What's your Theory?

Inquiry-Driven Science

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Acknowledgements

There are many excellent web sites devoted to science demonstrations that are suitable for the classroom. The links listed below have been checkout and many of the ideas in this document have been adapted from these sources. If you only have time to check out a couple websites, I recommend the first two on the list.

Steve Spangler Science is a comprehensive site that explains how to set up, perform and explain the most current and popular demonstrations around. This site includes experiments, colour photos and even videos of many of the demonstrations.

The Exploratorium Science Museum in San Fransisco is renowned for it hands-on public engagement science displays. Their website has a section devoted to the replication of these museum displays in a simple and economical manner for your classroom.

- http://www.stevespanglerscience.com
- http://www.exploratorium.edu/snacks
- http://www.californiasciencecenter.org/FunLab/DoItYourself
- http://scifiles.larc.nasa.gov
- http://www.mcrel.org/whelmers
- http://www.csulb.edu/~lhenriqu/300demo.htm

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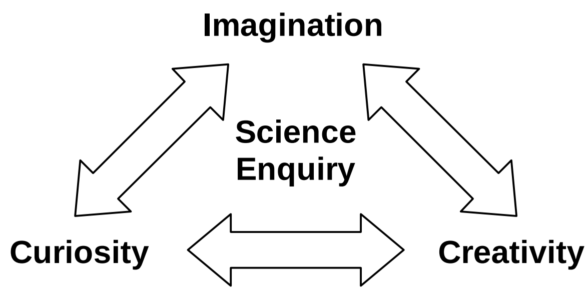
Preface

Curiosity exists naturally in everyone, but if untapped it can become buried with age. Science and independent investigation can indulge this curiosity in a student. A healthy curiosity provides a capacity to imagine and imagination is the pre-curser to creativity. Curiosity, imagination, and creativity form the foundations of science and can all be nurtured through an inquiry process.



This workshop was developed to introduce Kivalliq Teachers to the process of science inquiry through student-generated questions and experiments. In particular, it provides the necessary templates and examples to *"What's Your Theory"* into any classroom.

As a teacher who facilitates the student science inquiry, you will wear many hats including mentor, manager, and motivator. It is exhausting work, but well worth it in the end. Students' gain general and scientific knowledge, skills, and attitudes through this process that may lead to the development of a school science project and will serve them throughout their lives and possibly lead them down a career path related to science and technology. However, regardless of their career choice, the world is in dire need of their curiosity, their imagination, and their creativity.

The demonstrations included are intended to spark curiousity and lead students down the path of inquiry. Try to encourage students to ask questions and then propose ways to answer those questions. This process gets messy and may lead to some dead ends, but it is fun and well worth the trouble.

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, February 25, 2008

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.

Table of Contents

What's Your Theory?

Event Name:____

Observations:

Thoughts and Ideas:

Plans and Designs:

Results and Conclusions

Process Skills

The scientific process is dynamic and involves active participation on the part of the student. Process skills are those intellectual skills which are encouraged and develop from participation in the scientific inquiry. The basic process skills of science are developed in Grades K-12 and include:

Observing

Observation is more than sight alone. It relies on using the senses of hearing, touch, taste, smell and sight to investigate and receive information about a topic of study. These senses may also be enhanced through the use of technological tools like magnifying glasses, thermometers, etc.

Measuring

Measuring involves assigning a numerical quantity to an observation therefore making a measurement a quantified observation. Care, accuracy and the use of proper units are important measurement skills and students should be familiar with the common tools of measurement for length, volume, time, and temperature.

Classifying

Classification involves the organization of objects or ideas into groups based on their observable characteristics.

Communicating

Communication in science includes the sharing of ideas, the presentation of results, and the reporting of knowledge learned. Both written and verbal communication are important and should be stressed but students should also be given the opportunity to communicate science through alternate means like art and music.

Controlling Variables

Controlling variables is a stage in the Experimentation process. It involves the manipulation of the conditions of an experiment.

Interpreting Data

This involves the ability to make conclusions based on observations or measurements. Often interpretations can be aided by graphing the results.

Defining Operationally

Operational definitions define object or concept by outlining the function or role that the object performs. They are useful mechanisms for students to communicate their understanding of a concept.

Formulating Hypotheses

An hypothesis is an educated guess. Students should be given the chance to use their knowledge and understanding to predict the causes of an event.

