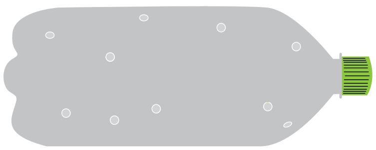
SODA BOTTLE SCIENCE EDUCATOR KIT

(for Grades 3-8)



Activity guide for 13 experiments!

Educator programs are underwritten by FMC

CAUTION: Do not consume any of the contents within this kit. Dispose of all materials after use.

Presenting Sponsor: DOW

Created by Philadelphia's science, cultural and educational institutions and organized by The Franklin Institute

GREETINGS EDUCATOR!

We're so glad that you have received our PSF 2015 Educator Resource Kit. Inside this package are many of the materials needed to facilitate three engaging, amazing, and educational science activities with your students. All activities utilize the very common, very inexpensive plastic soda bottle in some manner, so each activity is repeatable, recyclable and reusable!

There are enough bottles included in your kit to make one **Cartesian Diver**, one **Lung Model**, and one **Cloud**. If you'd like to have students make their own, encourage them to bring in an empty soda bottle, maybe one for every 3 students, and work in groups as you conduct the activity in class. The only other things you'll need for these three activities are some classroom basics, such as scissors, markers, and tape!

This packet also outlines an additional TEN activities that you can explore with your students! Everyone is a scientist, and these activities will call upon you and your students to hypothesize, observe, and experiment in many different ways.

We hope to see you, your students, and their families throughout the 2015 Philadelphia Science Festival. There are a litany of Explorer Sunday events on April 26 all over the region where children and adults can explore gardens, farms, laboratories, and more! This year, we will feature five Discovery Day events on Saturday, April 25, where activities and experiments are guaranteed to educate and instill a sense of wonder. And of course, the festival culminates with the Science Carnival on the Parkway—our signature event—on Saturday, May 2, featuring more than 150 exhibitors offering non-stop, family-friendly experiments, games, a packed line-up of live entertainment! We've included flyers that you can send home with your students so they won't miss a minute of the action!

We also have opportunities exclusively for educators! Choose from 19 educator workshops offered throughout the region, all designed to make it easier for you to incorporate STEM into your classroom in new and innovative ways!

Please visit www.PhilaScienceFestival.org for more information.
Have a fantastic spring and we'll see you soon!

If you are able, please post pictures of the kits in action to social media tagged with #GetNerdyPHL and #FMClovesteachers. We've included some tips and recommended posts below.

Those who participate before April 23 will be entered into a raffle for a FREE Franklin Institute Traveling Science Show classroom visit!

SAMPLE FACEBOOK POSTS

[School Name] just received an educator kit from @PhilaScienceFest and @FMCCorporation! Our students loved learning about "soda bottle science!" #GetNerdyPHL [attach photo]

[Teacher's Name]'s science class experimented with "soda bottle science" today courtesy of the @ PhilaScienceFest and @FMCCorporation! #GetNerdyPHL [attach photo]

We want to thank @PhilaScienceFest and @FMCCorporation for sending [School Name] an educator kit containing all types of "soda bottle science!" [Teacher's Name]'s class had a great time experimenting today. #GetNerdyPHL [attach photo]

SAMPLE TWEETS

[School Name]'s students loved experimenting w/ their new science kit from @PhilaScienceFest & @FMCCorp! #GetNerdyPHL [attach photo]

[Teacher's Name]'s class experimented w/ "soda bottle science" courtesy of @PhilaScienceFest & @FMCCorp #GetNerdyPHL [attach photo]

Thanks to @PhilaScienceFest & @FMCCorp, our [Xth] grade class can perform "soda bottle science!" #GetNerdyPHL [attach photo]

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Supplied Activities

Additional Activities

1. CARTESIAN DIVER BUOYANCY

Goal of Activity:
Students will learn the principles of buoyancy by making a diver sink or float.

Safety Concerns/Precautions:

Eyedroppers used in this activity may be fragile and require dexterity to fill properly, so younger students may need help with this step.

Supplies:

- Eyedropper
- 2 Liter soda bottle

Educators provide:

- Drinking glass or large cup
- Water
- Paperclips

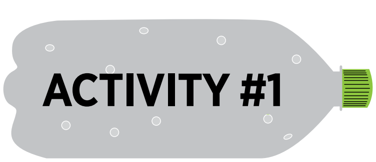
Procedure:

1. Fill a drinking glass or large cup with room temperature water.
2. Draw water into the eyedropper slowly so that it floats in the glass with the bulb barely above the surface of the water.
3. If needed to keep the dropper upright, place a paperclip around the dropper near the opening.
4. Fill the 2 liter soda bottle almost to the top with room temperature water.
5. Place the eyedropper in the bottle without changing the amount of water in the dropper.
6. Screw the cap on the bottle tightly.
7. Squeeze the bottle and see what happens!

Background Science:

The reason why an object floats in water is because of the buoyant force. This force pushes up against an object in water in opposition to the force of gravity pulling down. As an object is introduced to water (or any fluid), it displaces the water, pushing it out of the space it is occupying. This displaced water has weight, and if the weight of the displaced water is equal to or greater than the weight of the object in the water, the object becomes buoyant and will float.

As you squeeze the 2 liter bottle, the water from the bottle pushes into the eyedropper. This is because water is effectively incompressible, meaning that it cannot be squeezed into a higher density. However, air is compressible, so the small bubble of air inside the eyedropper is squeezed smaller to allow more water in. The more water in the eyedropper, the more weight it has despite displacing the same amount of water in the bottle. This decreases the buoyant force on the eyedropper which causes it to sink.



