Easy Crystal Experiments You Can Share With Your Kids

By Aurora Lipper, Supercharged Science

Crystals are formed with atoms line up in patterns and solidify. There are crystals everywhere – in the form of salt, sugar, sand, diamonds, quartz… and more!

When making crystals, there is a very special kind of solution to make. It's called a "super saturated solid solution". What does that mean? Here's an example: If you constantly add salt by the spoonful to a cup of water, you'll reach a point where the salt doesn't disappear (dissolve) anymore and forms a lump at the bottom of the glass.

The point at which it begins to form a lump is just past the point of being a saturated solution. If you heat up the saltwater, the lump disappears. You can now add more and more salt, until it can't take anymore salt (you'll see another lump starting to form at the bottom). This is now a super saturated solid solution. Mix in a bit of water to make the lump disappear. Your solution is ready for making crystals. But how?

If you add something for the crystals to cling to, like a rock or a stick, crystals can now grow. If you "seed" the object (coat it with the stuff you formed the solution with, like salt or sugar), they will start forming faster.

TIP: If you keep the solution in a warm place, crystals will grow faster.

If you have too much salt (or other solid) mixed in, your solution will crystallize all at the same time and you'll get a huge rock that you can't pull out of the jar. If you have too little salt, then you'll wait forever for crystals to grow. Finding the right amount to mix in takes time and patience.

Geodes A geode is a crystallized mineral deposit, and are usually very dull and ordinary-looking on the outside, until you crack them open! An eggshell is going to be used to simulate a gas bubble found in flowing lava. By dissolving alum in water (real life uses minerals dissolved in ground water) and placing it into your eggshell (in real life, it’s a gas bubble pocket), you will be left with a geode. (Note: these crystals are not for eating, just looking.)

Making the Geode Make sure your eggshells are clean. Fill a small cup with warm water and dissolve as much alum in the water as you can to make a saturated solution (meaning that if you add any more alum, it will only fall to the bottom and not dissolve). Fill the eggshells with the solution and set aside. Observe as the solution evaporates over the next few days. When the solution has completely evaporated, you will have a homemade geode. If no crystals formed, then you had too much water and not enough alum in your solution.

Gemstones Fill a clean glass jar with saturated solution made above and leave it for two days. Strain it and save the water for later. Keep the crystals!

String Crystals Fill another glass jar with spare saturated solution, and suspend a crystal (from experiment above) with string from the jar lid. Lower it into the solution and wait several days. (Seed the string for quicker growth.)

Rock Candy We're going to take advantage of the process of crystallization to make candy. You are going to make a super saturated solution of sugar and use it to grow your own homemade sugar candy crystals. A super saturated solution is one that has as much sugar dissolved in the water as possible. (If we didn't heat the water, we'd wind up with only a saturated solution.)

Making Rock Candy Boil three cups of water in a large pot on the stove. Add eight cups of sugar, one cup at a time, slowly stirring as you go. The liquid should be thick and yellowish. Turn off the heat and let it sit for four hours (or until the temperature is below 120 degrees F). Pour the sugar water solution into clean glass jars and add a couple drops of food coloring (for colored crystals). Tie a string to a skewer, resting the skewer horizontally across the jar mouth.

Jelly Crystals This water jelly crystal (found in the gardening section of your hardware store, usually called "Soil Moist") will grow over 300 times its own size when hydrated (adding water). Fill each cup half full of water. Add a few drops of food coloring and stir. Add a handful of crystals and let stand 20 minutes. Squish them with your hands! Combine several different colors (in layers) in a empty water bottle and watch the colors melt into each other (try layering blue, yellow, and red and watch orange and green appear out of nowhere!) Make a huge rainbow wand using a plastic fluorescent tube casing (from the hardware store – they come in 4 to 8' sections!) with stoppers glued to the ends. To reuse crystals, lay on a paper towel and let dry (they may stain beneath the towel, so add a layer of foil) over a few days.

