Homeschool Science Activity Manual & Video Guide

Vol. 4

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

Supercharged Science

www.SuperchargedScience.com

A collection of exciting science experiments that work you through physics, electricity, air pressure, and present project ideas guaranteed to get your kids crazy-wild about science. Designed by real scientists for our future generation.

Thank You for purchasing the *Homeschool Science Activity Manual*. 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/scienceguide425.htm

Access code: ESC4

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.

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

STOMP ROCKETS

Activity

These rockets use air pressure to launch your lightweight rocket skyward.

Using simple materials, you'll not only be able to make your launcher in minutes, but also as many rockets as you want.

The first time I flew these, they got stuck on the roof! So be prepared with a few extras just in case.

Materials

- 2L soda bottle
- 1/2″ PVC pipe
- duct tape
- pen or pencil
- index cards
- sheets of paper
- bicycle inner tube

Experiment

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

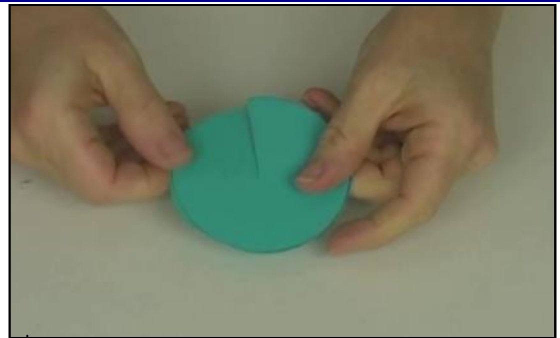
SuperchargedScience.com/scienceguide425.htm

Access code: ESC4

Here's what you do to make the launcher and rockets:

1. Cut the bike tube in half. Save one of the halves for another project.

2. Stretch one end of the half-tube over the end of



the PVC pipe and secure with duct tape. Make sure there aren't any air leaks!

3. Remove the cap from the soda bottle. Stretch the other end of the tube over the top of bottle and secure with duct tape (again, make sure this is air tight!)

4. Roll a sheet of paper around the PVC tube and use tape to secure it into shape. Slide the tube off the PVC. This is your rocket body.

5. Cut a 2 inch circle from a sheet of paper. Cut a slit halfway across the diameter (see image above) and slide one flap over the other to form a cone shape. Use tape to secure into shape.

6. Attach the cone to the rocket body. Make sure this connection is air-tight.

7. Cut out several triangle fins and attach to the rocket with tape. Your rocket is ready for launch!

8. Slide the rocket onto the PVC pipe.

9. Stomp HARD on the bottle. Your rocket will blast high in the sky!

What's Going On?

Newton's Third Law states that all forces come in pairs.

When you push against the wall, the wall pushes back against you with an equal amount of force (or push).

When a rocket fires, the rocket moves forward as the exhaust gases move in the opposite direction.

An inflated balloon will zip through the air as the air escapes. For every action there is an equal and opposite reaction.

The higher pressure is generated inside the bottle when you stomp on it. Because air is a gas, it's also compressible, which means you can pack the same volume of air into a tighter space.

When you decrease the volume, you increase the pressure. Since higher pressure always pushes, the rocket feels a push as soon as the bottle collapses down, which moves the rocket forward.

In 1666 Newton did his early work on his Three Laws of Motion. To this day, those laws still hold true. There has been some allowances for really big things (like the cosmos) and for really small things (like the atom). Other than that, Newton's Law's are pretty much dead on.

Newton's Laws are all they used to get the first man to the moon. They are an amazingly powerful and wonderful area of physics.

I like them because evidence of them is everywhere. If something moves or can be moved, it follows Newton's Laws.

You can't sit in a car, walk down the road, drink a glass of milk, or kick a ball without using Newton's Laws.

I also like them because they are relatively easy to understand and yet open up worlds of answers and questions.

They are truly a foundation for understanding the world around you.

