Science Activity & Video Series

Volume 9: Science Mysteries

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

Designed by real scientists for our future generation.

A collection of quick and inexpensive science experiments that baffle most people today. Use them in magic shows, presentations, and demonstrations to amaze and educate. Guaranteed to get your kids excited to do real science.

Supercharged Science

www.SuperchargedScience.com

Thank You for purchasing the *Homeschool Science Activity & Video 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 child to be a homeschool parent. As you know, this is a huge commitment. 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/savs9.htm

Access code: ESCI

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 launching rockets with more and more fins, go for it! Or if you'd like to combine rockets with the wings of an airplane, grab the tape and start creating your inventions. You're the pilot of this adventure!

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.

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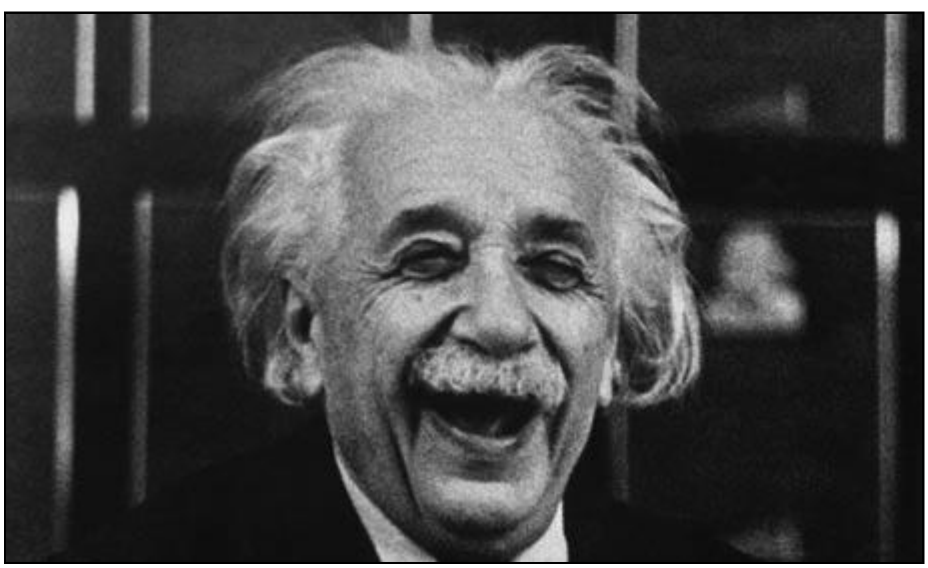
"Imagination is more important than knowledge. For knowledge is limited to all we now know and understand, while imagination embraces the entire world, and all there ever will be to know and understand."

~Albert Einstein



Unipolar Motor

Activity

Two magnets, one from an electromagnet and one from a permanent magnet, interact to spin an object. At first glace, it looks a lot like a unipolar ("one pole") motor, which is totally impossible in the physics world.

Materials

- AA battery
- Small screw
- Wire (small piece)
- One ceramic magnet
- One very strong magnet that is metal-coated so it conducts electricity. Order online here from KJ Magnetics (#DC2).

Experiment

To start with, watch the video for this experiment:

SuperchargedScience.com/savs9.htm

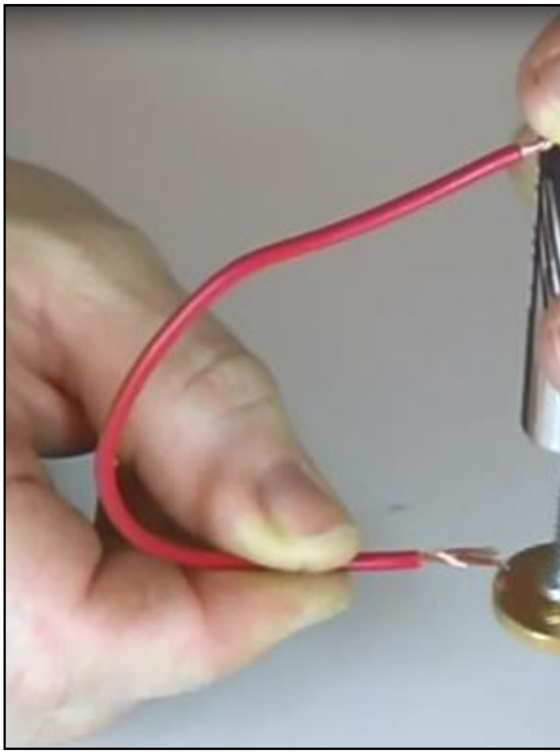
Access code: ESCI

First, let's explore the idea of magnetic poles. Find a ceramic magnet, one you really don't care about, for this first part of the experiment. (We're going to break it, so choose wisely.)

