Ultimate Science

Activity Series Guidebook

Part 1

by Aurora Lipper

Supercharged Science

www.SuperchargedScience.com

Includes detailed project steps, explanations and key concepts, tips & tricks, and access to instructional videos.

Thank You for using the *Ultimate Science Activity Series.* I hope you will find it to be both helpful and insightful in sparking young minds in the field of science!

INTRODUCTION

Do you remember your first experience with *real* science? The thrill when something you built yourself actually *worked*? Can you recall a teacher that made a difference for you that changed your life?

First, let me thank you for caring enough about your students to pick up this guide and work through it. As you know, this is a huge commitment to grow as a teacher. While, you may not always get the credit you deserve, never doubt that it really does make a difference.

This book has free videos that go with it to show you step-by-step how to do each experiment. You can view the videos at: SuperchargedScience.com/usas1.htm

Access code: DV2 Go to this page now so you can get a preview of the videos.

Think of this activity book as the "Idea Book", meaning that when you see an experiment you really like, just take it and run (along with all its variations).

A Word About Safety… make sure you work with someone experienced when you're working with new stuff you're unsure about. Just use common sense—If it seems like it could be dangerous, ask for help.

Are you ready? Then let's begin…

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"The future belongs to those that believe in the beauty of their dreams."

~Eleanor Roosevelt

Making Plasma

Activity

We're going to create the fourth state of matter in your microwave using food. *Note - this is NOT the kind of plasma doctors talk about that's associated with blood.*

Plasma is what happens when you add enough energy (often in the form of raising the temperature) to a gas so that the electrons break free and start zinging around on their own.

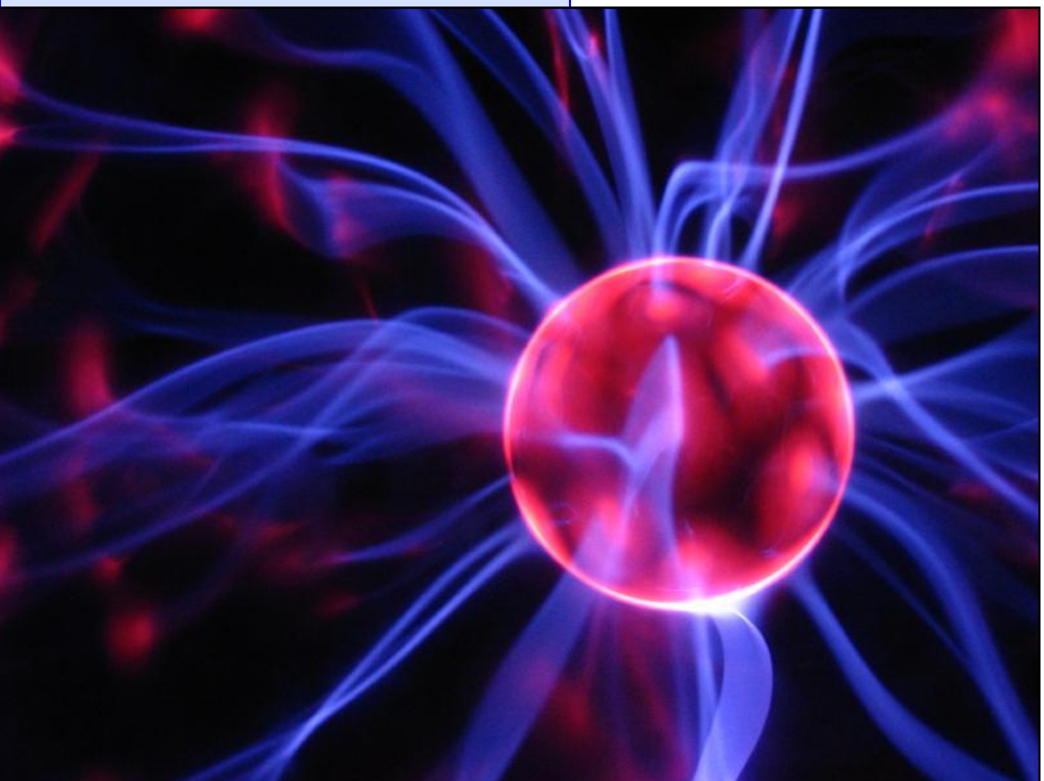
Since electrons have a negative charge, having a bunch of free-riding electrons causes the gas to become electrically charged.

This gives some cool properties to the gas, like the ability to conduct electricity and also to glow (give off light).

Anytime you have charged particles (like naked electrons) off on their own, they are referred to by scientists as *ions*.

Materials

Microwave
A grape
Knife, with adult help
A Plate



Experiment

To start with, watch the video for this experiment at:

SuperchargedScience.com/usas1.htm

Access code: DV2

Be careful with this!! This experiment uses a knife AND a microwave, so you're playing with things that slice *and* gets things hot. If you're not careful you could cut yourself or burn yourself. Please use care!

1. Carefully cut the grape almost in half. You want to leave a bit of skin connecting the two halves.

2. Open the grape like a book. In other words, so that the two halves are next to one another still attached by the skin.

3. Put the grape into the microwave with the outside part of the grape facing down and the inside part facing up.

4. Close the door and set the microwave for ten seconds. You may want to dim the lights in the room.

You should see a bluish or yellowish light coming from the middle section of the grape. This is plasma! Be careful not to overcook the grape. It will smoke and stink if you let it overcook. Also, make sure the grape has time to cool before taking it out of the microwave.

Other places you can find plasma include neon signs, fluorescent lights, plasma globes, and small traces of it are found in a flame.

What's Going On?

The microwave cooks your dinner by shooting light beams at the food. These light beams are specially tuned to increase the energy of the water molecules inside your food.

Grapes are made mostly with juice that conducts electricity (think of how salt water conducts electricity). The grape halves are like little cups full of this conductive juice connected by a tiny bridge (the part that you didn't cut all the way through).

When you hit the ON button on the microwave, the energy being shot at your grape moves the electrolytes across the bridge very quickly, which heats up the bridge until it bursts into flame.