If I asked you to define the word force, what would you say? You probably have a feeling for what force means, but you may have trouble putting it into words.

It's kind of like asking someone to define the word "and" or "the". Well, this lesson is all about giving you a better feeling for what the word force means.

The simplest way to define force is to say that it means a push or a pull like pulling a wagon or pushing a car. That's a correct definition, but there's a lot more to what a force is than just that.

This experiment is a wonderful way to show kids *Newton's Laws of Motion* as well as the concept that *higher pressure always pushes*.

When you stomp on the rocket, the higher pressure pushes on the rocket with a force. The harder you stomp, the higher the rocket goes. If you were to hold your rocket in place as you stomp, you could feel the force with your hand.

Questions to Ask

1. Does it matter how many fins you use?
2. What happens if there's an air leak in the system?
3. How can you make the rocket fly *higher*? Name three different ways.

Robot Cable Car

Activity

We're going to make a durable cable car that can travel as long as you have string for it to move along!

It's really a cool and simple project, and you can add cups or berry baskets below to transport cargo.

Materials

- 6 popsicle sticks
- AA battery case with 2 batteries
- two 3VDC motors
- Tack
- string
- scissors
- hot glue gun
- glue stick for glue gun and also another one for use in the project itself (watch the video)
- four alligator clip wires

Experiment

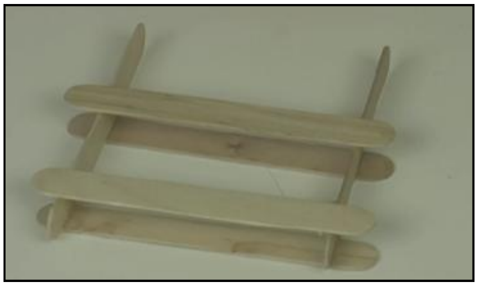
To start with, watch the video for this experiment:

SuperchargedScience.com/scienceguide425.htm

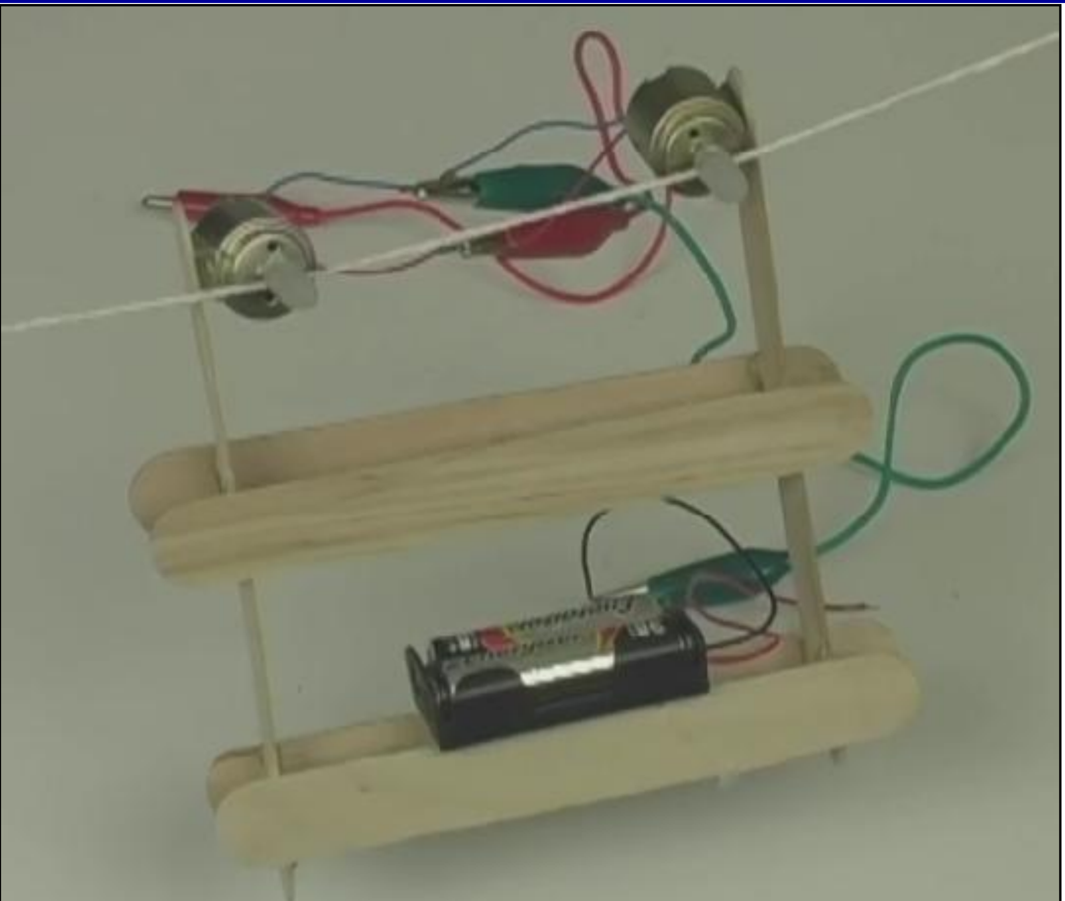
Access code: ESC4

This simple activity is easy to build, but the video really shows you how to put it together. Here are the main steps of the project:

1. Cut two 1" pieces from a glue stick (the kind that goes into the end of a hot glue gun).
2. Use a tack to make a hole in one end of both glue stick nubs.
3. Insert the motor shaft into the hole made by the tack. Do this for both motors. The glue stick nub should be firmly attached to the motor shaft. You will not need to add any glue to make this stick.
4. Construct the frame using tongue-depressor sized popsicle sticks



   (see image below).
5. Hot glue the motors to the inside edges of the structure as shown in the image. Don't get any hot glue in the air vents of the motors.
6. Glue the battery pack as shown in the image.
7. Use alligator clips to wire up the battery pack to the motors as follows:
8. Connect one alligator clip lead to the red wire from the battery pack. The other end of the wire goes to one of the tabs on the back of a motor.
9. Connect a second wire from the red wire on the battery pack (again) to a tab on the second motor.
10. Connect a third wire from the black wire from the battery pack to an available motor tab.
11. Connect the fourth wire from the black battery pack wire (again) to the last available motor tab.
12. Insert your batteries and make sure that both motors are going in the same direction. If not, switch the position of the two wires on the back of one of the motors. Check the motor direction again.
13. Run a tight string through your room. Place the car on the string (the string goes



in the space between the glue stick nub). Insert the batteries and watch it zip across the room!

14. You can add berry baskets to hold cargo after you've successfully made a trip across the room.

What's Going On?

A cable car transports people or things in a vehicle that uses a strong cable to pull at a steady speed.

Also called aerial lift, aerial tramway, or gondola, these are different from the cable cars associated with San Francisco, which use buried cables to move the car up steep streets.

The world's longest working cable car is in Sweden and covers 26 miles.

Sweden used to operate a 60-mile cable car, but only a 8.2 miles (13.2 km) of it still works today, however this section is the longest passenger cable car in operation currently.

You've just build a small model of a cable car that really works.

How can you make it faster? Stronger?

Science Equipment: How to Avoid Getting Ripped Off

So often kids get excited about a new telescope, only to get frustrated shortly after opening the box, and eventually not only trashing the telescope but also their whole interest in science.

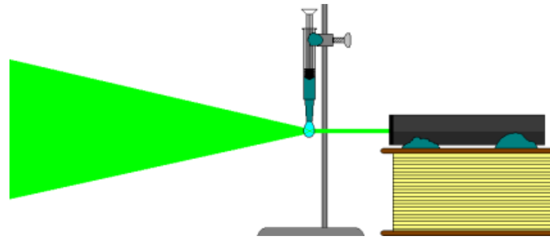
Getting a cheap telescope or microscope is the fastest way to kill your child's passion for science. You'll find when you invest up front, the rewards just keep coming for years after. Here are my personal recommendations for the three biggies all families serious about science should have:

Binoculars Orion's 10×50 UltraViews are outstanding for terrestrial and astronomy viewing. Also get an L-adapter and camera tripod for longer viewing sessions. Expect to pay at least $140 for a pair of binocs worth keeping.

