Project #1 – Inquiry Demonstration of a Discrepant Event

You will present a five minute inquiry lesson to the class. A discrepant event will be used to start an inquiry discussion on a science topic. Follow the steps below to prepare your lesson:

STEP 1 – Read through the discrepant event assigned to you. The discrepant event should challenge students’ understanding of a particular science concept. The demonstration should present an unexpected or surprise result. (Do NOT give away the surprise!)

STEP 2 – Gather the materials needed. Please see me or the TA for assistance if you are having trouble finding the materials. Practice performing the demonstration until you feel comfortable using the materials.

STEP 3 – Think about how the demonstration will lead to a discussion about the concept being illustrated. Construct questions that probe students’ understanding, including “why” questions.

STEP 4 – Write a detailed lesson plan for the inquiry demonstration and discussion. Include the following elements in your written lesson plan:

   A) Title of lesson
   B) Complete list of objectives
   C) Complete list of materials
   D) Detailed description of lesson including all anticipated questions. Be sure to include the answers to those questions.
   E) Evaluation of the lesson (to be completed after the lesson has been taught)

STEP 5 – Bring all necessary materials to perform your demonstration. A written copy of your lesson plan should be given to the instructor before presenting the lesson. You can complete the evaluation after and hand that in the next class.

You will be graded using the following rubric (see attached sheets)
#1  Density Tower – Magic with Science

Make objects float in the middle of a liquid with this amazing trick.

With this trick, you'll put a new spin on our famous Density Column demonstration. First, we'll teach you how to make layers of liquid sit on top of each other. This density demonstration looks cool, but what if you could make different objects float in the middle of those cool looking liquids? You'll impress yourself and your friends with what you can do with your Density Tower.

Materials

- Tall, narrow, clear container (500 mL or 1000 mL graduated cylinders are perfect)
- 50-100 mL (1.5-3.5 oz) lamp oil
- 50-100 mL rubbing alcohol
- 50-100 mL vegetable oil
- 50-100 mL tap water
- 50-100 mL dish soap
- 50-100 mL milk
- 50-100 mL maple syrup
- 50-100 mL corn syrup
- 50-100 mL honey
• Ping pong ball
• Soda bottle cap
• Plastic bead
• Grape tomato
• Board game die
• Popcorn kernel
• Metal nut or bolt

Experiment

1. Start your column by pouring the honey into the cylinder. Now, you will pour each liquid SLOWLY into the container, one at a time. It is very important to pour the liquids slowly and into the center of the cylinder. Make sure that the liquids do not touch the sides of the cylinder while you are pouring. It’s okay if the liquids mix a little as you are pouring. The layers will always even themselves out because of the varying densities. Make sure you pour the liquids in the following order:
   o Honey
   o Corn syrup
   o Maple syrup
   o Milk
   o Dish soap
   o Water
   o Vegetable oil
   o Rubbing alcohol
   o Lamp oil

2. After letting the liquid layers settle, you'll notice that they remain in the order you poured them into the cylinder and that they are clearly distinguishable from each other. What scientific principle do you think contributes to the column's layers?

3. Make a chart that shows the order of each layer.

4. Take the various small objects and drop them into the column. Drop them in the following order:
   o Metal nut or bolt
   o Popcorn kernel
   o Board game die
   o Grape tomato
   o Plastic bead
5. Each of the objects will sink through or float on a different layer of the density column. What makes some objects sink deeper into the column while some hardly sink at all?

**How Does It Work?**

The same amount of two different liquids will have different weights because they have different masses. The liquids that weigh more (have a higher density) will sink below the liquids that weigh less (have a lower density).

To test this, you might want to set up a scale and measure each of the liquids that you poured into your column. Make sure that you measure the weights of equal portions of each liquid. You should find that the weights of the liquids correspond to each different layer of liquid. For example, the honey will weigh more than the Karo syrup. By weighing these liquids, you will find that density and weight are closely related.

Density is basically how much “stuff” is smashed into a particular area… or a comparison between an object's mass and volume. Remember the all-important equation: Density = Mass divided by Volume. Based on this equation, if the weight (or mass) of something increases but the volume stays the same, the density has to go up. Likewise, if the mass decreases but the volume stays the same, the density has to go down. Lighter liquids (like water or rubbing alcohol) are less dense than heavy liquids (like honey or Karo syrup) and so float on top of the more dense layers.

The same goes for the small objects that you dropped into your density column. The metal bolt is more dense than any of the liquids in the column and therefore sinks directly to the bottom. Less dense objects will float on individual layers of the column, however. For instance, the plastic bead is more dense than the vegetable oil and everything above it but less dense than the water and everything below it. This makes the bead settle on the top of the water.

**Additional Info**

In the materials, we had you grab a bunch of miscellaneous tiny objects. This is the perfect opportunity to get in some scientific exploration! Use what you learned from dropping the bead, soda bottle cap, tomato, and die
into the container to figure out which items are more and less dense than water. Which items have more density than vegetable oil? What items are less dense than honey?

**Observations**

When all the liquids and small objects have been added to your density tower, you will have what appears to be a magic column. All of the liquids will be clearly distinguishable from each other and each of the objects will have settled at different levels within the liquids. Construct a chart to show the order that the liquids are in and the position of each object.

Why do you think these two phenomena happen? What scientific principle is this illustrating?
#2  Soda Can Jump

The Soda Can Jump introduces the power of air pressure and Bernoulli’s principle.

Air pressure is one of our favorite invisible forces, especially when Bernoulli’s Principle is involved. The Soda Can Jump utilizes this awesome principle to launch an empty soda can out of a coffee mug. It’s a hands-on experience in physics that you won’t want to miss.

Materials

- Empty soda can
- 2 Coffee mugs
- Adult supervision

Experiment

1. Open the soda and drink it.
2. Place one mug in front of the other.
3. Place the empty soda can in one of the mugs.
4. Blow air between the soda can and mug to make it “jump” into the empty mug. Adjust the distances between the mugs if necessary.

**How Does It Work?**

What causes the drastic “launch” of the empty soda can from one mug to the other? It’s the invisible force that we reference so often: air pressure!

Blowing air in between the can and the first coffee mug creates an area of high pressure between the bottom of the can and the inside of the coffee mug. The harder you blow, the more rapidly the air pressure between the surfaces increases. As the pressure between the surfaces raises, the pressure above the can stays the same, creating a bigger difference in pressure. This difference of pressure pushes the empty can up and out, like a jump!
#3 Coin Tower

Use stacked coins as an immaculate kids’ science demonstration in inertia, friction, and movement.

When it comes to scientific muses, Sir Isaac Newton is definitely near the top of our list. Our favorite laws to break involve physics, movement, and motion! That’s why we came up with the Coin Tower demonstration. Using a butter knife, you’ll remove the bottom coin from an entire tower of coins. What’s the secret? Perform the project to find out!

Materials

- Coins
- Butter knife
- Adult supervision
Experiment

1. Stack the coins into an even and straight tower.
2. Use the dinner knife to swipe a coin out from the bottom of the tower.
3. See how many coins you can swipe out before the tower topples!

How Does It Work?

The key to safely removing a coin from from the bottom of a stack comes from friction and inertia. Inertia comes from Newton's first law of motion, stating that an object in motion (or at rest) tends to stay in motion (or at rest). This means that the balanced coins wants to stay in their stacked position, in the spot they are stacked. However, when you attempt to remove the bottom coin, you apply an outside force that causes the stack of coins to topple over.

This is where friction becomes a factor. There is friction between the bottom coin and stack above it. There is so much friction that the bottom coin brings the next coin with it, that coin drags the next coin, and so on. To overcome the amount of friction, you swing the knife at the bottom of the stack. This process is fast-moving, but there is plenty of force to remove the bottom coin. The amount of force applied to the coin is enough that the friction isn’t allowed to tip the tower over. Instead, the tower drops, almost perfectly, into the spot that it was before.
#4 Ice Tray Battery

Electrifying kid science that turns ordinary items into a real, working battery!

Do you know what a voltaic battery is? You probably do! Voltaic batteries come in all shapes and sizes, turning chemical energy into the electrical energy we need to power our cell phones, iPods, tablets, cars… you name it! These batteries seem pretty complicated, but you can make a real voltaic battery right at home! Grab some vinegar, nails, copper wire, and an ice tray… you’re in for a lesson in circuits you’ll never forget.

Materials

- Distilled white vinegar
- 5 pieces of copper wire
- 5 galvanized nails
- Ice tray
- 1 LED light
- Adult supervision
Experiment

1. Wrap a nail with a piece of copper wire, leaving a section of wire extending from below the head of the nail.
2. Repeat Step 1 with the remaining 4 nails and 4 pieces of copper wire.
3. Fill 6 wells of an ice tray with distilled white vinegar.
4. Create a circuit by inserting each nail into a well of vinegar while placing the extended wire into the next well.
5. Place one “leg” of an LED light into the well with only a copper wire inside it and place the other LED “leg” into the well with only a nail in it. If the bulb lights up, you nailed it! If the bulb doesn’t light up, flip the legs around!

How Does It Work?

Batteries are comprised of two different metals suspended in an acidic solution. With the Ice Tray Battery, the two metals are zinc and copper. The zinc is in the galvanization of the nail, and the copper wire. The acid comes from the vinegar inside the ice tray. More specifically, the acid comes from the 4-8% of the vinegar that is acetic acid.

The two metal components are electrodes, the parts of a battery where electrical current enters and leaves the battery. With a zinc and copper set-up, the current will flow out of the wire and into the nail. The electricity also passes through the acidic solution inside the tray wells.

Once the Ice Tray Battery is connected to the LED, you create a complete circuit. As the electrical current passes through the LED, it lights the LED, and passes back through all of the components.
#5 Inseparable Books

Friction makes two notebooks, intertwined by their pages, impossible to pull apart!

Notebooks are a necessity in every science setting. Graphs, observations, procedures… all of science falls by the wayside without a way of recording the information. Here’s a fun fact: two notebooks are even better than one! When you intertwine two notebooks, page by page, they become Inseparable Books! Check out this hands-on activity and see if you can overpower the friction between the books!

Materials

- 2 notebooks
- Adult supervision

Experiment

1. Place the notebooks on a flat surface with the bindings facing inward
2. Make sure the covers completely overlap with each other
3. Alternate pages from each notebook placing one over the last, continuing until the notebooks are entirely intertwined.

4. Holding the notebooks just inside the binding pull as hard as you can. Go ahead and have a friend pull on one of the notebooks while you pull the other.

**How Does It Work?**

No. We didn’t cover the notebook pages with super glue, and you can really pull as hard as you want on the notebooks… they just aren’t going to come apart! Since we know you’re wondering, friction.

Friction is the force that opposes motion when two surfaces are in contact. Friction is the reason you can’t roll a ball for eternity with one toss, but it’s also what enables you to run as you press your feet against the ground. Friction slows the ball to a stop while preventing your feet some sliding out from under you.

You may think that the amount of friction between sheets of paper to be pretty minimal, and you’d be right. When you multiply that friction by hundreds of surfaces – like each of the pages interwoven together – you wind up with an amount of friction that is insurmountable.
#6 Inertia Ring

This hands-on science project will teach physics and motion in a simple, yet awesome, way!