The electrons that are traveling through the flame zip across and mix with the air, and a burst of bright plasma shoots up. If you watch carefully, you will see two flames, not one.

Everything is matter. Well, except for energy, but that's everything else (and we'll get to that later).

Everything you can touch and feel is matter. It is made up of solid (kind of) atoms that combine and form in different ways to create light poles, swimming pools, poodles, jell-o and even the smell coming from your pizza.

Traditionally, there have been three states of matter. State of matter means the way the atoms tend to hang out together. Not to be confused with a state like Utah, Wyoming, or confusion. The three states are solids, liquids and gases. However, leave it up to a science teacher to tell you that that's not the whole story.

There are two more states of matter. They are *plasma* and (are you ready for this next one?) the *Bose-Einstein condensate*. These two states of matter are both pretty uncommon on Earth.

Believe it or not, plasma makes up a very large percentage of the matter in the universe. Are you wondering how come you've never heard of it before? (By the way, blood plasma is different from this stuff, and a good thing too!)
Well, there is very little of it on Earth and the plasma that is here is very short lived or stuck in a tube. Plasma is basically ionized gas or in other words it is gas that is electrically charged.

The stuff in florescent light bulbs is plasma. Plasma TV's have plasma (go figure) inside of them. Lightning and sparks are actually plasma!

Questions to Ask

1. Does it matter where the grape is located inside your microwave?
2. What happens if you put two grapes in?
3. Does grape size matter?
4. Does the power setting matter?
5. How does a microwave heat your food?

Disappearing Glass

Activity

We're going to bend light to make objects disappear.

Materials

Two glass containers (one that fits inside the other), and the smaller one MUST be Pyrex. It's okay if your Pyrex glass has markings on the side.

Cooking oil (such as canola or olive oil), enough to fill the larger container.

Experiment

To start with, watch the video for this experiment at:

SuperchargedScience.com/usas1.htm

Access code: DV2

Do this experiment on a cutting board stretched over the sink, letting the large container stay put during the activity. You're going to douse the glass with oil, and it can easily slip out of your hands, so be careful.

1. Fill the larger glass container halfway with cooking oil.
2. Insert the smaller container into the larger container.

3. Add oil into the smaller container, and watch it disappear!
4. To make the smaller container completely disappear, fill both containers almost completely.

What's Going On?

When a beam of light hits a different substance (like glass), the speed of light changes.

The color of the light (called the wavelength) can also change. In some cases, the change of wavelength turns into a change in the direction of the beam.

For example, if you stick a pencil in a glass of water and look through the side of the glass, you'll notice that the pencil appears shifted.

The speed of light is slower in the water (140,000 miles per second) than in the air (186,000 miles per second), called optical density, and the result is bent light beams and broken pencils.

You'll notice that the pencil doesn't always appear broken. Depending on where your eyeballs are, you can see an intact *or* broken pencil.

This is a very fine point about refraction: when light enters a new substance (like going from air to water) perpendicular to the surface (looking straight on), refractions do not occur.

However, if you look at the glass at an angle, then depending on your sight angle, you'll see a different amount of shift in the pencil. Where do you need to look to see the greatest shift in the two halves of the pencil? (Hint: move the pencil back and forth slowly.)

Depending on if the light is going from a lighter to an optically denser material (or vice versa), it will bend different amounts.

Glass is optically denser than water, which is denser than air.

Here's a chart:

Vacuum	1.0000
Air	1.0003
Ice	1.3100
Water	1.3333
Pyrex	1.4740
Cooking Oil	1.4740
Diamond	2.4170

This means if you place a Pyrex container inside a beaker of vegetable oil, it will disappear.

This also works for some mineral oils and Karo syrup. Note however that the optical densities of liquids vary with temperature and concentration, and manufacturers are not perfectly consistent when they whip up a batch of this stuff, so some adjustments are needed.

Not only can you change the shape of objects by bending light (broken or whole), but you can also change the size.

Magnifying lenses, telescopes, and microscopes use this idea to make objects appear different sizes.

Questions to Ask

1. Does the temperature of the oil matter?
2. What other kinds of oil work? Blends of oils?
3. Does it work with mineral oil or Karo syrup?
4. Is there a viewing angle that makes the inside container visible?
5. Which type of lighting makes the container more invisible?
6. Can we see light waves?

"The definition of insanity: doing the same thing over and over again and expecting different results."
~Albert Einstein

Hot Tips for Cool Parents

There are seven BIG mistakes that most folks make when teaching science. Have you made any of these?

Failure to make an impact. You can't teach them if you don't have their attention. Do an experiment that hooks them *before* delivering academic content. They'll be asking for the how and why *after* their curiosity is sparked.

Give away the ending. What in their right mind would do an experiment when they already know the ending? Skip the conclusion in your textbook and come up with your own. You'll be honing your observations skills and ability to ask better questions.

No tools for the job. You wouldn't build a house without wood, so why try to learn science without experiments? Science is much more than a textbook— it's the process of asking questions and interpreting your results. It doesn't have to be a fancy setup or cost a fortune, either. In fact, great scientists simply see what others don't.

Want more? Get your copy of the *Seven Biggest Mistakes Made in Teaching Science* by clicking this link:

SuperchargedScience.com/usas1.htm

Access code: ESCI

Mixing Cold Light

Activity

When you mix three cups of red, green, and blue paint, you get a muddy brown. But when you mix together three cups of light, you get white.

Materials

Three light sticks (red, green, and blue)

Paper towel or coffee filter

Disposable clear cup

Scissors and adult help

Experiment

To start with, watch the video for this experiment at:

SuperchargedScience.com/usas1.htm

Access code: DV2

Do this experiment in the sink, and use disposable gloves. The chemicals inside the light sticks can irritate the skin.

1. Activate each light stick by bending it until you hear a *CRACK!* That's the little glass capsule inside breaking and allowing the two chemicals to mix.
2. While wearing gloves, carefully slice off one end of the light stick tube with strong scissors, being careful not to splash (do this over a sink).
3. Cut off the ends for all three light sticks. You can stick them in a second cup to hold them upright until you need them.
4. Pass the contents of the light sticks through a coffee filter (or paper towel) into a disposable cup to catch the glass bits. Throw the glass and filter in the trash.
5. Your cup should be glowing white.