1. CARTESIAN DIVER BUOYANCY

Goal of Activity:

Students will learn the principles of buoyancy by making a diver sink or float.

Background Science (cont.):

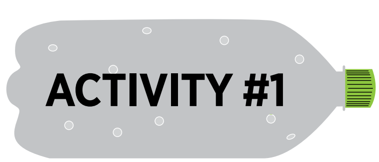
The Greek philosopher Archimedes was first to notice the buoyant force and think of the above relationship, which is now known as Archimedes' Principle. Archimedes was tasked by King Hiero II to determine if his golden crown was made with added silver. The catch was that Archimedes was not allowed to destroy or change the crown in the process. Archimedes realized that if he submerged the crown in water, he could find its volume and divide by its measured weight to find its density, which would reveal if the crown was pure gold. As the story goes, Archimedes figured this out as he lowered himself into a bathtub and saw the water rise, leading him to jump out of the tub and shout "Eureaka!" meaning "I've found it!" in Greek.

The activity is known as the Cartesian Diver because it was first devised by French philosopher and mathematician Rene Descartes.

National Science Education Standards:

Next Generation Science Standards Cartesian Diver

5-12 B: Physical Science
MS: Forces & Interactions



2. MAKE A CLOUD IN A BOTTLE

Goal of Activity:

Students will learn how and why a cloud forms while exploring principles of air pressure, condensation, and evaporation.

Safety Concerns/Precautions:

- This activity requires matches to be briefly lit. Please exercise strong supervision with students of any age.
- Do not add boiling water to the 2 liter soda bottle, only water as warm as the tap will provide.
- If the experiment doesn't work the first time, try, try, try again!
- Check for holes in the bottle or the cap, and be sure the cap is always on tight.

Supplies:

- Box of matches
- 2 Liter soda bottle

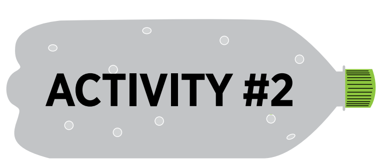
Educators provide:
- Warm water

Procedure:

1. Fill the 2 liter bottle about one-third full with warm water.
2. Cap the bottle and swish the water around.
3. Empty most of the water leaving just a small amount at the bottom of the bottle.
4. **EDUCATOR:** Light a match and let it burn for a few seconds.
5. **EDUCATOR:** Blow out the match and quickly drop it in the bottle
6. Cap the bottle quickly allowing little smoke to escape.
7. Squeeze the bottle hard for a second and let go. See what happens!

Background Science:

As water heats, it evaporates, a process by which it is transformed from a liquid to a gas called water vapor. The warmer the water, the quicker it evaporates. In nature, water from rivers, lakes or the ocean can evaporate after being heated by the sun. In our atmosphere, the layer of air surrounding Earth, the higher altitude you go, the colder it gets. One reason this occurs is because of air pressue, how much the air pushes on things underneath it. As there is less air above you at higher altitudes, there is also lower air pressure, and as a result, there is also lower temperature.



2. MAKE A CLOUD IN A BOTTLE

Goal of Activity:

Students will learn how and why a cloud forms while exploring principles of air pressure, condensation and evaporation.

Background Science (cont.):

As water warms and evaporates, the resultant water vapor rises higher into the atmosphere into areas of lower air pressure and temperature. As the water vapor cools, it will begin to condense from a gas back into a liquid. This can only take place, however, due to small particles of dust that are always in our air called condensation nuclei. The water vapor will condense onto these nuclei and form a tiny water droplet, and when millions and billions and trillions of water droplets form in the same area of the sky, it is known as a cloud.

In the 2 liter soda bottle, the warm water at the bottom creates water vapor, and as you squeeze the bottle, the pressure and temperature inside increases. When you let the bottle go, the pressure and temperature both decrease rapidly and the water vapor temperature drops, as well. The smoke from the extinguished match is actually millions of little condensation nuclei, which provide the surface upon which the water vapor condenses and forms the cloud.

To Test:

- Try varying the temperature of the water.

Clean Up:

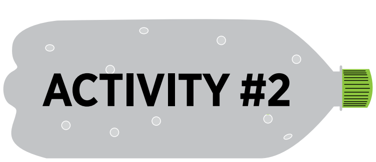
- Be sure that all used matches are fully extinguished before they are thrown away.
- Be sure that unused matches are cleaned up and securely put away.
- Empty the bottle and allow it to dry inside.

National Science Education Standards:

Next Generation Science Standards
Cloud in a Bottle

K-4 D: Earth & Space Science

MS: Weather & Climate



3. BREATHE WITH A LUNG MODEL

Goal of Activity:

Students will learn how our lungs fill and the role of the diaphragm and air pressure in respiration.

Safety Concerns/Precautions:

- Rubber bands and balloons will be used, so be aware of those students with latex allergies.
- Some complex cuts must be made with a sharp pair of scissors; this is best left for the educator to prepare ahead of time.