Developing Models

This involves the ability to construct both physical and mental models to account for observed phenomena.

Inferring

Inferring is the ability to make judgments or conclusion based on observations, comparisons or interpretations of data.

Predicting

In science, prediction means the use of known principles, laws theories or observations to forecast the outcome of an experiment or event. The ability of student to predict an outcome of an event that he or she has never seen before, is a good indicator that the concept is understood.

Experimenting

Experimenting involves planning, conducting, and communicating experiments in which the problem is clarified, hypotheses are stated, observations are made and data is interpreted. Experimentation and the use of the scientific method depends upon the student's ability in the other process skills.

Problem Solving

The following activities are designed to encourage and strengthen the problem solving skills of students doing Senior Science.

Problem solving is a cognitive skill. We have defined it to include the following:

Creative Thinking

This is where a student or group of students think about a problem in a different way than another person would think about the same problem. The solution may or may not be different than that obtained by another person, but the method/ thought processes used to arrive at the solution are.

Critical Thinking

This is where a student *analyzes, evaluates* and/or *judges* a problem and the solution/strategy used to solve that problem.

Decision Making

This is where students are asked/required to make decisions that may/may not impact on the solution to the problem. By making decisions, students are able to arrive at a solution to the problem or help find a strategy for the problem.

Evaluating

This is where students evaluate, ask questions, revise and or discard a strategy or strategies to a problem. They also evaluate the problem for its worth and what possible solutions may exist.

The Problem Solving Plan

Science is really all about solving problems and creating solutions for those problems. Problem solving skills are encouraged and strengthened from participation in scientific inquiry activities. Whether simple of complex, all problems can be solved by following the plan below.

1. Think About the Problem

As you start any problem ask yourself the following two questions:

- What information am I given?
- What am I asked to do?

You may also want to think about the following questions:

- Do I understand what the problem is about?
- Is there information that I need to get elsewhere?
- Is there information given that is not needed?

2. Think About/Select a Strategy

Look for a skill or strategy that will help you solve the problem. Some strategies used include:

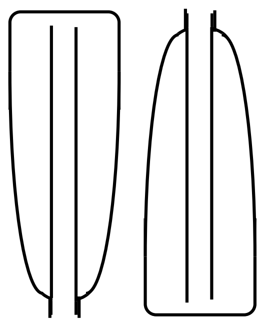
- Look for a pattern
- Work Backwards
- Act it out
- Make a table
- Simplify the problem
- Draw a diagram
- Use manipulatives
- Make a model
- Make a chart
- Guess and Check

Other strategies exist. Just remember to pick one that works for you.

Model Behaviour

The following activities are design to encourage students to construct their own conceptual and physical models. Teachers must construct the models outlined below and demonstrate them for the students. The challenge is for students to construct an apparatus that behaves just like the teacher's demonstration. The catch is, the students never get to take a look at how the teacher's apparatus is made. The value of their models is based on how closely they approximate the behavior of the teacher's model. This activity is similar to the traditional Black Box experiment.

Self-Filling Bottle

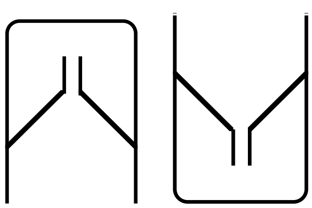


Preparation:
Insert a piece of garden hose or PVC conduit into the opening of an opaque plastic bottle (or painted bottle) and position so that it does not touch the bottom of the bottle. Seal the top edge of the pipe to the inside of the bottle neck with silicone chalking. When sealant has set, make a small hole near the top of the bottle (to let the air escape when filling the bottle with a liquid).

Demonstration:
Tell the class that you have a self-filling bottle that never runs out of liquid. Pick up bottle so that your thumb is covering the small hole near the top and pour the liquid into a glass or beaker. The bottle will appear to empty after some liquid has decanted. Put the bottle on the counter, then pick it up and repeat the procedure again and again and again.

How it Works:
Only the water that is in the pipe is able to pour out of the bottle. Each time you turn the bottle right side up, the pipe fills up with water and is ready to pour again.

Thirsty Can



Preparation:
Insert a plastic funnel into a large tin can . Position so that the bottom of the funnel does not touch the bottom of the can and seal the top edges of the funnel to the inside of the can.