What's Going On?

Imagine you're a painter. What three colors do you need to make up any color in the universe? (You should be thinking: red, yellow, and blue.)

Here's a trick question - can you make the color "yellow" with only red, green, and blue as your color palette? If you're a scientist, it's not a problem. But if you're an artist, you're in trouble already.

The key is that we would be mixing light, not paint. Mixing the three primary colors of light gives white light.

If you took three light bulbs (red, green, and blue) and shined them on the ceiling, you'd see white. And if you could magically un-mix the white colors, you'd get the rainbow (which is exactly what prisms do.)

If you're thinking yellow should be a primary color - it is a primary color, but only in the artist's world. Yellow paint is a primary color for painters, but yellow light is actually made from red and green light. (Easy way to remember this: think of Christmas colors – red and green merge to make the yellow star on top of the tree.)

The light sticks are making cold light, meaning that you get light without the heat. In an incandescent light bulb, you get both heat *and* light).

The light stick is giving off its own light through a chemical reaction called chemiluminescence, which started as soon as you broke the glass inside.

Mixing cold light liquid is different from mixing cups of paint. The cups of paint are only reflecting nearby light. The cold light is actually producing the light.

It's like the difference between the sun, which gives off its own light, and the moon, which you see only when sunlight bounces off it to your eyeballs.

EXPERIMENT TIP: Sometimes the chemical light sticks contain a glowing green liquid encapsulated within a red or blue plastic tube, so when you slice it open to combine it with the other colors, it isn't a true red.

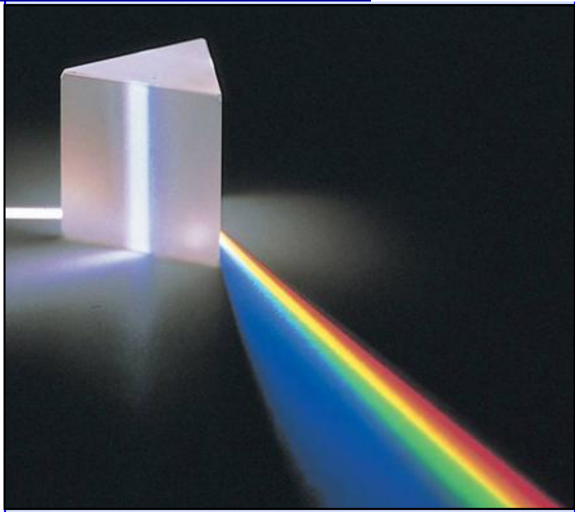
Be sure that your chemical light sticks contain a glowing red liquid and blue liquid in a clear, colorless plastic tube, or this experiment won't work.

Going Further

You can go further with this experiment by arming your kids with three flashlights, each with a different color beam. Cover the end of the flashlights with colored cellophane and secure with a rubber band. Turn down the lights, and your kids will be able to mix the three colors of light as well as make rainbow shadows on the wall!

Questions to Ask

1. What two colors make yellow light?
2. Does the temperature of the cold light matter? What happens if you stick it in the microwave? Freezer?
3. Do you need equal parts of all three, or is one liquid more concentrated than the rest?
4. What happens when you combine other light stick colors?
5. What color do you get if you combine a red, yellow, and blue light stick together?
6. How do you un-mix white light?



ELECTROSTATIC MOTOR

Activity

Did you know that you can make a motor turn using static electricity? We're going to use the concept that *like* charges repel (think two electrons) and *opposite* charges attract.

Materials

Balloon

Soup spoon

Flat table

Yard stick

Experiment

To start with, watch the video for this experiment at:

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Access code: DV2

1. Set the spoon face-down on the table, near the edge.
2. Carefully balance the yardstick on the back of the spoon. You want the meter stick to be perfectly balanced and not touching the table or falling off the edge.
3. Blow up the balloon.
4. Charge the balloon by scrubbing it on your head.
5. Bring the balloon near the edge of the yardstick that's hanging off the table. The yardstick should begin to chase the balloon.

What's Going On?

Different parts of the atom have different electrical charges. The proton has a positive charge, the neutron has no charge (neutron, neutral get it?) and the electron has a negative charge.

These charges repel and attract one another kind of like magnets repel or attract. Like charges repel (push away) one another and unlike charges attract one another.

So if two items that are both negatively charged get close to one another, the two items will try to get away from one another. If two items are both positively charged, they will try to get away from one another. If one item is positive and the other negative, they will try to come together.

How do things get charged?

Generally things are neutrally charged. They aren't very positive or negative. However, occasionally (or on purpose as we'll see later) things can gain a charge.

Things get charged when electrons move. Electrons are negatively charged particles. So if an object has more electrons than it usually does, that object would have a negative charge.

If an object has less electrons than protons (positive charges), it would have a positive charge. How do electrons move? It turns out that electrons can be kind of loosey-goosey.

Depending on the type of atom they are a part of, they are quite willing to jump ship and go somewhere else. The way to get them to jump ship is to rub things together. Let's play with this a bit and see if we can make it more clear.

Remember, in static electricity, electrons are negatively charged and they can move from one object to another. This movement of electrons can create a positive charge (if something has too few electrons) or a negative charge (if something has too many electrons). It turns out that electrons will also move around inside an object without necessarily leaving the object. When this happens the object is said to have a temporary charge.

Try this: Blow up a balloon. When you rub the balloon on your head, the balloon is now filled up with extra electrons, and now has a negative charge. Now stick it to a wall— to create a temporary charge on a wall.

Opposite charges attract right? So, is the entire wall now an opposite charge from the balloon? No. In fact, the wall is not charged at all. It is neutral. So why did the balloon stick to it?

The balloon is negatively charged. It created a temporary positive charge when it got close to the wall. As the balloon gets closer to the wall, it repels the electrons in the wall. The negatively charged electrons in the wall are repelled from the negatively charged electrons in the balloon.