Microscope Your best option is a student-grade *compound* microscope with at least three objectives (40X, 100X, 400X) with a mechanical stage, dust cover or box, both a mirror and a light (so you can do both outdoor and indoor work), and a set of slides with cover slips. Expect to pay at least $130.

Telescope A scope is useless unless you know where to point it, so I strongly encourage you to get the binoculars first. Visit your local astronomy club to find the best scope for your family's favorite celestial objects! Don't buy anything under $400. (Check my website for scope recommendations.)

LASER MICROSCOPE



Activity

Did you know that you can use a laser to see tiny paramecia in pond water?

We're going to build a simple laser microscope that will shine through a single drop of water and project shadows on a wall or ceiling for us to study.

Materials

- red laser (watch video for laser tips)
- large paperclip
- rubber band
- stack of books
- white wall
- pond water sample (or make your own from a cup of water with dead grass that's been sitting for a week on the windowsill)

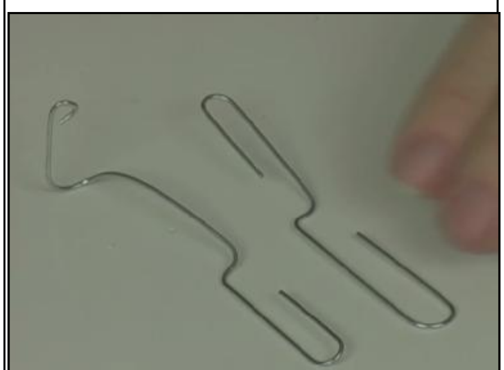
Experiment

To start with, watch the video for this experiment:

SuperchargedScience.com/scienceguide425.htm

Access code: ESC4

1. Get a sample of pond water. You can get some from a nearby still-water pond or puddle, or grow your own by adding grass clippings and fallen leaves to a jar of water and leave it on a windowsill for a week.
2. Bend your paperclip into a shape like the one on the right in the image below. Now create a small loop like the one on the left. This loop will hold your drop of water in the laser beam.



3. Wrap your rubber band several times around the laser pointer.
4. Insert the non-loop end under the rubber band so that when you turn on your laser, the beam goes right through the paper clip loop. You will need to bend and tweak the paper clip position to make this work.
5. Do not rubber band the laser in the 'on' position. Lasers are actually meant to have a momentary 'on' that gets pushed only when needed so the laser doesn't burn out too quickly.
6. Dip the loop (*not* the laser) in the water sample.
7. Turn off the light and turn on your laser and aim it at the wall. Steady the laser on a pile of books.
8. Depending on your sample, you may be able to see protists, paramecium, and more!
9. To focus the image, adjust your distance from the wall. For greater magnification, pull further away from the wall.

What's Going On?

Inside your loop, you have a drop of water that is fatter in the middle than at the edges.

This makes the water act as a lens as it bends the light passing through it, just like a hand held magnifying lens.

By shining a laser though a drop of water, we can see the shadows of objects inside the water.

It's like playing shadow puppets, only we're using a highly concentrated laser beam instead of a flashlight.

If you're wondering how a narrow laser beam spreads out to cover a wall, it has to do with the shape of the water drop. Water has surface tension, which makes the water want to curl into a ball shape. The ball thins out where it's attached to the wire and bulges up in the center.

This makes the water act like a convex lens, which magnifies the light and spreads it out.

As the list passes through the water, it changes direction, the same way sunlight goes through a prism.

A green laser will give you a brighter image, but a red laser will work just as well in a dark room.