1. Bring your magnet it up close to another magnet to find where the north and south poles are on the spare magnet. Did you find them?
2. Mark the spots with a pen – put a N for north, and a S for south.
3. Now break the ceramic magnet in half. Use a hammer if you need to separate the north from the south pole. You should have one half be a north magnet, and the other a south. Or do you?
4. Try putting the pieces of the magnet back together. What happens? Are your N and S ends still the same, or did one of them switch?

One of the big mysteries of the universe is why we can't separate the north from the south end of a magnet. No matter how small you break that magnet down, you'll still get one side that's attracted to the north and the other that's repelled. There's just no way around this!

If you COULD separate the north from the south pole,



you could point a magnet's south pole toward your now-separated north pole, and it would always be repelled, no matter what orientation it rotated to.

(Normally, as soon as the magnet is repelled, it twists around and lines up the opposite pole and snap! There go your fingers.)

But if it were always repelled, you could chase it around the room or stick a pin through it so it would constantly move and rotate.

Well, what if we sneakily use electromagnetism?

Let's make the motor using an electromagnet and a permanent magnet.

Note that you can use a

metal screw, ball bearing, or other metal object that easily rotates. If your metal ball bearing is also magnetic, you can combine both the screw and the magnet together.

1. Place your strong metal magnet on the head of the screw.
2. Put the point of the screw on the plus end of the battery. Everything should hold together if you've got a nice, strong magnet.
3. Fan the ends of one end of the wire out to make it look like a little paintbrush.
4. Hold the battery in your hand with the negative side up.
5. Take the other end of the wire and press it on the negative end of the battery with your finger. Hold the battery with the rest of your fingers so that the magnet dangles an inch or two above the table.
6. Take the little wire paintbrush end and barely touch the top of the magnet. The magnet and screw should start to spin!
7. **IMPORTANT NOTE:** Do not leave the paintbrush wire attached to the magnet or you will roast your battery (which may explode).
8. You may need to re-center your screw, especially once you really get it going.

What's Going On?

Current flows anytime there is an "electric potential difference", which means anytime you connect a battery, it will cause electricity to move through the wire.

Specifically, it makes charge move through the wire. With this experiment, the charge moves through the wire, screw, magnet (since it's metal-coated), and battery, forming an unusual-looking circuit.

The current from the battery is flowing through the wire, creating a magnetic field around the wire, which interacts with the magnetic field in the gold disk magnet.

Since the wire creates a magnetic field that is perpendicular to the field in the metal-coated magnet, the magnet feels a push, which causes it to rotate.

Famous scientist Michael Faraday built the first one of these while studying how magnetism and electricity fit together.

Exercises

1. What happens if you attach the screw to the other side of the battery?
2. How do you get your motor to spin faster?
3. Does it matter what type of screw you use? What if you try a longer or wider one? Or one made from brass or aluminum?
4. Explain how this works to an adult of your choice, get them to understand it, and then hand them materials so they can build their own and explain it back to you!

Mystery Toy

Activity

A can rolls away from you, and then mysteriously rolls right back! No batteries required. You can easily create one of these mystery energy transfer toys to keep small kids and cats busy for hours.

Materials

- Can with a lid (I used an old baking powder can in the video)
- Small, heavy rock or large nut
- 2 paper clips
- rubber band

Experiment

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

SuperchargedScience.com/savs9.htm

Access code: ESCI

1. You'll need two holes punched through your container, one in the lid and the bottom.
2. Thread your rubber band through the heavy washer and tie it off (this is important!) to secure the object to the rubber band.

3. Poke the ends of the rubber band through one of the holes and catch it on the other side with a paper clip. (Just push a paper clip partway through so the rubber band doesn't slip back through the hole.)

4. Do this for both sides, and make sure that your rubber band is a pulled mildly-tight inside the can. You want the nut or rock to dangle in the center of the can without touching the sides of the container.
5. Now for the fun part… gently roll the can on a smooth floor away from you. The can should roll, slow down, stop, and return to you! If it doesn't, check the rubber band tightness inside the can.

What's Going On?

The hexnut is a weight that twists up the rubber band as the can rolls around it. The motion energy of the can gets transferred and stored in the rubber band. When the rubber band untwists itself and makes the can rotate, the stored up elastic energy gets transferred to kinetic motion energy.

