BOOM

AN ACTIVITY BOOK

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FOAM ERUPTION

Zips, zooms, and booms can be found in lots of different places, but not all of them are loud or fast. For example, do you know there's a kind of firework that stays on the ground, and spouts a coil of ash that looks like a snake? These surprising serpents are a kid favorite because they seem to grow out of nothing. Now, your child can make her own colorful version using a yeast solution, liquid detergent, and hydrogen peroxide. When these ingredients react, they send a stream of foam shooting up out of a bottle and, after a minute or so, turn into a moving stream that resembles toothpaste being squeezed from a tube. Even if you kid doesn't seem to be very interested at first, this activity is sure to grow on her!

What You Need:

- ☐ 16 ounce empty plastic bottle
- ☐ 20 ml (0.675 fluid ounces) hydrogen peroxide (6% solution, purchased from a beauty supply store)
- ☐ 10 ml (0.3382 fluid ounces) dishwashing liquid
- ☐ Food coloring
- ☐ 1-ounce package of powdered yeast
- ☐ Small funnel
- ☐ Aluminum foil cake pan with 2-inch sides
- ☐ Safety glasses

* Although the following activity is safe, it is always a good practice to have kids wear safety glasses whenever they conduct any type of activity that involves working with chemicals.

What You Do:

1. Ask your child to place the empty plastic soda bottle into the center of the empty aluminum cake pan, and then put the funnel into the bottle's mouth.
2. Help her add 3–4 drops of food coloring to the peroxide and pour the peroxide through the funnel into the bottle.
3. Add the dishwashing liquid to the peroxide in the bottle.
4. Pour the yeast mixture into the bottle and quickly remove the funnel. Have your child touch the bottle to feel if any temperature changes are taking place.
5. Ask your child to step back; things are about to get pretty foamy.

THE SCIENCE BEHIND IT

Hydrogen peroxide, when mixed with a liquid detergent and a catalyst (yeast), will generate an exothermic (heat-producing) reaction. That's why the bottle feels warm to the touch! As a result of this chemical reaction an oxygen gas is produced in the form of foam. After a minute or two, the foam will shoot up out of the bottle, run into the pan, and eventually begin to come out in a steady stream. In case you were worried about whether or not the foam is safe, your kid can feel free to play with it. After all, it's just soap and water with oxygen bubbles!

FILM CANISTER ROCKET

What's cooler than watching a rocket take off? This simple activity lets kids build their own pop rocket and watch it take off thanks to a basic chemical reaction. Be sure to keep an eye on your young rocket manufacturer. Once the rocket has been successfully assembled, put on your safety goggles and let 'er rip!

What You Need:

- ☐ Empty 35mm plastic film canister with a snugly fitting lid
- ☐ Fizzy antacid tablets
- ☐ Goggles, sunglasses, or other eye protection
- ☐ Water
- ☐ Colored paper *(optional)*

What You Do:

1. Whatever you do, don't try this experiment inside—your rocket might make a dent in the ceiling! Instead, pick a level space outdoors. Remember to put on safety glasses or other eye protection!

2. Ideally, the film canister should be one with a cap that fits inside the rim, not over the outside of the rim. This makes the experiment work much better. But whatever kind you've got, have your kid open it up and fill it with water so it's between ¼ and ⅓ full.

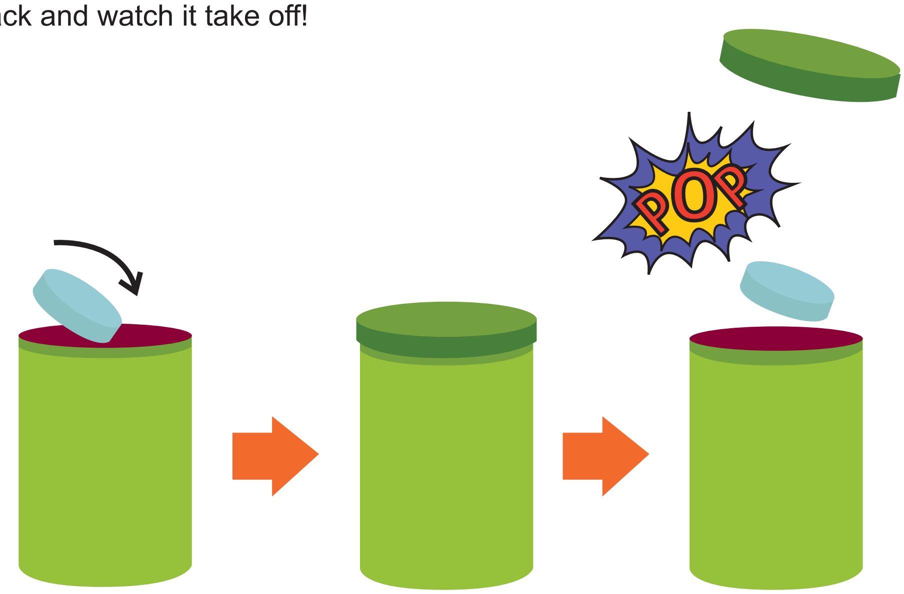
3. This next step needs to happen very quickly *(in just a few seconds)* so get the antacid tablet unwrapped and ready. Break it in half and put the film canister lid right next to it.

