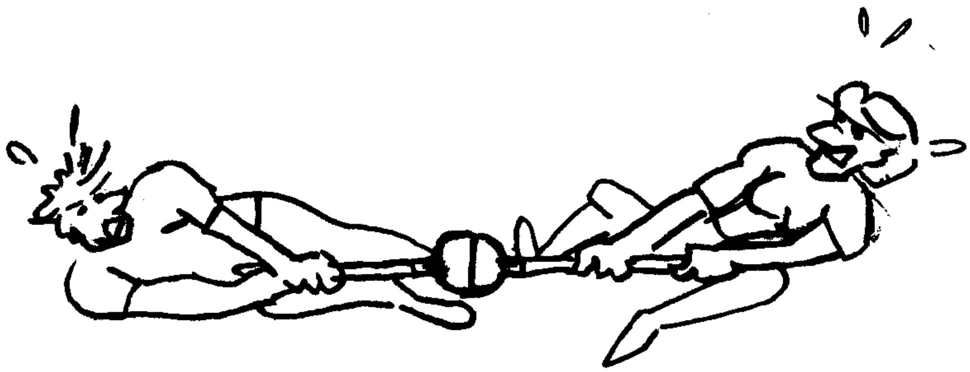
Procedure:
1. Challenge two students to compete against each other blowing up the windbags. This can take a few minutes and is humourous to watch.
2. Give the winner time to rest and state that you will now challenge him or her.
3. Start the race and while your competition is huffing and puffing, ham it up by doing some calisthenic exercises.
4. When you are ready, hold the bag out so that it is in front of your face out about 6-8 inches and blow. Two or three big breaths and the bag will be filled. With practice, you can fill it with one big breath.

Explanation:
This demonstration illustrates Bernoulli's principle which states: If the velocity(speed) of a fluid is high, then the pressure is low. When you blow into the bag at a distance, it creates a low pressure zone in that area. This causes the higher air pressure around the bag to push into that area. This causes more air molecules to get caught up in the jet stream and put into the bag.

Teacher Note:
Windbags may be purchased from Boreal or similar science equipment supplier for about 4/$11. They may also be made by cutting and taping together garbage bags with duct tape (8 inch diameter by 8 feet).

Take the Plunge
(Magdeburg Plungers?)

Introduction:
In the 17th century, 12 brewery horses and two metal hemispheres made Magdeburg famous among scientists and scholars throughout Europe. Otto von Guericke proved that a vacuum could exist with his first "Magdeburg Hemisphere Experiment" in 1657. And he offered onlookers an entertaining spectacle in the process. In the courtyard of his house in Magdeburg, he harnessed 12 horses to two metal hemispheres that had been joined together and emptied of air. Despite their combined traction power and numerous attempts, the horses were unable to pull the hemispheres apart. Not until the pressure valve was opened and air filled the sphere did the two halves separate, virtually unaided. In this updated version of the demonstration, pristine toilet plungers take on the role of the hemispheres and two students provide the strength of the 12 horses.

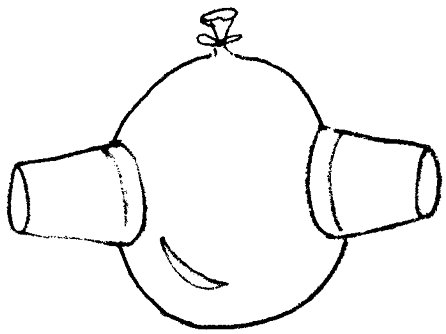


Procedure:
1. Tell your class about the Magdeburg Hemispheres and ask them to recreate the famous demonstration with the toilet plungers provided.
2. Push the two plungers together and ask two students to pull them apart.
3. If the plungers are clean and make a good seal, they will be very difficult to pull apart.

Explanation:
When the two plungers are pressed firmly against each other, nearly all the air between the two of them is forced out. In between the two plungers, there is very little air, and therefore very little air pressure. However, surrounding the plungers there is a lot of air which exerts pressure on the outside and forces the plungers to stay together. When the students try to pull the two plungers apart, they must pull until a small bit of air is able to sneak in between the two plungers and equalize the pressure. When a little air is able to get in between the plungers, the suction is broken and the plungers come apart. A practical application of this demonstration is the suction cup.

Teacher Note:
Wetting the plungers will increase the chances of a tight seal. Petroleum jelly also works, but over time will degrade the rubber in the plungers.

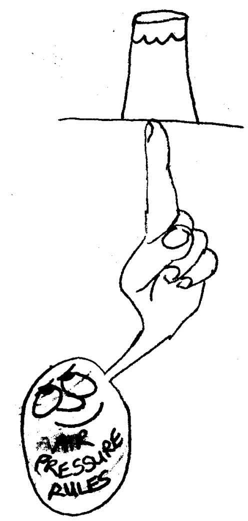
Suction Cup I



Introduction:
This demonstration introduces students to the science behind the suction cup.

Procedure:
1. Ask a student to blow up a balloon.
2. As this is being done, press two styrofoam cups against the outside of the balloon.
3. When the student stops blowing, the cups will stay attached to the side of the balloon.

Explanation:
The sides of the balloon are curved and as it expands it pushes into the styrofoam cup and displaces some air. This reduction in air particles reduces the pressure inside the cup and the ever-present air pressure outside the cup applies its force to hold the cup to the wall of the balloon.



