Science

Activity and Video Guide

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

Designed by real scientists for our future generation.

Supercharged Science

www.SuperchargedScienceCast.com

A collection of quick and inexpensive science experiments that work you through electricity, introduce you to chemistry, and present project ideas guaranteed to get your kids excited to do science.

Thank You for downloading the *Science Activity Guide*.

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 child to be looking for resources like this guide book. As a parent or teacher, you know this is a huge commitment to finding the materials your students need to excel in the field of science. Rest assured at your efforts really do 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 here at this link.

Access Code: **SSCAST**

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). For example, if you find yourself drawn to building your own speakers, our ideas are just the beginning. Try building your speakers in various sizes, with different wire, and so forth. Does the strength of the magnet matter?

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.

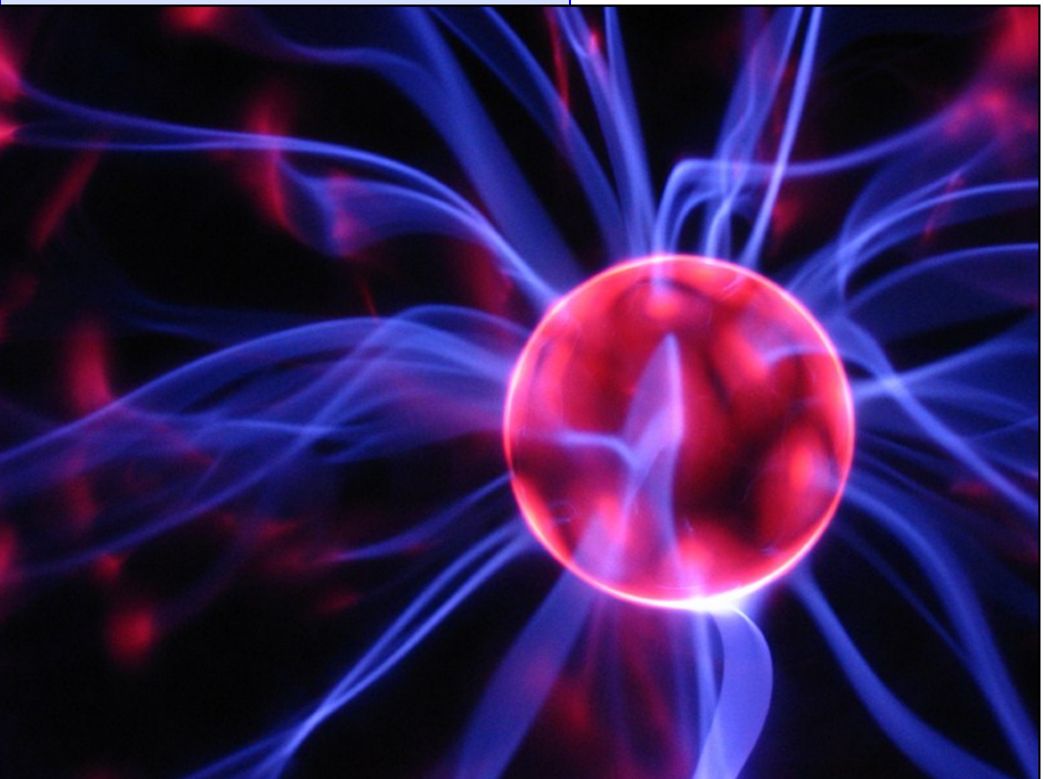
Since electrons have a negative charge, having a bunch of free-riding electrons causes the gas to become electrically charged.

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 here at this link.

Access code: SSCAST

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, jello 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 here at this link.

Access code: SSCAST

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 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), you won't find any refractions at all.

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 Teachers

There are 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.

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 here at this link.

Access code: SSCAST

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 with 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 mixing the light together.

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.