Supplies:

- Balloons
- 2 Liter soda bottle
- Lung/Diaphragm illustration

Educators provide:

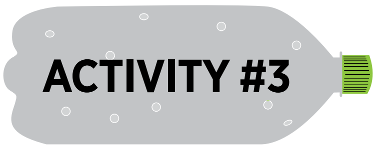
- Plastic trash bag or plastic sheet
- Scissors
- Markers
- Masking or clear tape

Procedure:

1. **EDUCATOR:** Cut the 2 Liter soda bottle around its circumference about one-fourth of the way up from the bottom.
2. **EDUCATOR**: Cut a 30-centimeter circle out of a plastic trash bag or plastic sheet.
3. Push the round end of the balloon inside the top of the cut bottle.
4. Stretch the mouth of the balloon around the mouth of the bottle and secure with a rubber band.
5. Fold the pre-cut plastic circle in half twice, making a rounded triangle.
6. Use a bit of tape to wrap the tip of the plastic triangle, making a small handle.
7. Unfold the plastic and wrap the round edge on the outside of the bottle just an inch or so up from the cut bottom.
8. Use tape to thoroughly attach and seal the plastic to the outside wall of the bottle.
9. Pull down on the plastic gently and see what happens to the balloon inside!

Background Science:

The respiratory system includes the parts of our bodies that enable us to take in oxygen and use it for cellular energy production (cellular respiration). The parts of this system include the mouth and nose, the trachea, the bronchial tubes, the lungs, the alveoli and the diaphragm. The lungs—two football-sized pouches filled with increasingly smaller recesses—contain no muscles and rely completely on the diaphragm to inflate them.



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Goal of Activity:

Students will learn how our lungs fill and the role of the diaphragm and air pressure in respiration.

Background Science (cont.):

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To Test:

- Try varying the temperature of the water.

Clean Up:

- Be sure that all used matches are fully extinguished before they are thrown away.
- Be sure that unused matches are cleaned up and securely put away.
- Empty the bottle and allow it to dry inside.

National Science Education Standards:

Next Generation Science Standards
Cloud in a Bottle

K-4 D: Earth & Space Science

MS: Weather & Climate

4. MAKE A VORTEX IN A BOTTLE

Goal of Activity:
Students will make a vortex in a bottle and observe how forces of motion affect a fluid.

Safety Concerns/Precautions:

- This activity uses food dye, so be careful not to spill on porous surfaces or fabrics.

Supplies:

- Two (2) Two Liter soda bottles
- One (1) Tornado Tube connector, available at: http://www.spectrum-scientifics.com
- Food dye (optional)
- Glitter (optional)

Procedure:

1. Fill one two liter soda bottle about two-thirds of the way full with water.

2. If desired, you can add a few drops of food dye and glitter.

3.Screw the Tornado Tube connector to the full bottle.

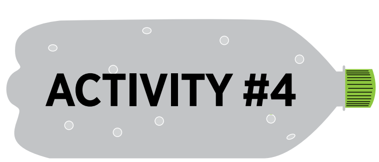
4. Invert the empty 2 liter soda bottle and screw that onto the other end of the Tornado Tube connector.

5. Flip the bottles over with the full one on top and swirl the apparatus in a circular shape.

Background Science:

The shape the water makes as it swirls down toward an opening is known as a vortex. Vortices are commonly seen in the bathtub, occasionally observed as severe storms called tornados, and form the shape of many far-away star-filled galaxies.

When the full bottle of water is on top, water will flow through the opening in the Tornado Tube due to the force of gravity. But as you swirl the bottles, the water begins to move in a direction other than just down toward the empty bottle. The water begins to move in a sideways direction, and it will continue to move that way unless it is stopped; the water has momentum. In this case, the water with its sideways momentum is also being pulled downward by the force of gravity, so it begins to swirl. The water now has angular momentum, and will continue to swirl unless it is slowed down by something else.



4. MAKE A VORTEX IN A BOTTLE

Goal of Activity:
Students will make a vortex in a bottle and observe how forces of motion affect a fluid.

Background Science (cont.):

This combination of angular momentum and gravity that is always pulling down and toward the center creates centripetal force, meaning “center seeking.” If you observe a piece of glitter in the water, which can be tricky, you will see how these forces act upon it and the water. You can also see how strong the centripetal force is by looking at the slope of the water in the vortex. The water near the edge is gradually sloped, so the centripetal force is small. But the water in the center of the vortex has a steep slope, so the centripetal force is greater.

It is also worth noting that the water, as it swirls toward the center, appears to speed up. In actuality, the water is traveling at the same speed (with the same momentum), but as the path it traverses becomes smaller, it completes a rotation of the circular path more quickly; the linear velocity remains the same, but the angular velocity increases. This is similar to runners on a circular track; the runners on the inside lanes complete the track faster than runners on the outside, but only because the inside track is actually shorter, not because the runners are faster or slower.

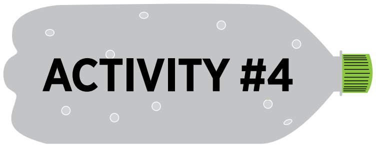
In short, a vortex is a bunch of stuff – be it water or air or stars – that is being drawn toward a center but constantly missing, and therefore constantly rotating around and around until it all meets together.

To Test:

- See what happens if you don’t swirl the bottles after flipping them.
- Observe how the water travels toward the outside of the vortex compared to the center.

Clean Up:

- If you wish to dismantle your tornado bottles, simply remove the Tornado Tube connector over a sink and drain the bottles. Be careful of the glitter!



5. BUILD A TERRARIUM

Goal of Activity:
Students will build and maintain a plant-based ecosystem.