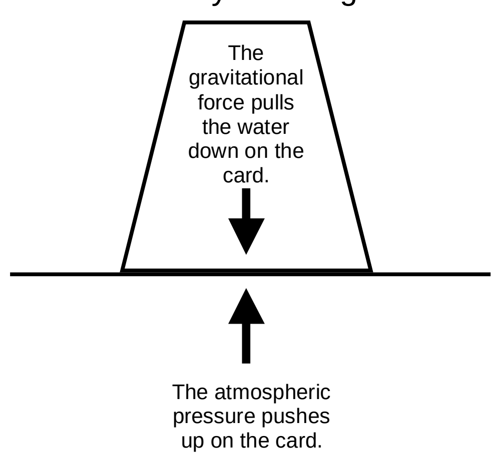
Suction Cups II

Introduction:
This demonstration pits air pressure against gravity with possibility of a wet mess.

Materials:
- Drinking glass (clear polystyrene glasses work well)
- Index card
- Basin or bucket (just in case!)

Procedure:
1. Fill a drinking glass with water right to the brim.
2. Place an index card on top of the glass and press down slightly in the center. This will displace a small amount of water.
3. With your hand still on the card, flip the glass over so that the card is now holding the water in the glass.
4. Slowly remove your hand—the card stays in place and the water stays in the glass!

Explanation:
Atmospheric air pressure pushes on objects with a force of approximately 1 kg/cm^2 (at sea level). This is enough pressure to hold the cardboard in place and the water on top of it (so long as there is an adequate seal formed by the liquid between the lip of the glass and the cardboard, and the weight of the water above does not exceed the force exerted by the atmospheric pressure.



Teacher Note:
You might want to practice this one over a sink.

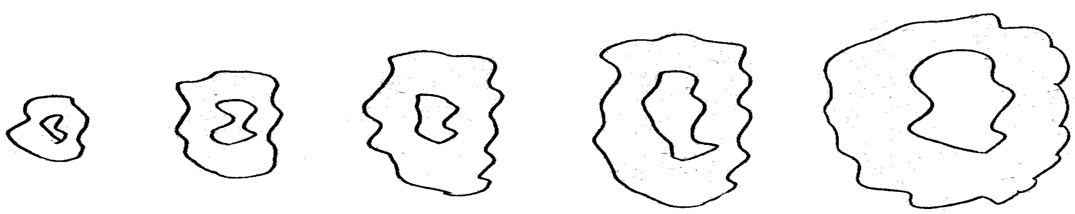
Vortex Candle Snuffer

Introduction:
In this activity students will see how stable a vortex of air is and how easily it can be directed. It's also a pretty cool way to blow out your birthday candles!

Materials:
- 4 large elastic bands
- hole saw or knife
- candle
- sturdy 10 - 25 L plastic container
- 40 cm x 40 cm piece of weather balloon
- smoke generator (optional)

Procedure:
1. Cut a circle (approx 5 cm diameter) in the center of the bottom of the container.
2. Stretch the balloon rubber over the top of the container and secure it with the elastic bands. You should now have a drum with a hole in the bottom!
3. Aim the hole at a burning candle and firmly strike on the rubber membrane. A powerful vortex of air will shoot out of the hole, and if your aim is straight, snuff out the candle.
4. If you have a smoke generator or if you can improvise one, fill the container with smoke before the demonstration. Now the students will easily see the air vortexes as smoke rings.

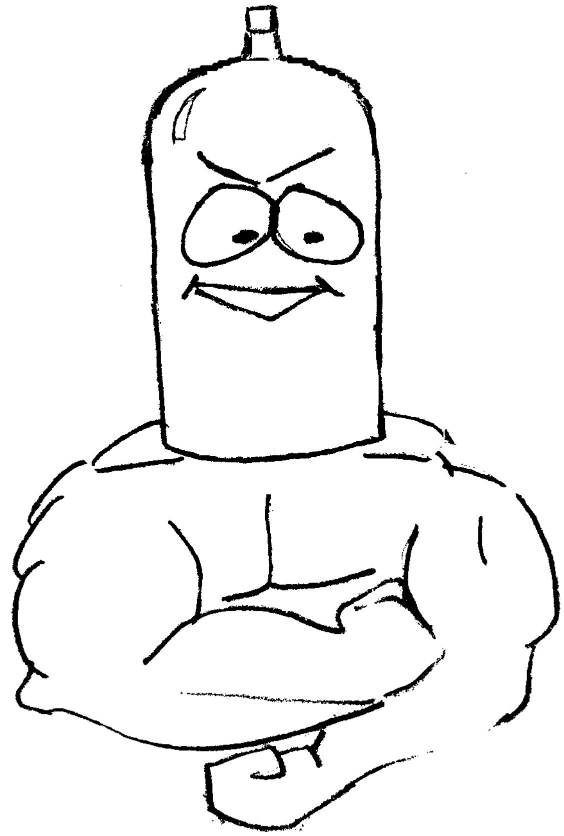
Explanation:
Normally air blown in a given direction meets with resistance from other air and is broken up. It does not go very far unless it is accompanied by a great force. For example try blowing out a candle from the distance of one metre. The Vortex Candle Snuffer sends air out in a stable configuration. A spinning vortex allows the air to continue in a straight line and for a great distance. The same spinning principle helps a rifle bullet and a well-thrown football to travel far and straight.



Teacher Note:
The vortex will easily travel the length of the classroom but practice is need at hitting the candle. If smoke is not used, you can chart the direction of the vortex by lining your students up behind the candle and asking them who can feel the wind. Readjust your aim accordingly and with a little patience and practice the candle will be snuffed.

A smaller version of this apparatus may be made from a styrofoam cup, balloon and a rubber band.