Demonstration:
Tell students that you have a thirsty can, one that drinks any liquid you put into it. Pour a small beaker of water into the can, then slowly lift the can and tip it over your head. The water does not pour out. This demonstration may be repeated a number of times before the can fills up.

How it Works:
The water passes through the funnel and into the bottom of the can. When the can is inverted, the water can not get back out the funnel opening, unless the can is nearly full. A hole must be made near the bottom of the can to empty the water trapped inside. Resealing the hole with a cork will allow the can to be reused.

Sink or Swim

Materials:

- Aquarium,
- Cans of diet pop
- Can of regular pop
- Water

Procedure:

1. Fill the aquarium 3/4 full of water.
2. Take the regular can of pop and place it in the aquarium; observe what happens.
3. Remove the regular can of pop.
4. Now try the diet pop; observe what happens.

How it Works:
Regular pop and diet pop have basically the same recipe except for the sweetener used. Regular pop contains 10-12 teaspoons of sugar dissolved into each can. (That is equivalent to the recommended total daily amount of sugar we should eat.). Most diet pop uses aspartame and acesulfame as its sweetners, Aspartame is 180 times sweeter than sugar and acesulfame is 200 times sweeter. As a result of their sweetness, only a small amount of aspartame and acesulfame are needed to sweeten a can of pop. Coke contains 36 grams of sugar to sweeten one can, while Diet Coke contains only 0.16 grams of aspartame and acesulfame to sweeten one can.

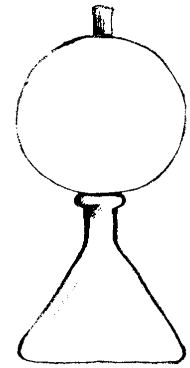
The sugar dissolved in regular pop makes it heavier than diet pop and therefore more dense than the diet pop. Water has a density of 1 gram/cm^3 a can of regular pop has density greater than 1 gram/cm^3 and therefore sinks in the aquarium. The can of diet pop is less dense than the water and therefore will float.

Teacher Note:
Your student can easily calculate the densities of a can of diet pop and regular pop. Simply have them determine both the mass and volume of a can of pop and compute the density from the equation:

Density = mass/volume

Do not use the volume listed on the can, this is the volume of the fluid in the can. You must submerge the can of pop in container of water and measure the increase in the water's volume.

Hoop-la
(Shootin' with Newton)

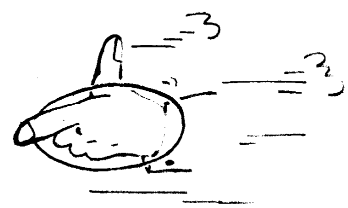


Objective:
To have a cork fall directly into a flask or graduated cylinder.

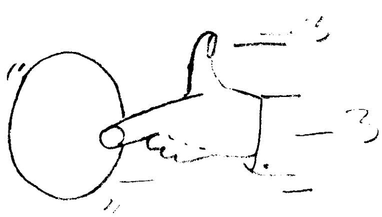
Materials:
- One large needle point hoop
- One cork or rubber stopper (small enough to fit inside the flask)
- One cylinder or flask
- One sleight of hand

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. <u>You may also make the same apparatus from a bottle, paper loop, and a small piece of chalk.</u>

Cartesian Diver

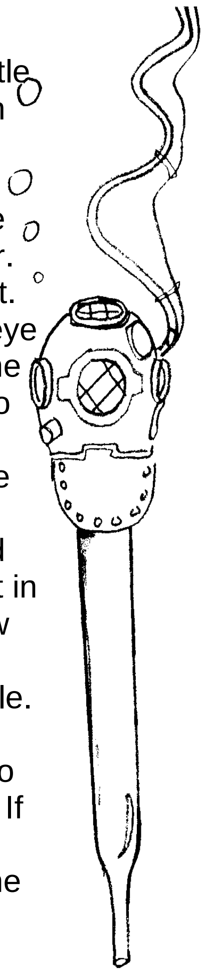
Introduction:
This demonstration shows students how fish and submarines regulate their buoyancy.

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.