Do you think you can successfully perform the Steve Spangler Science inertia challenge? Balance a yellow ring on the mouth of an empty 1 or 2 liter bottle and place a hex nut or other heavy object on top of the ring. When the yellow ring is removed, the hex nut will drop straight into the bottle. It might take a little bit of practice, but you'll get it. Inertia rings are a perfect tool for introducing students to physics, motion, and inertia.

**Materials**

- Hex nuts
- Plastic rings
- Empty soda bottle
- Adult supervision
**Experiment**

1. Balance the ring on the mouth of the empty bottle; then place a hex nut or other object on top of the ring so it rests directly over the bottle opening. Check out the illustration.

2. There’s a way to hit the ring so the nut can drop through the mouth of the bottle and fall to the bottom, though it may seem impossible.

3. Consider other possibilities and think of ways you can hit the ring to move it to the side and let the nut drop straight down. Remember that the plastic flexes when you hit it.

4. Of course, the solution is written below, but see if you can get gravity to work for you before you read on.

**How Does it Work?**

You won’t get this to work if you hit the ring on the outside. The best way to get the nut to drop is to hit the ring from the inside, as shown. It may take a bit of practice to get the nut to drop into the bottle but once you get it, you’ll love the sound.

There’s a law of motion stated by a cool guy named Newton that says an object at rest wants to remain at rest unless something smacks it (OK, maybe those aren’t his exact words). By hitting the ring on the outside, you cause it to flex upward and push up on the nut, moving the nut away from the bottle opening. When you hit the ring from the inside out, the ring flexes downward, drops out from under the nut, and zips sideways. The nut loses its support but, because it’s not moving, it doesn’t do anything for a few nanoseconds. Then gravity takes over and the nut starts moving straight down into the bottle. By the way, once it’s moving, it doesn’t want to stop unless something (like the bottle, your hand, the floor, or the ground) gets in the way and makes it stop. Science is so e–motion–al!
#7 Water Twist

Experience cohesion, hydrogen bonds, and the polarity of water molecules first hand with this hands-on science experiment.

When you poke five, evenly-spaced wholes into the side of a bottle, they come out as five separate streams. That is, until you run your finger through the streams. Like magic, the five streams combine to form one! The principle at work is a force called cohesion, and the Water Twist is a great hands-on way to experience cohesion, polarity, and the properties of water.

Materials

- 1 liter bottle with cap.
- Thumbtack
- Water
- Adult supervision
Experiment

1. Fill a 1 liter bottle with water and screw on the cap.
2. Using a thumbtack, make 5 evenly spaced holes on the side of the bottle, near the bottom.
3. Loosen the cap to release the water.
4. Run your finger along the streams of water that are coming from the bottle. What happens each time you run your fingers through the streams?

How Does It Work?

The force at work, when you run your finger through the streams of water, is called cohesion. Cohesion happens when molecules of a substance stick to each other. Water is a very cohesive substance because the molecules are polar. When you run your finger over the stream again, the bonds are broken and the streams resume their separate flows.

Water is the perfect substance to demonstrate cohesion because of the simplicity of a water molecule. Water molecules consist of one oxygen atom, possessing a weak negative charge, and a pair of hydrogen atoms that sport a slightly positive charge. The negative charge of the oxygen attracts the positive charge of the hydrogen atoms and hydrogen bonds are formed. These bonds are strong enough to create cohesion, but are easily broken.
#8 Money Under Bottle

It's a quick way to make a buck. Challenge your friends with this amazing table trick.

A bottle balances precariously on its mouth. Nothing special, right? Well… put a dollar bill underneath the bottle's mouth. Now, bet your friends a dollar that they can't pull the dollar out from under the bottle without knocking it over. Sit back and enjoy their futile attempts as friend after friend knocks the bottle over. What's the secret? Read on to find out!

Materials

- Dollar bill
- Glass bottle

Experiment

1. Place a flat dollar bill on a smooth, flat surface.
2. Balance a bottle, on its mouth, right over the top of George Washington's face.
3. Tell your friends that they can have the dollar if they can pull it out from under the bottle without making the bottle fall.

4. Watch them fail. Watch them fail a lot.

5. You should probably show them how it's done. Carefully roll the dollar bill, from one end, towards the bottle.

6. When the rolled up dollar gets to the mouth of the bottle, continue rolling, but be careful to nudge the bottle towards the opposite edge.

7. Once the bottle is off of the edge… you've made a buck!

**How Does It Work?**

The key to safely removing the bottle from atop the dollar bill comes from friction and inertia. Inertia comes from Newton's first law of motion, stating that an object in motion (or at rest) tends to stay in motion (or at rest). This means that the balanced bottle wants to stay in the position, in that spot. However, when you attempt to remove the dollar bill, you apply an outside force that causes the bottle to topple over.

This is where friction becomes a factor. There is friction between the dollar bill and bottle. There is so much friction that the dollar bill pulls the bottom of the bottle with it. To overcome the friction, you roll the dollar bill to the edge of the bottle. This process is slow-moving, but there isn't enough movement to tip the bottle.

Dollar, dollar bill y'all!
#9  Sinking Soda Surprise

Which of your favorite sodas will sink, and which carbonated beverages will swim? It's density at its finest!

Plug the drain, fill the sink with water, and take the plunge with Steve Spangler’s floating science challenge. We all know that certain things float in water while other things sink, but why? Do all heavy things sink? Why does a penny sink and an aircraft carrier float? Think you know the answers? Well, get ready for a few amazing surprises!

Materials

- Demo tank
- An assortment of different sodas (standard 12 oz cans)

Experiment

1. Ask your audience the question, “Will this can of regular soda float or sink in the bucket of water?” After gathering everyone’s answer, place the can of regular soda in the water and notice that it sinks to the
bottom. If the can of regular soda floats, you might have an air bubble trapped under the bottom of the can.

2. Pick up a can of diet soda and pose the same question. Be sure to point out the fact that the cans are exactly the same size and shape and contain the same amount of liquid (compare the number of milliliters… probably 355 mL). Place the can of diet soda in the water. It floats! Wobble the can from side to side to show your audience that there are no bubbles trapped under the bottom. It still floats. Why?

3. Let your group experiment with different kinds of soda. Why do the diet sodas float and the regular soda cans sink, no matter the brand?

Try the experiment again using salt water. Are your results any different? What if you continue adding salt? How much salt do you have to add before your results change? Consider changing the temperature of the water or the temperature of the cans. Do either of those changes affect the results?

How Does It Work?

This demonstration is an excellent way to learn about density. We are all familiar with the basic concepts of sinking and floating. Objects less dense than water float, and those more dense than water sink. Empty cans float, rocks sink. This is only possible because of differences in density.

If both diet and regular soda cans are placed on a double pan balance scale, it would be clear that the regular soda is heavier than the diet soda. This demonstrates the difference between mass and volume. Mass refers to how much stuff exists within an object. If something is heavier than another object, it contains more mass. Mass is measured in grams.

Volume, on the other hand, refers to how much space an object occupies. For fluids, volume is usually measured in liters (L) or milliliters (mL). There are 1000 mL in one liter. This is what we were referring to when we told you that the cans contained the same amount of liquid – 355 mL. Since both cans have the same volume, the heavier can must have a greater mass. We can now conclude that the heavier can is more dense than the lighter can.

Diet sodas usually contain aspartame, an artificial sweetener, while regular sodas use sugar. Take a look at the nutritional information on the side of the cans. Notice how much sugar is in a regular soda (look under carbohydrates). Most regular sodas have about 41 grams of sugar. How much is 41 grams? Try 18 packets of sugar like the ones you might find at a restaurant! Yikes! That's a lot! Diet soda is flavored with a relatively
small amount of an artificial sweetener (like aspartame) which is 200 times sweeter than an equal amount of sugar. Therefore, only a tiny amount of aspartame is needed. Both sugar and aspartame are more dense than water, which can be easily demonstrated by adding small amounts of each to a container of water (they sink). So it is actually a matter of how much of each is used. The 41 grams or so of sugar added to a can of regular soda make it sink. The relatively tiny amount of aspartame used in diet sodas will have a negligible effect on the mass, enabling the can to float.

Why do cans of diet soda float? It is all due to the fact that there is a little bit of space, called “headspace,” above the fluid in each can of soda. This space is filled with gas, which is much less dense than the soda itself. It is this space above the soda that lowers the density of diet drinks just enough to make them float. Sugared drinks also have this headspace, but the excessive amount of sugar added makes the can more dense than water.
#10 CO2 Fire Extinguisher

Carbon dioxide extinguishes flames, but you've never put out a candle like this, before.

Carbon dioxide is a gas that we interact with every day. For instance, CO2 enables plants to perform photosynthesis, you exhale CO2 when you breathe, and CO2 can extinguish fire. You probably knew all those facts, but did you know that you can get really science-y and extremely creative when putting out flames with CO2? It's as simple as pouring the gas onto fire. Pouring? You better believe it!

Materials

- White vinegar
- Baking soda
- Clear container
- Candle(s)
- Lighter or matches
Experiment

1. Pour some baking soda into a clear beaker or glass.
2. Add some vinegar into the mix by pouring white vinegar into the same container as the baking soda.  
   Whoa… that's a foamy reaction!
3. Wait a few moments while the reaction tapers off.
4. Use a lighter or matches to ignite the candle(s).
5. Grab the container with what used to be vinegar and baking soda and slowly “pour” the air from the  
   container. Be careful not to pour the liquid!
6. As you move the container from candle to candle as you pour the air out, the flames will extinguish. No  
   way!

How Does It Work?

Most flames require oxygen, fuel, and sufficient heat to ignite and stay lit. These three components of fire are  
referred to as the fire triangle or combustion triangle. Removal of any of the three components will cause the  
flame to extinguish or “go out.”

The secret to extinguishing fire is the removal of one of the three components. In CO2 Fire Extinguisher  
experiment, that lies in the bubbling mixture in the container. The baking soda (also known as sodium  
bicarbonate) is a base. The vinegar, or acetic acid, is a weak acid. When baking soda and vinegar are  
combined, the immediate acid-base reaction creates carbonic acid. Carbonic acid is unstable and decomposes  
into carbon dioxide (CO2) and water (H2O). The bubbling that you see inside of the container is the  
production of the CO2 gas. When you “pour out” the container, you're exposing the flame to concentrated CO2  
gas. The lack of oxygen extinguishes the flame.

How can you possible pour a gas? The air that we breathe is comprised largely of nitrogen gas, a very light  
gas. The CO2 that was created inside of the cylinder is much heavier and, therefore, able to be poured like a  
liquid, out of the container.
#11 The Floating Egg

Eggs sink in regular tap water, but creating a saltwater solution… that's an egg-citingly different story.

We've shown you how different sodas will either sink or swim in plain tap water, but what's the deal with eggs? Drop as many eggs into plain tap water as you want, but they'll all sink to the bottom. In the Floating Egg experiment, we'll show you how the addition of something as simple as table salt, can drastically alter what happens to eggs in water.