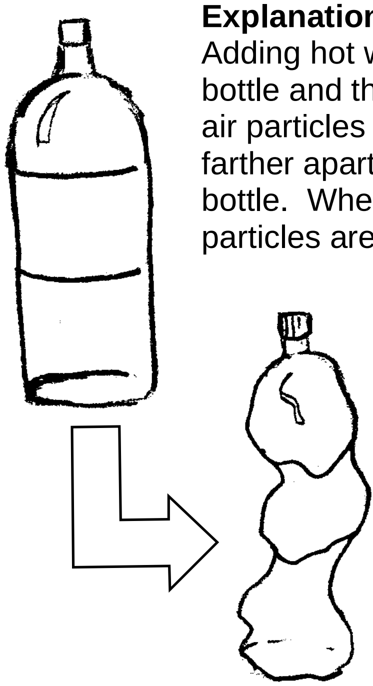
A Crushing Experience



Introduction:
In this demonstration students will see the relationship between temperature and air pressure.

Materials:
- One plastic pop bottle with lid
- Hot water

Procedure:
1. Pour hot water into a plastic pop bottle and swirl it around to heat up the bottle.
2. Empty the bottle, quickly screw on the lid, and set the bottle down so that the class can observe it.
3. Slowly the bottle will begin to collapse as if invisible hands are crushing it.



Explanation:
Adding hot water to the bottle heats the bottle and the air particles inside. As the air particles heat up they move faster and farther apart and are pushed out of the bottle. When the lid is screwed on the air particles are prevented from moving in and out of the bottle. As the bottle cools the air particles inside slow down, move closer together, and exert less pressure on the inside of the bottle. As this continues, the outside pressure becomes too strong and crushes the bottle. This demonstration is the reverse of an explosion and is called an implosion.

Teacher Note:
If you can find a tin can with a screw-on lid, this demonstration is even more impressive as the irrepressible air pressure twists and mangles the metal container. This same action can also be put to good use in getting an egg into a bottle.

Hard-Bottled Eggs

Introduction:
Here are two great air pressure demonstrations involving hard-boiled eggs. One gets an egg into a flask and the other gets it out!

Egg in the Hole!

Materials:

- Hard boiled egg, shell removed
- Cooking oil, margarine, or soap
- Piece of paper (3" x 5" will work)
- Clear, glass flask or bottle with opening big enough so that egg rests on top but does not fall through
- Paper towel
- Matches or lighter

Procedure:

1. Lubricate inner rim and mouth of bottle with oil using paper towel.
2. Fold paper into a fan so it will fit down bottle.
3. Light paper with match and drop into bottle.
4. Immediately place egg onto mouth of bottle.
5. As vacuum is created, the egg will be sucked into the bottle!

Explanation:

1. The pressure in the bottle was reduced when the fire heated up the gas particles inside the bottle causing them to move faster, spread out and leave the bottle. The egg then blocked the opening so that the particles could not get back in once the bottle cooled down. Low pressure created inside the bottle allowed the air pressure outside the bottle to push the egg in.
2. There is also some chemistry occurring in the flask. As the paper burns it combines with oxygen in the air and produces carbon dioxide gas and water vapour. As the flask cools the water vapour turns to liquid lowering the pressure inside the flask. This allows the outside pressure to push the egg in. In this combustion reaction the vapour pressure of the products is less the vapour pressure of the reactants.

Teacher Note:
This demonstration can also be done with hot water instead of burning paper (then only explanation #1 applies). Also, if eggs are not available substitute a small water balloon filled to the size of an egg or a little bigger.

Egg on your Face!

Introduction:
Now that you have successfully put an egg into a bottle, here is how to get it back out.

Materials:

- Same as above

Procedure:

1. Invert flask so that the egg blocks the opening, preferably with the more-narrow end of the egg pointing down.
2. Hold the flask up to your mouth and blow hard into the opening.
3. Quickly pull the flask away from your mouth and catch the egg in your free hand as it comes rushing out. If you are too slow you will get egg on your face!

Explanation:
When the flask is inverted the egg acts as a valve that will allow air in but not let it out. One large blast of air can enter the flask, but can only escape by pushing out the egg blocking the opening. The increased air in the flask increases the air pressure inside and this pressure easily pushes the egg out.

Teacher Note:
If a clean flask was used, you can wash the ash off the egg and eat it.

Water

Water, Water Everywhere

Introduction

This demonstration helps students to see how important water is.

All organisms rely on water to sustain life. Some require more water than others and some can live on very little water but the bottom line is, every living thing needs water to live. The surface of the Earth is over 70% water but how much water is actually usable by organisms? We will use an apple to demonstrate just how much salt water, that is not readily usable, and fresh water that is readily usable, is found on the planet.

Materials:
- One Apple
- Knife
- Plate

Procedure
1. Cut an apple into quarters.
2. Take one quarter (25%) and cut it in half to represent 12%.
3. Now take one of those halves and cut it in half to show 6%.
4. Cut one of those halves in half again to show 3%. This slice represents all of the fresh water in the world, while the rest of the apple represents the oceans.
5. The fresh water can be further divided into usable and unusable by cutting the 3% slice into a 1/3 and 2/3 section (1% and 2% respectively). The 1% slice represents the usable fresh water that is available to all of the organisms on Earth.

Teacher Note

For this demonstration, it is best to cut the apple into the described sections prior to the demonstration (so that we don't have to wait while you cut). However, as soon as an apple is cut and exposed to the air, the surface of the apple turns brown due to oxidation. Squeezing a few drops of lemon juice on the cut surface of the apple may prevent this. The ascorbic acid (vitamin C) in the lemon slows down the oxidation process.

