Science Activity & Video Series

Volume 8: Flight Edition

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 work you through aerodynamics, introduce you to rocketry, and present project ideas 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/savs8.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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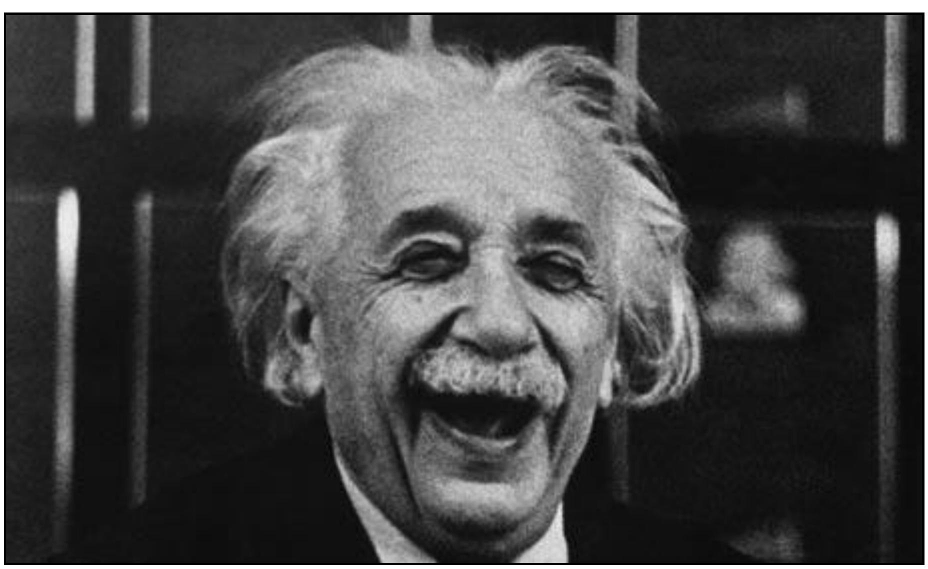
"Imagination is more important than knowledge. For knowledge is limited to all we now know and understand, while imagination embraces the entire world, and all there ever will be to know and understand."

~Albert Einstein



FLYING MACHINES

Activity

You're going to build several different flying machines and observe the balance between the four aerodynamic forces to get you thinking about how and why things fly.

Materials

- Several sheets of paper
- Paper clips
- Tape and scissors
- Measuring tape
- Stopwatch

Experiment

To start with, watch the video for this experiment:

SuperchargedScience.com/savs8.htm

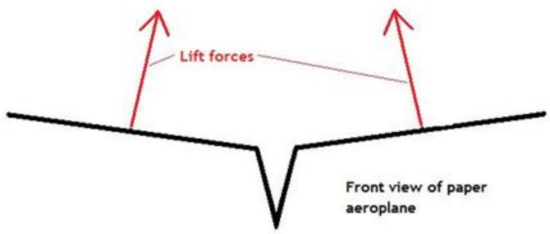
Access code: ESCI

You're about to build several different flying machines! We're going to start with something pretty basic.