Safety Concerns/Precautions:

- Some complex cuts must be made with a sharp pair of scissors; this is best left for the educator to prepare ahead of time.
- These terraria do not always yield successful plants. It might be worth obtaining extra supplies in case some terraria need to begin again.

Supplies:

- 2 Liter soda bottle
- Potting soil
- Stones or pebbles
- Scissors
- Seeds or seedlings
- Activated charcoal (optional, available at pet stores)
- Sphagnum moss (optional, available at pet stores)

Procedure:

1. **EDUCATOR:** Cut the 2 Liter soda bottle around its circumference about six inches up from the bottom.
2. Put a layer of stones at the bottom of the bottle about 1 or 2 inches deep.
3. If you are using active charcoal, layer it about a half-inch above the stones.
4. If you are using sphagnum moss, place a layer above the charcoal.
5. Add a healthy later of potting soil.
6. Add a bit more moss.
7. Be sure there is about an inch of space between the upper-most layer and the top of the cut bottle.
8. Plant some seeds and add water to moisten the soil, but don't soak it!
9. Place the top, with the cap tightly in place, back onto the cut bottom. If necessary, make a small slit in the edge of the bottom so the plastic can be bent to fit inside the top.

Upkeep:

- Be sure your terrarium gets the right amount of sunlight. Too much and it will get too hot. Not enough and the plants won't grow.
- The soil should always look moist, but not soaking wet. Condensation may also form on the walls of the bottle. If it looks too wet, uncap the bottle for a day or two.

ACTIVITY #5

5. BUILD A TERRARIUM

Goal of Activity:

Students will build and maintain a plant-based ecosystem.

Background Science:

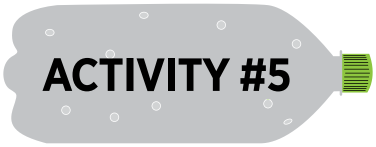
In building this terrarium, students are constructing a closed ecosystem in which all of the initial contents remain in the bottle. Each part of the terrarium plays an important part. The pebbles at the bottom allow water to flow below the soil, which prevents it from getting too moist. The activated charcoal has a very high surface area, which acts to filter the water before it drips through the rocks. The moss helps to prevent the soil from settling down into the pebbles, and of course the soil serves as the bed and nutrient source for the plants

To Test:

- See what conditions are best for plants to grow by placing the terraria in different conditions. This will mean that some plants will not grow, if any grow at all.

Clean Up:

- No cleanup is needed since the terrarium will take some time to fully develop.



6. CONSTRUCT A WATER FILTER

Goal of Activity:

Students will build a water filter using different filtering media. This will also allow them to examine and discuss the important process of water filtration and conservation.

Safety Concerns/Precautions:

- Some complex cuts must be made with a sharp pair of scissors; this is best left for the educator to prepare ahead of time.

Supplies:

- 2 Liter soda bottle
- Napkins
- Cotton balls
- Sand
- Gravel
- Activated Carbon (optional)
- Scissors
- Cups
- Water
- Dirt (not potting soil)
- Cooking oil (optional)
- Food dye (optional)

Procedure:

1. **EDUCATOR:** Cut the 2 Liter soda bottle around its circumference about one-third of the way up from the bottom.

2. Remove the cap from the bottle.

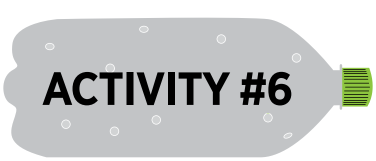
3. Invert the top half of the bottle and place it into the bottom half of the bottle.

4. Layer the materials as follows:

    - Pack cotton balls or napkins into the funnel of the bottle top.
    - Add an inch or so of activated carbon if desired.
    - Add two or so inches of sand.
    - Add two or so inches of gravel.

5. Add some dirt, food dye, or cooking oil to a cup of water.

6. Pour the water through the filter and wait a bit for the water to work its way through. This step will likely take some time.



6. CONSTRUCT A WATER FILTER

Goal of Activity:

Students will build a water filter using different filtering media. This will also allow them to examine and discuss the important process of water filtration and conservation.

Background Science:

As students may have noticed, each later of filtration becomes finer and finer. Therefore, each layer of the filter serves to remove smaller and smaller impurities from the water. The gravel layer will remove large impurities from the water like clumps of dirt or plant particulate. The sand will remove even finer grains of dirt or large liquid droplets like the cooking oil.

And if used, the activated carbon will filter out the smallest particles, including bacteria and some of the food dye. The activated carbon has an innumerable amount of pores throughout; just one gram has a surface area – the total outer surface of an object – exceeding 500 m2. That entire surface allows for the absorption of a lot of impurities.

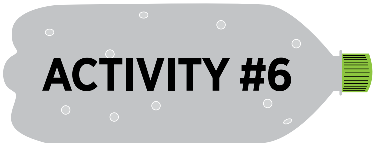
This activity also provides educators the opportunity to discuss many issues that arise when treating water. Clean water is obviously necessary for people to drink or wash with, but it is not always accessible to everyone. The water will likely not leave the filter completely clean, which provides a good platform to discuss how it may be easy to pollute water and much more difficult to successfully clean it.

To Test:

- Ask students if they notice anything about the different media they are layering in the filter.
- See what happens if there are more of some filtering materials than others. Try switching some materials like sand for clay, or cotton balls for coffee filters. Only change one thing at a time.
- Run the dirty water through the filter a couple of times to see how clean it can get.