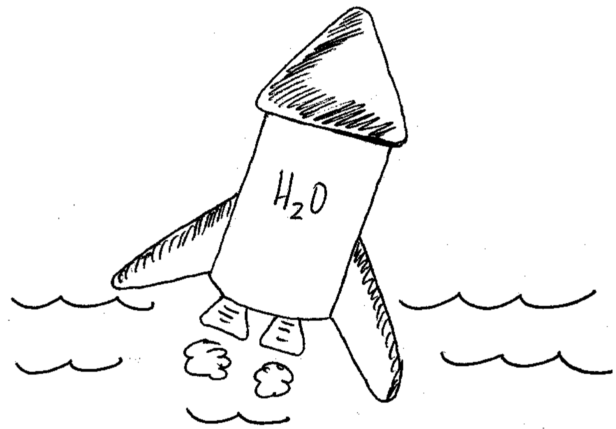


Explanation:
As you squeeze the bottle the pressure inside increases and this causes the air inside the eyedropper to compress. As the air compresses, water moves into the eyedropper to take its place. This water increases the overall mass of the eyedropper, causing it to sink. When you release your squeeze the air inside the eyedropper expands pushing out some water thereby reducing its mass and making it buoyant again. Throughout this experiment the size or volume of the eyedropper has remained constant and only the mass has changed. This means that the density of the eyedropper has increased and decreased as a result of squeezing and releasing. The density of water is 1 g/mL. Objects with a greater density will sink and objects with a lesser density will float. Objects with the same density are said to be neutral buoyant and can stay suspended at any depth. Submarines and fish are able to change their depths by this same method of compressing and expanding air. Submarines use pumps and tanks accomplish the task, while fish use muscles and a large air bladder.

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. Fast food ketchup bags have an air bubble trapped inside and by adding the right number of paper clip as ballast you can fashion a make shift diver for this demonstration.

Water Rocket

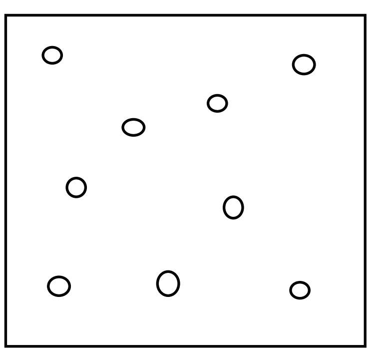
Introduction:
This demonstration provides an excellent introduction to pressure, forces and Newton's laws of motion. It also demonstrates the compressive properties of air molecules



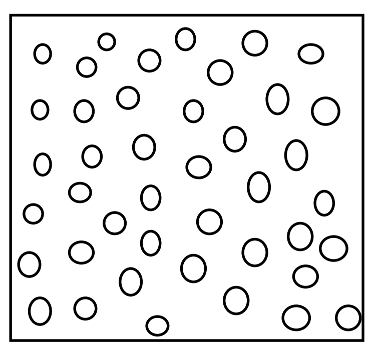
Materials:
- 1 L pop bottle
- Cork or rubber stopper
- 50 mL of water
- Air compressor or hand bicycle pump
- Needle for air compressor or pump.
- Ring stand

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.

How It Works:
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 increases the force pushing out of the rocket and the 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.

Squeeze Bottle Rocket

It's easy to get a little action-reaction going on and turn a plastic juice bottle into a rocket launcher.

Materials:
- Drinking straws—regular and milk shake (one straw must fit easily inside the other)
- Plasticine
- Plastic bottle (juice, water, pop, even ketchup or soap bottles will work)

Procedure:
1. Clean and dry a plastic bottle.
2. Place the smaller straw into the opening of the bottle and seal it up snuggly with plasicine.
3. Plug one end of the bigger straw with a piece of plasticine.
4. Place the larger straw over the smaller straw.
5. Ready, aim, squeeze! The larger straw launches off the smaller straw

How it work
This activity demonstrates Newton's Third Law of Motion. According to Newton, for every action there is an equal and opposite reaction. As you squeeze the bottle, air is forced out through the straw and pushes against the clay plug in the larger straw. The resulting force causes the straw to "launch" through the air. The plasticine plug gives the straw some stability and it soars like a dart.

Teacher Note:
Squeeze rockets launch with surprising force. Never let your students point their rockets at anyone. Be to cover the plugged end of the straw with enough plasticine to cover the sharp edges of the straw. Be creative! Once you've mastered the simple straw rocket, challenge your students to improve the design. What effect does the addition of fins have on the rocket’s flight? This activity makes a great science Olympic event.

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
- <u>Safety glasses</u>
- 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.