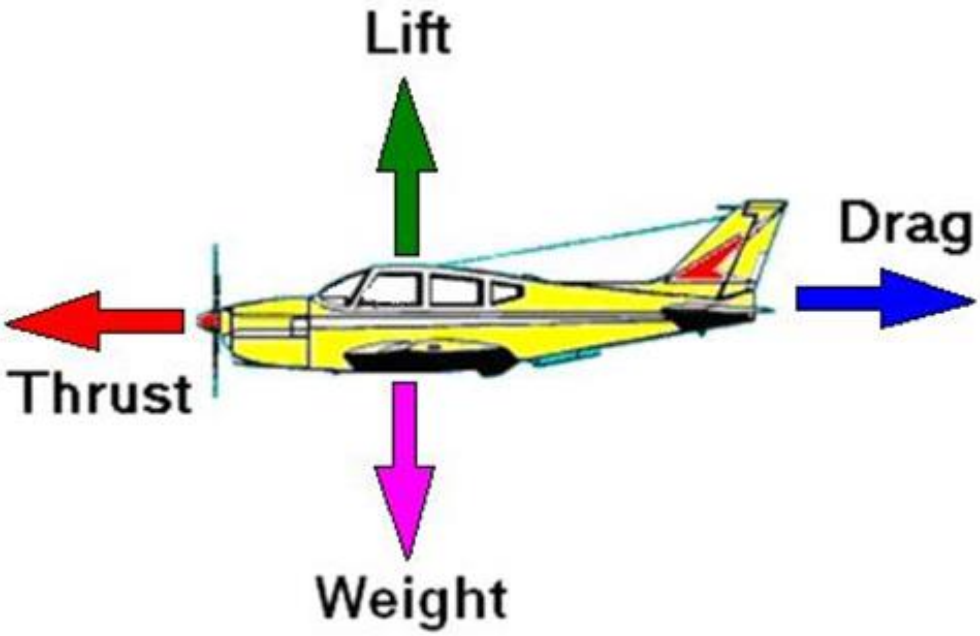
1. Start with a single sheet of paper, hold it up, and then let it go. Record your observations in the data table.
2. Now fold over one of the edges about an inch, and then let it go again. Was there a difference? Record this in your data table.
3. Fold over the edge again, so now there are two folds on your sheet of paper. Hold it up and let it go. Any difference?
4. Fold over the edge a third time, creasing well. Hold it up and let it go. Any difference?
5. Clip 2 large paperclips (or 5-6 small) onto the folded edge to increase the weight. Hold it up and let it go. Was there any difference now?
6. Now you try… see how you can fold, roll, cut, tape, split, curl, and tuck to make the perfect flying machine, but remember, only change one thing at a time so you know which change had which effect on your design. You can use string, rubber bands, straws, toothpicks, and add passengers (jelly beans or popcorn kernels).
7. Track your results in your data table, just like a real scientist! Make a data table by tracking the type of airplane, how long it flew, how far it flew, and anything else you observed!

What's Going On?

The four fundamental forces on an airplane are lift, weight, thrust, and drag. There's a balance between lift and weight, as well as between thrust and drag. Too heavy of an aircraft, and it can't sustain flight in the Earth's gravitational field. If the engine's too small to generate enough thrust in the Earth's atmosphere, then it's not going anywhere. Any flying object must deal with finding a balance between these four forces.



TIP: If your flying machine doesn't work right, see if you can figure out exactly it is doing (or not doing), and then take a more careful look at how it's constructed. Focus on watching what happens when you make small changes, and try to change only one thing at a time.



Questions to Ask

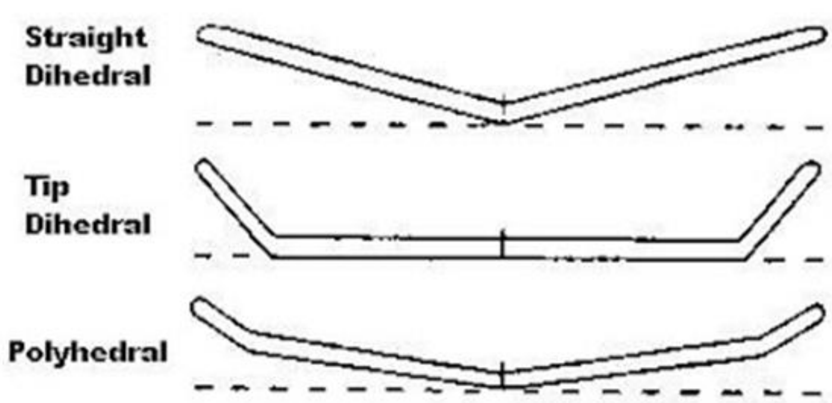
1. If your plane takes a nose dive, you should try:

a. changing the elevators by pinching the edges
b. change the dihedral angle
c. change how you throw it
d. all of the above

2. What are the four forces that act on every airplane in flight?

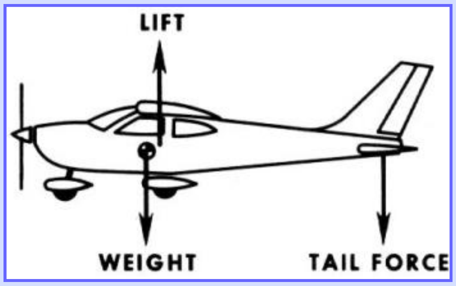
3. Draw a quick sketch of your plane viewed from the front with a positive dihedral.