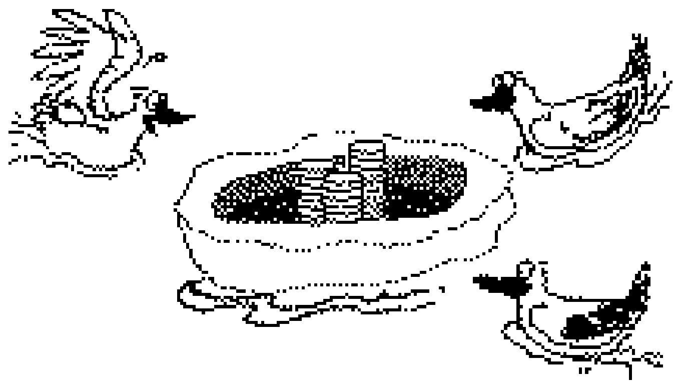
Stay Afloatilla

Introduction
This demonstration helps students to understand what density is and how it affects buoyancy.

Density = mass/volume

Materials:

- Plasticine
- A large beaker or tank of water
- 3 marbles or pennies
- Scale or triple beam balance



Procedure:
1. Fill a large beaker with water.
2. Form plasticine into a ball.
3. Place the plasticine and marbles in water and watch them sink.
4. Remove plasticine and marbles from water.
5. Shape plasticine into boat.
6. Set plasticine on water and watch it float.
7. Place 3 marbles on plasticine boat as cargo.

Explanation:
Even though a ship is huge and weighs a lot, it floats, whereas a small but light marble sinks. The weight of an object is not a factor. The amount of water an object "displaces" or pushes aside determines if it will float. Shaping the plasticine into a boat increases its size or volume which reduces its overall density. If the density is less than the density of water (1 gram/cm3) the object will float because it weighs less than the mass of the water it displaces.

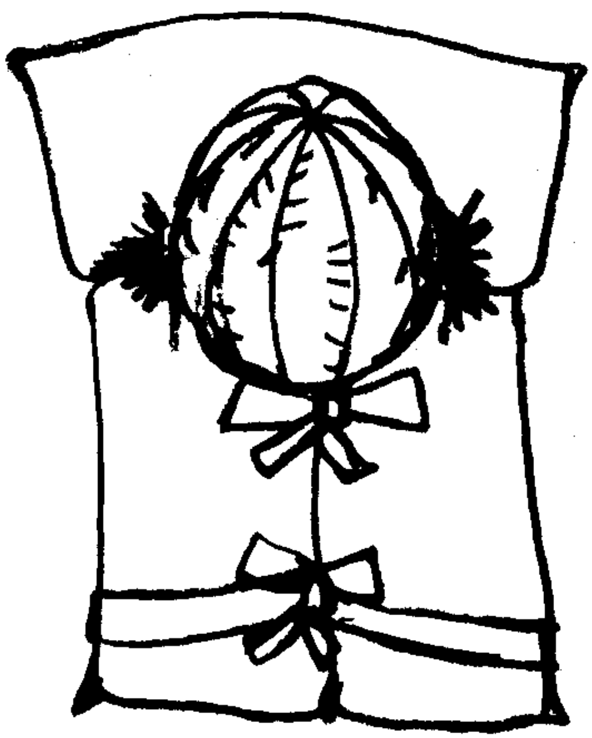
Orange Life Jacket

Introduction

Life jackets are an essential part of boating safety and this demonstration illustrates why we should always use one.

Materials:
- Two oranges
- Two large beakers
- Water

Procedure:
1. Place a whole unpeeled orange in a beaker or tank of water--it will float.
2. Now peel an orange and place the peels in a beaker of water--they will float.
3. Take the peeled orange and place it in a beaker--it will sink.



Explanation:

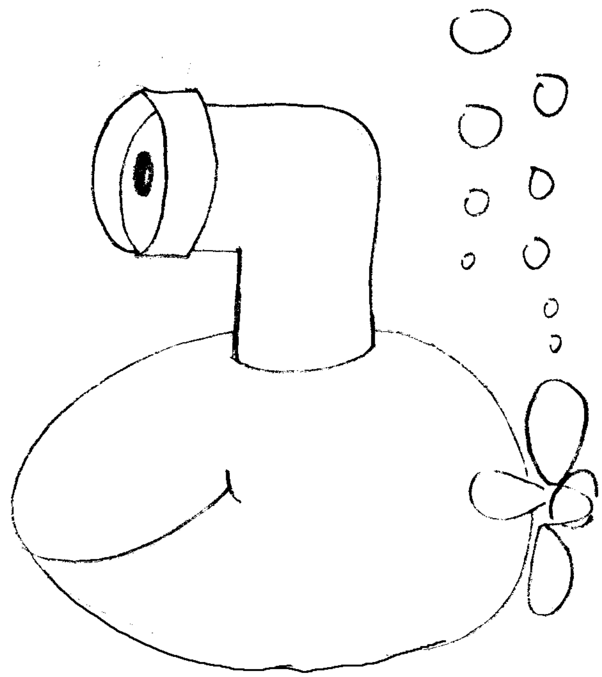
The whole orange floats because it is less dense than water. The skin is very buoyant because it has a low density (its mass is small compared to its volume). Removing the skin changes the density of the orange and makes the peeled orange more dense and less buoyant. This is completely analogous to humans with and without life jackets. Life jackets make us more buoyant because they reduce our overall density. The fact that most life jackets are the colour orange helps make the connection as well.