TIP:

Try adding some paper decorations to the canister, to make it look more like a rocket!

4. Help your kid drop the half tablet into the film canister and quickly snap on the lid. Make sure it's tight. Then place the rocket with the lid down on a level, firm surface.

5. Stand back and watch it take off!



THE SCIENCE BEHIND IT

Sometimes, when you combine two materials (like the antacid and the water) you get a chemical reaction. In this case, a gas is created and lots of bubbles form. Since the bubbles of gas have nowhere to go in order to escape, they press against the sides of the canister, pushing against the lid until there's so much pressure, the lid pops off!

MAKE A BAGGIE EXPLODE

Like the homemade film canister rocket, this exploding baggie activity involves a bit of chemistry to complete. Unlike the rocket, this creation isn't made to fly—it's made to pop! All you need are a few ingredients from the pantry to create a satisfying, and safe, reaction. Your child may be surprised as he watches the baggie expand until it explodes with a dramatic boom.

What You Need:

- ☐ Paper towels
- ☐ Plastic zip-top sandwich bag (make sure it seals completely and has no holes)
- ☐ ½ cup white vinegar
- ☐ 1 ½ tablespoons baking soda
- ☐ ¼ cup warm water
- ☐ Scissors
- ☐ Clear outdoor area

What You Do:

1. Draw a square measuring about 5–6 inches on each side onto a paper towel. Ask your child to cut it out.

2. Measure the baking soda and help him scoop it into the middle of the towel. Fold and gather the towel inwards on four sides, so you have a little packet of powder. It should look like a sachet, with the powder contained inside.

3. Mix the vinegar and warm water together, and pour it into the sandwich bag.

4. Give your child the paper towel packet you've just made and tell him to quickly but carefully drop it into the bag, and immediately seal it closed.

5. Standing in your outdoor area, let your child shake the bag a bit. Then put it on the ground, step away, and get ready to see chemistry in motion!

THE SCIENCE BEHIND IT

As the vinegar and baking soda combine, a chemical reaction takes place that produces carbon dioxide. As the ingredients in the bag mingle, carbon dioxide gas begins to fill the bag, inflating it until it's bursting at the seams. When the bag can no longer contain what's inside, it will burst, creating a very loud pop. Be sure to keep extra materials on hand—your child will likely want to do this one again.

INSIDE FIREWORKS

Fireworks are a well-known and truly beautiful kind of explosion. If your kid is curious about fireworks have him take a look at this:

Aerial fireworks come in many different shapes and sizes, and all explode in bright colors! While no two fireworks are alike, they all have similar make-ups.

WORD BANK FUSE STARS BURSTING CHARGE CONTAINER LIFTING CHARGE

ENIATCONR

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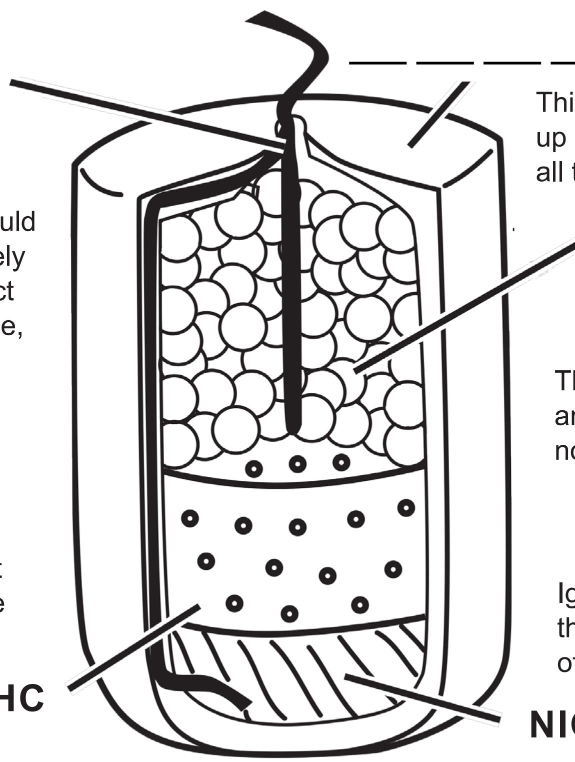
This plastic like paper is made up of multiple layers and wraps all the parts of the fireworks.