Clean Up:

- If you wish to dismantle your water filter, simply discard the contents of the lid and clean out the halves of the bottle.



7. MAKE A STETHOSCOPE

Goal of Activity:

Students will build their own stethoscope and learn what the sound of their heart actually is.

Safety Concerns/Precautions:

- Some complex cuts must be made with a sharp pair of scissors; this is best left for the educator to prepare ahead of time.
- The stethoscopes do not amplify sound a great deal, so a quiet room may be necessary to hear the heart clearly.

Supplies:

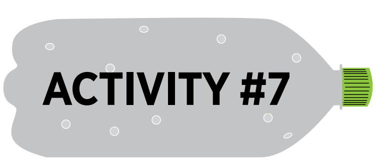
- 20 Ounce or 1 Liter soda bottle
- Vinyl tubing
- Balloons (optional)
- Rubber bands (optional)
- Scissors
- Markers
- Masking or clear tape
- Heart illustration

Procedure:

1. **EDUCATOR:** Cut the soda bottle around its circumference to make a funnel out of the top portion of the bottle. Discard the bottom of the bottle.
2. Remove the cap from the bottle.
3. Cut a foot-long piece of vinyl tubing and insert it into the mouth of the bottle.
4. Secure the tubing in the mouth of the bottle with a piece of masking or clear tape.
5. If desired, take a balloon and cut the opening off, leaving just the round part of the balloon.
6. Stretch the balloon around the cut opening of the bottle.
7. Have students place the bottle on another student's heart and listen through the vinyl tubing.

Background Science:

The heart is one of the most important organs of the body. It is responsible for circulating (think "circle" or "circuit") blood to throughout the entire body, delivering oxygen, water and nutrients and removing carbon dioxide and other waste from every organ and cell. The heart is not a reservoir for blood (it only holds a few ounces at a time!), but is a pump that moves blood. Most of our blood is circulating throughout our body, flowing through our 60,000 miles of blood vessels!



7. MAKE A STETHOSCOPE

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Students will build their own stethoscope and learn what the sound of their heart actually is.

Background Science:

Doctors can learn a lot by listening to the heart through a stethoscope. If the “lub-dub” doesn’t sound right, the might be a problem with one of the valves or walls between the chambers. Sometimes valves can be replaced with artificial or biological (pig or cow) valves or repaired via surgery. If the heart is not beating with the correct rhythm, medicine can be prescribed or a pacemaker – a device that uses a small bit of electricity to make the heart beat – can be installed.

To Test:

- Have the students run in place or do a few jumping jacks. Then have them listen to their hearts again.
- It may be difficult for students to locate each other’s hearts. Have them use the stethoscope to search for their hearts.

Clean Up:

- None

ACTIVITY #7

8. SEE YOUR PULSE

Goal of Activity:
Students will build a pulse visualizer that will help them take a pulse.

Safety Concerns/Precautions:

- This visualizer uses the pulse found along the inside of the elbow, the brachial pulse, or the wrist, the radial or ulnar pulse. It may be difficult for students to locate these pulses as each student's arm will vary in size and shape.
- Students should not use their thumbs when searching for a pulse as the thumb has an easily detectable pulse of its own which can cause students to miscount heart beats.

Supplies:

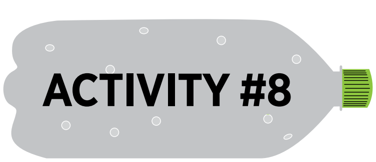
- Cap from a 2 Liter soda bottle
- Drinking straw
- Modeling clay or play dough
- Stopwatch (optional)
- Pencil and paper (optional)

Procedure:

1. Take the bottle cap from a 2 Liter soda bottle.
2. Fill the bottle cap more than halfway with some modeling clay or play dough.
3. Insert the drinking straw into the clay so that it is sticking straight up out of the bottle cap.
4. Have the students use two fingers to locate their pulse along the inside of the elbow or wrist.
5. Place the bottle cap on the location where they found a pulse.
6. Watch for the straw to move and if desired, count how many times the straw wiggles in 15 seconds. Multiply this number by 4 to find heartrate in beats per minute.
7. If desired, write down these results on a piece of paper and have students compare their pulses.

Background Science:

The heart is one of the most important organs of the body. It is responsible for circulating (think "circle" or "circuit") blood to throughout the entire body, delivering oxygen, water and nutrients and removing carbon dioxide and other waste from every organ and cell. The heart is not a reservoir for blood (it only holds a few ounces at a time!), but is a pump that moves blood. Most of our blood is circulating throughout our body, flowing through our 60,000 miles of blood vessels!



8. SEE YOUR PULSE

Goal of Activity:

Students will build their own stethoscope and learn what the sound of their heart actually is.

Background Science:

Blood vessels that take blood from the heart to the organs and cells of the body are called arteries. Main arteries that carry a lot of blood can be large, while arteries that deliver just a few blood cells at a time are microscopic. Wherever there is a large artery close to the skin or against a bone, a pulse can be felt. These include the brachial artery along the inside of the upper arm, the radial or ulnar arteries along the inside of the wrist, the femoral artery along the inside of the leg, the tibial artery along the ankle bone, and the carotid artery along the front side of the neck beside the larynx. The study of the pulse is called sphygmology, and using the hands to feel for something in or on the body is known as palpation.