Eggcellent Submarines

Introduction:
This demonstration shows students the effect that salt has on the buoyancy of water.

Materials:

- An egg
- A glass
- Water
- Salt
- A teaspoon



Procedure:

1. Carefully place the egg in a glass half full of water. It will sink.
2. Stir salt into the water, one teaspoonful at a time. The egg will gradually float up as you add more salt.
3. When the egg is floating at the surface, carefully add more water to nearly fill the glass. Dribble it slowly over a spoon held against the side of the glass, so that the fresh water doesn't mix with the salt water. You will end up with the egg floating on the boundary in between the fresh and salt water layers.

Explanation:
The weight of fresh water displaced by the egg weighs less than the egg, so the egg will not float on fresh water. (The overall density of the egg is greater than that of fresh water.) The weight of the salt water displaced by the egg, however, is greater than the weight of the egg, and so the egg floats on the salt water. (The overall density of the egg is less than that of salt water.) Fresh water will float on salt water as long as the two don't get mixed together. The general rule of sinking and floating is: the less dense substance floats and the more dense substance sinks.

Cartesian Diver

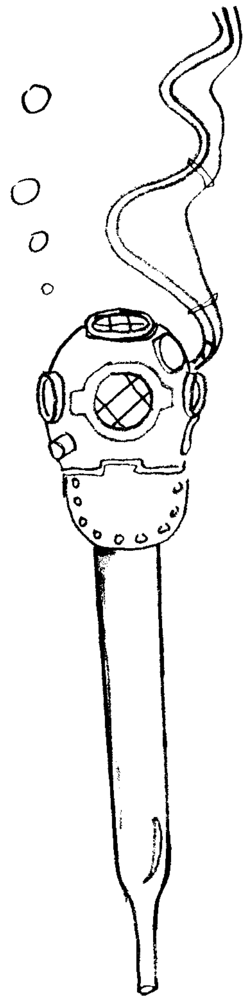
Introduction:
This demonstration shows students how fish and submarines regulate their buoyancy.

Materials:

- 2 liter pop bottle with cap
- Small container such as a yogurt container
- Glass eye dropper

Procedure:

1. Take the empty pop bottle and fill it completely with water.
2. Fill the yogurt container with water and place the eye dropper in the water. The dropper should float.
3. Adjust the mass of the eye dropper by drawing some water into it. You want to get the dropper to just barely float upright in the water.
4. Once you have adjusted the eye dropper, place it in the pop bottle and screw on the cap tightly.
5. Gently squeeze the bottle. As you squeeze, the dropper will dive (sink) to the bottom of the bottle. If you stop squeezing, the dropper floats back to the top.



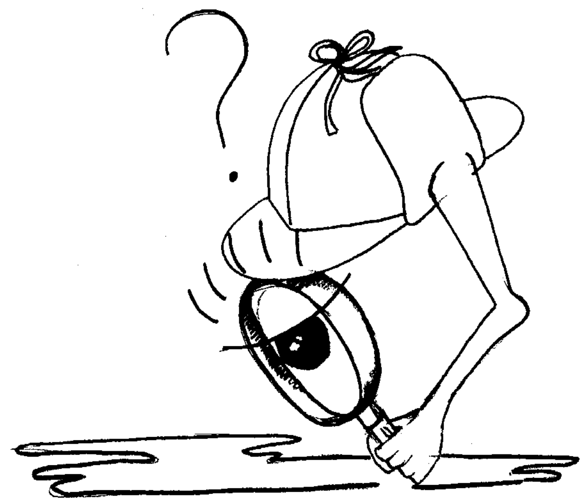
Explanation:
This experiment demonstrates the property of buoyancy. An object is buoyant in water due to the amount of water it displaces or 'pushes aside'. If the weight of water that is displaced by an object in water exceeds the weight of the object, then the object will float. In other words, if the density of an object is less than the density of water, the object will float. If the object is denser than water the object will sink. With the Cartesian Diver, the buoyancy changes as the air bubble in the eye dropper contracts from compressing the bottle. As the bubble gets smaller, more water fills the eye dropper increasing its mass and overall density to the point that it sinks. When the bottle is released, the bubble becomes large again pushing out some water, reducing the density of the dropper making it buoyant again.

Teacher Note:
If you can't find an eye dropper, you can duplicate the same effect by bending half of a plastic drinking straw in half and securing it with a paper clip. Put a small amount of plastercine on the bottom end of the straw and, like the eye dropper, just get it to barely float on the surface of the water. Fastfood ketchup bags also work well as a diver in this demonstration.

Fantastic Fluids

Introduction:
The following two activities give students some experience with substances that do not fit neatly into our classifications of matter.

Mystery Mud



Materials

- 1 cup of corn or potato starch
- 1/2 cup water
- Pie plate or shallow bowl
- Food coloring (optional)

Procedure

1. Put the starch into the container.
2. Add 1-2 drops of the food coloring. (optional step)
3. Add water slowly to the starch while stirring. Make sure not to add so much water that you dilute the starch.
4. Now play with the mystery mud in front of the class.
5. Stirring and agitating the mud exhibits its liquid properties.
6. Slamming your fist down into the mud makes it behave like a solid.

Explanation
Mystery mud is a solid suspended in a liquid. When agitated the solid particles freely move around in the liquid and the mixture behaves like a fluid. However, if allowed to settle or if put under great stress, the solid particles form a rigid structure. Mystery mud is similar to quick sand in this respect.