My students have nicknamed potential energy the "could" energy. The battery "could" power the flashlight. The light "could" turn on. I "could" make a sound. That ball "could" fall off the wall. That candy bar "could" give me energy.

Potential energy is the energy that something has that can be released. For example, the battery has the potential energy to light the bulb of the flashlight if the flashlight is turned on and the energy is released from the battery. Your legs have the potential energy to make you hop up and down if you want to release that energy (like you do whenever it's time to do science!). The fuel in a gas tank has the potential energy to make the car move.

Kinetic energy is the energy of motion. Kinetic energy is an expression of the fact that a moving object can do work on anything it hits; it describes the amount of work the object could do as a result of its motion.

The kinetic energy (the rolling motion of the can) transforms into potential (elastic) energy stored in the rubber band the free side twists around.

When the can stops (at the point of highest potential energy, lowest kinetic energy), it reverses direction and retraces its path. This is when the potential energy is being transformed back into kinetic energy. The farther the toy is rolled the more elastic potential energy it stores.

Each time the can rolls back and forth, a little bit of energy is lost to the atmosphere in the form of heat and sound.

Questions to Ask

1. Does it work up a ramp? Does the angle of the incline matter?
2. Does it work better on smooth or rough surfaces?
3. Why does the can stop and reverse direction?
4. What kind of energy does the can have when stopped?
5. What kind of energy does it have when it's at maximum speed?
6. Why does the can eventually slow down and stop moving in any direction?
7. How man you improve this toy so it works better?

FLUORESCENCE

Activity

Lasers emit only one color of light. Why does a rainbow appear when you shine a laser on a scribble drawn by a neon orange highlighter?

Materials

- Laser (green)
- Highlighter (pink or orange)
- Diffraction grating
- White paper

Experiment

To start with, watch the video for this experiment:

SuperchargedScience.com/savs9.htm

Access code: ESCI

When light hits a material, it's either reflected, transmitted, or absorbed. You already know that windows transmit light and mirrors reflect light.

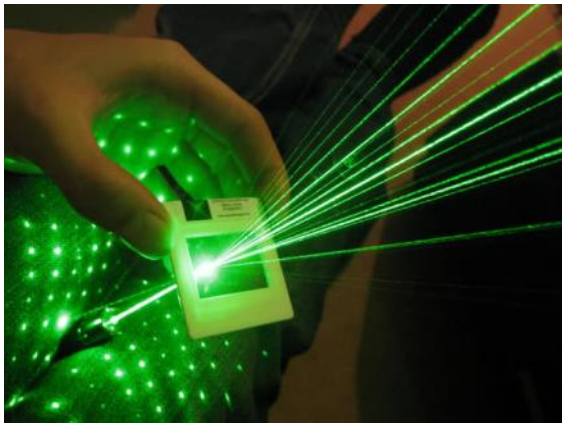
However, certain materials will absorb one wavelength and emit an entirely different wavelength, and when this happens it's called "**fluorescence**".

Let's do an experiment first, and then we'll go over why it does what it does. Here's what you do:

1. Point your laser at the wall, making a bright green dot. (Red lasers won't work with this experiment.)
2. Look at the dot through the diffraction grating. What do you see? How many different colors are there?

(If you don't have a diffraction grating, then simply shine your laser onto a CD and look at the reflected beams.)

We'll do more on diffraction another time, but just note that a diffraction grating is made up of a lot of tiny prisms that un-mix light into its different colors. That's why you see several different dots coming from the laser when you pass it through the diffraction grating.

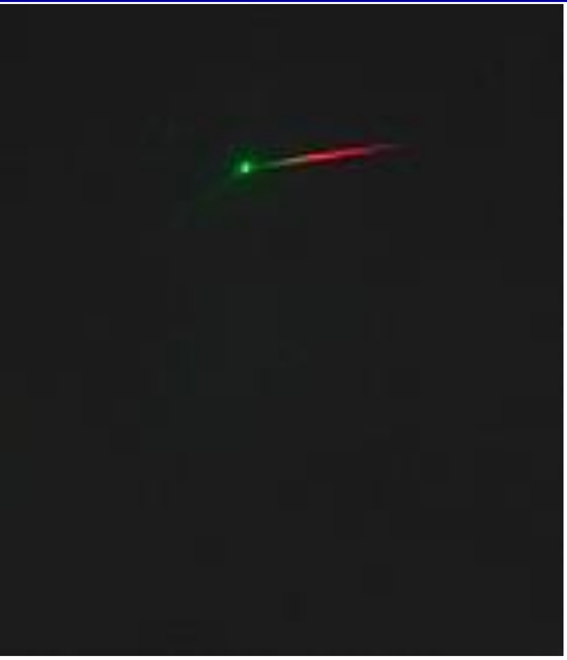


If you look at a candle flame through a diffraction grating, you'll see a whole rainbow, since the white light from a candle is made up of the rainbow. (Image below is a laser through a diffraction grating.)