EFUS

___ ___ ___ ___

Without this string, there would be no way for people to safely light up fireworks! This object is also connected to the base, causing the firework to lift.



RSSAT

___ ___ ___ ___ ___

These pea-sized balls explode and create the bright, sparkly, noisy effects of fireworks.

This charge explodes at just the right time and ignites the stars.

RSTUBNIG ERGAHC

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Ignited by a secondary fuse, this charge lifts the firework off the ground as it explodes.

NIGFLIT HGRAEC

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* After your kid has examined the inner workings of this well-known incendiary device, it's time to make some of his own!

SODA FIREWORKS

One of the best things about summer is the amazing fireworks show on the Fourth of July. There's nothing like watching the sky explode in bursts of color! But you don't have to save all the fun for just one day. With just a few ordinary supplies, your child can make some fabulous firework explosions of her own and learn a little bit about the physical and chemical interactions at play in the process.

What You Need:

- ☐ 2-liter bottle of diet soda
- ☐ Rolls of mint Mentos (it's important that you use the original mint flavor—not mixed fruit or other kinds)
- ☐ Different kinds of soda and additional rolls of Mentos *(optional)*
- ☐ Open, outdoor area that can handle getting sprayed with soda

What You Do:

1. Find an open area where you can place the 2-liter bottles of soda upright, with plenty of space around for a big sticky mess. Backyards and empty parking lots are two good options.

2. Have your child remove the Mentos from the wrapper. She will need to use one whole package of Mentos and drop it into the mouth of the soda bottle all at once. This can be tricky. Some folks like to do it by hand; others roll up a paper tube or use a leftover paper towel roll to feed the Mentos into the bottle.

3. Unscrew the lid of your soda (make sure it hasn't been recently shaken). Working as quickly as possible, help your child drop all of the Mentos into it. Then make sure everyone stands back!

4. Right before her eyes, she'll see an explosion of soda come streaming out of the bottle! Various experimenters have reported soda geysers rising as high as several meters into the air. It's definitely fun to see how high your soda fireworks can get. No matter what the result though, this activity is sure to be a crowd pleaser.

5. While this project is loads of fun, it's also great opportunity to do a little investigative science along the way. For that, you'll need some more soda and Mentos.

   Note: The people who developed this experiment have found that diet soda, perhaps because of the molecular structure of its artificial sweeteners, seems to bubble higher, and that fruit flavored Mentos are too smooth to get a good bunch of bubbles going.

6. If your child is eager to create more soda geysers, use your first blowup as the "control experiment," and try exploring different variables. You and your child can find out if there's a difference between chilled and room-temperature soda and test the difference between diet and regular soda as well. The sky's the limit! (Literally!) You may even want to have your child record and graph her results and observations. Be sure to approach one variable at a time, and to discuss the different steps along the way.

THE SCIENCE BEHIND IT

The "why" behind this explosion is actually twofold—both physical and chemical—and has been the subject of some spirited debate among experimenters. When you drink "soda pop," you're enjoying a sugary liquid into which carbon dioxide has been pumped at high pressure. Water molecules in the soda form a "mesh" of surface tension around the liquid, keeping it relatively stable. *(Think about a balloon with water inside of it; the balloon is holding the water together.)* The Mentos disrupt that surface tension, while simultaneously providing a rough surface ideal for carbon dioxide bubbles to form and fizzle. Drop in a full roll of Mentos, and wham! You get a massive stream right out of the top of your bottle.

KINETIC COLORS

As your kid knows by now, when certain ingredients are combined, all kinds of reactions take place. Some reactions are loud, some are quick, and some are completely unexpected. Much like the foam explosion, this activity isn't all flash and dash. In fact, as far as reactions go, it's pretty low-key, but the results are beautiful. Watch as different colors zip around on a liquid surface.

What You Need:

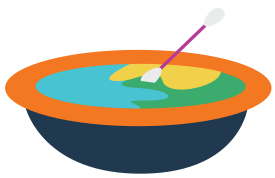
- ☐ Bowl
- ☐ Small container
- ☐ Milk (whole or 2%)
- ☐ Liquid dish soap
- ☐ Cotton swab
- ☐ Food coloring in a variety of colors

What You Do:

1. Pour a small amount of the liquid dish soap in the container.

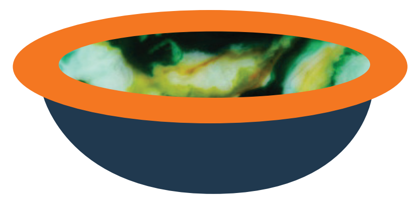
2. Set the bowl on a flat surface and pour some milk into it.