Crazy Putty

Introduction:
Crazy Putty demonstrates the principle of a chemical reaction - two substances combining to form something new, which has properties different than those of the ingredients.

Materials:

- Elmer's White School Glue or carpenters glue
- Borax powder
- Water
- Food coloring
- Paper cups
- Popsicle stick
- Two litre pop bottle
- Small Ziploc bags

Procedure:

1. In a two litre pop bottle mix warm water and 4 tablespoons of Borax powder. Shake until the Borax is mostly dissolved.
2. Add a big blob of glue to each student's cup.
3. Add a drop or two of food coloring and have students mix with the popsicle stick.
4. Now add half a cup of borax solution to each cup and mix well with stick.
5. Continue mixing until rubbery blob has formed.
6. Students should now use their hands to heat the mixture to complete the reaction.
7. Have students rinse hands and Crazy Putty with water to remove excess Borax.

Explanation:

Crazy Putty is a special type of material called a polymer. Polymers are things made up of long twisted molecules. Because the molecules are long and twisty, they can get tangled together (like long hair). This is why it will seem solid if we hit them or pull quickly. Yet if we try to move the material slowly the molecules have time to slide over each other and behave more like a thick liquid.

Alka-Seltzer® Rocket

Your students will have a gas with this activity. It can be adapted to be an experiment a wonderful Science Olympic Challenge.

Materials:

- Film canister with snap-on lid (Fuji film canister - the kind where the lid fits inside the canister works best!)
- Alka-Seltzer® tablets
- Safety glasses
- Wash basin
- Paper towel for clean-up

Procedure:

1. Place empty wash basin the floor away from any lights. If conditions are just right these rockets can launch up to 5 metres in the air, so practice in the gym first to gauge the height.
2. Divide the Alka-Seltzer® tablet into four equal pieces.
3. Fill the film canister 1/2 full with water. If you vary the temperature of the water, your rocket will shoot to different heights. The warmer the water, the faster the reaction. Varying the amount of water and Alka-Seltzer® will also affect the reaction.
4. Drop 1/4 tablet of Alka-Seltzer® into canister and quickly snap on the lid.
5. Turn the canister over and place it upside down in the basin and stand back. The carbon dioxide produced will launch the canister into the air.
6. Mop up any spray that escapes the basin.
7. Rockets can be modified by adding tail fins and a nose cone from an paper or an index card, but keep the overall mass a small as possible. Also a launch tube can be fashioned from a toilet paper tube or plastic pipe.

Explanation:

Carbon dioxide gas is produced by the chemical reaction between the ingredients in the Alka-Seltzer® tablet in water. The gas builds up enough pressure to pop the lid off of the canister and launch the rocket. The rocket is propelled according to the principle stated in Newton's third law of motion: "For every action there is an opposite and equal reaction." In our rocket, gas pressure builds inside the film canister and the gas applies a force to both the canister and the lid. Eventually, enough pressure builds to blow apart the canister and lid. The action is the lid, gas and water pushing down, and the reaction is the rocket canister pushing up.

A more detailed explanation of the chemistry and physic involved is given below:
The active ingredients in Alka-Seltzer® are Sodium Bicarbonate and Citric Acid (a base and an acid). When these two chemicals are mixed in a water solution, Carbon Dioxide gas and Sodium Citrate salt are created in an *exothermic* (generates heat) reaction

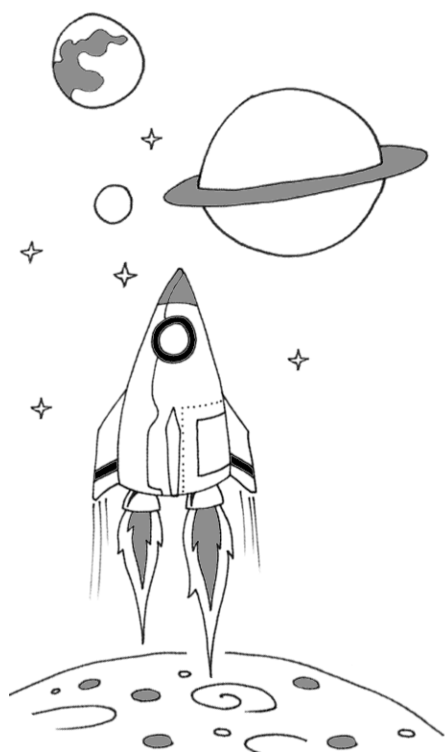
$$H_3C_6H_5O_7(aq) + 3\ NaHCO_3(aq) \rightarrow 3\ CO_2\ (g) + 3\ H_2O(l) + NaC_6H_5O_7\ (aq)$$

The heat released in the reaction increases the pressure of the CO_2 gas that is liberated. The pressure required to pop the lid off the canister is the limiting factor that determines the height that can be reached. This is because, regardless of water temperature, amount of water or amount of CO_2 gas, the "lid popping pressure" determines the maximum CO_2 gas pressure that can build up in the canister. Increasing heat should increase the rate of reaction and result in higher launches. However, hot water will soften the plastic canister and reduce the pressure needed to pop off the lid. So although you can speed up the rate at which CO_2 gas is generated by using hot water, the altitude may decrease, because the maximum pressure attainable within the canister decreases.