Salt Stalactites Make a saturated solution from warm water and Epsom salts. (Add enough salt so that if you add more, it will not dissolve further.) Fill two empty glass jars with the salt solution. Space the jars a foot apart on a layer of foil or on a cookie sheet. Suspend a piece of yarn or string from one jar to the other. Wait impatiently for about three days. A stalactite should form from the middle of the string!

Since 1996, Aurora Lipper has been helping families learn science. As a pilot, astronomer, mechanical engineer and university instructor, Aurora can transform toilet paper tubes into real working radios and make laser light shows from Tupperware.

If you enjoyed this experiment and want more, jump online to get your free copy of the Science Workbook at:

Nine Quick and Easy Laser Experiments to Share with Your Kids

By Aurora Lipper

The word "LASER" stands for Light Amplification by Stimulated Emission of Radiation.   A laser is an optical light source that emits a concentrated beam of photons. Lasers are usually monochromatic – the light that shoots out is usually one wavelength and color, and is in a narrow beam.

By contrast, light from a regular incandescent light bulb covers the entire spectrum as well as scatters all over the room. (Which is good, because could you light up a room with a narrow beam of light?)

There are about a hundred different types of atoms in the entire universe, and they are always vibrating, moving, and rotating. Think of kids on sugar. When you add energy to these atoms (even more sugar to the kids), they really get excited and bounce all over the place.

When the atoms relax back down to their "normal" state, they emit a photon (a light particle). Think of the kids as coming down from their sugar high, and they all collapse on the couch.

A laser controls the way energized atoms release photons. Imagine giving half the kids sugar, and picture how they would bounce all over the place (like light from a bulb)when it took effect. They would be very high-energy among the other half who were contently sitting down.

Now imagine those sugar kids jumping in unison (a focused laser beam). The sugar-kids are infectious, and pretty soon, the kids around them are joining in and sharing in their excited energy. This is how a laser charges the atoms inside the gas medium.

Now imagine a cat-flap that lets out a limited number of kids out at a time, while the rest are bouncing around inside, charging up everyone. That cat-flap exit is the laser beam exiting the laser. The atoms remaining inside the laser bounce off mirrors as they charge each other up.

Before we start, you'll need eye protection – tinted UV ski goggles are great to use, as are large-framed sunglasses, but understand that these methods of eye protection will not protect your eyes from a direct beam. They are intended as a general safety precaution against laser beam scatter and spinning mirrors. (Yes, you will be wearing sunglasses in the dark!)

A very neat addition to the experiments below is a fog machine. (Rent one from your local party supply store.) Turn it on, be sure you have good ventilation, darken the lights, and turn on the lasers for an outstanding laser experience!

A quick note about lasers: keychain lasers from the dollar store work just fine with these projects. Do *not* use the green lasers sold in astronomy stores – they are too dangerous for the eyes.

Plastic Bottle Beam Fill up a plastic water or clean soda bottle with water and add a sprinkle of cornstarch. Turn down the lights and turn up the laser, aiming the beam through the bottle. Do you see the original beam in the bottle? Can you find the reflection beam and the pass-through beam?

Light Bulb Laser In the dark, aim your laser at a frosted incandescent light bulb. The bulb will glow and have several internal reflections! What other types of light bulbs work well?

CDs Shine your beam over the surface of an old CD or DVD. Does it work better with a scratched or smoother surface? You should see between 5-13 reflections off the surface of the CD, depending on where you shine it and how good your "seeing" conditions are.

Glass and Crystal Pass the laser beam through several cut-crystal objects such as wine glasses or clear glass vases. Is there a difference between clear plastic or glass, smooth or multi-faceted? Try an ice cube, both frosted and wet.

Microscope Slides Shine the laser beam through a flat piece of glass, such as a microscope slide or single-paned window. Can you find the pass-through beam as well as a reflected beam?

If you have it, fill a clear tank with water, add a sprinkling of cornstarch, and put the slide underwater. Shine the laser through the side wall through the slide and both beams will be visible.

Lenses If you have an old pair of eyeglasses, pop out the lenses and try one or both in the beam to see the various effects. Try one lens, and then try two in line with each other to see if you can change the beam.