Materials

- Two drinking glasses
- Two raw eggs
- Table salt
- Spoon

Experiment

1. Fill one of the drinking glasses almost to the top with plain tap water.
2. Gently drop one of the eggs into the water-filled glass. It sinks right to the bottom!
3. Fill the second drinking glass half-full with water.
4. Add four tablespoons of table salt to the water, and stir.
5. Fill the rest of the cup with water, almost to the top.
6. Gently place the second egg into the salt water solution… it floats!

How Does It Work?

All you did was add salt to your water. How in the world does the second egg float?

The first egg sinks to the bottom of the glass of regular tap water. This is because a raw egg has a greater density than regular tap water. Essentially, the egg has more matter stuffed into a specific area (volume) than the same amount of water. When you add salt to the water, you increase the density. That is to say, the salt packs into the same volume of water. With enough salt added to the water, the density of the water is greater than the egg, allowing the egg to float.
#12 Singing Rod

A classic science demo that is sure to wake you up...

Here's a classic science demonstration that is sure to wake you up… and the people down the street… and every dog in the neighborhood! With a little practice and some science know-how, you'll turn an ordinary piece of aluminum rod into a singing virtuoso.

Materials

- A solid aluminum rod - approximately 5/8” in diameter and 24” long (You can experiment with different lengths of rod to produce different sounds)
- Violin rosin
- Patience
**Experiment**

1. Hold the rod in the middle with your first and second fingers on top and the thumb supporting the rod from below. The key is to make as little contact with the rod as possible so as not to dampen the vibrations.
2. Apply some rosin to the thumb and fingers of your other hand and lightly coat the aluminum rod with rosin.
3. Use your rosin coated fingers to pinch the metal while sliding your fingers from the middle to the end of the rod. Don’t stop. As soon as your fingers reach the end, repeat this pinch-n-slide process…and again…and again…maybe upwards of 20 times before the metal bar begins to resonate. Don’t give up.
4. Because of the sticky nature of rosin, your fingers should stick and slide across the rod causing it to resonate.
5. The sound of the vibrations will be soft at first but will strengthen with each successive stroke. The resulting high pitch sound will be ear-piercing! Each stroke reinforces the vibrations of the last. Pinch and slide, pinch and slide, pinch and slide…don’t give up!
6. Try holding the bar in the middle and tapping on the sides. Compare this sound to the sound produced by hitting the bar directly on the end. How does this sound compare to the sound made by stroking the bar?

**How Does It Work?**

“Vibrations…the reason the bar makes the sound is because of vibrations.” Your students might be inclined to offer this simple explanation before you increase their level of understanding by asking these additional questions:

- Why did the pitch of the bar sound different when you tapped the bar instead of stroking the bar?
- Why does the metal bar vibrate when you rub it with your fingers? Why is the rosin necessary?
- Where is the high pitch sound coming from (middle, sides, or ends of the bar) and why?

In terms of making the bar vibrate, the rosin is responsible for making your fingers stick and slide as they move across the bar. In turn, this repeated stick and slide action sets up vibrations in the bar.

You probably noticed that holding the bar in the middle and tapping it on the sides produced a lower pitch sound and striking the bar on the very end created a higher pitch sound. The same high pitch sound is also
made by stroking the bar with your fingers. In either case, the high pitch sound resulted from the formation of compression waves or longitudinal waves throughout the bar. Each successive stroke of the bar reinforces the strength of the previously established longitudinal wave, resulting in a louder sound.

Here’s a way to illustrate a longitudinal wave using a Slinky toy. Picture a Slinky stretched out on the floor with another person holding the Slinky at the other end. Compress a section of the spring and let go. Notice how the energy of the released coil moves up and down the length of the spring. This is an example of a compression or longitudinal wave. The high pitch sound of the metal rod is the result of a longitudinal wave which travels throughout the entire length of the bar.

If the rod is held in the middle and tapped on the side with a solid object, a transverse wave is created. These waves have much longer wavelengths and, as a result, have a much lower tone or pitch compared to the higher pitched longitudinal wave. A transverse wave is made by moving the Slinky in an up and down motion, creating nodes and antinodes. Notice the formation of standing waves.

Practice hitting the bar with a solid object close to the end with a slight diagonal stroke. By doing so, you can actually create both longitudinal and transverse waves at the same time, and you’ll be able to hear both sounds at once.

**Additional Info**

Over the years, this activity has been published in a number of demonstration books, and my initial efforts to perform the Singing Rod always resulted in tired fingers and no sound. Success came after seeing Dr. Albert Baez present the demonstration in San Antonio in 1995. The motion of repeatedly sliding your hand down the bar is smooth and graceful. Dr. Baez effortlessly caused the metal bar to resonate a high pitched sound that filled the auditorium to everyone’s amazement. So can you!
#13 Centripetal Force Penny

Explore physics and Newton's first law by spinning a coin on the tip of a wire hanger.

As a penny balances precariously on the hook of a wire hanger, you might think any sort of movement would send the penny flying. With a bit of physics know-how, you can spin the entire hanger around in a circle without losing the 1¢ coin. When it comes down to it, you just need to thank Sir Isaac Newton.

**Materials**

- Wire hanger
- Penny

**Experiment**

1. Bend the hook portion of the wire hanger until the end is pointed back in the opposite direction.
2. Stretch the hanger and open it up. The resulting shape should be very similar to a diamond.
3. Balance the penny on the hooked end of the hanger. It might take a few attempts, but we promise you'll get it.
4. Begin to swing the hanger back and forth, starting with a very small amplitude (swing height) and gradually increasing the swing until you can spin it in a full circle. It might take a few times (we'll admit, it definitely took us more than a few) to get it right. But, we promise, it is possible!

**How Does It Work?**

According to Newton's first law of motion, objects in motion tend to remain in motion unless acted upon by an external force. In this case, Newton's law requires the penny to continue moving along a tangent to the circle. Thus a force is required to keep it always turning toward the center of the circle. The interpretation of this demonstration is potentially confusing when one considers that at the top of its arc, the penny is accelerating downward because of the motion, but that the force of gravity is also downward.

You can explain that the equation Force=Mass x Acceleration (F = ma) is thus satisfied without the penny leaving the hanger. Force is a push or pull (the swinging of the hanger) that causes an object with mass (the penny) to accelerate. So, Force of the hanger is equal to the mass of the hanger and penny, times the acceleration given by swinging the hanger. This demonstration provides the opportunity to discuss non-inertial (accelerated) frames of reference and inertial (fictitious) forces (such as the centrifugal force).
#14 Heavy Newspaper

Demonstrate the incredible properties of air and air pressure.

Materials

- Several pieces of pine wood or wood paneling (1" wide x 36" long x 1/4" thick)
- Several large sheets of newspaper
- Work gloves
- Table

Experiment

1. Place the piece of wood on a table and let one end hang over the edge about 4 inches. Ask the spectators, “What will happen if I hit the piece of wood that is hanging over the edge of the table?" Make sure
everyone is out of harm's way as you karate-chop the stick. Of course, the stick goes flying end over end just as expected.

2. Return the stick to the table allowing about 4 to 10 inches of the stick to hang over the edge. “Let's use a piece of newspaper to help secure the stick in place.” Show a single sheet of newspaper and fold it in half 3 or 4 times. Place the folded newspaper over the end of the stick that is lying on the table. Again, make sure everyone is standing away from the table as you hit the end of the stick that is hanging over the edge of the table. What happened? Did the newspaper help to hold the stick in place? Of course, the answer is “NO.”

3. Finally, show the spectators a new sheet of newspaper and use it to cover the portion of the stick that is lying on the table. Make sure that the newspaper is flush with the edge of the table. “What do you think will happen now if I hit the stick with the unfolded newspaper covering the stick?” You might anticipate an answer like, “The newspaper will go flying…or the sheet of newspaper will tear apart.” Smooth down the newspaper with your hands so that there are no pockets of air under the sheet of paper. Put on your karate-chopping glove to protect your hand. Strike the protruding edge of the stick with your hands with a sudden sharp hit. To everyone's amazement, the stick breaks. Remind the audience that the weight of flat newspaper is exactly the same as the folded newspaper, yet the flat newspaper stayed in place and held the stick in place. That's amazing… but how does it work?

How Does It Work?

The results of the experiment prove that the newspaper is more difficult to lift when it is spread out over a large area, yet the weight of the folded and flat newspaper remain the same. What other force is exerted on the newspaper that could account for these differences? The answer is as simple as the air we breathe. It is the pressure of the air pushing downward on the newspaper that prevents the paper from rising.

It might be useful to picture a giant column of air resting on top of the newspaper. This column of air is 250 miles (402 km) tall! This column of air above the newspaper pushes down with a force of 14.7 pounds of pressure per square inch (this is at sea level). In other words, each square inch of the newspaper has 14.7 pounds pushing down on it. So, if you know the area of the newspaper, you can calculate the total amount of pressure pushing downward on the paper. Let's say that the newspaper dimensions measure 20 inches by 30 inches. The total area is 20 inches X 30 inches = 600 square inches. If each square inch has a force of 14.7 pounds pushing on it, then 600 square inches X 14.7 pounds per square inch = 8,820 pounds! That's the equivalent weight of two large automobiles. It's no wonder that the newspaper stayed in place at the moment when you hit the stick. 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.

**Additional Info**

As a follow-up activity, have the students calculate the force of the air pressure exerted on the folded sheet of newspaper and compare this number to the force pushing on the flat newspaper. The comparison is startling.
#15  Flying Ping Pong Ball

Moving air and pressure makes a ping pong ball float in midair.

Amuse the neighbors for hours as you make objects float in midair. Believe it or not, the secret to this mystery of levitation is right in front of your nose. All you'll need is a hairdryer and a ping pong ball to experience the power of air.

Materials

- Hair dryer
- Empty toilet paper tube
- Ping-pong ball
- Balloon
- Beach ball
- Roll of toilet paper
- Stick or piece of dowel rod
- A leaf blower!
## Experiment

1. Set the hair dryer to cool, switch it on, and point it at the ceiling.
2. Carefully put the ping-pong ball in the stream of air. Hold the hair dryer very steady and watch as the ping-pong ball floats in the stream of air.
3. Carefully move the hair dryer from left to right and watch how the ball moves as well, staying in the stream of air.
4. Try floating other lightweight objects in the air stream at the same time! With the hair dryer on, place an inflated balloon over your levitating ping-pong ball. You might want to place a penny in the balloon before you blow it up to give it some added weight.
5. Try to float two or more balls in the same air stream. How many can you float at once? How do they behave when there is more than one?
6. Need more power? Try using a leaf blower in place of the hair dryer. Now you can float larger objects like beach balls.

**Flying Toilet Paper!** Just hold a roll of toilet paper in the stream of air and watch the paper take off! Be sure to hold the toilet paper roll on a long stick (piece of dowel) in order for it to spin fast and unroll the paper.

And for the finale… balance a ping-pong ball in the air stream. Then place your now empty toilet paper tube above it in the air. Watch it float above the ball. Then watch the ball get sucked up inside the toilet paper tube! Always conclude this demo with a thanks to Bernoulli (see below if you don't get it).

## How Does It Work?

The floating ping-pong ball is a wonderful example of Bernoulli’s Principle, the same principle that allows heavier-than-air objects like airplanes to fly.