Since the electrons are repelled, what is left behind? Positive charges. The section of wall that has had its electrons repelled is now left positively charged. The negatively charged balloon will now "stick" to the positively charged wall. The wall is temporarily charged because once you move the balloon away, the electrons will go back to where they were and there will no longer be a charge on that part of the wall.

This is why plastic wrap, Styrofoam packing popcorn, and socks right out of the dryer stick to things. All those things have charges and can create temporary charges on things they get close to.

Questions to Ask

1. What happens if you rub the balloon on other things, like a wool sweater?
2. If you position other people with charged balloons around the table, can you keep the yardstick going?
3. Can we see electrons?
4. How do you get rid of extra electrons?
5. Does the shape of the balloon matter?
6. Does hair color matter?
7. Rub a balloon on your head, and then lift it up about 6". Why is the hair attracted to the balloon?
8. Why does the hair continue to stand on end after the balloon is taken away?
9. What other things does the balloon stick to besides the wall?
10. Why do you think the yardstick moved?
11. What other things are attracted or repelled the same way by the balloon? (Hint: try a ping pong ball.)

"I have not failed. I have just found 10,000 ways that won't work."

~Thomas Edison

BUILDING SPEAKERS

Activity

We're going understand how speakers transform an electrical signal into sound by building one.

Materials

Foam plate
Sheet of copy paper
Business card
Scrap of cardboard
Scrap of sandpaper
Tape
Hot glue gun
Scissors
Boombox or old stereo

From Radio Shack:
Magnet wire
(RS #278-1345)
4 rare earth magnets
(RS #64-1895)
1 audio plug
(RS #42-2420)

Experiment

To start with, watch the video for this experiment at:

SuperchargedScience.com/usas1.htm

Access code: DV2

Note that these speakers are for demonstration purposes only, and you'll need to place your ear close to the speaker to detect the sound.

DO NOT connect these speakers up to your iPOD or other expensive stereo equipment, as these speakers are very low resistance (less than 2 ohms) and can damage your sound equipment if you're not careful.

The best source of music for these speakers is an old boom box with a place to plug in your headphones.

1. Cut a business card in half lengthwise. Fold each strip in half, and then fold the lengths in half again so you have a W-shape.
2. Stack your magnets together and roll a small strip of copy paper around the magnets. Tape the paper into place. Do this one more time, so you now have two paper cylinder sleeves around your magnets.
3. Wrap the magnet wire 20-50 times around the paper tube (keep the magnets inside so this step is easier). Secure with tape.
4. Carefully remove only the *inside* paper sleeve and discard (you can take the magnets out when you do this).
5. Trim one side of the paper so one side of the coil is near the paper edge.
6. Hot glue the uncut side of the paper tube to the bottom of a foam plate.
7. Hot glue one side of the W-shape of the business card to the bottom of the foam place. You want a W-shape on either side of the paper tube, an inch or two away.
8. Hot glue your magnets to the center of a stiff piece of cardboard.
9. Place your paper tube over the magnets and glue the W-shapes to the cardboard. These are your 'springs' .
10. Tap the plate lightly with your finger. Make sure the foam plate is free to bounce up and down.
11. Sand the ends of each magnet wire to strip

away the insulation.

12. Unscrew the plastic insulation from the audio plug and wrap one wire around each terminal. Make sure the two contacts and wires don't touch each other, or your speaker won't work. You can secure each connection with tape.
13. Plug it into your boombox and play your music on the highest volume. You should hear the music coming from your speaker!

What's Going On?

Let's talk about the telegraph. A telegraph is a small electromagnet that you can switch on and off.

The electromagnet is a simple little thing made by wrapping insulated wire around a nail.

An electromagnet is a magnet you can turn on and off with electricity, and it only works when you plug it into a battery.

One of the most important discoveries in science is this: **anytime you run electricity through a wire, you also get a magnetic field.**

You can amplify this effect by having lots of wire in a small space (hence wrapping the wire around in a coil) to concentrate the effect.

The opposite is true also - if you rub a permanent magnet along the length of the electromagnet, you'll get an electric current flowing through the wire.

Here's what it all boils down to: **magnetic fields cause electric fields, and electric fields cause magnetic fields.** Got it?

A microphone has a small electromagnet next to a permanent magnet, separated by a thin space. The coil is allowed to move a bit (because it's lighter than the permanent magnet). When you speak into a microphone, your voice sends sound waves that vibrate the coil, and each time the coil moves, it causes an electrical signal to flow through the wires, which gets picked up by your recording system.

A loudspeaker works the opposite way. An electrical signal (like music) zings through the coil (which is also allowed to move and attached to your speaker cone), which is attracted or repulsed by the permanent magnet. The coil vibrates, taking the cone with it. The cone vibrates the air around it and sends sounds waves to reach your ear.

If you placed your hand over a speaker as it was booming out sound, you felt something against your hand, right? That's the sound waves being generated by the speaker cone. Each time the speaker cone moves, it creates a vibration in the air that you can detect with your ears. For deep notes, the cone moves the most, and a lot of air gets shoved at once, so you hear a low note.

Questions to Ask

1. Does it matter how strong the magnets are?
2. What else can you use besides a foam plate?
3. Which works better: a larger or smaller magnet wire coil?
4. How can you detect magnetic fields?
5. How does an electromagnet work?
6. How does your speaker work?
7. Is a speaker the same as a microphone?
8. Does the shape and size of the plate matter? What if you use a plastic cup?

Pop Rockets

Activity

We're going to launch a rocket by building up pressure using a chemical reaction.

I really like this activity because it challenges kids to think outside the box. Most kids initially see the water and tablets as 'fuel' and assume that the more they use, the higher it will go (which is actually the opposite of what really happens). Kids get to hone their observation skills as they try different variations to get their rocket to land on the roof.

I also really like this experiment because it combines chemistry, gas pressure, and Newton's laws of physical motion all in one cool experiment.

Here's what it's all about:

Rockets shoot skyward with massive amounts of thrust, produced by chemical reaction or air pressure. Scientists create the thrust force by shoving a lot of gas (either air itself, or the gas left over from the combustion of a propellant) out small exit nozzles.