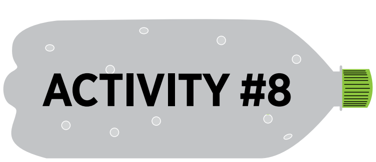
Doctors take a pulse to ensure that the heart is beating properly and that blood is being delivered to other parts of the body. If a pulse has an irregular rhythm, it may indicate a problem with the heart or that part of an artery may be blocked. If this happens, doctors may prescribe medicine to regulate the heart, install a pacemaker (a device that uses a small bit of electricity to make the heart beat), or repair the artery via surgery.

To Test:

- Have the students run in place or do a few jumping jacks. Then have them take their pulses again.
- Have students sit calmly in their seats or lay in the grass. Then have them take their pulses again.
- Have students compare their pulses to your own, or maybe an older adult in their family.
- See if students can find any other places where they can feel a pulse.

Clean Up:

- If so desired, remove modeling clay from cap and return it to an airtight bag or container so it does not dry out.



9. MENTOS AND SODA GEYSER

Goal of Activity:

Students will create soda geysers using Mentos mints to accelerate the reaction.

Safety Concerns/Precautions:

- The soda geysers can shoot soda very quickly from the mouth of the bottle, so exercise caution. Do not point the bottles at or near anyone.
- If done indoors, this experiment will surely make a mess and could leave a sticky residue on surfaces.

Supplies:

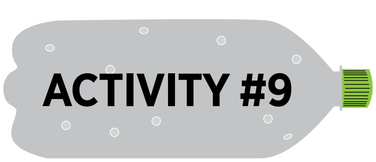
- Full 2 Liter bottle of diet soda (diet is important)
- Mentos mints
- String or thread
- Paper towel
- Geyser Tube (optional, found here http://goo.gl/JQoB8e)
- Other carbonated drinks (optional)

Procedure:

1. Tie a string or thread around the Mentos mint, leaving a 6-inch or so length of string to hold onto.
2. Uncap the full 2 Liter bottle of diet soda and place it on a solid level surface.
3. Hold the Mentos mint just inside the mouth of the bottle by the string.
4. Drop the Mentos mint into the bottle and stand back!
5. If desired, use a Geyser Tube setup to help introduce the Mentos mints to the soda.

Background Science:

Soda is a carbonated beverage, which means that the liquid in the bottle also contains carbon dioxide (CO2) gas. If you look at an unopened bottle of soda, the liquid tends to be still and devoid of bubbles. But if the bottle is opened (especially after being shaken), bubbles form and rise to the top of the soda quite quickly. This is because the carbon dioxide gas in the liquid soda is slightly pressurized – or squeezed – and when the cap is removed, the pressure decreases and larger visible bubbles begin to form.



PHILADELPHIA SCIENCE FESTIVAL

9. MENTOS AND SODA GEYSER

Goal of Activity:

Students will create soda geysers using Mentos mints to accelerate the reaction.

Background Science:

Carbon dioxide gas bubbles form in the soda typically along the walls of the bottle. If you pour some soda into a glass, you might see that bubbles form on the bottom or walls of the glass. When water boils in a pot, bubbles first form along the bottom of the pot as it begins to boil. This is because bubbles must form on a surface, not just anywhere in the liquid. Though the plastic bottle feels smooth, it actually has tiny imperfections that allow bubbles to form and grow once the pressure is released. A tiny point on which anything can grow or expand is known as a nucleation site.

Mentos mints, though apparently smooth, are actually rough along their surface, with microscopic pores and bumps. This means that the mints have a very high surface area—the total outer surface of an object—and many, many nucleation sites. As the mint is introduced to the soda, the carbon dioxide forms expanding bubbles very rapidly and cause the soda to erupt out of the spout.

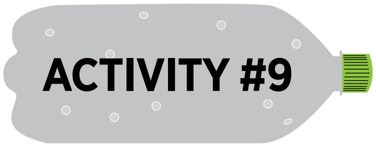
It is important to use diet soda for this experiment because of a special chemical called aspartame. This chemical is an artificial sweetener about 200 times sweeter than table sugar (sucrose), so when used to make soft drinks, far less is used to sweeten the drink and fewer calories are consumed. Another effect of aspartame is a lower surface tension of the liquid soda, meaning that the individual molecules of the liquid are less drawn to one another. This allows bubbles to form more easily and quickly, speeding up the geyser reaction.

To Test:

- Try other carbonated drinks to make your geysers, including non-diet soda, seltzer water, club soda, etc.
- Try adding more than one Mentos mint at once.
- Take photos of the geyser to see how high it goes.

Clean Up:

- Soak up discharged soda with paper towel, and rinse and wipe all surfaces clean with water.



10. TEST YOUR FOOD'S SUGAR CONTENT

Goal of Activity:

Students will test how much sugar foods have using yeast and fermentation to fill a balloon.

Safety Concerns/Precautions:

- Yeast produces chemicals that can smell unpleasant, so be aware when opening the bottles in the classroom.
- A balloon must be attached tightly to the top of a bottle, so younger students may need help with this step.

Supplies:

- 20 Ounce or 1 Liter soda bottle
- Packet of Active Dry Yeast
- Warm water
- Balloons
- Sugar
- Candy (optional)
- Small marshmallows (optional)

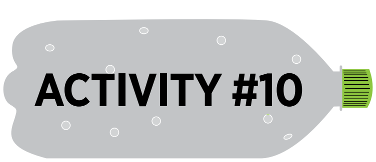
Procedure:

1. Stretch out the balloon by blowing it up and deflating it about 3 or so times.
2. Add the packet of Dry Active Yeast and a few teaspoons of sugar to one cup of warm water.
3. Stir the yeast/sugar/water until everything is dissolved.
4. Pour the solution into the soda bottle.
5. Attach the deflated balloon to the mouth of the bottle and keep an eye on it!