4. If you were designing your own "Flying Paper Machine Kit", what would be inside the box?



Stability of Flight: An airplane two key points that you need to know about in order to have stable flight.

Those points are the Center of Gravity (or Weight) and the Center of Lift (or Pressure). If the Center of Gravity (CG) is too far back, or the Center of Lift (CL) is too far forward, the airplane is not going to be stable when it flies.



For example, if the CL is forward of the CG, the plane will always "nose up", which causes the airplane to lose lift. Most planes are designed to have their CG slightly forward of the CL to create a "nose down" tendency, and is a safety feature in flight.

Finding the CG: Balance your plane on the tip of a pencil. Mark the point as CG.

Finding the CL: Using a fan to blow up under your airplane, put a finger on the top surface of your plane and find the point where you can hold the plane in the airflow with only the tip of your finger. This is your CL.

Balsa Planes

Activity

Every flying thing, whether it's an airplane, spacecraft, soccer ball, or flying kid, experiences four aerodynamic forces: lift, weight, thrust, and drag.

Materials

- Balsa wood plane (about $2 from a toy store)
- Additional piece of balsa wood
- Razor or scissors
- Paperclips
- Rubber bands
- Clay (optional for weight on the nose)

Experiment

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

SuperchargedScience.com/savs8.htm

Access code: ESCI

1. Punch out the parts on the flyer, separate all the parts, and detach the metal nose-tip if included.
2. Grab just the wing section and throw it as if you were attempting to make them fly on their own. Did you see how fast it somersaults?
3. Now attach the wings to the body and give it a good throw. Did the somersaults get faster or slower? The body should give the wings a bit more stability, but we need more stabilizers to keep our passengers from getting sick.
4. Add the elevator (horizontal tail part). Now throw it, but when you do, give it a twist to one side. Can you get it to "skid" in the air? Did the somersaults stop? Now we need to do something about that skidding problem (called 'yawing' in airplane-speak).
5. Here are two additional variations you can test:
6. First, add the rudder (vertical tail piece). Throw it again, and notice what initially happens. It will probably pitch up, stall, and fall out of the sky to the ground.
7. NOTE: When flying, a 'stall' doesn't have anything to do with the engine, but rather it means the airflow over the wings isn't sufficient to keep the airplane flying.
8. Next place a fingertip on the underside of the body. Where does the plane balance now? Where is most of the weight? If you've left off the nose weight, you know now what you need to do!
9. Add the nose-clips to balance your weight and give it a good, hard throw! Your plane should soar across the room. If not, you'll need to do a bit more tweaking with the design as described above.

What's Going On?

An airplane uses a propeller or jet engine to generate thrust. The wings create lift. The smooth, pencil-thin shape minimizes drag. And the molecules that make up the airplane attribute to the weight.

Think of a time when you were riding in a fast-moving car. Imagine rolling down the window and sticking out your hand, palm down. The wind slips over your hand. Suppose you turn your palm to face the horizon. In which position do you think you would feel more force against your hand?

When designing airplanes, engineers pay attention to details, such as the position of two important points: the center of gravity and the center of pressure (also called the center of lift).

On an airplane, if the center of gravity and center of pressure points are reversed, the aircraft's flight is unstable and it will somersault into chaos. The same is true for rockets and missiles!

Add the nose-clips to balance your weight and give it a good, hard throw! Your plane should soar across the room. If not, you'll need to do a bit more tweaking with the design as described above.