A laser is one color, **monochromatic ,** so you should expect to see only one color through the diffraction grating.

Now let's try something else...

1. On your white sheet of paper, color an area with your marker.
2. Hold the paper against the wall. You can tape it into place if that makes it easier.
3. Turn off the lights



and point a green laser at the highlighter area you colored in.

4. Look at the dot next to the main dot through the diffraction grating.
5. Do you see more than one color now? Whoa!

What's Going On?

This is a fantastic experiment because it gives you totally unexpected results!

Where did the colors come from when you shined your laser on the highlighter area? And why weren't they present when you just used a plain white wall?

It has to do with something called **fluorescence.** When the green laser hits the orange square, the electrons are excited by the laser and jump up to a higher energy state, and then relax back down.

When they relax down, they release **photons** (light particles) that are made up of several different wavelengths. The diffraction grating makes it possible to see those wavelengths individually as a **spectrum**.

What kind of light is it?

Light bulbs use **incandescence**, meaning that the tungsten wire inside a light bulb gets so hot that it gives of light. Unfortunately, bulbs also give off a lot of heat, too. Incandescence happens when your electric stove glows cherry red-hot. Our sun gives off energy through incandescence also - a lot of it.

On the other end of things, *cold light* refers to the light from a glow stick, called **luminescence**. A chemical reaction (chemiluminescence) starts between two liquids, and the energy is released in the form of light. On the atomic scale, the energy from the reaction bumps the electron to a higher shell, and when it relaxes back down it emits a photon of light.

Phosphorescence light is the 'glow-in-the-dark' kind you have to 'charge up' with a light source. This delayed afterglow happens because the electron gets stuck in a higher energy state. Lots of toys and stick-on stars are coated with phosphorescent paints.

Triboluminescence is the spark you see when you smack two quartz crystals together in the dark. Other minerals spark when struck together, but you don't have to be a rock hound to see this one in action - just take a Wint-O-Green lifesaver in a dark closet with a mirror and you'll get your own spark show. The spark is basically light from friction.

Fluorescence is what you see on those dark amusement-park rides that have UV lights all around to make objects glow.

The object (like a rock) will absorb the UV light and remit a completely different color. The light strikes the electron and bumps it up a level, and when the electron relaxed back down, emits a photon (particle of light).

PHOTOELECTRIC EFFECT

Activity

Using stuff from the trash can, you can recreate the experiment that won Einstein his first Nobel prize that explained the weird effect used in solar cells today.

Materials

- soda or steel can
- paper clip
- sand paper
- tinsel (or aluminum foil and scissors)
- tape
- foam cup
- PVC pipe (any size)
- brown paper bag
- UV shortwave lamp (sometimes called a "germ -free portable lamp")

****ADULT SUPERVISION REQUIRED due to use of a short wave UV lamp.****

Experiment

To start with, watch the video for this experiment:

SuperchargedScience.com/savs9.htm

Access code: ESCI

To get started, follow these simple steps:

Straighten one of the loops of a paper clip into a straight line.

1. Rub the soda or soup can with sand paper to rub off the oxidized layer.
2. Tape tinsel to the straightened end of the paper clip. If you're making your own tinsel, cut thin strips from aluminum foil or Mylar.
3. Tape the other end of the paper clip to the can where you just sanded.
4. With scissors, cut out a section of the bottom of a foam cup to make a trough so that the can sit levelly.
5. Adjust your setup so that the tinsel dangles high enough so it can't possibly touch the can or the tabletop.
6. Now run the PVC pipe through the tinsel. (Nothing should happen yet.)
7. Now rub the PVC pipe with brown paper (like from a grocery bag or lunch bag) . Run the pipe through the tinsel (charging the tinsel.)
8. Now touch the tinsel.

What happened?

9. Repeat step #8, and now touch the soda can. (The tinsel should discharge again, like it did in step 9.)
10. Repeat step #8 again, only this time bring the UV light close (but not turned on) to the soda can as you watch the tinsel. (Be sure that nothing happens yet.)