Filters Paint a piece of cellophane or stiff clear plastic with nail polish (or use colored filers) to put in the laser beam. You can make a quick diffraction grating by using a feather in the beam.

If you have polarizer filters, use two. You can substitute two sunglass lenses – no need to pop out the lenses – you can just use two pairs of sunglasses. Just make sure they are polarized lenses (most UV sunglasses are). Place both lenses in the beam and rotate one 90 degrees. The lenses should block the light completely in one configuration and allow it to pass-through the other way.

Laser Maze Hot glue one 1" mosaic mirror (found at most craft stores) to each wooden cube. In a pinch, you can use aluminum foil or Mylar. Add a fog source, such as a fog machine or nearby dry ice – just be sure to have proper ventilation, as you will also need the room to be very dark. Turn on the laser adjust the cubes to aim the beam onto the next mirror.

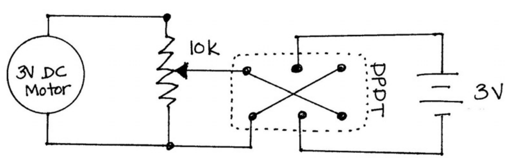
Laser Light Show What happens when you shine a laser beam onto a moving mirror, as opposed to the static mirrors in the above "Laser Maze" experiment above?

Prepare the mirror-motor assembly by cementing with epoxy the small gears onto the motor shaft (don't glue the shaft to motor – you want shaft the spin!) Spend time making this connection solid, as the motors are going to twirl the mirrors around 3000PRM, and you don't want spinning glass around any eyeballs. You can add the mirror to the flat side of the gear with epoxy at the same time if you prefer. (I use 5-minute 2-ton epoxy myself.)

Once the motors are built, plug them to batteries so the mirrors spin. Turn down the lights and crank up the laser, aiming the beam onto the motor. Shine the reflection somewhere easy to see, like the ceiling.

If you're adventurous, add a second mirror to this system. Is it tough to hold it all in place? If you are the do-it-yourself type, grab a clean Tupperware and mount your laser light show inside and cap with a lid. (Hint: use pipe clamps to hold the motors and laser, and mount on the side of the container.)

You can add potentiometers for a quick motor control as shown below and DPDT switches with a "center off" position to reverse the motor direction.



Why Does It Work? If you haven't figured this out yet, I will give you a hint: imperfections.

This Laser Lightshow works because the mirrors are mounted off-center, the motors wobble, the shafts do not spin true, and a hundred other reasons why our mechanics and optics are not dead-on straight.

And that's exactly what we want – the wobbling mirrors and shaky motors make the pretty pictures on the wall! If everything were perfect, it would not work well. Just be sure to put the lid on before you spin up. Enjoy!

Since 1996, Aurora Lipper has been helping families learn science. As a pilot, astronomer, engineer, rocket scientist, and former university instructor, Aurora can transform toilet paper tubes into real working radios and make robots from junk in the back desk drawer.

Nine Quick and Easy Light Experiments to Share with Your Kids

By Aurora Lipper

Can you make the color 'yellow' with only red, green, and blue as your color palette? If you're a scientist, it's not a problem. But if you're an artist, you're in trouble already.

The key is that we would be mixing *light*, not paint. Mixing the three primary colors of light gives white light. If you took three light bulbs (red, green, and blue) and shined them on the ceiling, you'd see white. And if you could un-mix the white colors, you'd get the rainbow. That's what prisms do.

If you're thinking yellow should be a primary color - it *is* a primary color, but only in the artist's world. Yellow *paint* is a primary color for painters, but yellow *light* is actually made from red and green light. Confused? Good, because we're going to spin colors, mix and un-mix colors, and play with the electromagnetic spectrum. Let's get started.

Mixing Colors Find three flashlights. Cover each with colored cellophane or paint the plastic lens cover with nail polish (red, green, and blue). Shine onto a white ceiling or wall, overlap the colors and make new colors. Leave the flashlights on, line them up on a table, turn off the lights, and dance - you will be making rainbow shadows on the wall! In addition, you can paint the lens of a fourth flashlight yellow.