Bernoulli, an 18th century Swiss mathematician, discovered something quite unusual about moving air. He found that the faster air flows over the surface of something, the less the air pushes on that surface (and so the lower its pressure).

The air from the hair dryer flows around the outside of the ball and, if you position the ball carefully, the air flows evenly around each side. Gravity pulls the ball downwards while the pressure below the ball from the
moving air forces it upwards. This means that all the forces acting on the ball are balanced and the ball hovers in mid-air.

As you move the hair dryer you can make the ball follow the stream of air because Bernoulli's Principle says that the fast moving air around the sides of the ball is at a lower pressure than the surrounding stationary air. If the ball tries to leave the stream of air, the still, higher pressure air will push it back in. So, the ball will float in the flow no matter how you move.

When you place the empty toilet paper tube into the air stream, the air is funneled into a smaller area, making air move even faster. The pressure in the tube becomes even lower than that of the air surrounding the ball, and the ball is pushed up into the tube.

Airplanes can fly because of Bernoulli's Principle. Air rushing over the top of airplane wings exerts less pressure than air from under the wings. So the relatively greater air pressure beneath the wings supplies the upward force, or lift, that enables airplanes to fly.
#16 Rising Water Secret

Watch closely as air pressure forces water into a flask.

You’ll have to watch closely and use everything that you know about air in order to explain the mystery of the rising water. You heard right! Air is the key to why the water rises in this experiment… but you’ll have to do the experiment yourself to find out just how air affects the water.

Materials

- Candle and matches
- Pie pan or dish
- Juice bottle, jar, or clear vase
- Water
- Food coloring
- Matches
Experiment

1. This experiment requires the use of matches… and that means adult supervision.
2. Fill a plastic cup up with water. About 9 oz. should do the trick.
3. Add 2 or 3 drops of food coloring to the water. This will make the movement of the water easier to see later on in the experiment.
4. Pour the water into the plate or pan and place the candle in the middle of the water.
5. Light the candle.
6. Cover the candle with the vase and think about what is taking place both inside and outside of the vase.
   What invisible thing is inside the vase? Carefully observe what happens to the water around the vase. It's bubbling! What happens to the candle flame?
7. Repeat the experiment several times until you can write down or draw a picture that explains why the water level rises.

How Does It Work?

The candle flame heats the air in the vase, and this hot air expands. Some of the expanding air escapes out from under the vase — you might see some bubbles. When the flame goes out, the air in the vase cools down and the cooler air contracts. The cooling air inside of the vase creates a vacuum. This imperfect vacuum is created due to the low pressure inside the vase and the high pressure outside of the vase. We know what you're thinking, the vacuum is sucking the water into the vase right? You have the right idea, but scientists try to avoid using the term “suck” when describing a vacuum. Instead, they explain it as gases exerting pressure from an area of high pressure to an area of low pressure.

A common misconception regarding this experiment is that the consumption of the oxygen inside of the bottle is also a factor in the water rising. Truth is, there is a possibility that there would be a small rise in the water from the flame burning up oxygen, but it is extremely minor compared to the expansion and contraction of the gases within the bottle. Simply put, the water would rise at a steady rate if the oxygen being consumed were the main contributing factor (rather than experiencing the rapid rise when the flame is extinguished)
#17  Do Not Open Bottle – Soda Prank

Create the ultimate prank with a 1-liter bottle and water

It's the ultimate prank using the simplest of props… a plastic soda bottle filled with water. Even though the words “DO NOT OPEN” are printed on the bottle, people just can't resist the temptation. Watch out, the fun is just beginning!

Materials

- Two plastic soda bottles (1-liter size works well)
- Cap
- Large nail
- Deep sink or large pan
- Sharpie pen
- Thumbtack
Experiment

Hey, if you're a kid who is trying to do this experiment, get an adult to help you poke the holes in the bottle. You don't want to hurt your hand!

The Leak-Proof Bottle

1. Use the nail to poke a hole on the side of the bottle close to the bottom.
2. Cover the hole with your finger while you fill the bottle with water all the way to the top. Screw on the cap.
3. Slowly take your finger away from the hole. Are you ready for the water to come rushing out? Hey, there's no leak!
4. Unscrew the cap and watch what happens. Okay, now it's time to stand back!

The “Do Not Open” Bottle Trick

1. Start with a new plastic soda bottle (don't use the one from the previous experiment). Clean and dry the bottle and remove the label.
2. Use the permanent marker to write” DO NOT OPEN!” in fat letters on the bottom half of the bottle.
3. Carefully, use a sharp push pin (thumbtack) to poke tiny holes through the bottle along the lines of all the letters (the letters will help hide the holes).
4. Place the bottle in a deep sink or pan and fill it with water. This is the tricky part. Water will leak out of the holes as you're filling the bottle. Keep the water running as you screw on the cap. Don't squeeze the bottle or it will start leaking before you're ready.
5. Carefully set the bottle on the kitchen counter (word-side out) where someone can see it as they pass by. Stay close enough to watch what happens. Eventually, someone is bound to ask about the bottle. Play dumb with, “I dunno,” when they ask about it. Let them unscrew the cap and you'll witness science in action!

How Does It Work?

Let's start by examining an empty soda bottle. Is the bottle really empty? No. The bottle is filled with air (gotcha!). When you pour water into the bottle, the molecules of air that once occupied the bottle come rushing
out of the top. You don't notice this because molecules of air are invisible. When you turn a bottle filled with water upside down, the water pours out (thanks to gravity) and air rushes into the bottle. Think of it as an even exchange of water for air.

You might think that poking a tiny hole in the bottom of a bottle would cause it to leak, and it does if air molecules can sneak into the bottle. When the lid is on the soda bottle, air pressure can't get into the bottle to push on the surface of the water. The tiny holes in the bottom or sides of the bottle are not big enough for the air to sneak in. Believe it or not, the water molecules work together to form a kind of skin to seal the holes—it's called surface tension. When the lid is uncapped, air sneaks in through the top of the bottle and pushes down on the water (along with the force of gravity) and the water squirts through the holes in the bottle.

It's kind of a tag team combo between gravity and air pressure. Gravity is pushing downward on the water whether the lid is on the bottle or not. Air pressure can't do anything until it somehow gets into the bottle. When the lid is on, air pressure can't get into the bottle to push on the surface of the water. It does, however, push against the outside of the bottle on all sides. Since the outside atmospheric pressure is greater than the force of gravity, most of the water stays in the bottle. When the lid is uncapped though, the outside atmospheric pressure (14.7 pounds per square inch at sea level) and the force of gravity push down on the water at the same time. The water shoots out and the nosy person gets a scientific (but well-deserved) soaking.
#18 Balloon in a Bottle

How hard would it be to inflate a balloon in a plastic soda bottle?

Some things look so easy until you try them. Case in point… how hard would it be to inflate a balloon in a plastic soda bottle? Hey, no big deal. Just put the balloon down inside the bottle and puff away. That’s until you realize something about the properties of air. Don’t worry… Steve Spangler will show you how to be amazing.

**Materials**

- 1-liter bottle
- Latex balloons
- Rubber stopper or cork
- Water
- Nail
- Hammer
Experiment

1. Slip the balloon inside the neck of the bottle and stretch the mouth of the balloon over the bottle top.
2. Take a deep breath and try to blow up the balloon inside the bottle. Good luck!
3. Remove the balloon, fill the soda bottle to the brim with water, then seal it with a cap.
4. Ask an adult to punch a small hole with a nail and hammer in the side of the bottle, close to the base.
5. Remove the nail, uncap the bottle, and empty the water out the top.
6. Place the balloon in the bottle again (Step 1) and try to blow up the balloon. Quite a difference! Blow hard until the balloon fills most of the bottle (a little water left in the bottle helps). Place a finger (or thumb) over the nail hole when you stop blowing. You are too cool! Now, move your finger.

How Does It Work?

The balloon won’t inflate much the first time because the bottle is already filled with air. There’s no room for the balloon to expand inside the bottle. However, when you punch a hole in the bottle, the air molecules in the bottle have an exit. They’re pushed out as the balloon fills the space inside. As long as you plug the hole, the balloon stays inflated. When you take your thumb off the hole, outside air flows back into the bottle as the balloon collapses. Because of the elasticity of the rubber or latex, the balloon shrinks to its original size as the air rushes out the top of the bottle. By the way, when you filled the bottle with water, you made its walls more rigid and it was easier to push the nail through the flexible plastic. Who’d ever think that flowing, soft water could give that much support?

Try this! Inflate the balloon in the bottle again and cover the nail hole with your thumb. Pour water into the balloon while keeping your thumb over the hole. Go outside or hold the bottle over a sink before you remove your thumb. Watch out for that stream of water gushing out of the bottle top! You might decide to hand a full water-balloon-bottle to a friend and just “forget” to tell them about the hole.

Suppose your thumb gets tired while the balloon is inflated. Put a cap tightly on the bottle and remove your thumb. For the air to flow, both holes have to be open. How would more holes or even one large hole change the speed of inflating and deflating the balloon? What would more or bigger holes do to the stream flowing from the water-balloon-bottle? Try it out! Balloons and bottles make a great science combo!
#19 Stuck Like Glue – Air Pressure Trick

Simple and fun demonstration where a jar is able to lift a plate by creating a slight vacuum.

A flame goes out inside of an upside down jar and, like magic, the jar is stuck to a plate. You might think that the jar has sucked right to the plate, but we’ll explain why this trick is actually a result of pushing! The Stuck Like Glue experiment is an incredible demonstration of the power of air pressure and a great way to help explain the way that forces work.

Materials

- Small plate
- Widemouth jar
- Paper towel
- Water
- Small pieces of paper
- Lighter or matches
Experiment

1. Fold a paper towel into a square or rectangle that is slightly wider than the mouth of a widemouth jar.
2. Wet the folded paper towel and lay it flat in the center of the plate.
3. Tear off a small piece of normal paper, roughly the size of a sticky note.
4. Use a lighter or match to light the small piece of paper on fire and drop it in the widemouth jar.
5. Immediately flip the jar over and onto the wet paper towel. Firmly press the jar onto the paper towel and plate, letting the lit piece of paper go out.
6. When the piece of paper inside the jar is completely extinguished, lift the jar. Wow… the plate comes with it!

Take It Further!

Try changing factors within the demonstration to turn it into an experiment!

- Change the size of the burning piece of paper.
- Try different types and sizes of glass or jar.
- Attempt the trick with different brands of paper towel.

Those are just a few ideas to try out, but we bet you can think of even more variables to test.

How Does It Work?

Usually if you want to replicate air movement like in this experiment, you need a Hoover or Dyson. Well, that's kind of what's happening… you're creating a vacuum! When the piece of paper inside of the overturned jar is lit, the air inside the jar is heated, causing it to expand. When the flaming paper is extinguished, the air inside the jar cools and contracts, leaving a void of air within the jar. This is an example of an imperfect vacuum.

When you think of a vacuum, you think of suction, but scientists like to avoid the term “suck,” and instead rely on the pushing forces from outside. With the vacuum inside the jar, air from outside really wants to get inside. Were it not for the wet paper towel, the outside air would succeed and the vacuum would be no more. However, the water in the paper towel effectively stops the air from rushing back into the jar.