According to the universal laws of motion, for every action, there is equal and opposite reaction. If flames shoot out of the rocket downwards, the rocket itself will soar upwards. It's the same thing if you blow up a balloon and let it go—the air inside the balloon goes to the left, and the balloon zips off to the right (at least initially).

A rocket has a few parts different from an airplane. One of the main differences is the absence of wings. Rockets utilize fins, which help steer the rocket, while airplanes use wings to generate lift. Rocket fins are more like the rudder of an airplane than the wings.

Another difference is the how rockets get their speed. Airplanes generate thrust from a rotating blade, whereas rockets get their movement by squeezing down a high-energy gaseous flow and squeezing it out a tiny exit hole.

If you've ever used a garden hose, you already know how to make the water stream out faster by placing your thumb over the end of the hose. You're decreasing the amount of area the water has to exit the hose, but there's still the same amount of water flowing out, so the water compensates by increasing its velocity.

This is the secret to converging rocket nozzles—squeeze the flow down and out a small exit hole to increase velocity.

Materials

Water

Alka-seltzer tablets

Fuji film canister (or bottle with a cork or snap-on lid)

Experiment

To start with, watch the video for this experiment at:

SuperchargedScience.com/usas1.htm

Access code: DV2

Be careful with this!! These rockets can wind up on your roof, so do this activity outside and away from structures!

1. Fill your container partway with water
2. Drop in a tablet
3. Working quickly, cap the container and invert it so the film canister is bottom-side up. If you're using a cork and bottle, stand the bottle right-side up so that the cork is the thing that flies off.

Experiment with different amounts of water and tablets to see how high your rocket can go. You can add a nose and fins using hot glue later.

What's Going On?

For every action, there is equal and opposite reaction. If flames shoot out of the rocket downwards, the rocket itself will soar upwards. It's the same thing if you blow up a balloon and let it go-the air inside the balloon goes to the left, and the balloon zips off to the right (at least, initially).

Your rocket generates a high pressure through a chemical reaction. The alka seltzer and water combine to form carbon dioxide gas (CO2) which builds until it pops the lid off your film canister. The lid flies one way and the tube goes the other. Newton's Third Law in action!

You don't have to just use alka seltzer and water... what about baking soda and vinegar? The combination of those two also produces carbon dioxide gas.

What other chemicals do you have around that also produces a gas during the chemical reaction? Chalk and vinegar, baking soda, baking powder, hydrogen peroxide, isopropyl alcohol, lemon juice, orange juice...?

You can also modify your rocket body design. Add foam fins and a foam nose (try a hobby or craft shop), hot glued into place. Foam doesn't mind getting wet, but paper does.

Put the fins on at an angle and watch the seltzer rocket spin as it flies skyward. You can also tip the rocket on its side and add wheels for a rocket car, stack rockets, for a multi-staging project, or strap three rockets together with tape and launch them at the same time! You can also try different containers using corks instead of lids.

This experiment is a prime example of Newton's Third Law of Motion: for every action there's an equal and opposite reaction. When the film top flies off in one direction (usually held into place by the floor), the rocket body shoots in the opposite direction.

Questions to Ask

1. Does water temperature matter?
2. Do crushed tablets work better than whole pieces?
3. How many tablets can you add at once?
4. What if you use vinegar instead of water? Soda water?
5. Does more water, tablets, or air space give you a higher flight?
6. What happens if you strap this rocket to a matchbox car? Which way does the lid go, and which way does the car move?

Simple Hovercraft

Activity

When you slide a hockey puck on the street, it quickly comes to a stop. Take that same puck and slide it over a sheet of ice and you'll find it zooms a lot farther. What gives?

This experiment is great for teaching kids about air-cushioned vehicles and air pressure.

Materials

7-9" balloon

Old CD

Sport-top from a water bottle

Razor or scissors

Paper cup

Hot glue

Tack

Experiment

To start with, watch the video for this experiment at:

SuperchargedScience.com/usas1.htm

Access code: DV2

Do this experiment on a very flat surface, like a clean tile floor or kitchen counter.

1. Close the top of the water bottle. Use a tack to puncture the top of the cap. You'll want air to stream through these holes.
2. Place a bead of hot glue around the bottom rim of the sports cap and press it onto the center of the CD, making an air-tight seal.
3. Punch out the bottom of the paper cup using a razor or scissors.
4. Blow up the balloon. Do NOT tie off. Twist a few times so the air stays inside.
5. Thread the neck through the bottom of the paper cup and stretch over the sports cap.
6. Untwist your balloon to start the air stream.
7. If your hovercraft isn't floating easily, add more holes to the sports cap or try a flatter surface.

What's Going On?

Hovercraft use air to reduce the drag (friction) between the bottom surface and the ground. The first hovercraft was designed for military use in 1915, but was mostly operated over later. In the 1930's, inventors combined simple aircraft principles into their designs to produce the first vehicles that utilized 'ground effect' and could hover on land.

ACVs require at least two engines: one for the lift (hovering action), and the other for forward thrust.

The hovering motor pushes air out the bottom, which creates a pocket of higher pressure to accumulate.

As the higher pressure escapes out the bottom, it lifts the vehicle up, creating the 'hovering' effect. Although some hovercraft utilize air ducts to use one engine for both jobs (thrust and hover), most require two or more. In addition to small vehicles, two hover trains are currently in operation (one in Japan, the other in Austria) since 1985, using an underground cushion of air to reduce track friction and increase speed.

The balloon is shoving air through the tiny holes in the cap, which escapes out the sides of the CD. Make sure your CD and table are both pretty flat, or you'll have drag issues. The air is a lubricating layer between the CD and table that allows the hovercraft to slide a lot easier by reducing the friction between the CD and the table.

Friction is the force between two objects in contact with one another. Friction is dependent on the materials that are in contact with one another: how much pressure is put on the materials, whether the materials are wet or dry, hot or cold. In other words, it's quite complicated! The friction between the puck and the street are a lot higher than with ice.