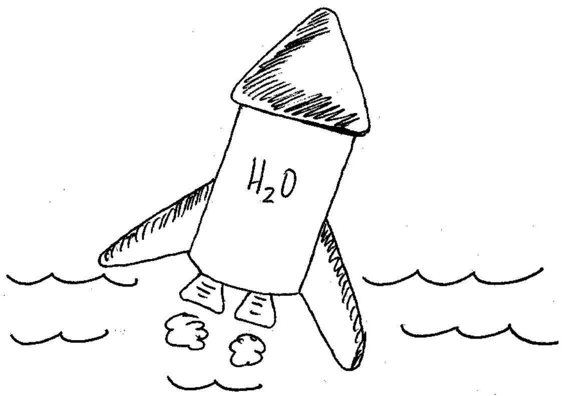
Teacher Note:
You may need to experiment with several different film canisters before you are successful at building a rocket that launches with a blast. If the lid fits too tightly or too loosely, it won't work. If you have difficulty finding the correct type of film canister, try using a regular film canister and fitting it with a rubber stopper. Care must be taken to avoid injury from launched rockets—safety glasses are a must.

If you decide to have your students decorate and modify their rockets, check out the following web site for rocket templates and patterns.

http://www.sci-experiments.com/seltzer_rocket/seltzer.html



Water Rocket

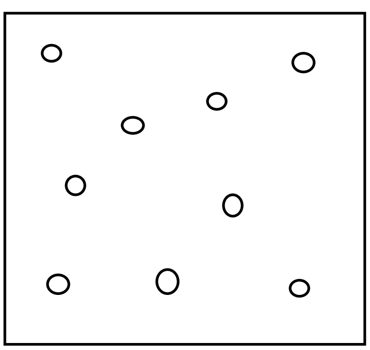


Introduction:
This demonstration provides an excellent introduction to pressure, forces and Newton's laws of motion. It also demonstrates the compressive properties of air molecules

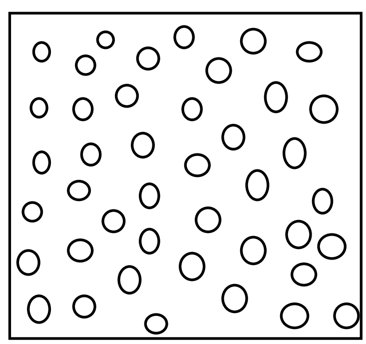
Materials:
- 1 L pop bottle
- cork or rubber stopper
- 50 mL of water
- air compressor or hand bicycle pump
- needle for air compressor or pump.
- ring stand

Procedure:
1. Connect the needle to the air compressor or hand pump.
2. Carefully push the needle through the cork/ rubber stopper.
3. Place the empty bottle neck down through the ring, angle it at 45 degrees.
4. Push the cork stopper into the bottle opening.
5. Turn on air compressor or begin to pump the hand pump.
6. Measure how far the bottle travels.
7. Retrieve the bottle and place the water into the bottle.
8. Carefully plug the bottle with the cork - compressor apparatus.
9. Again, place the bottle neck down into the ring at 45 degrees.
10. Turn on the air compressor or begin to pump the hand pump.
11. Measure how far the bottle travels.

Explanation:
Pumping air into the bottle increases the number of air particles (molecules and atoms) bouncing around and exerting pressure on the sides of the bottle. The air particles are forced to move closer together and become compressed. Eventually the pressure builds up to the point that it is strong enough to blow the cork off the end of the bottle.



air molecule (before pumping)



compressed air molecules:

Once the cork blows off the compressed air escapes, pushing the water out with it. This exhaust of air and water is what propels the rocket forward. Newton's 3rd Law of Motion states that for every action there is an equal and opposite reaction. In this case, the action is the air and water rushing out the back of the rocket, the reaction is the rocket moving forward.

Water does not compress very easily and therefore does not increase the pressure that builds up in the rocket however, water does add considerably to the rocket's power. According to Newton's 2nd law of motion, force is a product of mass and acceleration. The water adds mass to the exhaust, which accelerates out the back of the rocket. This added mass translates into increased force pushing out of the rocket and hence increased force propelling the rocket forward. Repeating the demonstration without water will produce a less powerful rocket.

Teacher Note:
Care must be taken not to hit a student, window or glassware with the rocket. The demonstration may be done in a classroom if care is taken, but is better suited to a gymnasium or out of doors.

Water Attraction

The following demonstrations deal with water and the concepts of cohesion, adhesion and surface tension.

Water Screen

Materials:

- Bug screen or plastic mesh bag (garlic bags work well—small mesh is required)
- Wide mouth bottle
- Rubber band
- Index card
- Pitcher of water
- Bucket or basin

Procedure:

1. Cut a piece of mesh to drape over the mouth of the cup or bottle.
2. Stretch the mesh over the cup and use a rubber band to secure it in place.
3. Over top of a basin or bucket, fill the cup with water by pouring the water through the mesh. This will prove to your students that the water easily flows through the mesh. Fill the cup almost to the very top.
4. Cover the top of the bottle with an index card and hold the card in place as you turn the bottle upside down.
5. Slowly remove the card from the opening and the water mysteriously stays in the cup.
6. Tip the cup slightly to the left or right and the water will fall. Shake the cup and the water will fall. Touch the mesh and the water will fall.
7. While the cup is turned upside down and the water is defying gravity, gently feed a toothpick through one of the mesh holes without breaking the water seal and watch it float to the surface. This is a very delicate move and requires some practice to master.