Water (as well as other substances) has two properties called adhesion and cohesion. Adhesion is water's ability to stick to other materials, and cohesion is, you guessed it, water's ability to stick to itself. When the
flaming paper is extinguished and you add pressure onto the jar, the adhesion and cohesion of the water create an air-tight seal between the plate, paper towel, jar, and water. This air-tight seal means that air is constantly trying to push its way up and into the jar without success. The air pushing at the seal creates the phenomenon of the plate sticking to the mouth of the jar.
#20 Balloon Expansion – Sick Science!

Witness air growing when it is heated

Is there a way to see air changing? Sure, there are clouds and fog, but those are particles of water. Does anything happen to air when it gets cooled or heated? We've come up with a great way to see how air changes when it gets hotter and colder… and you can do it all with just a few things you probably already have in your house!

**Materials**

- Glass bottle
- Balloon
- Hot plate
- Ice
- A bucket
Experiment

1. Stretch the opening of the balloon around the open end of the bottle.
2. Set the bottle on the hot plate.
3. Give the bottle and balloon apparatus a few moments to get warm. This may take a while, but you won't want to take your eyes off of the balloon.
4. Once the bottle is warm, what happens to the balloon? Wow! It's filling with air. But how?
5. Now carefully place the bottle into the bucket filled with ice. What happens now?

How Does It Work?

So what made the balloon begin to fill with air? We could be wrong here, but we're pretty sure that there isn't a tiny person in there blowing as hard as he can. Instead, you are seeing the expansion of air. Unlike water, which expands when it is cooled, air expands when it is heated. Since the bottle was full of air when you stretched the balloon over it, it only had one place to go when it began expanding… into the balloon! Note: Charles’ Gas Law.
#21 Egg in a Bottle

Use air pressure to squeeze a hardboiled egg through the mouth of a bottle.

With just a few household items, we can show you how a hard-boiled egg can squeeze right through the mouth of a bottle. The Egg in a Bottle Trick is a science classic, dating back at least a hundred years. It's a brilliant method of teaching just how powerful air pressure can be and the trick is also a great way of messing with your friends. We won't stop there, we'll also show you how to perform a gravity defying version of the trick… it's an “eggsclusive” upside-down twist!

Materials

- Hardboiled eggs (peeled)
- Large-mouthed bottle
- Matches or lighter
- Strips of paper
- Small birthday candles
- Scissors
- Adult supervision
Experiment

The Standard “Right-Side-Up” Version

1. Using a pair of scissors, cut a strip of paper about 8” x 1.”
2. Carefully use a match or lighter to light the strip of paper at one end and drop it into the large-mouthed bottle.
3. While the strip of paper is still burning in the bottle, set an egg on the mouth of the bottle.
4. Watch carefully! With the egg sitting atop the bottle, the burning strip of paper extinguishes itself.
5. Keep watching! The hardboiled egg slowly, then quickly, squeezes through the top of the bottle and drops to the bottom. Whoa!

Get the Egg Out of the Bottle!

1. Want to do the experiment again? You'll need to get that egg out of the bottle. Be extra careful doing this!
2. Put your mouth on the mouth of the bottle and forcefully blow air into the bottle.
3. The egg will pop out of the bottle just like it popped into it!

The “Eggsclusive” Upside-Down Twist

1. Carefully push two or three small birthday candles into the narrower end of a hardboiled egg. Make sure the candles can fit easily inside the large-mouthed bottle.
2. Light the candles and sing a quick happy birthday song to the egg.
3. Turn the large-mouthed bottle upside-down and slowly put the candles inside the mouth of the bottle.
4. Allow the flames to heat up the air inside the bottle for just a few seconds and then place the mouth of the bottle against the egg. The candles will go out and with a “pop!” the egg will squeeze up into the bottle.

What’s Shaped Like an Egg? A Water Balloon!

1. Carefully fill the balloon with water so the balloon is about the size of a tennis ball. Tie it off. Make a few balloons just in case the first one breaks!
2. Before going any further, make sure that the water balloon is slightly larger than the mouth of the bottle.
3. Smear some water around the mouth of the bottle.
4. Set a strip of paper on fire. Quickly put the burning strip into the bottle. Be careful you don’t accidentally burn your fingers.

5. Immediately cover the mouth of the bottle with the balloon. In just seconds, the balloon will start to wiggle around on the top of the bottle, the fire will go out, and some invisible force will literally “push” the balloon into the bottle. That’s amazing!

6. Now that you’ve mastered the trick, it’s on to the next challenge. Can you get the balloon back out of the bottle? Use what you learned about air and air pressure to come up with a way to get the balloon back out. Here’s a hint… Try sneaking a straw alongside the balloon when you pull it out. If the outside air can get inside the bottle, the water balloon will come out!

How Does It Work?

In the traditional version of the Egg in the Bottle experiment, the burning piece of paper heats the molecules of air in the bottle and causes the molecules to move far away from each other. Some of the heated molecules actually escape out past the egg that is resting on the mouth of the bottle (that’s why the egg wiggles on top of the bottle). When the flame goes out, the molecules of air in the bottle cool down and move closer together. This is what scientists refer to as a partial vacuum. Normally the air outside the bottle would come rushing in to fill the bottle. However, that darn egg is in the way! The “push” or pressure of the air molecules outside the bottle is so great that it literally pushes the egg into the bottle.

In the Upside-Down Twist, the science is the same as the traditional Egg in the Bottle trick, but the whole thing is just inverted. It’s a nice twist on a classic science demonstration… and it looks like the egg is defying gravity! Now that will mess with your friends.
#22 Fruit-Power Battery

Convert chemical energy from the acid in a lemon into electrical energy

Voltaic batteries of all shapes and sizes are objects that convert chemical energy into electrical energy. You probably use batteries to power your cell phone, iPod, or any number of wireless gadgets. But did you know that you can actually use chemical energy stored within a lemon to power a small LED light? It's true, and we'll show you exactly how in the Fruit-Power Battery experiment.

Materials

- Four lemons (the bigger and juicier the better)
- Four pennies
- Five zinc-galvanized nails
- Five sets of alligator clips
- LED light
- Kitchen knife
Experiment

1. Use a kitchen knife to cut a penny-sized slit in all four lemons.
2. Insert a penny halfway into each of the four slits that you cut.
3. Push a zinc-galvanized nail into each of the lemons, opposite the penny. Be sure you don’t let the nail and penny touch each other.
4. Connect all four lemons together with alligator clips. Each set of alligator clips should connect a nail with a penny.
5. Attach the two loose alligator clips to the LED light.
6. Check that out! The energy from the lemons lights up the LED.

How Does It Work?

Batteries are comprised of two different metals suspended in an acidic solution. With the Fruit-Power Battery, the two metals are zinc and copper. The zinc is in the galvanization of the nail, and the penny is actually copper-plated zinc. The acid comes from the citric acid inside the lemon.

The two metal components are electrodes, the parts of a battery where electrical current enters and leaves the battery. With a zinc and copper set-up, the current will flow out of the penny and into the nail. The electricity also passes through the acidic solution inside the lemon.

Once the Fruit-Power Battery is connected to the LED, you create a complete circuit. As the electrical current passes through the LED, it lights the LED, and passes back through all of the lemons.
#23 Air Pressure Can Crusher

There are lots of different ways to crush a soda can...

There are lots of different ways to crush a soda can… with your foot, in your hands, on your head. But nothing compares to the fun you’ll have doing the soda can implosion experiment. Just wait until the can goes “POP” and then you’ll see who has nerves of steel.

Materials

- Empty soda cans (search the recycling bin or start drinking!)
- Stove or hot plate
- Cooking tongs
- Gloves
- Bowl
- Cold water
Experiment

1. Start by rinsing out the soda cans to remove any leftover soda goo.
2. Fill the bowl with cold water (the colder the better).
3. Add one generous tablespoon of water to the empty soda can (just enough to cover the bottom of the can).
4. Place the can on the burner of the stove while it is in the “OFF” position. It’s time for that adult to turn on the burner to heat the water. Soon you’ll hear the bubbling sound of the water boiling and you’ll see the water vapor rising from the can. Continue heating the can for one more minute.
5. It’s important to think through this next part before you do it. Here’s what's going to happen: you’re going to use the tongs to lift the can off of the burner, turn it upside down, and plunge the mouth of the can down into the bowl of water.
6. Get a good grip on the can near its bottom with the tongs held so that your hand is in the palm up position. Using one swift motion, lift the can off the burner, turn it upside down, and plunge it into the cold water. Don’t hesitate… just do it!
7. Wow… and you thought that you had nerves of steel. The can literally imploded. How does that work?
8. Don’t just sit there… get back to that stove and do it again! Each time you repeat the experiment, carefully observe what is happening in order to try to figure out how it works.

How Does It Work?

Here’s the real scoop on the science of the imploding can. Before heating, the can was filled with water and air. By boiling the water, the water changed states from a liquid to a gas. This gas is called water vapor. The water vapor pushed the air that was originally inside the can out into the atmosphere. When the can was turned upside down and placed in the water, the water vapor condensed and turned back into the water. Water molecules in the liquid state are many times closer together than molecules in the gas state. All of the water vapor that filled up the inside of the can turned into only a drop or two of liquid, which took up much less space.

This small amount of water cannot exert much pressure on the inside walls of the can, so the pressure of the air pushing from the outside of the can is great enough to crush it. The sudden collapsing of an object toward its center is called an implosion. Nature wants things to be in a state of equilibrium or balance. To make the
internal pressure of the can balance with the external pressure on the can, the can implodes. Hey, air pressure is powerful!

One more thing… if you watch very closely when you turn the can upside down, you’ll see that the cold water in the bowl shoots up into the can. This is similar to what happens when you drink from a straw. Though we say we are “sucking” liquid up through the straw, we really aren't. Outside air pressure is pushing down on the surface of the liquid. When you reduce the pressure in your mouth (that sucking action) the outside pressure is greater than the pressure inside your mouth and the soda shoots through the straw and into our mouths. The same thing is true with the can. The force applied downward into the cold water pushes the water up into the can. To put it simply, science doesn't suck… it just pushes and pulls.

**Additional Info**

Explore the many mysteries of air with more hands-on science that makes learning fun.
Believe it or not, you can make paper so strong that it cannot be ripped!

Tissue paper is known for a few things. For example, tissue paper is soft and nice for blowing your nose. Tissue paper is not, however, known for its tensile strength. Most people wouldn't be surprised if a common housefly could tear through a piece. In the Magic Tube – Strong Tissue Paper experiment, though, we'll show you a way to make tissue paper nearly impenetrable.

**Materials**

- Tissue paper
- Toilet paper roll
- Wooden dowel
- Rubber band
- Salt
Experiment

1. Place the tissue paper over one end of the paper towel roll. Secure the paper in place with a rubber band.
2. Try puncturing the tissue paper using a wooden dowel. See how easily the dowel pushed through the tissue paper?
3. Place a new piece of tissue paper over the end of the toilet paper roll and, once again, secure it with a rubber band.
4. Set the toilet paper roll on a flat surface so that the tissue paper is flat against the surface.
5. Pour salt into the toilet paper roll until the roll is 3/4-full with salt.
6. Lightly tap the toilet paper roll on a hard surface to help pack the salt.
7. Again, try to push the dowel through the tissue paper on the end. Wow… it's next to impossible!