Background Science:

Though it appears to be a powder, yeast is actually a colony of microorganisms, tiny living creatures that need food and oxygen just like you and your students. Yeast is a type of fungi, and the yeast used by bakers, brewers and winemakers is named Saccharomyces cerevisiae. This yeast needs sugar, specifically glucose, to survive, hence its name "saccharo," meaning "sugar," and "myces" meaning "fungus" in Greek.

The yeast uses the dissolved sugar in the water as a food source, just as we would. Table sugar, which is sucrose, is a combination of glucose and fructose, the sugar found in fruit. As the yeast consumes the sugar, it makes waste in the form of carbon dioxide (CO_2) gas. As millions and millions of yeast cells "burp" out the CO_2 gas, it fills the bottle and begins to inflate the balloon. The conversion of sugar to gas by means of a microorganism is called fermentation.



10. TEST YOUR FOOD'S SUGAR CONTENT

Goal of Activity:

Students will test how much sugar foods have using yeast and fermentation to fill a balloon.

Background Science:

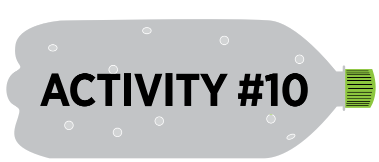
When yeast is added to bread dough, a bit of honey or sugar is typically added as well. Before being baked, most bread recipes require the dough to "rest" in a covered bowl. The time given for the dough to rest is actually granting the yeast time to consume the glucose from the sugar or honey, thereby producing thousands of CO2 gas pockets that fill the dough and make it "rise." When the bread is put into the oven, the small pockets of CO2 gas expand even more, making the bread light and airy on the inside. The sugars near the exterior of the dough heat and caramelize, making a flaky and crispy crust.

To Test:

- Try adding different sugary foods to the water and yeast and see what happens to the balloon.
- Change the temperature of the water and see how the yeast reacts. What temperature yields the best result? Is there a temperature that doesn't work at all?
- Try using baking powder instead of yeast and see what happens to the balloon.

Clean Up:

- Remove the balloon from the top of the bottle and pour contents down the drain.
- Rinse out bottle and allow it to dry before conducting the experiment again.



11. INFLATE A BALLOON WITH CHEMISTRY

Goal of Activity:

Students will trap gas produced by an acid-base reaction using a soda bottle and a balloon.

Safety Concerns/Precautions:

- A balloon must be attached tightly to the top of a bottle, so younger students may need help with this step.
- This experiment will use a diluted acid, but caution should still be exercised so students don't consume any ingredients.

Supplies:

- 20 Ounce or 1 Liter soda bottle
- Baking Soda
- Vinegar
- Teaspoon
- 1/4 Cup measuring cup
- Funnel (optional)
- pH scale illustration

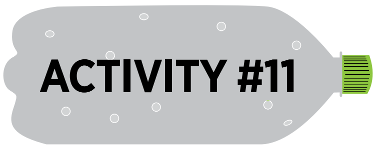
Procedure:

1. Stretch out the balloon by blowing it up and deflating it about 3 or so times.
2. Uncap the soda bottle and pour in 1/4 cup of vinegar.
3. Use a funnel or a rolled piece of paper to pour about 2 teaspoons of baking soda into the deflated balloon.
4. Keeping the body of the balloon turned down, stretch the mouth of the balloon over the mouth of the bottle.
5. Lift up the balloon to allow the baking soda to pour into the vinegar and watch what happens!

Background Science:

The pH scale measures whether a substance is an acid or a base. The scale ranges from 0 to 14; lower than 7 is an acid, and higher than 7 is a base. 7 even is neutral—neither an acid nor a basel—and is a close estimate of the pH level of pure water. Common acids include orange juice, lemon juice and tomato, while common bases include soap, blood, and lye.

Baking soda is actually a chemical named sodium bicarbonate. This chemical is considered to be a base, with a pH of about 8.5. Vinegar is a water-based liquid containing a chemical named acetic acid, with a pH of about 2.4. When the sodium bicarbonate is dropped into the vinegar, the chemicals react and produce carbon dioxide (CO_2) gas that rapidly expands and produces bubbles.



11. INFLATE A BALLOON WITH CHEMISTRY

Goal of Activity:

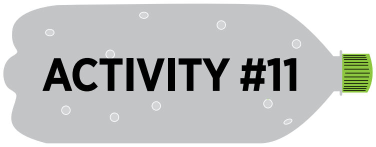
Students will trap gas produced by an acid-base reaction using a soda bottle and a balloon.

To Test:

- Try adding different amounts of baking soda and vinegar to the balloon and bottle.
- Try using other acids like orange juice or lemon juice.

Clean Up:

- Remove the balloon from the top of the bottle and pour contents down the drain.
- Rinse out bottle and allow it to dry before conducting the experiment again.



12. BUILD A BAROMETER

Goal of Activity:
Students will build a barometer to test air pressure.

Safety Concerns/Precautions:

- This activity uses food dye, so be careful not to spill on porous surfaces or fabrics.
- This activity works best if it is setup on a rainy day.