Questions to Ask

1. Why do you need wings on an airplane?
2. Where is most of the weight on your plane?
3. What happens if you add a "passenger", like a M&M? How does it affect the flight? What can you do to re-stabilize the airplane's flight?
4. Notice how the wings can slide forward or back in their slot (if not, use a sharp knife to widen the slot do they can). What is the best position for the wings?

What IS Science?

Science is more than a classroom… it's actually pretty difficult to define. Science is not about what we know, but rather about how we face what we *don't* know.

It's not a textbook of principles, set of rules, or collection of factoids. It's a process, a *thing* you do.

Science is what happens when you ask questions, get back answers, and try to figure out and make sense of it all. There are many different ways to do this, the *Scientific Method* is only one of the ways of sorting and sifting through the information as you go along.

Believe it or not, there's a straightforward method to doing science. You can't just sit around and argue about how things work, but you actually have to do experiments and be able to measure your results.

And other people have to be able to get those same results on their own, too!

Learn more about how to do real science with the e-Science Online Program: www.SuperchargedScience.com

ROCKETS

Activity

You're going to build several different find designs on your rocket body to see how it affects the flight of your rocket.

Materials

- Sheet of paper
- Two straws (one fits inside the other)
- Tape and scissors
- Measuring tape
- Stopwatch

Experiment

To start with, watch the video for this experiment:

SuperchargedScience.com/savs8.htm

Access code: ESCI

You're about to build several different rocket designs.

1. Start with a rocket that doesn't have any fins. How well does it fly?

2. Now add two fins across from each other on the body tube. How well does it fly now?

3. Add a couple more fins and notice any changes to your rocket's flight.

4. After you've played with the experiment a bit, see if you can make the perfect rocket that goes the furthest, but remember, only change one thing at a time so you know which change had which effect on your design.

5. When you're ready, use the data table to track your results, just like a real scientist!

What's Going On?

Rockets are vehicles that launch people and payloads into space. Newton's Third Law of Motion is the principle of action and reaction.

With rockets, the action is the force generated by the exhaust gases shooting out the back end of the rocket through the nozzle. This force moves the rocket in the opposite direction.

Rockets need fins for flight stability. During flight, a model rocket can wobble off course by wind. For a rocket to maintain stable flight, the center of gravity (CG) must be forward of the center of pressure (CP).

If the nose of the rocket tips to the side during coasting or powered flight, the lift and drag forces move the nose back to the flight direction, meaning that the tail section of a stable rocket will swing the nose back to upright position.

There is a simple test you can do to test to see if your rocket is stable. Tie a string around the body at the CG point.

(For a model rocket like *Estes*, make sure you've prepared it for launch, so the engine, wadding and parachute are on board.)

Swing the rocket around your head in a circle. The nose points in the direction of rotation for a stable rocket. Unstable rockets will wobble, spin sideways, or go tail-first.

You can fix any stability problems by lowering the center of pressure (make the fins bigger) or by moving the CG forward (adding weight to the nose).

Questions to Ask:

1. If your rocket flips end over end during flight, what should you try? (Change the number of fins, add weight to the nose, or all of the above?)

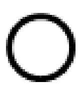
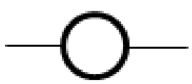
2. What are the four forces that act on every object in flight?

3. Draw a quick sketch of your best rocket:

4. Do fins provide lift for a rocket? Why or why not?

5. What happens if you add wings to near the front end of the rocket (called *canards*)? Or glue the fins on all slanted the same way? How does this affect the flight of the rocket?

Rocketry Data Table

Type of Airplane *(Draw fins as seen from back of rocket)*	**Time Aloft** *(units?)*	**Distance Traveled** *(units?)*	**Stability Observations**
No fins 			
Two fins 			

Slingshot Rockets

Activity

This project is simple, yet highly satisfying. The current distance record is 74 feet… can you beat that?

Make sure you launch these UP, not horizontally!

You only need three items, all of which are in your house right now...