How Does It Work?

It may seem obvious that a wooden dowel can easily push through a piece of tissue paper, but what changes when you add salt to the tube? The amount of force you push into the tube remains the same. In fact, you might add even more force into the tube once the salt is added… but the tissue paper just won't budge.

The key to the tissue paper's newfound strength is the addition of salt. The hundreds of thousands of salt grains offer much more surface area to dissipate the force you thrust into the tube. As the force spreads from grain to grain of salt (and against the outside of the tube), the force is also spread across the entire area of the tissue paper. The increased surface area makes the tissue paper appear much stronger than before!

Take It Further!

Don't stop your testing with salt in the tube… keep experimenting!

- Try different materials in the toilet paper roll! Gravel, sugar, beads… which works best?
- Does the length of the tube make a difference? Try a paper towel roll and see!
- Test different brands of tissue paper to find the strongest of them all!
#25 Falling Ring Catch – Sick Science!

Engage your friends with this puzzling trick

Is it possible to catch a falling ring with a loop of string? Sure it is! It's going to take a bit of experimentation and trial and error, but you'll get the hang of it in no time! You'll see how motion and force can sometimes create unexpected results.

**Materials**

- Thin string or yarn
- Roll of masking tape
- Metal washer

**Experiment**

1. Cut approximately 1 meter of string (or yarn).
2. Run the string through the hole in the middle of the washer and then loop it through the washer two or three more times.
3. Fashion the ends of the string into a knot, forming the string into a loop with the washer at the bottom.
4. Use your non-dominant hand to hold the string with the washer at the bottom of the loop. Spread your fingers so that the top of the loop has a slightly larger width than the roll of masking tape.
5. Use your dominant hand to hold the roll of masking tape parallel to the floor. Lift up the string and guide your washer/string loop down through the middle of the roll of masking tape.
6. Keeping the tape parallel to the floor, bring it all the way up to the top of the string loop.
7. Let go of the ring. Does it fall to the floor?
8. If it fell to the floor, repeat the steps and try it again. But this time, as you let go, flick one side of the tape downward. Bet it doesn't fall to the floor this time!

How Does It Work?

The combination of gravitational force and friction caused by the tape roll falling toward the ground is to blame for the washer/string loop tying itself to the tape roll. Giving the tape roll just the right flick at the top of its fall will cause the washer to loop around both the roll of tape and the string loop, forming a lark's head knot.

Additional Info

You may be thinking, “How will I apply this experiment?” This activity is a great tool for teaching observation, trial and error, and experimentation. Encourage kids to keep trying to get the tape roll caught by the string and washer loop.
#26 Magic Rollback Can – Sick Science!

Potential and kinetic energy at work in this magical demonstration

In our long line of “magical” science, we introduce the Magic Rollback Can. The Magic Rollback Can appears to be a normal can of coffee or oats, but after you roll it along the ground a little ways and watch it come back, you’ll be wondering just how it works.

Materials

- Coffee or oats can
- Nail or other hard pointed object
- 9-volt battery or object with similar weight
- Rubber band
- 2 paperclips
- Tape

Experiment

1. Using the nail, make a hole in the middle of the bottom of your coffee or oats can. Be extra careful when using sharp objects. Also, if you are using a coffee can, be careful around the sharp metal edges that you may create when making the hole.
2. Poke the same kind of hole in the lid of the can.
3. Tape the 9-volt battery to the middle of the rubber band. Make sure both sides of the rubber band are taped to the bottom of the battery.
4. Push one end of your rubber band loop through the hole in the bottom of the can and secure it there by attaching one of the paperclips. Once you have it secured, tape the paperclip down.
5. Stretch the rubber band across the length of the can and push the other end of the rubber band loop through the hole in the lid.
6. Secure the rubber band with a paperclip and tape it down.
7. Put the lid on the can. Does the battery rub against the side of the can? If not, you’re good to go. If it does, try a shorter rubber band.
8. Getting the set-up just right may take a bit of experimentation, but you’ll get it!
9. Set the can on its side on a hard surface or short carpet floor and give it a roll. Once the can comes to a stop, try to contain your excitement as it begins to roll back to you!

**How Does It Work?**

The Magic Rollback Can is a great example of transfer of energy. When you roll the can, it has kinetic energy. As it slows down, the energy is transferred into potential energy within the twisted rubber band inside the can. The twisted rubber band's potential energy is then transferred back to the can in kinetic energy as it untwists. The secret to all this energy transfer comes from the weight that you've taped to the rubber band inside the can. While the weight is being pulled down by gravity, it is also being subjected to a twisting force from the rubber band. So long as the force being exerted by gravity on the weight is greater than the twisting rubber band's force on the weight (meaning the weight never goes over the rubber band), the rubber band will continue to twist.

Once all of the kinetic energy from the rolling can has been exhausted by converting to heat (friction) or potential energy (twisted rubber band), the can stops rolling and the weighted rubber band is able to unwind. Because of the weight in the middle of the rubber band, only the ends of the loop are able to unwind and, therefore, the can begins to roll backwards.

**Additional Info**

If you are looking to take the Magic Rollback Can to the next level, try painting it a solid color. If you do this, observers won't be able to see the apparatus on the ends of the can. This makes the Magic Rollback Can a perfect “Black Box” tool for teachers. Show your students what the Magic Rollback Can does, and have them observe and hypothesize how the can might work.
#27 Walking on Eggs

Can you walk across eggs without cracking them?

The phrase “walking on eggshells” is an idiom that is often used to describe a situation in which people must tread lightly around a sensitive topic for fear of offending someone or creating a volatile situation. Literally walking on eggshells would require exceptional caution, incredible skill, and a sense of self-control that would be nothing short of amazing. But what if eggs were really much stronger than most of us imagine? What if nature’s design of the incredible edible egg was so perfect that the thin, white outer coating of an egg was strong enough to withstand the weight of your body? Wake the kids! Phone the neighbors! It’s time for the Walking on Eggshells challenge.

Materials

- A few dozen eggs that are in egg cartons (Select large-sized eggs)
- Large plastic trash bag
- Bucket of soap and water (and some disinfectant)
- Barefoot friends
Experiment

1. If you just want to attempt the feat of standing on eggs, you’ll only need two cartons of eggs (two dozen eggs). If, however, you’re feeling up to the Walking on Eggs challenge, pick up six or eight cartons of large-sized eggs.

2. Spread the plastic trash bag (or bags) out on the floor and arrange the egg cartons into two rows.

3. Inspect all of the eggs to make sure there are no breaks or fractures in any of the eggshells. Make any replacements that might be necessary.

4. It’s important to make sure all of the eggs are oriented the same way in the cartons too. One end of the egg is more “pointy” while the other end is more round. Just make sure that all of the eggs are oriented in the same direction. By doing this, your foot will have a more level surface on which to stand.

5. Remove your shoes and socks . . . and pick the lint out from between your toes. (This has no bearing on the success of the challenge, but let’s face it, toe fuzz is kind of gross.)

6. Find a friend to assist you as you step up onto the first carton of eggs. The key is to make your foot as flat as possible in order to distribute your weight evenly across the tops of the eggs. If the ball of your foot is large, you might try positioning it between two rows of eggs instead of resting it on the top of an egg.

7. When your foot is properly positioned, slowly shift all of your weight onto the egg-leg as you position your other foot on top of the second carton of eggs.

8. There will be creaking sounds coming from the egg carton, but don’t get nervous. Ask your friend to step away and allow your fans to click pictures. Just think . . . for all the right reasons, you’ll be an Internet sensation in just minutes.

9. If you have more than two cartons of eggs, what are you waiting for? Keep walking! The cheers and wild screams from your fans grow louder with each step you take until finally you land on firm ground and marvel at your success.

Okay, there’s a second scenario that we should mention: you forget to make your foot as flat as possible, your friend doesn’t provide any support, and your foot crushes through eight of the twelve eggs. As the goo erupts from between your toes, you think to yourself, “Maybe the other carton will be better.” Quickly you discover that both feet are covered in eggy goo and the experiment is a complete failure. Don’t worry, your fans are still taking pictures and you’re still going to be an Internet sensation, but for a completely different reason. Ah, show business!
How Does It Work?

Plain and simple, the shape of the egg is the secret! The egg’s unique shape gives it tremendous strength, despite its seeming fragility. Eggs are similar in shape to a three-dimensional arch, one of the strongest architectural forms. The egg is the strongest at the top and the bottom (or at the highest point of the arch). If you hold an egg in your hand and squeeze it on the top and the bottom, the egg doesn’t break because you are adding pressure to the ends which are the strongest parts of the egg. The curved form of the shell also distributes pressure evenly all over the shell rather than concentrating it at any one point. If you completely surround the egg with your hand and then squeeze, the pressure you apply by squeezing is distributed evenly all over the egg. However, eggs do not stand up well to uneven forces, which is why they crack easily on the side of a bowl (or why it would crack if you just pushed on one side). This also explains how a hen can sit on an egg and not break it, but a tiny little chick can break through the eggshell. The weight of the hen is evenly distributed over the egg, while the pecking of the chick is an uneven force directed at just one spot on the egg. If you guessed that the egg carton probably played a role in keeping the eggs from breaking, you’re right. Joseph Coyle is credited as the inventor of the first container made specifically to keep eggs from breaking as they were transported from the local farm to the store. As the story goes, Coyle invented the egg carton in 1911 as a way to solve a dispute between a farmer and a hotel operator who blamed the farmer for delivering broken eggs. Coyle designed a container made out of thick paper with individual divots that supported each egg from the bottom while keeping the eggs separated from one another. As legend has it, the fully loaded egg carton can even be dropped, and if it lands just right, the eggs will survive the fall.
#28 Newton’s Bottle – Dollar Bill Inertia Trick

You'll experience Sir Isaac Newton's First Law of Motion with a trick that shows inertia and friction.

Table tricks come in all shapes and sizes. Some tricks use toothpicks and water, while others involve whipping a tablecloth off of a plate-filled table. This trick, called Newton's Bottle, is a fantastic demonstration of inertia, the acting force behind Newton's First Law of Motion. You might want to know the secret behind the trick, now, but we think you should probably perform the trick yourself. It's sure to make everyone at the dinner table gasp with delight.

Materials

- Glass soda bottles
- Dollar bill
- Quarters
Experiment

1. Place a dollar bill on the mouth of a glass soda bottle. Mr. Washington's face should be right over the hole.
2. Stack the quarters (six should be enough) directly over the mouth of the bottle, on top of the dollar bill.
3. Stick out your index finger, and swipe down at the dollar bill. Be careful not to hit the quarters or the bottle.
4. If you do it right, your finger should pull the dollar bill out from under the quarters, leaving them stack atop the bottle.
5. Take it further! Instead of quarters, stack a second glass soda bottle (upside down) on top of the dollar bill on the first glass soda bottle.
6. With the bottles balanced, grip one end of the dollar bill so that it is moderately taut. Use the index finger on your other hand to repeat the swiping motion. TADA!

How Does It Work?