Supplies:

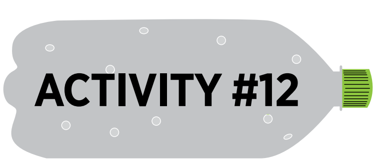
- Large clear plastic cup
- 2 Liter soda bottle
- Water
- Food dye
- Markers

Procedure:

1. Pour a few inches of water into a large clear plastic cup and add a few drops of food dye.
2. Remove the cap from the 2 Liter soda bottle.
3. Invert the plastic bottle and place it in the cup of water making sure that the mouth of the bottle is not touching the bottom of the cup.
4. Mark the water level on the side of the cup using a marker.
5. Observe the apparatus over the course of the next few days, particularly if the weather has changed. Compare the water level to the mark you made.

Background Science:

The blanket of air that surrounds the entire Earth is called the Atmosphere. Though we may not feel it, the air around us is exerting a force on our bodies, the ground, the water, and every object within the atmosphere. This force is called air pressure, and it presses down on every square inch of surface with about 14.7 pounds of pressure. Air pressure is what allows us to breathe, what makes vacuum cleaners work, and what allows us to drink out of straws. An instrument that measures air pressure is called a barometer.



12. BUILD A BAROMETER

Goal of Activity:
Students will build a barometer to test air pressure.

Background Science:

When students build their barometers, the air presses on the surface of the water in the cup just as much as the air in the bottle presses on the surface of the water inside. However, when the air pressure changes in the atmosphere, it may press more or less on the surface of the water in the cup, all while the pressure inside the bottle remains the same. This can manifest as an increase or decrease in the amount of water in the cup.

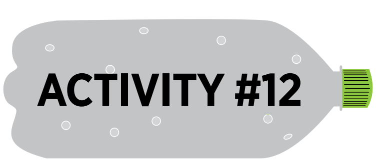
Days that are stormy or humid tend to have a lower air pressure than days that are dry and clear. This is why it is best to setup this experiment on a rainy day, as the air pressure on a clear day will push the water in the cup into the bottle. Meteorologists—scientists who study the weather—may refer to air pressure as "barometric pressure." They use the values of air pressure to forecast what the weather will be like in the upcoming days. Air pressure also decreases with altitude, so pilots use barometers on planes to determine how high they are in the air.

To Test:

• If possible, try setting up this experiment on days with different weather.

Clean Up:

• Simply empty the cup and bottle, rinse, and allow them to dry.



13. HOMEMADE THERMOMETER

Goal of Activity:

Students will construct their own thermometer and learn how temperature and volume are related.

Safety Concerns/Precautions:

- This experiment uses rubbing alcohol, which should not be consumed.
- This activity uses food dye, so be careful not to spill on porous surfaces or fabrics.

Supplies:

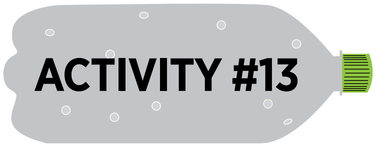
- 20 Ounce or 1 Liter soda bottle
- Drinking straws
- Modeling clay
- Food dye
- Water
- Rubbing alcohol

Procedure:

1. Mix equal parts tap water and rubbing alcohol and fill the bottle about 1/2 of the way.
2. Add a few drops of food dye to the liquid.
3. Put a drinking straw in the bottle without letting it touch the bottom of the bottle.
4. Seal the neck of the bottle around the straw well using the modeling clay.
5. Be sure the opening of the straw is still open but the seal around the straw is sound.
6. Place the apparatus in place with a different temperature, like a cool corner or a warm window sill, and see what happens!

Background Science:

We know temperature well as the feeling of being hot or cold, warm or cool, blistering or freezing. But temperature is actually the average amount of kinetic energy in a system. Kinetic energy is the energy of motion, and in this case, we are not referring to the motion of an object that is hot, like a warm frying pan or a pie. Instead, we refer to the motion of the tiniest parts of that object. These unbelievably small parts of an object are known as molecules. Molecules are the basic chemicals that make up all the matter around us, including the water and air, and how much kinetic energy these molecules have relate directly to the temperature of that object. The faster the molecules of an object are moving are moving, the hotter that object is.



13. HOMEMADE THERMOMETER

Goal of Activity:

Students will construct their own thermometer and learn how temperature and volume are related.

Background Science:

Moreover, the faster these molecules move (the more energy they have), the farther they bounce off of one another. Think of a tennis ball. If dropped, it will bounce back to a given height, but if thrown downward (giving it more energy), it will bounce much further. The same is true of molecules; the more energy they have, the farther they bounce. This means that a hotter object will have molecules that are bouncing farther and farther away from one another, which causes this hot object to increase in size, or volume. This is why doors stick in doorjambs in the summer, or inversely, why the lids of pickle jars stick if they're refrigerated.

As the water-alcohol mixture and air warm in the bottle, the molecules become more energetic and bounce farther and farther apart. This increases the volume of both the bottled air and the liquid, which causes it to expand and force its way up the straw. The students have built a rudimentary but effective working thermometer. These same principles are what make analog glass-mercury thermometers work so well.

To Test:

- Try building the thermometer in a warm location, then place it somewhere cold.
- Build the thermometer in a cool location, then place it in the sun.

Clean Up:

- If so desired, remove modeling clay from the mouth of the bottle and return it to an airtight bag or container so it does not dry out.
- Empty the bottle and straw, rinse, and allow them to dry.