Friction happens due to the electro-magnetic forces between two objects. Friction is not necessarily due to the roughness of the objects but rather to chemical bonds "sticking and slipping" over one another.

Questions to Ask

1. Does the shape of the balloon matter?
2. Why bother using the paper cup?
3. What happens if you open the cap of the bottle to allow greater airflow from the balloon?
4. Is there higher pressure inside or outside the balloon?
5. What else can you use besides a CD?
6. Does it matter if the air is heated or chilled?
7. How (and where) can you add a thruster to your design?
8. What is the longest hover time your hovercraft can do?
9. What happens if you poke more (or less) holes in the sport top?

The Secret to Teaching Science

What is learning *really* all about?

Kids are naturally curious about their world. When we feed that curiosity, their minds thrive.

Science is all about understanding the world around is. It's NOT about memorizing facts that don't seem to relate to the real world.

Why learn science?

Studying science helps kids better understand their world, provides them with logical and critical thinking skills as they learn a systematic approach to solving problems, and helps them be better prepared for life. Or course, it's fun, too!

What's the most important factor in determining how well kids learn?

Motivation. Motivation comes first, learning comes second. When kids are fired up about a topic, they do whatever it takes to learn it. Scale the depth you go into according to your kid's age. Don't worry if this seems like too much work… there's a shortcut! (See page 14...)

FAST CATAPULT

Activity

The higher you pitch a ball upwards, the more energy you store in it. Instead of breaking our arms trying to toss balls into the air, let's make a simple machine that will do it for us.

I really like this experiment because there's so much room for creativity and new ideas.

After you've done this activity once, hand the kids extra supplies to see how they can improve this design to launch objects even farther.

Materials

9 tongue-depressor-size popsicle sticks

Four rubber bands

Milk jug cap OR plastic spoon

Something to toss around, like a ping pong ball, marshmallow, or ball of crumpled up aluminum foil

Experiment

To start with, watch the video for this experiment at:

SuperchargedScience.com/usas1.htm

Access code: DV2

Watch out for the hot glue gun—help your kids as they need it when adding the spoon launcher.

1. Stack 7 popsicle sticks together. Wrap a rubber band around each end to keep the stack together.

2. Stack 2 popsicle sticks together, and secure only one of the ends with a rubber band.

3. Open up the two-stack (like the jaws of an alligator) and slide the stack of seven in between to form a T-shape (see image).

4. Secure three sides (as shown in image) with a rubber band, binding it together.

5. Hot glue a film can lid or plastic spoon to the top popsicle stick.

6. Add your ball to the spoon, grab the cross0bar handle, and launch!

What's Going On?

Catapults store energy until you hit the trigger. You store energy in a rubber band every time you stretch it out - the pull you feel from the rubber band is called potential energy.

Catapults store potential energy by stretching ropes and rubber bands, and even by bending and flexing the wooden lever. The more energy you pack in, the higher your ball will go.

This catapult uses elastic kinetic energy stored in the rubber band to launch the ball skyward.

We're utilizing the "springiness" in the popsicle stick to fling the

ball around the room.

By moving the fulcrum as far from the ball launch pad as possible (on the catapult), you get a greater distance to press down and release the projectile.

The fulcrum is the spot where a lever moves one way or the other - for example, the horizontal bar on which a seesaw "sees" and "saws".

If your kids get stuck for ideas, you can show them how to vary their models:

- glue a second (or third, fourth, or fifth) spoon onto the first spoon for multi-ammunition throws
- increase the number of popsicle sticks in the fulcrum from 7 to 13 (or more?)
- use additional sticks to lengthen the lever arm
- use ping pong balls and build a fort from sheets, pillows, and the backside of the couch!

These simple catapults are quick and easy versions of the real thing, using a fulcrum instead of a spring so kids don't knock their teeth out.

After making the first model, encourage kids to make their own "improvements" by handing them additional popsicle sticks, spoons, rubber bands, etc.

For Older Students:

For high school and college -level physics classes, you can easily incorporate these launchers into your calculations for projectile motion.

Offer students different ball weights (ping pong, foil crumpled into a ball, and whiffle balls work well) and chart out the results.

This project lends itself well to taking data and graphing your results: you and your child can jot down the distance traveled along with time aloft with further calculations for high school students for velocity and acceleration.

Questions to Ask

1. Does a golf ball go the same distance as a ping pong ball? How about a marshmallow?
2. How many popsicle sticks can you add to the stack to increase your flight distance?
3. What if you add a second plastic spoon to make a double-launcher?
4. What would you change (lengthen, shorten...?) to make the ball fly further?

6 Master Steps to Teaching Science

1. Decide what you want your student to learn. Start with a topic that's interesting to them. (Ex: air pressure)
2. Find a practical application of it (airplanes)
3. Arrange an opportunity for them to experience the application (first flight lesson in a real airplane)
4. Feed their excitement. (ask them about that they learned, and what they want to do next.)
5. Give them tools to experiment (the chance to learn about flying)
6. Introduce academic material that supports them (teach about lift, drag, airfoils, etc.)

BUZZING SLING HORNET

Activity

Did you know that you can make a very LOUD parent-annoyer using simple household materials and a quick lesson in resonance?

This activity is a great example of how tiny vibrations can be amplified into something incredibly loud using a sound chamber. I especially like this one because it looks like a piece of junk... until you play it.

Materials

tongue-depressor size popsicle stick

approximately 3" x 1/4" rubber band

2 index cards

3 feet of string (or yarn)

scissors

tape or hot glue

Experiment

To start with, watch the video for this experiment at:

SuperchargedScience.com/usas1.htm

Access code: DV2

1. Run a bead of hot glue along the edge of the long side of the index card and attach it to a popsicle stick.
2. Cut the corners off the free corners.
3. Cut a second index card in half. Fold each half three times. Hot glue one of these pieces to one side of the popsicle stick.
4. Take the second folded half and tie the end a 3' length of string to the folded card.
5. Hot glue the folded half with string to the other side of the popsicle stick.
6. Stretch a fat rubber band lengthwise over the popsicle stick so that the rubber band rests only on the folded index card halves (see image).
7. Grab the end of the string and whip it in a fast circle to get a sound!