Questions to Ask

1. Does this work with other clear liquids?
2. What kind of lens occurs if you change the amount of surface tension by using soapy water instead?
3. Does the temperature of the water matter? What about a piece of ice?
4. Does this work with a flashlight instead of a laser?

Do lasers hurt eyes?

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

You'll often see warnings about never pointing telescopes, magnifying lenses, or lasers into your eyes.

If you've never used a hand-held magnifying lens to focus the energy onto a dead leaf, you have to give it a try! Just be sure to do this on a flame-proof surface (like cement) with adult help.

This activity will show you the REAL reason that you should never look at the sun through anything that has lenses in it.

When you concentrate the sun's energy to a single point, the leaf burns. This is exactly what happens at the back of your eye with focused sunlight and laser beams. Never look at intense light with your naked eyes.

Cloud Tracker

Activity

We're going to learn how to build a weather instrument that will record whether (weather?) the day was sunny or cloudy using a very sensitive piece of paper.

This is a great addition to your home weather station!

Materials

- Sunprint paper
- Film canister/soup can
- Drill with drill bit
- Scissors
- Sunlight

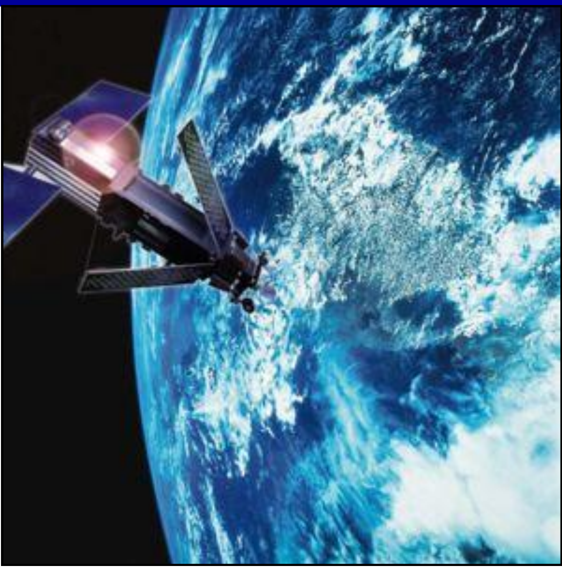
Experiment

To start with, watch the video for this experiment:

SuperchargedScience.com/scienceguide425.htm

Access code: ESC4

1. Work with the sunprint paper in a dark room, not in direct sunlight.
2. If you are using a soup can, remove the top, empty the contents, wash and clean it out.
3. Cut a piece of sunprint paper to a size that will line the inside of the can. You only need it to cover one half of the can as shown in the image below.
4. Drill a hole in the side of the canister or soup can. The smaller the hole, the finer the imprint line on your paper. Try starting with an 1/16" to 1/8" hole. You can increase the size the following day if needed.
5. Insert the sunprint paper to the side of the can opposite the hole. Sunlight will stream through the hole and onto the paper.
6. Place the cap on the can or tape the lid back on and seal against any stray light leaks.
7. Leave the can outside in the morning. Aim the hole straight up to the sky with the can angled toward the sun. (For folks in the northern hemisphere, prop the can so that the hole in faces a bit south.) Make sure the wind or active animals won't disturb the can during the day. Also make sure the can is in a position where it will be exposed to full sun all day long.
8. In the evening, grab the can and bring it indoors.
9. Pull the paper out of the can and look at the arc sketched across the paper. This is the path the sun traced through the hole. Any missing spots in the arc mean



that there was no sunlight at that time. If your can was in direct view of the sun all day, then these blank areas are when clouds blocked the sun. The highest point of the arc is at noon. Can you estimate the times on the arc?

10. Set the print according to the directions on the package so that ambient light doesn't wash out your sun trace.

What's Going On?

We've used light-sensitive paper to record the path of a narrow beam of sunlight as the sun arcs across the sky.

As the sun moves, the path of light moves, and the light on the paper actives a chemical reaction which results in a color change on the paper itself.