3. Add a few drops of 2–4 different colors of food coloring to the milk.



4. Dip the cotton swab into the dish soap and lower it into the milky food coloring. Ask your child to describe what is happening to the liquid in the bowl.

5. Remove the cotton swab and dip it into the detergent again.



6. Encourage your child to find a different spot in the bowl and lower the cotton swab into the liquid once again.

THE SCIENCE BEHIND IT

All that swirling and whirling of colors is a sight to behold, but why does the food coloring move around like that? Detergent has quite unusual molecules. One side of the molecule is drawn toward fats and oils, while the other side is drawn toward water. The soap molecules in the detergent interact with the fat molecules in the milk in such a way that the food coloring molecules are jostled about. The food coloring serves as a kind of tracer that shows what's going on between the fat molecules and the soap molecules.

MAKE TONGUE DEPRESSORS COME ALIVE!

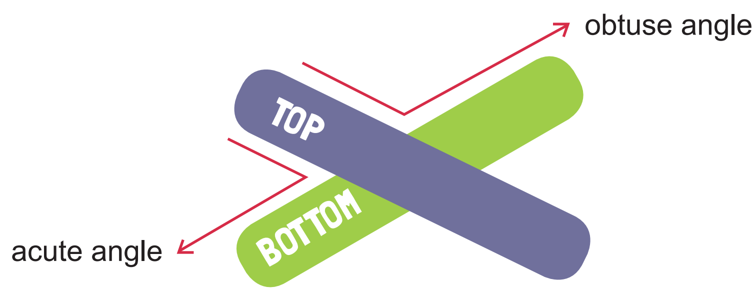
Tongue depressors—the place you're most likely to see them is the doctor's office. But tongue depressors go by another name: craft sticks, and crafters use them for all kinds of projects. Did you know that if they are positioned correctly tongue depressors have explosive potential? In this activity you'll help your kid construct a cobra weave, which was originally constructed by the mighty Kinetic King, Tim Fort. When you let go, those tongue depressors will go flying every which way.

What You Need:

- ▢ Tongue depressors, a.k.a. craft sticks (at least 26 to produce a decent explosion)
- ▢ Flat surface—carpet is easier to work on than hardwood

What You Do:

1. Begin by asking your child to take two craft sticks and cross them in the shape of an X. It's easier if you use colored sticks or number the sticks to keep track of which ones go where. We used purple and green for our first two sticks. For our weave, we chose a green stick for the bottom and the purple stick for the top. The "x" should be oblong so that the top and bottom angles are obtuse and the left and right side of the "x" are acute.



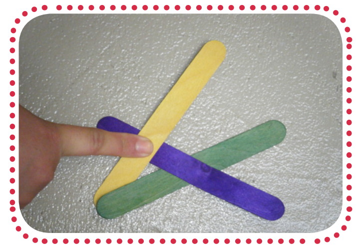
From now on we'll be using color names to identify the sticks for the sake of clarity.

TIP:

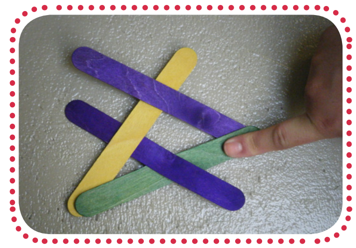
Make sure the stick that's on the bottom looks like a backslash and the one that's on top resembles a forward slash.

2. Have your child push down in the middle of the X shape he's created.

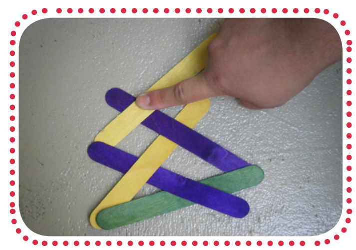
3. Now, take a yellow stick and add it to the left-hand side of the X by sliding one of its tips underneath the bottom tip of the green stick and over the purple stick. Slide the yellow stick until the yellow and green stick create a V-shape. Your weave should now look like this:



4. Take second purple stick and add it to the right side of the X by sliding the tip of the stick underneath the upper right-hand tip of the green stick and over the yellow stick. The two purple sticks should run parallel to one another.

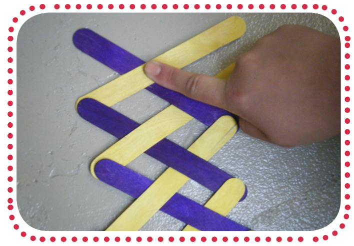


5. Grab a second yellow stick and help your child add it to the left-hand side of the weave by sliding one end of the yellow stick underneath the tip of the first purple stick (the one that was used to make the original X) and over the second purple stick. The two yellow sticks should be parallel.



6. Continue adding sticks, purple to the right and yellow to the left, making sure that sticks are being placed under and then over the previous sticks.