The key to the Newton's Bottle trick is inertia. Inertia is described in Sir Isaac Newton's (see where we get the name?) First Law of Motion. Inertia is the tendency for an object at rest to remain at rest until an outside force acts upon it. Inertia is important in the Newton's Bottle trick because, according to the law, the quarters and bottle (the objects) will not move unless an outside force moves them.

Aside from inertia, friction also plays a factor. Thankfully, the surface of the dollar bill is smooth, and doesn't create a lot of friction against the quarters or bottle. Without a lot of friction, the dollar bill doesn't pull the quarters and bottle off of their balanced perch.
#29 Magic Pendulum Catch – Sick Science!

Will your hex nuts crash to the ground? Discover the shocking result yourself!

Have you ever seen a comedy bit from a black and white silent film? One of their favorite gags was someone hoisting a piano to a 3rd or 4th story window when someone cuts the string… CRASH! The piano comes crashing down as ivory keys and wood splinters go everywhere. The Magic Hex Nut Pendulum involves the same sort of thing, only on a much smaller scale. What will happen to your hex nuts? The result may surprise you.

**Materials**

- 15 hex nuts
- Shoe string or string/yarn of similar length
- Safety glasses

**Experiment**

1. To get started, thread your string through 14 of the 15 hex nuts.
2. Take the end of the string you just threaded through the hex nuts and tie it back onto the string right above the stack of hex nuts. Basically, you are making a loop of hex nuts.

3. Thread the string through the middle of the remaining hex nut and tie the string so that you have a string with 14 hex nuts at one end and one hex nut at the other.

4. With the string-hex nut apparatus you have constructed, grab the single hex nut end with one hand and hang the string over your opposite hand's index finger.

5. Pull the single hex nut end of the string so that the 14 hex nuts are touching your index finger. Make sure that the string is parallel or close to parallel with the ground.

6. From this position, let go of the string. Be sure to keep your index finger as still as possible. Oh no! This is going to be really loud! Wait… the hex nuts didn't hit the ground. What happened? You better try it again to make sure that it wasn't a fluke.

How Does It Work?

The apparatus that you've constructed out of some string and hex nuts is a pendulum. A pendulum is a weight suspended from a pivot (or fixed point) so that it can swing freely, back and forth. Common examples of pendulums can be found in time pieces such as grandfather clocks.

Pendulums like the one you constructed operate using acceleration from gravity. When you release the hex nut, gravity accelerates it towards the ground, giving it velocity. In a normal pendulum, the velocity decreases as the pendulum swings. The amplitude (how high the pendulum swings) also decreases the more the pendulum swings. This happens because of friction.

In our pendulum, the distance between the pivot (your finger) and the bob (the single hex nut) is decreased very rapidly when you release the string. As the distance between the bob and pivot decreases, the velocity of the pendulum increases. With the velocity increasing so rapidly, its amplitude is increased to a point that it makes a number of full swings, wrapping the string around your finger. The scientific explanation as to why the Magic Hex Nut Pendulum works is this: as the length of the pendulum decreases, the velocity increases, thus increasing the amplitude.

Additional Info

Want to spend some more time experimenting with Magic Hex Nut Pendulums? Here are a couple of ideas:
• Try dropping the pendulum from different heights. Is there a point, either too high or too low, that the magic of your pendulum no longer works? Is there a height that works better than in our original experiment?
• How many hex nuts can you add to the “bob” side of the pendulum and still have it work? How few can you have on the heavier side?
#30 Huff and Puff Challenge

Puff and puff, but the piece of paper won't go in the bottle. What in the air pressure is happening?

Putting an item into an empty soda bottle is a piece of cake. Just drop the object through the mouth of the bottle, right? Well, we have a challenge for you. Place a small item in the mouth of a bottle and attempt to blow the object into the bottle using a straw. Not so easy, now is it?

Materials

- Small paper ball
- 1-liter bottle
- Drinking straw
- Various small objects

Experiment

1. Create a small paper ball by bunching up a piece of paper. The ball needs to be able to loosely fit inside the mouth of the bottle.
2. Place the paper ball in the mouth of a 1-liter bottle that has been placed on its side.
3. Direct a straw towards the mouth of the bottle and attempt to blow the paper ball into the bottle.
4. The paper ball wiggles and jiggles around before flying out of the bottle!
5. Replace the paper ball in the mouth of the bottle and try again. The ball just will not go into the bottle.
6. Try doing the experiment with other objects! Try:
   - Small marshmallow
   - Miniature bow
   - Wedding mint
   - Piece of popcorn
7. Every item you try comes right back out of the bottle. What's going on here?

**How Does It Work?**

As you might have guessed, the Huff and Puff Challenge has a lot to do with air pressure and air movement. With an item like the paper ball resting in the mouth of the bottle, it would make sense that the air from the straw would blow it into the bottle, but the exact opposite happens.

The secret is inside of the bottle. Although we refer to the bottle as being “empty,” it’s actually full to the brim. That's impossible… we can't see anything! Well, can you see the air that you breathe? The bottle is filled with air! Trying to blow more air into the bottle is impossible, just like if you were to put your lips directly on the mouth of the bottle and blow. It doesn't work!

While you can't blow air into the bottle, you are moving quite a bit of air along the sides of the bottle. When the air blows past the mouth of the bottle, it creates an area of low pressure behind it. This is called Bernoulli's Principle. This area of low pressure is exactly what the paper ball needs to hop out of the bottle's mouth!
#31 Anti-Gravity Water

Amaze your friends by making water defy gravity.

Water in rivers, in a glass, or falling from clouds obeys gravity. It's going to fall towards the ground because of the physical pull of the earth. But, what if we told you that you could turn a glass of water completely upside down and the water wouldn't fall to the floor? That's what happens in the Anti-Gravity Water demonstration. It's a simple experiment that dramatically demonstrates the amazing physical properties of water.

**Materials**

- Tall glass with a round edge
- A handkerchief
- A pitcher of water
- Bowl or sink
Experiment

1. Drape the handkerchief over the glass, making sure that you push the center of the handkerchief down into the glass.
2. Fill the glass 3/4 full with water by pouring water into the middle of the handkerchief.
3. Slowly pull the handkerchief down the sides of the glass making it taut (stretched tightly across the surface of the glass). Grip the ends of the handkerchief at the bottom of the glass.
4. Place one hand over the mouth of the glass and turn it over with the other hand.
5. Pull the lower hand away from the glass (slowly) and the water should stay in the glass! This just goes to prove that the handkerchief has anti-gravity properties. The thunderous applause will drown out the cries of, “How did you do that?”
6. For the big finish, put your hand over the mouth of the glass and turn the glass right-side up. Remove the handkerchief from the glass and pour the water back into the pitcher. Of course, take your well-deserved bow.

How Does It Work?

Most people predict that the water will leak through the holes in the handkerchief because the water leaked through the holes as it was poured into the glass. The holes in the handkerchief literally disappeared when the cloth was stretched tightly across the mouth of the glass. This action allowed the water molecules to bond to other water molecules, creating what is called surface tension. The water stays in the glass even though there are tiny holes in the handkerchief because the molecules of water are joined together to form a thin membrane between each opening in the cloth. Be careful not to tip the glass too much because you'll break the surface tension and surprise everyone with a gush of water!
#32 Floating Water – Mason Jar Mystery

Turn the glass over and nothing spills.

Fill the glass jar with water and cover it with a card. As you turn the whole thing upside down, the audience can hardly contain themselves. The room quiets down as you precariously position the inverted jar and card a few feet above someone’s head. Just as they thought, no water spills out because the card magically sticks to the mouth of the upside down jar. But wait... there’s more.

**Materials**

- Mason jar (pint size) with twist-on lid
- Circular plastic screen insert
- Scissors
- Index cards
- Tub or sink to practice over
Experiment

1. Place the plastic screen material over the opening of the jar and screw on the lid (sealing band). Remove the lid and use scissors to cut around the indentation. What you’re left with is a screen insert that fits perfectly into the top of the sealing band.
2. Place the screen over the opening of the jar and twist on the lid. Make sure that you do not accidentally show your audience the secret screen.
3. When you’re ready to perform the trick, fill the jar with water by simply pouring water through the screen. Cover the opening with the index card. Hold the card in place as you turn the card and the jar upside down. Gently let go of the card. The water doesn’t spill!
4. Carefully remove the card from the opening and the water mysteriously stays in the jar! Replace the card, turn the whole thing over, remove the card and pour out the water. That’s amazing!

How Does It Work?

The water is mysteriously suspended in the jar because of air pressure and surface tension.

**Air Pressure:** The atmosphere exerts about 15 pounds of pressure per square inch of surface at sea level. Because it’s a gas, air not only pushes down, but also upwards and sideways. The card remains in place because the pressure of the air molecules pushing up on the card is greater than the weight of the water pushing down. But how does the water stay in the jar when the card is removed? The answer is *surface tension*.

**Surface Tension:** The surface of a liquid behaves as if it has a thin membrane stretched over it. A force called *cohesion*, which is the attraction of similar molecules to each other, causes this effect. The surface tension “membrane” is always trying to contract, which explains why falling droplets of water are spherical or ball shaped. The water stays in the jar even though the card is removed because the molecules of water are joined together (through cohesion) to form a thin membrane between each opening in the screen. Be careful not to jiggle the jar or touch the screen because you’ll break the surface tension and surprise everyone with a gush of water!
#33 Pop Rocks Expander – Candy Science

Discover the secret behind the famous popping candy by mixing Pop Rocks and soda.

If you are a candy enthusiast, like a lot of the people at Spangler Labs, you know that not all candies are created equal. And, if we're being honest, Pop Rocks are one of the greatest candies of all time! You dump a few of the tiny pebbles onto your tongue and, in an instant, they begin fizzing, popping, and snapping about in your mouth. What's going on here? Being scientists, we devised a way to figure out the popping secret behind the famous candy. Are you ready to expand your mind (as well as a few balloons)?

Materials

- Pop Rocks (try to find multiple flavors)
- Balloons
- Funnel
- 12-16 oz bottles of soda? (the greater soda variety, the better)
Experiment

1. The first item of business is to get an entire package of Pop Rocks into a balloon. You might be able to carefully pour the candies into the balloon's mouth, but we have found that it's much easier if you use a small funnel. Place the narrow end of the funnel into the mouth of the balloon and empty the Pop Rocks packet into the funnel. Make sure all the candies are in the balloon by giving the funnel a few firm taps.

2. Place the balloon over the mouth of a bottle of soda. Careful! You don't want the Pop Rocks to drop into the soda before you're ready. Stretch the mouth of the balloon over the mouth of the bottle, but make sure the valuable candy content of the balloon doesn't dump into the soda.

3. Are you ready? Grab the balloon and dump the Pop Rocks into the soda. Make sure to observe what's happening inside the soda as the liquid reacts with the candies. The balloon should be inflating, even if the change is only very slight.

How Does It Work?

The secret behind the famous “popping” of Pop Rocks candy is pressurized carbon dioxide gas. Each of the tiny little candy pebbles contains a small amount of the gas. These tiny carbon dioxide bubbles make the popping sound you hear when they burst free from their candy shells. Need more proof? Try finding a relatively large Pop Rock and using a spoon to break it against a hard surface. Once you achieve enough pressure, you should hear a similar “pop” to the sound you hear with a Pop Rock on your tongue.