Materials

- Sheet of paper
- Rubber band
- Scissors

Experiment

To start with, watch the video for this experiment:

SuperchargedScience.com/savs8.htm

Access code: ESCI

Watch the video for this experiment to see how to fold and cut it properly!

1. Fold paper in half lengthwise. Otherwise known as a "hot dog fold".

2. Fold down the two top corners of the paper, just like you would for a paper airplane.

3. Repeat step #2 two more times (three triangle folds total).

4. Fold in half so all the folds are on the inside. Crease crisp edges with your fingernails or the side of a pencil.

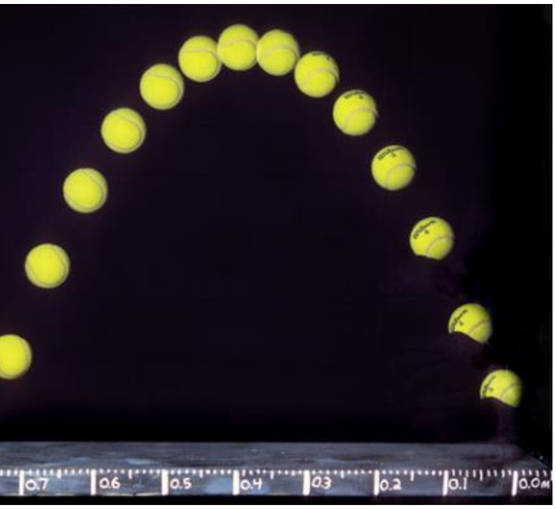
5. Take your scissors and make a cut about a third of the way down, angled up, about halfway through. The cut is on the double-fold side.

6. Open up the rocket and form the base of the arrow by folding the lower end in a fourth time. This forms the "hooks" that the rubber band will attach to.

7. Attach the rubber band as shown in the video. Stretch it back and point it up, away from anyone (the end of this rocket it very pointy and sharp!)

What's Going On?

Newton's Laws cover many aspects of motion, including projectile motion. Projectiles can be a cannon ball after being fired, a baseball after being thrown, a golf ball after being hit, a soccer ball after being kicked, or any other situation you can think of where an object is under the



influence of only gravity after the initial force applied to move the object. (Usually we ignore wind resistance when we do these types of problems on paper in a physics class.)

A projectile is a particle or object that is only experiencing gravity, and in most cases, gravity is only acting in one direction. Gravity doesn't influence the horizontal motion (if we accounted for air resistance, then there would be a force in this direction as well), only the vertical motion. That's why the ball falls to the ground when you throw it.

This means that a bullet fired horizontally from a gun experiences a constant horizontal velocity and a downward vertical acceleration.

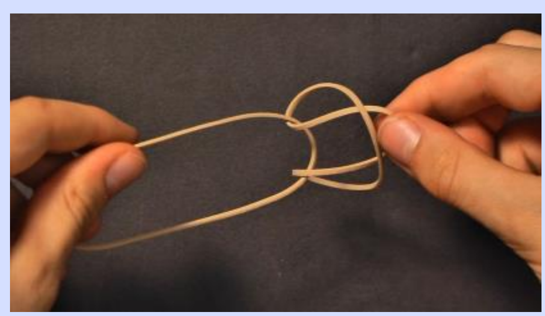
A bullet fired from a gun pointed up at a 45 degree angle also experiences a constant horizontal velocity and a downward vertical acceleration.

A bullet fired from a gun in outer space away from any gravitational influences would travel up at a 45 degree path away from the gun and experience constant horizontal and vertical velocity.

The path a projectile makes is parabolic (image left), meaning that it follows the shape of a parabola. The horizontal motion of the projectile is independent of the vertical motion. You'll need to think about each component as separate and independent.

Questions to Ask:

1. How far did it travel when launched horizontally?
2. What happens if you try to make one half this size from a smaller sheet of paper?
3. How could you attach this to a glider paper airplane so that it launches high and glides down slowly?
4. What if you chain rubber bands together to use more than one rubber band for launching?
5. Can you pop a balloon or



make it through a hula hoop target? (Goggles anyone?)