7. When your child is happy with the size of his weave he should grab a final green stick to tie it off. This will be the "trigger stick." We decided to stop after inserting a yellow stick. The green stick should be placed under the tip of the second to last yellow stick and then over the last yellow stick. But instead of being positioned so it's parallel to the previous purple stick, your kid should continue to rotate it in and tuck the other end under the last purple stick.



8. Encourage your kid to remove the trigger stick, while holding the final sticks of the weave down.

9. Finally, have him let go of the weave. An explosive chain reaction should occur that sprays the sticks all over the place!

* If you construct an especially long weave, the sticks might lock up. Try to make sure while building that the weave is as wide as possible to produce the best results. The more parallel you make sticks the better. If it locks up, scoop at the weave with the toe of your shoe and it will probably set it off again!

THE SCIENCE BEHIND IT

Layering the sticks together to create the cobra weave builds tension. This tension is a form of potential energy that is harnessed by the continual layering of one stick on top of another. Once the trigger stick is removed and the weave is released the potential energy is converted to kinetic energy as the tongue depressors escape from the weave and leap up off the ground.

MATCH ROCKETS

Match rockets have been around for decades. It's easy to understand the appeal of these mini rockets; they're easy to construct and fun to watch as they fly through the air. Show your child how to build one of these classic projectiles and then have him test out his workmanship by setting off a few to see how far they fly. When launching your mini match rockets, monitor your child closely and be aware of your surroundings; you don't want your kid's foray into rocketry to start any fires!

What You Need:

- ☐ Standard matches
- ☐ Aluminum foil
- ☐ Large paper clip
- ☐ Small paper clip
- ☐ Long stick matches

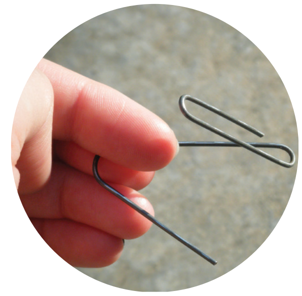
What You Do:

1. Cut out a piece of aluminum foil that's about 5" x 3" and lay it on a flat surface.

2. Have your child position two matches at one end of the piece of foil so the match heads are facing one another and the ends stick out over the edges of the aluminum foil.

3. Wrap the aluminum foil around the matches. One of the matches should be tightly wrapped and the other a little more loosely.

4. Bend the end of the paper clip outward and insert it into the loosely wrapped end of the rocket. Holding the paper clip against the match stick, scrunch the foil tightly around the match and slowly pull the paper clip out. Explain to your child that the space created by the paper clip will serve as a chamber for the smoke and gas to escape and propel the rocket forward.



5. Bend the middle part of the large paper clip upward so it's at a 45 degree angle to the ground. Then bend the outer arm of the paper clip away from its center so the base resembles a triangle and looks more stable. It should look like this when you're finished:

   The paper clip will be your mini launch pad.

6. Have your kid position his rocket on the launch pad making sure the match with the loosely-wrapped foil is the match that is closer to the ground.

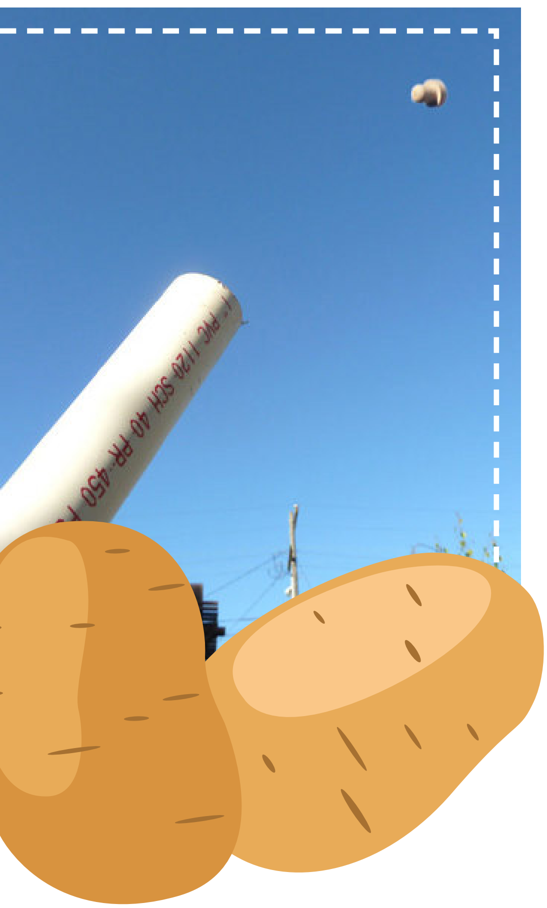
7. Help your child light the long stick match and tell him to hold the flame right in the middle of the rocket where the two match heads meet.