The paper from a sun print kit has a very special coating that makes the paper react to light.

Most sunprint kits use set of light-sensitive chemicals such as potassium ferricyanide and ferric ammonium citrate to make a cyanotype solution. The paper changes color when exposed to UV light.

In fact, you can try exposing the paper to different colors and see which changes the paper the most over a set amount of time!

The last step of this chemical process is to 'set' the reaction by washing it in plain water – this keeps the image on the paper so it doesn't all disappear when you hang it on the wall.

After the paper dries, the area exposed to UV light turns blue, and everything shaded turns white.

You can use sun print paper to test how well your sunblock works – just smear your favorite sunscreen over a sheet (or put a couple dabs of each kind) and see how well the paper stays protected: if it turns white, the light is getting through. If it stays blue, the sunscreen blocked the light!

One of the most remarkable images of our planet has always been how dynamic the atmosphere is . A photo of the Earth taken from space usually shows swirling masses of white wispy clouds, circling and moving constantly.

So what are these graceful puffs that can both frustrate astronomers and excite photographers simultaneously?

Clouds are frozen ice crystals or white liquid water that you can see with your eyes.

Scientists who study clouds go into a field of science called nephology, which is a specialized area of meteorology.

Clouds don't have to be made up of water – they can be any visible puff and can have all three states of matter (solid, liquid, and gas) existing within the cloud formation.

For example, Jupiter has two cloud decks: the upper are water clouds, and the lower deck are ammonia clouds.

What happens if you drill a larger size hole? Two holes? Use a lens in front of the hole? Leave it out all night on a full moon? Try different colors of light bulbs? Different kinds of light bulbs?

Mousetrap Race Car

Activity

A super-fast, super-cool car that uses the pent-up energy inside a mouse trap spring to propel a homemade car forward.

While normally this is reserved for high school physics classes, it really is a fun and inexpensive experiment to do with kids of all ages.

Materials

- Mousetrap (NOT a rat trap)
- Foam block or piece of cardboard
- Four old CDs
- Thin string or fishing line
- Wood dowel or long, straight piece from a wire coat hanger (use pliers to straighten it)
- Straw
- Two wood skewers (that fit inside straw)
- Hot glue gun
- Duct tape
- Scissors
- Four caps to water bottles
- Drill and drill bits
- Razor with adult help

Experiment

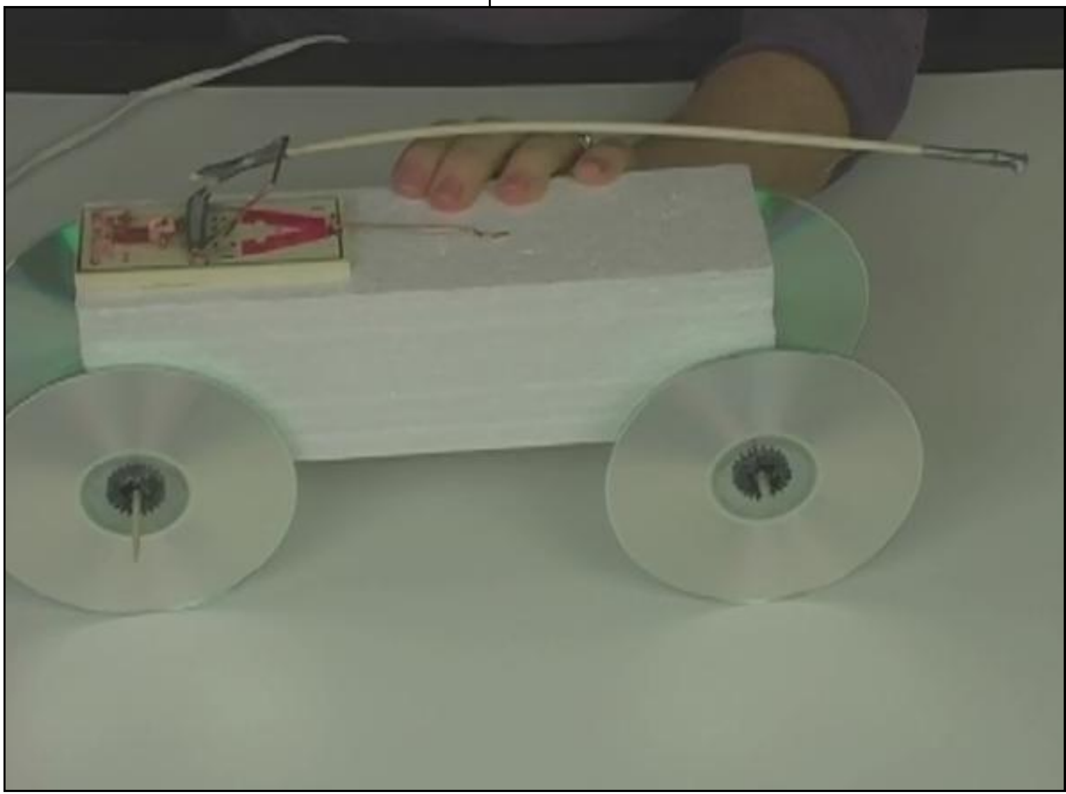
To start with, watch the video for this experiment:

SuperchargedScience.com/scienceguide425.htm

Access code: ESC4

Since the directions for this project are complex, it's really best to watch the instructions on the video. Here are the highlights:

1. Tape the dowel to the outside of the wire on the mousetrap car (image below). When the mousetrap sweeps to close, the dowel whips through the air along with it in an arc.
2. Attach a length of fishing line to the other end of the dowel. Don't cut the fishing line yet.
3. Attach one straw near each end of a block of foam using hot glue.
4. Insert a skewer into each straw. Insert a wheel onto each end of the skewer. This is your wheel-axel assembly.
5. The wheels on one side should be close to the straw, the wheels on the other end should have a 1/2" gap.
6. Wind the free end of the fishing line around the axel with the gap.
7. Load the mousetrap car by spinning the back



wheels as you set the trap.

8. Trigger the mousetrap with a pen (never use your fingers!). The dowel pulls the fishing line, unrolling it from the axel and spinning the wheels as it closes.

What's Going On?

This is a great demonstration of how energy changes form. At first, the energy was stored in the spring of the mousetrap as *elastic potential energy*, but after the trap is triggered, the energy is transformed into *kinetic energy* as rotation of the wheels.

Remember with the First Law of Thermodynamics: energy can't be created or destroyed, but it CAN change forms. And in this case, it goes from elastic potential energy to kinetic energy.

There's enough variation in design to really see the difference in the performance of your vehicle. If you change the size of the wheels for example, you'll really see a difference in how far it travels. If you change the size of the wheel axle, your speed is going to change. If you alter the size of the lever arm, both your speed and distance will change.

Energy has a number of different forms; kinetic, potential, thermal, chemical, electrical, electrochemical, electromagnetic, sound and nuclear. All of which measure the ability of an object or system to do work on another object or system.

In the physics books, energy is the ability to do work. Work is the exertion of force over a distance. A force is a push or a pull.

So, work is when something gets pushed or pulled over a distance against a force.

Work = Force x Distance

Let me give you a few examples: If I was to lift an apple up a flight of stairs, I would be doing work. I would be moving the apple against the force of gravity over a distance. However, if I were to push against a wall with all my might, and if the wall never moved, I would be doing no work because the wall never moved. (There was a force, but no distance.)

Another way to look at this, is to say that **work is done if energy is changed**. By pushing on the non-moving wall, no energy is changed in the wall. If I lift the apple up a flight of stairs however, the apple now has more potential energy then it had when it started. The apple's energy has changed, so work has been done.

All the different forms of energy can be broken down into two categories: potential and kinetic 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.

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 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 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/parents-reg.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 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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