11. **Using adult supervision, turn on the short wave UV lamp. NEVER look into the UV lamp** (It's like getting a sunburn on your eyes).
12. Aim the lamp only at the soda can and turn it on. Hold it in position for a few minutes and observe what happens.

What's Going On?

Einstein received a Nobel Prize for figuring out what happens when you shine blue light on a sheet of metal. When he aimed a blue light on a metal plate, electrons shot off the surface.

When Einstein aimed a red light at the metal sheet, nothing happened. Even when he cranked the intensity (brightness) of the red light, still nothing happened. So it was the energy of the light (wavelength), not the number of photons (intensity) that made the electrons eject from the plate. This is called the 'photoelectric effect'. Can you imagine what happens if we aim a UV light (which has even more energy than blue light) at the plate?

This photoelectric effect is used by all sorts of things today, including solar cells, electronic components, older types of television screens, video camera detectors, and night-vision goggles.

This photoelectric effect also causes the outer shell of orbiting spacecraft to develop an electric charge, which can wreck havoc on its internal computer systems.

A surprising find was back in the 1960s, when scientists discovered that moon dust levitated through the photoelectric effect. Sunlight hit the lunar dust, which became (slightly) electrically charged, and the dust would then lift up off the surface in thin, thread-like fountains of particles up ¾ of a mile high.

What happens if you charge the soda can positively?

3 Polarizier Expeirment

Activity

Shine a light through polarized sunglasses and the brightness decreases. If you hold two pairs of sunglasses one way, the light then is *completely* blocked! Not only that, but when you insert a third pair in between the two allows light to pass through again! Spooky!

Materials

- Three pairs of polarized sunglasses (or three lenses from two old pairs)
- Sunny window

Experiment

To start with, watch the video for this experiment:

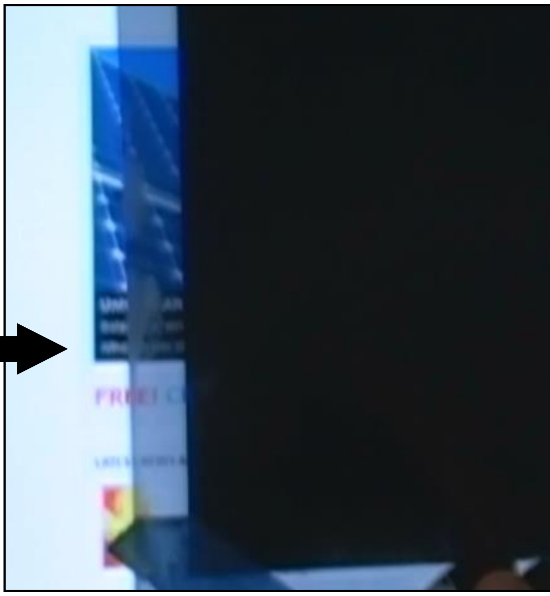
SuperchargedScience.com/savs9.htm

Access code: ESCI

1. First, hold up one polarizer up between your eyes and the window. Notice how dim just one lens makes the incoming light from the window to your eye.
2. Rotate that polarizer 90°. Does the light intensity (brightness) change? (It should not.)

3. Now stack a second polarizer in front of the first, so you're looking through two polarizers to get to the window. (The image above shows a computer screen with two polarizers on the screen. The polarizers are in alignment with each other so that some light gets through.)
4. Rotate <u>one</u> of the polarizers 90° so that the light is completely blocked. You should not be able to see the window at all through the polarizers. The image at the right shows the top polarizer rotated 90° and blocks all the light from the computer screen.
5. Repeat steps 3 and 4 and play with it a bit, until you're comfortable with the steps, then move onto the next step.