8. Encourage him to continue holding the flame underneath the rocket until the match heads ignite, launching the rocket into the air.

THE SCIENCE BEHIND IT

These mini rockets operate on Newton's Second and Third Laws of Motion. Newton's Second Law comes into play when you try to understand the thrust of the rocket. The thrust is essentially the same as the force and the Second Law states that the force is determined by calculating the mass times acceleration. In the case of the rocket, the amount of thrust will vary depending on the size of your exhaust chamber. If you create a larger chamber, the gas and smoke will be able to escape after a shorter amount of time. As a result, only a small amount of pressure will be able to build up before your match rocket takes off. If you create a smaller chamber, the gas and smoke will have less space to build up and they'll escape from the chamber at a faster rate. Newton's Third Law of Motion is instrumental in the takeoff. The Third Law states that for each action there must be an equal and opposite reaction. In this project, the action is the ignition of the match heads which pushes the smoke out of the chamber in one direction; the reaction is the rocket taking off in the opposite direction.

HOMEMADE POTATO CANNON



It pretty much goes without saying that potatoes are delicious and nutritious, but did you know they also have explosive potential? Give your kid a free pass to play with his food when he makes a working potato cannon! This spud-popping project will help your kid understand the potential power of an important force: pressure. What's more, he'll really get a kick out of sending chunks of potato hurling through the air.

What You Need:

- [ ] Potatoes
- [ ] PVC pipe, 2–3 feet long with 1-inch diameter
- [ ] Broomstick or similar object with a smaller diameter than the pipe
- [ ] Clear outdoor space
- [ ] Safety goggles for everyone involved

What You Do:

1. Find a large, open outdoor area where people and animals won't be in the path of your potato cannon.
2. Have your child lodge a piece of potato into both ends of the pipe to plug it. Try setting the potato on the ground, and then push the pipe down until it goes all the way through. Repeat for the opposite side.

   Note: Make sure there is enough potato in the front end to make an airtight seal; otherwise, your potato cannon won't work!

3. Have her hold the pipe in one hand and point the front of it away from people, animals, and anything fragile.

4. Help your child to position the broomstick at the end of the pipe closest to her, barely touching the potato plug.

5. Get ready to fire! With your help, have her ram the broomstick into the pipe, forcing the potato plug toward the front.

6. Watch out for flying potatoes!

* Ask your child what she thinks happened to make the potato fly out of the pipe. Can she shoot another potato even farther? What happens when the pipe's diameter is smaller?

* **Tip:** Remove the piece of potato that's still in the pipe after each shot by poking it out with the broomstick. Then, repeat the steps from the beginning.

THE SCIENCE BEHIND IT

How does such a seemingly simple device launch a potato? This explosive experiment demonstrates the basic principles of Boyle's Law, which states, "Under constant temperature, the volume of gas is inversely proportional to the total amount of pressure applied." In the case of the popping potato, the air in the pipe is the gas, lodged between two potato plugs. By shoving a broomstick into the pipe of the potato cannon, one plug pushes towards the other reducing the volume of gas, while increasing pressure. The pressure in the potato cannon is what sends the potato plug flying!

READY, AIM, FIRE!

We're so often caught up with discovering what's new and different,but the old school zooms and booms can be pretty awesome too. Travel back to medieval times and help your kid build a catapult similar to those that were once used to launch all kinds of projectiles over castle walls. Your kid will stick with marshmallows though; they're lightweight, which makes them easier to launch, and they're like little pillows which makes them less harmful! This explosively yummy project can be constructed indoors or out, so there are no bounds as to where your kid can launch her marshmallow attack.

What You Need:

- ☐ Narrow shoe box
- ☐ Ruler
- ☐ Marker
- ☐ Paper punch
- ☐ Craft knife
- ☐ Electrical tape
- ☐ 1-inch rubber band
- ☐ 3 pencils
- ☐ Plastic spoon
- ☐ Marshmallows

What You Do:

1. Help your child cut out one end of the shoe box, leaving a one-inch strip across the bottom.

2. Starting from that end, have your child mark a point one inch from the top and 2 ½ inches from the back of the box on one of the wide ends. Help your child use a hole punch or craft knife to punch a hole and enlarge it until it's about to the diameter of a pencil.

3. Repeat step 2 on the other wide side of the box. Insert a pencil through the holes, and help your child use a knife to poke a hole where the end of the pencil meets the bottom of the box.

4. Ask your child to use the electrical tape to fasten the spoon handle to the second pencil and cross this pencil to the first pencil, as shown in the picture.