Explanation:

Cohesion, adhesion, and surface tension are concepts that help explain how molecules of a particular substance stick together. Cohesion is the force of attraction between similar molecules, adhesion is the force of attraction between different molecules. If you dip a piece of the mesh into a glass of water, you will notice that the water fills the screen holes. A force of cohesion of water molecules causes this effect. Cohesion also pulls water molecules together to form round drops. Observe a drop of water on a clean plate and you will notice that it is not flat but rather it is shaped like a small iglu. Cohesion at the surface of a liquid is called surface tension. Water has strong cohesive properties and therefore a high surface tension. The water stays in the cup even though the card is removed because the molecules of water are joined together to form a thin membrane between each opening in the screen. Tipping the bottle or touching the screen will break the surface tension and allow the water to pass through. Once it starts, the kinetic energy of the moving water cannot be stopped by the cohesive properties of water.

Piling Water

Ask your class to estimate how many drops of water they can put on a penny before it spills off. Record their estimates before beginning this demonstration and/or student investigation.

Materials:

- Pennies (clean and dry)
- Eye dropper
- Paper towel

Instructions:

1. Place a penny of a flat surface.
2. Fill an eye dropper with clean water.
3. Add drops onto a penny, one at a time, and keep count as you go.
4. Stop from time to time and bring your eye down to the level of the penny. You will see the water form an iglu-shaped bump.
5. Keep adding water until it spills off of the penny. How many drop fit on the penny? Was it more than your estimate.
6. Let your students try the same activity.
7. Now add some liquid soap to the watr and repeat the activity. How many soapy drops stayed on the penny?

Explanation:

Water molecules exhibit strong cohesive forces, that is they attract one another and pull together. As the drops are placed on the penny they hold together and even start to pile up and form a dome or iglu-shape. The water looks as if there is a membrane holding it together. This is the tension of cohesive forces at the surface of the water drop. We call it surface tension. Water has a strong surface tension and this allows some insects to actually walk on water.

Adding soap to the water destroys the cohesive forces and reduces the surface tension. The soapy water cannot be piled like the pure water and so it spills off the penny.

Crazy Cork

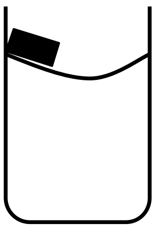
Materials:

- 2 glasses
- Water
- 2 pieces of corks
- Paper towel

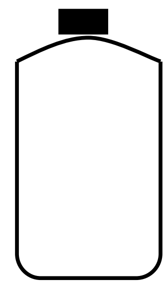
Procedure:

1. Fill the glass half way with water and float the cork on the water surface.
2. Where does the cork float? Try to push the cork to the center; it will not stay there!
3. Now fill another glass right to the brim, set it on the table and use a spoon to add water until it will hold no more.
4. Carefully add the cork to the glass. If water spills out add some more with a spoon
5. Observe where the cork floats now.
6. Try to push the cork towards the edge: it will not stay there!

Explanation:



Corks float and therefore move to the top of the water. However, in both cases the surface of the water is not flat. In the half filled glass the water is slightly higher where it touches the glass than it is in the center of the glass. This is called a meniscus and is the result of adhesion between the water and the glass. Water is attracted to the glass and is pulled up against the force of gravity. The cork floats to the top of the water that is at the edge of the glass.



When the glass is as full of water as it can be, the water level is higher in the middle than it is at the edges. This is a result of the cohesive forces between water molecules and is called surface tension. The surface tension of water is strong enough to hold the water together even when it is higher the sides of the glass. The cork floats to the top of the water, which at the center of the glass. If soap is added to this glass, the surface tension will be reduced, water will spill over the sides and the cork will float over to the side which is now the highest point

Teacher Note:
This meniscus effect is easier to observe in narrow glass tubes. If food colouring is added to the water it becomes even more pronounced.

Bend it Like Water?

This demonstration shows both the electrical properties of water and it strong cohesive forces.

Materials:
- Balloon
- Fur or the hair on your head
- Water tap

Procedure:
1. Turn on a water tap and adjust the flow until you have a slowest, steady stream possible.
2. Rub an inflated balloon on your head and bring it close the stream of water.
3. The stream will bend and be drawn towards the balloon.

Explanation:
Water is a polar molecule, which means that one side is slightly negative and the other side is slightly positive. Rubbing the balloon on your head creates a negative charge on the balloon. The positive side of the water molecules are attract to the negative balloon and so the stream of water moves towards the balloon. The surface tension of water holds the stream together as it bends and moves towards the balloon.

Appendix 1
Supply List for Demonstrations

Water

1. Water Appears
   chart paper, phenolphthalein, spray bottle of water
2. Confetti Gag
   2 buckets, water, confetti
4. Water Spin
   special spinning platform, styro cup, water
5. Water Rocket
   water, air compressor, 2L pop bottle, cork

Air

1. Karate Chop the Paper
   newspaper, three 30 cm rulers, suckers from audience
2. Blow a Fuse
   super balloon, 9 volt battery, steel wool, switch, circuit wire
3. Needle Through Balloon
   balloon, knitting needle
4. Candle Vacuum
   candle, shallow dish, clear graduated cylinder, food colouring, matches
5. Bubbles
   small kiddie pool, quality dish soap, hoola hoop, volunteer from audience
6. Smoke Rings
   smoke blower bucket, smoke machine

Earth

1. One Finger Lift
   participants
2. Spinning Chair
   rotating chair, 2 weights, bicycle tire, tire handles, participant from audience

3. Center of Balance of Males and Females
   chair, wall, male and female suckers from audience

General Supplies

Two fire extinguishers, fire blanket, four tables, sound/music tape, music machine, logo, Fire Fighting suits, judo suit, duct tape, special theatrical lights