What's Going On?

Sound is a form of energy, and is caused by something vibrating. So what is moving to make sound energy?

Molecules. Molecules are vibrating back and forth at fairly high rates of speed, creating waves. Energy moves from place to place by waves.

Sound energy moves by longitudinal waves (the waves that are like a slinky). The molecules vibrate back and forth, crashing into the molecules next to them, causing them to vibrate, and so on and so forth. All sounds come from vibrations.

Frequency is a measure of how many times something moves back and forth. A swing, a pendulum, a leg of a walking person all have a frequency.

All those things start at one place, move, and come back to the same position that they started.

This moving and coming back is one vibration. The faster something vibrates, the more frequency that something has. Frequency is measured in Hertz (Hz).

Waves are the way energy moves from place to place. Sound moves from a mouth to an ear by waves. Light moves from a light bulb to a book page to your eyes by waves.

Waves are everywhere. As you sit there reading this, you are surrounded by radio waves, television waves, cell phone waves, light waves, sound waves and more. (If you happen to be reading this in a boat or a bathtub, you're surrounded by water waves as well.) There are waves everywhere!

Our ears are very good antennas. They are very effective at picking up quiet, loud, high-pitched and low-pitched sounds. It is difficult for people to make microphones that are as sensitive as our ears.

Our ears can pick up and tell the difference between sounds as low-pitched as 20 Hz and as high-pitched as 20,000 Hz. Some animals can hear things that are even higher or lower pitched than that. Our ears and brain are also very good at picking out the direction a sound is coming from.

Do you remember where all waves come from? Vibrating particles. Waves come from vibrating particles and are made up of vibrating particles.

Here's rule one when it comes to waves.... the waves move, the particles don't. The wave moves from place to place. The wave carries the energy from place to place. The particles however, stay put. Here's a couple of examples to keep in mind.

If you've ever seen a crowd of people do the "wave" in the stands of a sporting event you may have noticed that the people only "vibrated" up and down. They did not move along the wave. The wave, however, moved through the stands.

Another example would be a duck floating on a wavy lake. The duck is moving up and down (vibrating) just like the water particles but he is not moving with the waves.

The waves move but the particles don't. When I talk to you, the vibrating air molecules that made the sound in my mouth do not travel across the room into your ears. (Which is especially handy if I've just eaten an onion sandwich!) The energy from my mouth is moved, by waves, across the room.

Questions to Ask

1. Does the shape of the index card matter?
2. What happens if you change the number of rubber bands?
3. What if you use a different thickness rubber band?
4. What happens if you make the string longer or shorter?
5. can you make a double by stacking two together?
6. Can you get a second or third harmonic by swinging it around faster?
7. Why do you need the index card at all?

"All our knowledge has its origins in our perceptions."

~Leonardo da Vinci

Microscope & Telescope

Activity

Kids will build a microscope and telescope to help them understand how lenses bend light to make things appear larger and smaller.

Things like lenses and mirrors can bend and bounce light to make interesting things, like compound microscopes and reflector telescopes.

What I like best about this activity is how easily we can break down the basic ideas of something that seems much more complex and intimidating, like a telescope or microscope in a way that kids really understand.

Materials

A window
Dollar bill
Penny
Two hand held magnifying lenses

Experiment

To start with, watch the video for this experiment at:

SuperchargedScience.com/usas1.htm

Access code: DV2

Did you know you can create a compound microscope and telescope using the same materials? It's all in how you use them to bend the light.

These two experiments cover the fundamental basics of how two double-convex lenses can be used to make objects appear larger when right up close or farther away.

1. Place a penny on the table.
2. Hold one magnifier above the penny and look through it.
3. Bring the second magnifying lens above the first so now you're looking through both. Move the second lens closer and/or further from the penny until the penny comes into sharp focus. You've just made a compound microscope!

4. Who's inside the building on the penny?
5. Try finding the owl on the dollar bill. (Hint: it's in a corner!)
6. Keeping the distance between the magnifiers about the same, slowly lift up the magnifiers until you're now looking through both to a window.

7. Adjust the distance until your image comes into sharp (and upside-down) focus. You've just made a refractor telescope!

What's Going On?

When a beam of light hits a different substance (like a window pane or a lens), the speed that the light travels at changes. (Sound waves do this, too!) In some cases, this change turns into a change in the direction of the beam.

For example, if you stick a pencil is a glass of water and look through the side of the glass, you'll notice that the pencil appears shifted. The speed of light is slower in the water (140,000 miles per second) than in the air (186,000 miles per second), called optical density, and the result is bent light beams and broken pencils.

You'll notice that the pencil doesn't always appear broken. Depending on where your eyeballs are, you can see an intact or broken pencil. When light enters a new substance (like going from air to water) perpendicular to the surface (looking straight on), refractions do not occur.

However, if you look at the glass at an angle, then depending on your sight angle, you'll see a different amount of shift in the pencil. Where do you need to look to see the greatest shift in the two halves of the pencil?

Depending on if the light is going from a lighter to an optically denser material (or vice versa), it will bend different amounts. Glass is optically denser than water, which is denser than air.

Not only can you change the shape of objects by bending light (broken pencil or whole?), but you can also change the size. Magnifying lenses, telescopes, and microscopes use this idea to make objects appear different sizes.

Questions to Ask

1. Can light change speeds?
2. Can you see ALL light with your eyes?
3. Give three examples of a light source.
4. Why does the pencil appear bent? Is it always bent? Does the temperature of the water affect how bent the pencil looks? What if you put two pencils in there?
5. What if you use oil instead of water for bending a pencil?
6. How does a microscope work?
7. What's the difference between a microscope and a telescope?
8. Why is the telescope image upside-down?

More About Light

Imagine tossing a rock into a still pond and watching the circles of ripples form and spread out into rings. Now look at the ripples in the water - notice how they spread out. What makes the ripples move outward is energy.

The ripples are like light. Notice the waves are not really moving the water from one side of the pond to the other, but rather move energy across the surface of the water.