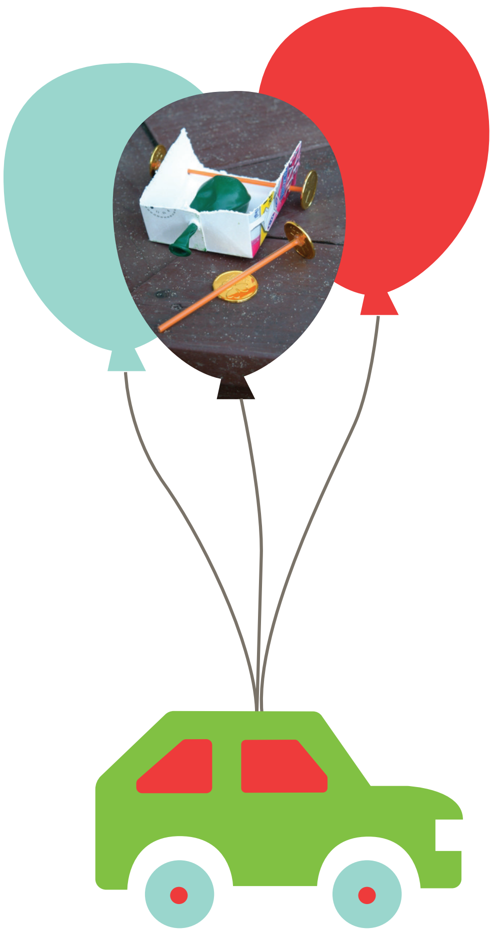
5. Help thread the rubber band through the hole on the bottom of the box, putting the third pencil through the loop beneath the box to keep the rubber band from slipping through the hole. Inside the box, loop the rubber band over the end of the second pencil.

6. Have her fire off a few marshmallows!

THE SCIENCE BEHIND IT

Because of the way the catapult is constructed, when a projectile is launched its flight path will be determined by its vertical speed and its horizontal speed. These two speeds are determined by the angle at which the launching arm of the catapult is positioned in relation to the ground. As your child pulls the spoon back, the rubber band stretches, and potential energy accumulates. When released, the energy transfers to the marshmallow in the form of kinetic energy and the marshmallow projectile goes flying through the air.

BALLOON-POWERED CAR



Explosions are tons of fun, but there's something special about cars. It's difficult to put your finger on exactly why people seem to be drawn to them. Sure, they get you from point A to point B a lot more quickly than traveling on foot, but for many people, the appeal of cars goes way beyond their practical function. Although your child might be too young to drive, he definitely isn't too young to build a car! Teach your car enthusiast a little about the physics of motion and satisfy his need for speed with this activity that will have him build his very own balloon-powered car.

What You Need:

- ☐ Clean, dry, half-gallon milk carton with the top cut off, cut in half along the length of the carton
- ☐ 4 empty thread spools (or substitute your own items for wheels, such as large bottle caps or plastic coins)
- ☐ Straws
- ☐ Balloon (and some extra ones, too!)
- ☐ Hot glue gun
- ☐ Supplies to decorate: we used markers, colored paper, tempera paint, and stickers

What You Do:

1. Ask your child to decorate the milk carton any way he likes. You can use tempera paint to cover the outside surface (put in a drop of dish soap so that the paint will stick to the waxy coating of the milk carton), or glue on strips of colored paper, and draw on windows and doors with a marker.

   Note: Don't cut decorative holes in the milk carton. The only holes will be those you make for the balloon and the axles.

2. Cut a hole in the middle of the square bottom of the carton for the balloon. Start with a small hole; you may need to make it bigger later if it doesn't let enough air escape from the balloon.

3. Have your child put the open end of the balloon through the hole, so the body of the balloon is inside the carton.

4. Next, make some holes in the sides of the carton for the straws to form axles (the straight stick-like parts of the car that hold the wheels). These holes need to be close to the bottom of the carton.

5. Stick the straws through the holes and glue on the spools to form wheels.

6. Now the car is built and ready for testing! Before your child tries it out, be sure to explain the principle behind it. Have your child fully inflate a new balloon, hold onto the end without tying it, and then let it go. What happens? It should zip around the room until the balloon is fully deflated. When the air comes out, it pushes the balloon with equal force in the opposite direction. The gas powers the movement of the balloon. The same principle works for the car as well.

7. Now, try it out! Have your child inflate his car's balloon, and hold it closed without tying it. Then, let go. How far can he make it roll?

* You may need to make some adjustments to tweak the design of the car, the size of the hole holding the balloon, or the size of the balloon to really make it zoom. Encourage your child to keep trying until it works, or even to make one or two more balloon cars that are different styles and shapes. Then it's off to the races!

THE SCIENCE BEHIND IT

The balloon-powered car is a great demonstration of potential versus kinetic energy. When your kid blows up the balloon and, holding the mouth of the balloon closed, sets the car down on a flat surface, the car has potential energy. As soon as your child lets go of the balloon the potential energy is converted to kinetic energy and the car zooms away! The balloon-powered car is also a great example of Newton's Third Law of Motion which states that for every action, there is an equal and opposite reaction. Our action here is the air inside of the blown-up balloon escaping and the reaction is the car racing forward.