So what causes the balloon to inflate? The carbon dioxide contained in the candy isn't enough to cause even the small amount of inflation you observe in the experiment. That's where the soda comes into play. The soda also contains pressurized carbon dioxide gas (it's why we call soda a carbonated beverage). When the Pop Rocks are dropped into the soda, some carbon dioxide is able to escape from the high fructose corn syrup of the soda and, because the carbon dioxide gas has no where to go in the bottle, it rises into the balloon.

Science Fair Connection:

Want to make the Pop Rocks Expander into a science fair project? That's a fantastic idea! There are a number of different variables that you can choose to get that blue ribbon. Remember though, whatever variable you choose, you need to keep everything else the same.
• Test whether the temperature of soda makes a difference in the amount of carbon dioxide released.
• Try testing different types (or brands) of soda to see which releases the most carbon dioxide gas.
• Test different Pop Rocks flavors to see if the flavor changes the amount of carbon dioxide in the balloon.

Those are just a few of the possible variables that you could use, but you're super creative…try coming up with your own!

**Additional Info**

**How are Pop Rocks Made?**

According to information from the manufacturer, Pop Rocks start like any other hard candy by combining sugar, lactose (milk sugar), corn syrup, and flavoring. These ingredients are heated to the boiling point and the hot sugar mixture is mixed with carbon dioxide gas under high pressure (about 600 pounds per square inch). The process causes tiny high pressure bubbles of carbon dioxide gas to form in the candy.

When the hot candy mixture cools and the pressure of the gas is released, the hard candy shatters into tiny pieces of carbonated candy. If you look carefully at the candy under a magnifying glass, you'll see the tiny bubbles – each containing a small amount of carbon dioxide gas under high pressure (600 PSI). When the candy melts in your mouth, the 600 PSI bubbles of gas are released with a loud popping sound. Very cool!
#34 Diving Ketchup

Cause a packet of ketchup to rise and fall on command.

Cause a packet of ketchup to rise and fall on command in a bottle of water. People will think that you have the ability to move objects with your mind! Telekinesis? No, just cool science!

Materials

- Clear plastic soda bottle with cap (1-liter size works great)
- Ketchup packets
- Bowl
- Water

Experiment

1. First, you'll need to perform a “float or sink” test to see how the ketchup packet works. Fill a bowl with water and drop the packet into it. If it floats, great! If it sinks to the bottom, no sweat. This shows that atmospheric pressure in the packet is pressing hard enough on the air bubble inside the packet to
sink it. If this happens, you get to make more trips to your favorite fast-food restaurant to find a ketchup packet that just barely floats!

2. Scrunch the packet in half lengthwise and carefully push it into the soda bottle. Do not open the packet. Just carefully push it into the bottle without tearing the edges.

3. Fill the bottle full to the brim with water and screw on the cap.

4. Squeeze the sides of the bottle and hold the squeeze to make the packet sink. Let go and the packet rises. The packet of ketchup has learned to dive!

How Does It Work?

The packet floats because an air bubble gets trapped inside the packet when it's sealed at the factory. If the packet sinks when you test-float it, then the air bubble is too small to make it float.

As you squeeze the bottle and push the water against the floating packet, you compress the air bubble into a smaller space. This happens because gases are more “squishable” than liquids, so the air compresses before the water. According to the density equation (Density = Mass divided by Volume), when you decrease the volume or make the bubble of air smaller, you increase the density and the ketchup packet sinks. When you release the pressure on the bottle, the compressed air expands inside the packet (increasing the volume), the density decreases, and the diving ketchup floats to the top of the bottle.

Additional Info

Here's how to turn this demonstration into a real science experiment. Ask yourself these questions and remember the 3 C’s… change, create and compare. Does the size of the bottle affect how much you have to squeeze to get the packet to sink? Do different food packs (ketchup, mustard, soy sauce) have the same density? Does the temperature of the water affect the density of the ketchup packet?

Learn how to make a classic Eye-Dropper Cartesian Diver.
#35 Disappearing Money – Sick Science!

Make a coin vanish before your audience's eyes

Magicians have made money appear from behind ears and out of nostrils for years. And you've seen Steve set a $100 bill on fire without harming Mr. Franklin. That's all well and good, but we want to take your money… er… teach you a trick that uses science to make money “appear” as if it has disappeared.

And if you want more leprechaun trickery and fun, check out our St. Patrick's Day Science Experiment Guide.

Materials

- Clear drinking glass
- Saucer
- Water
- Penny
Experiment

1. Set a penny on a flat surface like a table or counter.
2. Place the base of a clear drinking glass over the penny.
3. Cover the mouth of the glass with a small saucer. Looking in through the side of the glass, you can still see the penny.
4. Now, tilt the saucer back and fill the glass with water.
5. Once you've filled the glass, replace the saucer. Can you still see the penny through the side of the glass? It's disappeared!
6. Take the saucer off of the mouth of the glass. Peer straight to the bottom of the glass through the water. There's that tricky penny!

How Does It Work?

The trick behind the Disappearing Money experiment is the refraction of light. Images that we see are all light rays that reach our eyes. When these light rays travel through air, they experience little or no refraction. That's why you can still see the penny through the side of the empty glass.

When you poured water into the glass, it was as though the penny had disappeared, but it was really just some bending light rays. After traveling through the water and the side of the glass, none of the rays were able to reach your eyes. Refraction occurs because of the molecules in the substance that the light rays are passing through. Gas molecules are spread out. This is why little to no refraction occurs. However, when light rays pass through a substance such as water, the refraction is greater because the molecules are closer together.

So when the light rays are traveling from the money through the water, they are refracted and cannot make it to your eyes. In fact, the glass also refracts the light even more! The image ends up being projected near the top of the glass after the light refraction it has undergone. You would be able to see it… if the saucer were not strategically placed atop the glass.
#36  The Invisible Shield

Air becomes a powerful barrier.

Materials

- A glass
- A piece of paper
- A basin or large bowl
- water

Experiment

1. Crumble a piece of paper into a ball and push it in the bottom of a glass
2. Invert the glass and push down into a basin filled with water
3. Hold the glass underwater for a few seconds before slowly pulling the glass back up out of the water
4. Check to find out if the paper is wet or dry

How Does It Work?

The paper remains dry even after being submerged into the water because of the air trapped within the cup. Air is matter and occupies space. The space occupied by the air cannot be occupied by the water, thus the paper stays dry.
#37 The Candle Extinguisher
A burning candle magically extinguishes itself.

Materials

- A candle
- A book of matches
- A flat bowl
- 1 tbsp of baking soda
- Vinegar

Experiment

1. Place the candle in the bowl
2. Light the candle
3. Distribute the baking soda evenly around the candle
4. Pour the vinegar into the bowl up to about an inch

How Does It Work?

The combination of baking soda and vinegar react in a chemical reaction to form new substances including a gas (carbon dioxide). The carbon dioxide produced from the reaction surrounds the flame, pushing air containing oxygen away from the candle flame. The flame extinguished when it is surrounded by carbon dioxide which it cannot use to support combustion.
#38 The Candle Race
A candle covered by different size glasses extinguishes at different rates.

Materials

- 3 candles
- Book of matches
- One small jar
- One large jar
- Three saucers or lids

Experiment

1. Stand each candle on a lid so that it is steady
2. Light each candle
3. Simultaneously cover once candle with the small jar and one with the large jar
4. Leave the third candle uncovered

How Does It Work?

A candle flame uses oxygen as it burns. The flame will be extinguished when all of the oxygen is used up. The burning of materials such as wood, coal or oil are all examples of combustion that require oxygen.
#39 Balloon Inflates by Magic

A balloon seems to inflate on its own

Materials

- A small bottle
- A funnel
- A balloon
- 2 tbsp of baking soda
- ½ cup of vinegar

Experiment

1. Pour vinegar into a small bottle
2. Add the baking soda to the balloon using the funnel
3. Place the balloon over the mouth of the bottle and make sure it is secure
4. Tilt the balloon up so the baking soda falls into the bottle

How Does It Work?

A chemical reaction between the baking soda and vinegar produce new products. A gas (carbon dioxide) is produced in this reaction, causing the bubbling and inflating of the balloon. The carbon dioxide inflates the balloon.
#40 The Magic Paper Clip
A paper clip is suspended in air.

Materials

- A strong magnet
- A flat table
- Paper clips
- String
- Table

Experiment

1. Hide the magnet underneath the fingers of your right hand by curling your fingertip over it. Magicians call this a finger palm.
2. Reach over and pick up the two paper clips, one in each hand. Show them to the audience, showing the back of your hand so that the magnet is not exposed. The paper clip in the right hand should be touching the magnet.
3. Hold the right hand with the fingers pointed down and the paper clip pointing out under it. Take your other paper clip and place it at the end, so that the tips of the paper clips are touching. Dramatically remove your left hand so that they remain stuck together!

How Does It Work?

Magnetism is a force produced by the motion of charge particles within a substance. Objects can be attracted to the magnet without actually contacting if they are close enough to the magnet to be in its magnetic field.

Do more tricks with magnets!
<table>
<thead>
<tr>
<th>Criteria</th>
<th>Limited (1 pt)</th>
<th>Proficient (2 pt)</th>
<th>Exceptional (3 pt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Careful planning for demo</td>
<td></td>
<td></td>
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<tr>
<td>a) Completeness of written lesson plan</td>
<td></td>
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<tr>
<td>b) Includes a sequence of anticipated questions to spark class discussion</td>
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<tr>
<td>2. Skill in using materials to demonstrate discrepant event</td>
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<tr>
<td>a) Materials are well organized for the demonstration</td>
<td></td>
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<tr>
<td>b) Materials are appropriate for all students to view demonstration</td>
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<tr>
<td>c) Discrepant event is performed in a way that surprises students</td>
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<tr>
<td>3. Selection of questions to focus students on why the phenomenon occurred</td>
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<tr>
<td>a) Question types include higher levels of thinking</td>
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<tr>
<td>b) Questions are successful in generating a discussion about scientific phenomenon</td>
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<tr>
<td>4. Success in arousing students’ curiosity demonstrated by generating student participation</td>
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<tr>
<td>a) Demonstration is performed in a way to keep students’ attention</td>
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<tr>
<td>b) Students are attentive and on task</td>
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<tr>
<td>c) Students are eager to find out why the discrepant event occurred</td>
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</tr>
<tr>
<td>Criteria</td>
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<tr>
<td>5. Reaction and sensitivity to students’ responses</td>
<td>a) Student responses are used to modify subsequent questioning and explanations</td>
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<td></td>
<td>b) Wait time is appropriate</td>
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<td></td>
<td>c) Non-critical reaction to student responses</td>
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<tr>
<td>6. Success in guiding students to a more scientific understanding of the concept demonstrated</td>
<td>a) Students have a deeper understanding of the concept at the end of the demonstration</td>
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<td></td>
<td>b) Teacher ends the discussion in a satisfying way that reinforces the point or concept of the lesson</td>
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<td>7. Self-evaluation</td>
<td>After the lesson, write about how you think the lesson went and any improvements, etc</td>
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</table>

Additional comments:                                                                                   TOTAL SCORE ______(out of 50)