How it Work:

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

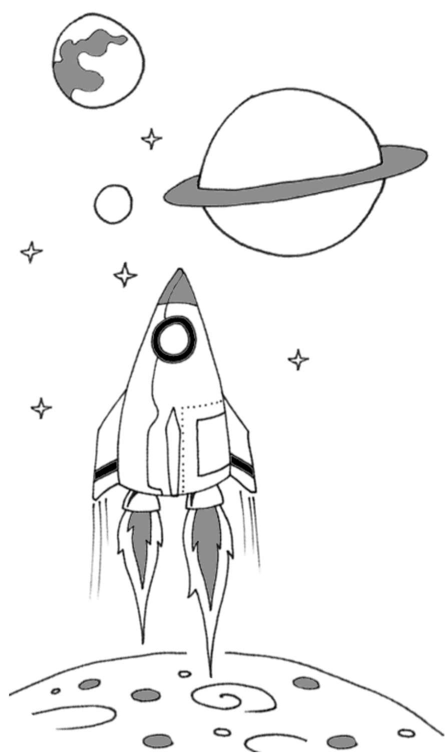
$$H_3C_6H_5O_7(aq) + 3\ NaHCO_3(aq) \rightarrow 3\ CO_2\ (g) + 3\ H_2O(l) + NaC_6H_5O_7\ (aq)$$

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 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 bottle.
2. Stretch the mesh over the bottle and use a rubber band to secure it in place.
3. Over top of a basin or bucket, fill the bottle 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 bottle 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 bottle.
6. Tip the bottle slightly to the left or right and the water will fall. Shake the bottle and the water will fall. Touch the mesh and the water will fall.
7. While the bottle 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.

How it work:

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 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. properties. The water stays in the bottle 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 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?

How it Works:

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 can not be pile like the pure water and so it spills off the penny.

Crazy Cork

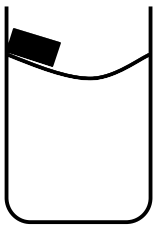
Materials:

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

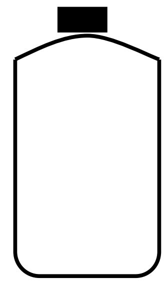
Procedure:

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!

How it Works:



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.

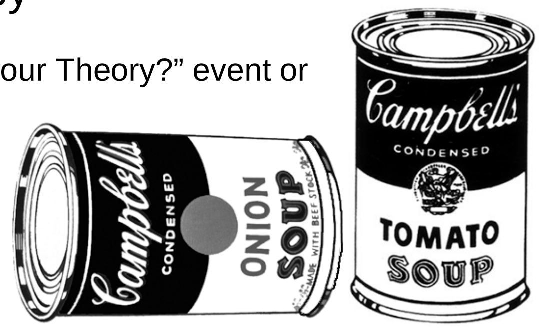


When the glass is as full of water as it can be, the water level is higher in the middle than it is at the edges. This is a result of the cohesive forces between water molecules and is called surface tension. The surface tension of water is strong enough to hold the water together even when it is higher 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.

Canned Soup Derby

This demonstration is well suited to a “What’s Your Theory?” event or a Science Olympic competition.



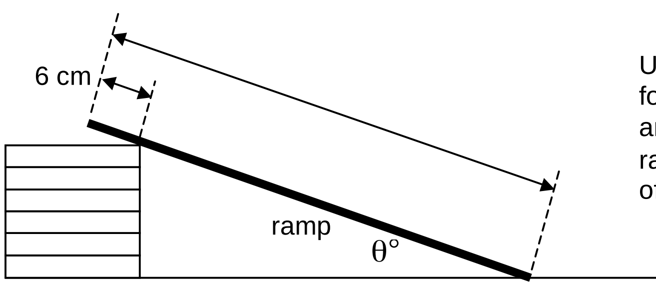
Materials:

- 8 cans of soup (different flavours all the same size and brand in dent-free cans) Suggested flavours: Consommé
- Wooden ramp
- Meter stick

The following cans of soup will ensure a variety of results.

1. Consommé or Beef Broth or Chicken Broth
2. Cream of Mushroom or Cream of Celery or Cream of Chicken,
3. Bean with Bacon
4. Scotch Broth
5. Chicken Noodle
6. Tomato
7. Vegetable
8. Beef Noodle

A stack of textbooks provides the height of the ramp.



Use a removable wooden shelf for your ramp. By varying the angle θ and the length of the ramp you can change the results of a distance race.