ROCKET CAR

Activity

This rocket car uses high pressure on the inside to blow a weight out the back (the neoprene stopper) and propel itself forward.

Materials

- 2L soda bottle
- scissors
- 2 straws
- 2 skewers (make sure these fit into your straws)
- 4 wheels (milk jug caps, film canister lids, cardboard circles…)
- needle valve (the kind you'd use to fill up a basketball with)
- neoprene stopper (fits your soda bottle) - corks will not work because they are not airtight!
- bike pump (make sure it fits the needle valve)
- hot glue gun with glue sticks

Experiment

To start with, watch the video for this experiment:

SuperchargedScience.com/savs8.htm

Access code: ESCI

Let's take a good look at Newton's laws of motion while making something that flies off in both directions.

This experiment will pop the top out of a bottle and make the car roll 10 to 30 feet! Needless to say, this is an outdoor experiment.

Please be careful with this, as the stopper comes out with a good amount of force. (Don't point it at anyone or anything, even yourself!)

Here's how to make this project:

1. Poke a hole through your stopper using something sharp (watch video). Be careful with this!
2. Press the needle valve through the stopper, so the side that attaches to the pump is on the larger size of the stopper.
3. Trim straw to 5-6" long.
4. Hot glue straw perpendicular to the soda bottle in two places (again, watch video to see where these go).
5. Insert one skewer into each straw and attach wheels on either side. Use a dab of hot glue in the outer edge where the skewer pokes through each wheel if you need it.
6. Try rolling your car—does it roll straight? If not, reposition the

wheels. You can reposition the straws by ripping them off and gluing them on again.
7. Make sure the wheel-axel assemblies are parallel, and that the skewer pokes through the wheels as close to the center of the wheel as possible.
8. Put on your safety goggles before pumping!
9. Attach your pump to your needle valve and pump up the bottle.

ALERT! The rocket car will break free when it's ready on its own, so wear your safety goggles before you begin pumping air inside.

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.

Another example is a balloon. An inflated balloon will zip through the air as the air escapes.

Newton's Third Law says: *For every action there is an equal and opposite reaction.*

When you pump air into the bottle, you are building up pressure inside the bottle. The neoprene stopper stays in because there's a high amount of friction between the bottle and the stopper.

Eventually, however, there's enough of a push from the inside pressure to overcome this frictional force and cause the stopper to go flying out of the bottle, which in turn propels the rocket forward.

The compressed air inside the bottle also escapes out the open end, which also propels the rocket car forward!

Questions:

1. How many pumps does it take to get the car to break free and roll?
2. How can you lower the friction of the wheels so it can roll even faster?

What is Math?

Math can be compared to a very useful tool, like a hammer, or a collection of tools like a set of screwdrivers.

A lot of kids get frustrated and bored with math, because many textbooks concentrate a lot on teaching the small, meticulous details of each and every type of tool. That's one of the fastest ways to kill your passion for something that could have otherwise been really useful!

Don't get me wrong – you do need to know how to tell a hammer apart from a screwdriver. But can you tell me *when* to use the hammer instead of the screwdriver?

It's really important to focus on how and when to use the different tools. This is my practical approach to teaching the subject.

Most kids think math just means numbers, when the truth is that math is much more than just numbers and being good at multiplying!

There are three main areas in math (at least when you first start out). Some kids enjoy adding and dividing, and for them, math is all about numbers. However, if you're really good with shapes and how they relate, then you might enjoy geometry. And if you are good at solving puzzles and people think you're unbeatable at certain games, chances are that logic will be a great match for your skills.

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

SUPERCHARGED SCIENCE

Focusing on wonder, discovery, and exploration.

Since 1999, our team has sparked the minds of thousands of K-12 students in physics, chemistry, and engineering. Supercharged Science offers exciting hands-on science workshops, science kits, online science programs and complete learning programs for families everywhere.

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