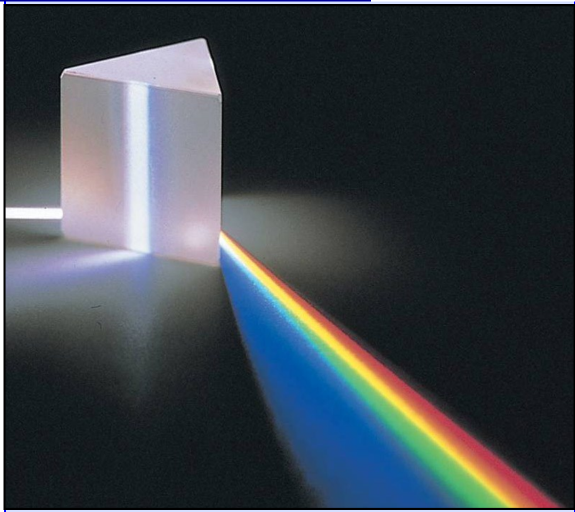
Be sure that your chemical light sticks contain a glowing red liquid and blue liquid in a clear, colorless plastic tube, or this experiment won't work.

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 here at this link.

Access code: SSCAST

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. Try the following experiment 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.

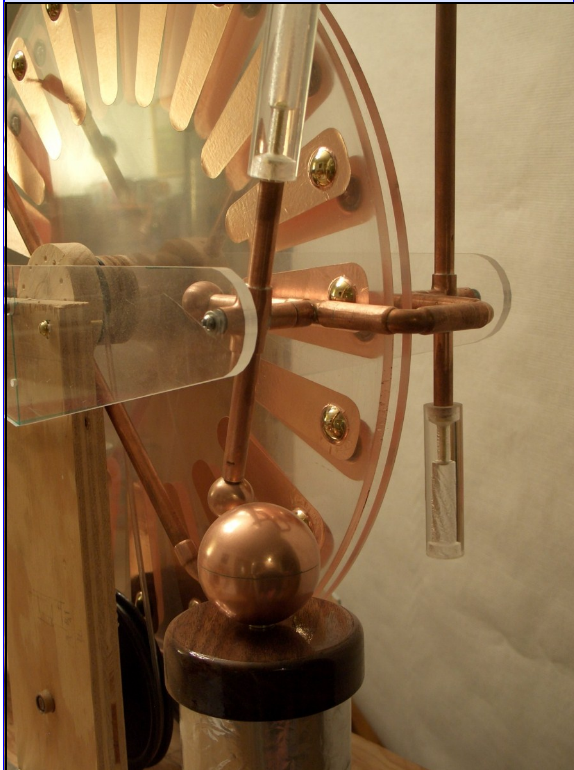
This is why plastic wrap, Styrofoam packing popcorn, and socks right out of the dryer stick to things. All those things have charges and can create temporary charges on things they get close to.

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 here at this link.

Access code: SSCAST

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?

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 kid doesn'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 programs 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 kids 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 kids genuinely interested and excited about a topic.

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

For example, suppose I want my 10-year old son to learn about aerodynamics. I'll arrange for him to go up in a small plane with a friend who is a pilot. This is the kind of experience that will really excite him.

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

This is where I take that excitement and let him explore it. I have him ask my friend for other chances to go flying. I'll also have my friend show him how he plans for a flight. My son 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.

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

My son is incredibly excited at this point about anything that has to do with airplanes and flying. He's sure he wants to be a pilot someday and is already wanting flying lessons (he's only 10 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 he's using 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. He learns about lift and drag, makes his own balsa-wood gliders and experiments by changing different parts. He calculates how big the wings need to be to carry more weight and then tries his model with bigger wings. (By the way, I got a video on model planes so I could understand this well enough to work with him on it).

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.

We're actually planning part of the next flight my son and my pilot buddy will take. 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! He has no idea that it's usually for high school and learns about cosines and tangents.

Throughout this, I'm giving him chances to get together with my pilot friend, share what he's learned, and even use it on real flights. 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 a kid 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 kid." 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 kids 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 your kinds through it step-by-step), you don't need to be involved unless you want to be.

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 "Is my kid getting the results I want from his or her 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, I give weekly live science and math lessons for parents and teachers and kids. To learn more about them, visit:

SuperchargedScienceCast.com

My hope is that you have some new tools in your toolbox to give your kids and students the best start you can in life.

Again, I want to thank you for taking the kind of interest that it takes to make a difference in a student's education. 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 child's education today will pay off many fold in the future.

My best wishes to you and your family.

Warmly,

Aurora

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