Procedure:

1. Set up incline plane.
2. Start the race by asking students to pick which can of soup they want to enter in the race
3. Place two of the cans at the top of the incline plane and hold in place with a metre stick.
4. Countdown from three to zero, lift the metre stick straight up and allow the cans of soup to roll down the incline plane.
5. The first can down the incline plane is the winner of that race.
6. The losing can of soup is eliminated from the race and the winning can of soup races the winner of the next race.
7. Repeat this process until all races are completed and a winner is declared.
8. A second race can be held to see which can rolls the farthest after leaving the ramp. The winners will be different.

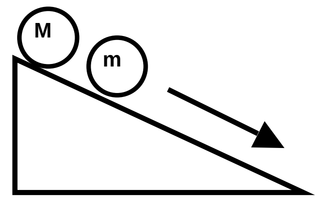
How it Works:
Rotational inertia is the property of matter that states: an object at rest will remain at rest, and a rotating object will continue to rotate, unless acted upon by a rotational force (torque). A

massive wheel is hard to get moving, but once it starts, it is hard to stop and it runs for a long time before succumbing to friction and stops. We say that it has a large rotational inertia. Rotational inertia depends on both mass and radius of the object (and also how the mass is distributed through the radius).

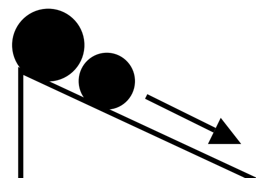
Rotation Inertia = Mass x Radius Squared

- The higher the mass, the greater the rotational inertia
- The larger the radius, the greater the rotational inertia
- Therefore, the further the mass is from the center of the object, the greater the rotational inertia.

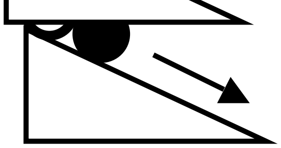
With an understanding of rotational inertia we can predict the following:



- If two can have identical mass and one has a larger radius, the can with the smaller radius will be easier to roll and will move quicker down a ramp.



- If two cans have the same radius and one has a greater mass, the can with the smaller radius will be easier to roll and will move quicker down a ramp.



- If two cans have identical mass and radius, and one can has its mass concentrated at the center and the other can has its mass concentrated at its rim, the can with its mass concentrated at its center will be easier to roll and will move quicker down a ramp.

The Canned Soup Derby is a little more complicated, as we are dealing with liquids, solids and gels. Generally speaking, liquid soups (Consommé or Beef Broth or Chicken Broth) get off to a faster start than solid soups (Bean with Bacon and Scotch Broth). The gel soups (Tomato and the Cream soups) can be the slowest off the mark, depending on the temperature of the classroom. When the can of liquid soup begins to roll the liquid inside does not rotate, therefore the rotating mass is less and it gets off to a quicker start. If you change the race to a distance race, then the solids roll farther and they are harder to stop.

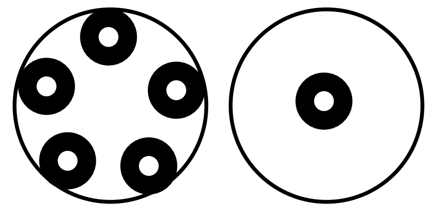
Teacher Note:

Demonstrating the effect of distribution of mass can be done easily with a "Ring and Disk Set" which can be purchased from Boreal or Spectrum for about $10. You can also make your own demonstration as outlined below.

Material:

- 2 identical round metal cookie tins
- 10 large metal washers
- Duct tape
- A ramp

Procedure:



1. Arrange five of the washers evenly around the outside rim of the bottom of one tin and secure with tape.
2. Stack five washers in the middle of the bottom of the second tin and secure with tape.
3. Replace the lids and put both tins at the top of the ramp.
4. Release the tins and let them roll down the ramp.
5. The tin with the mass closer to the center will always reach the bottom of the ramp first.

How it Works:

At the top of the ramp, both tins have identical potential energy, since both have the same mass and are at the same height. At the bottom of the ramp, each tin will have part of its original potential energy appearing as *linear* (or *translational*) *kinetic energy* and the rest appearing as *rotational kinetic energy*. Though both tins have the same total mass, each has this mass distributed differently.The tin with its mass distributed along the rim is harder to get rotating than the tin with its mass concentrated at the center. The tin with its mass concentrated around the rim will lose the race to the bottom of the ramp, and the tin with its mass concentrated at the center will win.