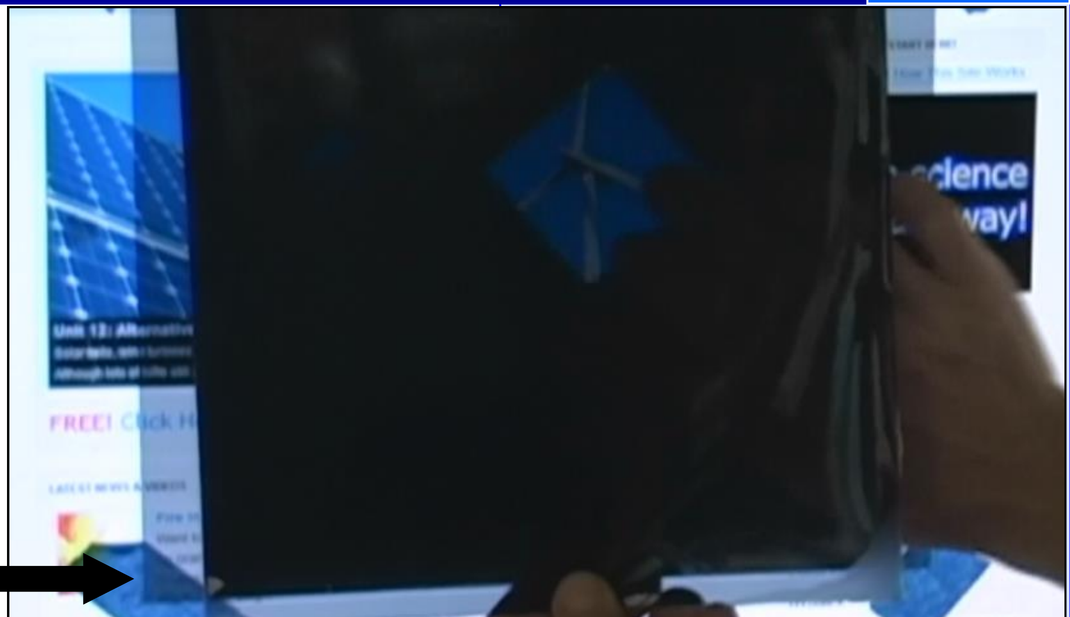
Imagine a picket fence—the kind with spaces between the wood. The polarizers are like picket fences in that they block out light that is in a



different direction. When you rotate one of the polarizers so that it's 90o from the first one, it's like rotating one picket fence 90o so that there are now very few gaps for light to get through.

Make sense so far? Now let's add the last piece:

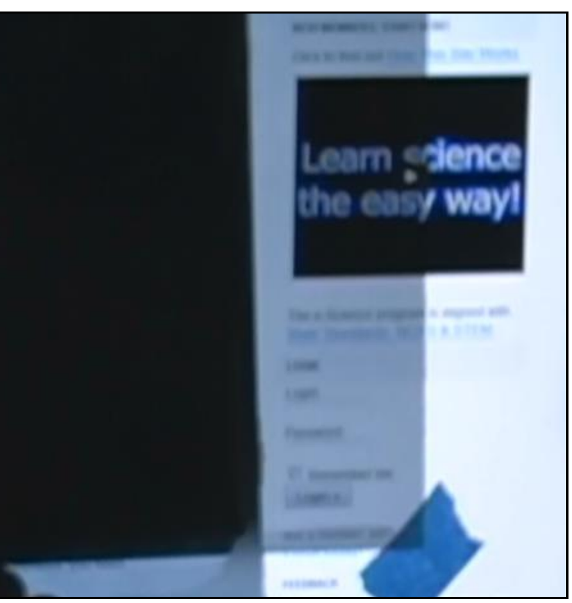
Insert a third polarizer in between the first two at a 45° angle to each of them, like in the image at the right. What do you see happen?



What's Going On?

The secret to making sense of this mystery is taking a look at one polarizer at a time.

Imagine having a polarizer that has it's lines running vertically, like a picket fence. Any light that is also vertical will be able to pass through.



Sunlight is unpolarized, meaning that it's in all directions. When it hits the first polarizer, only light that has components in the up-down vertical direction may pass through.

So if the incoming light is all completely vertical, then all the light will pass through and not lose any brightness at all.

If all the incoming light is horizontal, then none of it will pass through, since it's all blocked. What if the light is at a 45° angle?

Well, some of the light passes through and the rest does not, since light in this orientation has both vertical and horizontal components. Only the vertical component of the light is allowed to pass through the first filter, which in our example is about 71% of the light may pass through.

When that light hits the second filter, which is at a 45° angle from the first polarizer, again some of it is allowed to pass through and the rest is blocked.

The same is true when the light hits the third polarizer. Some passes through and the rest is blocked. When you total it up, about 25% of the original incoming light passes through all three filters.

When one polarizer is at a 90° angle from the second, then all the light is blocked, because none of the light coming out of the first polarizer has any components that are aligned with the second polarizer.

TEACHING SCIENCE RIGHT

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

But teaching homeschool 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 lets 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 homeschool 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, we regularly give free online tele-seminars for parents. To learn more about them, visit:

SuperchargedScience.com/freeteleclass.htm

My hope is that you have some new tools in your homeschool parent 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 child that it takes to homeschool. I know it's like a wild roller coaster ride some days, but I also know it's worth it. Have no doubt 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