To put it another way, energy travels across the pond in a wave. Light works the same way – light travels as energy waves. Only light doesn't need water to travel through the way the water waves do - it can travel through a vacuum (like outer space).

Light can change speed the same way sound vibrations change speed. (Think of how your voice changes when you inhale helium and then try to talk.)

The fastest light can go is 186,000 miles per second – that's fast enough to circle the Earth seven times every second, but that's also inside a vacuum. You can get light going slower by aiming it through different gases. In our own atmosphere, light travels slower than it does in outer space.

Teaching Science Right

Hopefully these activities have given you a small taste of how science can be totally cool AND educational.

But teaching science isn't always easy.

You see, there's a lot more to it than most traditional science books and programs accomplish. If your students don't remember the science they learned last year, you have a problem.

What do kids really need to know when it comes to science?

Kids who have a solid science and technology background are better equipped to go to college, and will have many more choices once they get out into the real world.

Learning science isn't just a matter of memorizing facts and theories. On the contrary, it's developing a deep curiosity about the world around us, AND having a set of tools that let kids explore that curiosity to answer their questions.

Teaching science in this kind of way isn't just a matter of putting together a textbook with a few science experiments and kits.

Science education is a three-step process (and I mean teaching science in a way that your kids will really understand and remember). Here are the steps:

1. Get kids genuinely interested and excited about a topic.
2. Give them hands-on activities and experiments to make the topic meaningful.
3. Teach the supporting academics and theory.

Most science books and curriculum just focus on the third step and may throw in some experiments as an afterthought. This just isn't how kids learn.

There is a better way. When you provide your kids with these three keys (in order), you can give your kids the kind of science education that not only excites them, but that they remember for many years to come.

Don't let this happen to you… you buy science books that were never really used and now your students are filling out college applications and realizing they're missing a piece of their education—a REALLY big piece. Now *that's* a setback.

So what do you do?

First, don't worry. It's not something that takes years and years to do. It just takes commitment.

What if you don't have time? What I'm about to describe can take a bit of time as a parent, but it doesn't have to. There is a way to shortcut the process and get the same results! But I'll tell you more about that later.

Putting It Into Action

Step one: Get students genuinely interested and excited about a topic.

Start by deciding what topic you want your students to learn. Then, you're going to get them really interested in it.

For example, suppose I want my 5th grade to learn about aerodynamics. I'll arrange for them to watch a video of what it's like to go up in a small plane, of even find a friend who is a pilot and cam come talk with the kids. This is the kind of experience that will really excite them.

Step two: Give your students hands-on activities and experiments to make the topic meaningful.

This is where I take that excitement and let them explore it. I have flying lesson videos, airplane books, and real pilots interact with my students. I'll also show videos on how pilots plan for a flight. My students will learn about navigation, figuring out how much fuel is needed for the flight, how the weight the plane carries affects the aerodynamics of it, and so much more. (And did I just see a spot for a future math lesson also?)

I'll use pilot training videos to help us figure this out (short of a live demo, video is incredibly powerful for learning).

My students are incredibly excited at this point about anything that has to do with airplanes and flying. They are all positive they want to be pilots someday and are already wanting flying lessons (they are only 10 years old now).

Step three: Teach the supporting academics and theory.

Now it's time to introduce academics. Honestly, I have my pick of so many topics, because flying includes so many different fields. I mean my students use angles and math in flight planning, mechanics and energy in how the engine works, electricity in all the equipment on board the plane, and of course, aerodynamics in keeping the plane in the air (to name just a few).

I'm going to use this as the foundation to teach the academic side of all the topics that are appropriate.

We start with aerodynamics. They learn about lift and drag, make paper and balsa-wood gliders and experiment by changing different parts. They calculate how big the wings need to be to carry more weight (jelly beans) and then try their models with bigger wings.

Then we move on to the geometry used in navigation. Instead of drawing angles on a blank sheet of paper, our workspace is made of airplane maps (free from the airport).

We're actually planning part of the next flight my students will "take" during their geography lesson. Suddenly angles are a lot more interesting. In fact, it turns out that we need a bit of trigonometry to figure out some things.

Of course, a 10-year old can't do trigonometry, right? Wrong! They have no idea that it's usually for high school and learns about cosines and tangents.

Throughout this, I'm giving them chances to talk with the pilot in class, share what they've learned with each other, and even plan a real flight. How cool is that to a kid?!

You get the idea. The key is to focus on building interest and excitement first, then the academics are easy to get students to learn.

Try starting with the academics and...well, we've all had the experience of trying to get kids do something they don't really want to do.

The Shortcut

Okay, so this might sound like it's time-intensive. If you're thinking "I just don't have the time to do this!" or maybe "I just don't understand science well enough myself to teach it to my students at that level." If this is you, you're not alone.

The good news is, you don't have to. The shortcut is to find someone who already specializes in the area you want your students to learn about and expose them to the excitement

that persons gets from the field.

Then, instead of you being the one to take them through the hands-on part and the academics, use a solid video-based science program or curriculum (live videos, not cartoons).

This will provide them with both the hands-on experiments and the academic background they need. If you use a program that is self-guided (that is, it guides you and your students through it step-by-step), you don't need to be hassled with the preparation.

I'm partial to the "e-Science" program from SuperchargedScience.com (after all, I'm in it), but honestly, as long as a program uses these components and matches your educational goals, it should be fine.

Your next step should be to take a look at how you're teaching science now and simply ask "Are my students getting the results I want for their science education?"

After this, consider how you can implement the three key steps we just talked about. Either go through the steps yourself, or use a program that does this for you.

If you want to learn more about how to teach science this way, we regularly give free online tele-seminars for teachers and homeschool parents. My hope is that you have some new tools in your teaching toolbox to give your kids the best start you can in life.

Again, I want to thank you for taking the kind of interest in your students that it takes to be a great teacher. I know it's like a wild roller coaster ride some days, but I also know it's worth it. Have no doubt that that the caring and attention you give to your students' education today will pay off many fold in the future. My best wishes to you and your students.

Warmly,

Aurora