MAKE LIGHTNING!

Man-made zips, zooms, and booms are tons of fun, but all natural ones are truly awe-inspiring. One of the most impressive chaotic displays of pure power found in nature is the combination of thunder and lightning that often occurs during thunderstorms. How does this amazingly powerful duo come into being? Lightning creates a vacuum that results in a sonic shock wave, producing the sound we know as thunder. Unleash your kid's inner mad scientist with this experiment that will enable him to bend electricity to his will by showing him how to make lightning!

What You Need:

- ☐ Rubber glove
- ☐ Plastic fork
- ☐ Aluminum foil
- ☐ Wood or plastic cutting board
- ☐ Styrofoam plate or rubber balloon
- ☐ Head of hair or wool
- ☐ Cool, low-humidity day (< 45% humidity, < 75˚ F temperature)

What You Do:

1. Help your child fold aluminum foil around the plastic fork so that it looks like a big spatula. Make sure it's as flat as possible with no sharp corners.

2. Put on the rubber glove and use your gloved hand to rub the Styrofoam plate or rubber balloon on your hair or wool.

3. Place the plate or balloon on the cutting board, and use the gloved hand to pick up the aluminum foil spatula.

4. Place the aluminum foil part of the spatula on the balloon or plate. Ask your child to touch the foil with his hand. *What happened? How can he explain what he saw?*

5. Pull the spatula up from the balloon or plate, and ask your child to touch it again. *What happened this time? Did he expect that?*

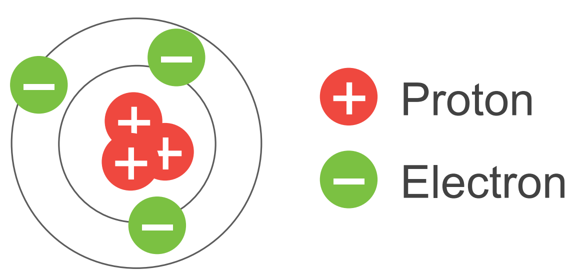
6. Now that you know the secret to creating lightning, let your child wear the rubber glove and help him repeat the process. Try experimenting with other materials. Remember to charge the charged object using hair or wool if necessary.

Extra: For even cooler results, conduct this experiment in a room that's as dark as possible!

* You should have seen and felt a spark when you touched the foil. When you lifted the foil off and touched it again, you should have felt another spark. Your hand doesn't spark, and most non-metallic objects won't spark when you touch the charged object either. All metals insulated by your glove that touch both your charged object and your hand will spark.

THE SCIENCE BEHIND IT

You're experimenting with **static electricity**. The static electricity you see is caused by the movement of **electrons**. Electrons carry a negative **electrical charge**, which causes them to be attracted to protons and repelled from other electrons. When you rub an object on your hair, it does one of two things: it either puts electrons onto the balloon, or strips electrons off of the Styrofoam plate. This rubbing action gives the balloon or plate a **net charge**, meaning the object has either more electrons or fewer electrons than protons.



Metals are special materials in that their electrons are free to move almost wherever they like, instead of being stuck on the material's molecules. When a metal object is placed near something with a net charge, all of the electrons in the metal will move to be either as far away from a negative charge as possible or as close to a positive charge as possible. Metals are called **conductors**. Your plate and your balloon are both **insulators**—they don't let their electrons move where they want.

When your spatula moves close to the charged object, the electrons either want to get close to or far away from the object. When you bring your hand up to touch the spatula, the electrons flow to you or flow onto the spatula, depending on whether the spatula is touching the Styrofoam plate (towards) or the rubber balloon (away). Your skin is actually quite conductive! After the electrons move, the aluminum foil has a good number of electrons for its location (close to the charged object). When you move the aluminum foil spatula away from the charged object, it suddenly has a lot more or way fewer electrons than it needs, and so more will jump from your body to balance it out. You can keep going back and forth like that for a long time, since the amount of electrons (or lack of electrons) on the charged object doesn't change.

Your hand doesn't spark because your body provides a **path to ground**. What that means is that when you bring your hand close to the balloon, all the extra electrons needed come from or go into the ground you're standing on! Because of the rubber glove you're wearing, the aluminum foil spatula has no path to ground, so it cannot equalize its charge. When you touch it, you are providing it with a path to ground for the electrons to move and balance things out. The earth has plenty of electrons to spare, and they move all over the place.

So what makes lightning? Lightning occurs when there's a big charge difference between the clouds in the sky and the earth. Lightning is just a bigger version of the sparks you saw!

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