More About Mixing Colors When you combine red and green light, you will get yellow light. Combine green and blue to get cyan (turquoise). Combine blue and red to get magenta (purple). Turn on the red and green lights, and the wall will appear yellow. Wave your hand in front of the lights and you will see cyan and magenta shadows. Turn on the green and blue lights, and the wall turns cyan with yellow and magenta shadows. Turning on the blue and red give a magenta wall with yellow and cyan shadows. Turn on all colors and you will get a white wall with cyan, yellow, and magenta shadows – rainbow shadows!

Spectrometer Find an old CD and a cardboard tube at least 10 inches long. Cut a clean slit less than 1 mm wide in an index card or spare piece of cardboard and tape it one end of the tube. Align your tube with the slit horizontal, and on the top of the tube at the far end cut a viewing slot about one inch long and ½" inch wide. Cut a second slot into the tube at a 45o from the vertical away from the viewing slot. Insert the CD into this slot so that it reflects light coming through the slit into your eye (viewing slot). Aim the 1 mm slit at a light source (such as a fluorescent light, neon sign, sunset, light bulb, computer screen, television, night light, candle, fireplace… any light source you can find. Look through the open hole at the light reflected off the compact disk (look for a rainbow in most cases) inside the cardboard tube.

Pinhole Camera Use a cardboard box that is light-proof (no leaks of light anywhere). Cut off one side of the box (there's no need to do this if you're using a shoebox). Tape a piece of tracing paper over the cutout side, keeping it taut and smooth. Make a pinhole in the side opposite the tracing paper. Point the pinhole at a window and move toward or away from the window until you see its image in clear focus on the tracing paper. You can hold up a magnifying glass in front of the pinhole to sharpen an image.

Kaleidoscopes Carefully tape together three identical mirrors, making a triangle-tube with the mirrors on the inside. (You can also use Mylar or silver wrapping paper taped to cardboard instead of mirrors.) Tape all rough edges well and peek through the opening as you walk around.

Kaleidoscope Variations By changing the size and shape of the mirrors, you can change the dimensional effect you see. Just be sure to look at the mirror surface, not the opening. Variations include: make mirrors wider at the bottom and narrower at the top (easier with cardboard mirrors); use four or five mirrors instead of three; change the length of the mirrors; use curved mirrors instead of flat (find curved cardboard from an oatmeal box or carefully cut apart a soda can and tape Mylar or spray with chrome paint from the hardware store).

Telescopes and Microscopes Hold one magnifying glass in each hand. Focus one lens on a printed letter or small object. Add the second lens above the first, so you can see through both. Move the lens toward and away from you until you bring the letter into clear focus again. You just made a microscope! The lens closest to your eye is the EYEpiece. The lens closest to the object is the OBJECTive. Now focus on a far-away object like a tree. You just made a simple telescope… but the image is upside-down!

Homemade Diffraction Take a feather and put it over an eye. Stare at a light bulb or a lit candle. You should see two or three flames and a rainbow X. Shine a flashlight on a CD and watch for rainbows.

Spinning Colors There are three primary colors of light: red, green, and blue (artists use red, yellow, and blue). Use a cup to outline circles on a sheet of stiff white paper (or manila folders). Stack several blank pages together and cut out multiple circles. Color the circles, push a sharp wooden pencil through a hole in the center, and spin! What color does yellow and blue make? Pink and purple? You can also make a button-spinner to really whirl it around by looping a length of string through two holes in the center of the disk circle.

Water Prism Set a tray of water in sunlight. Lean a mirror against an inside edge and adjust so that a rainbow appears on the wall. You can also use a light bulb shining through a slit in a flat cardboard piece as a light source.

Polarization If you have polarizer filters, use two of them. You can substitute two sunglass lenses (no need to pop out the lenses) using two pairs of good sunglasses. Make sure your sunglasses are polarized lenses (most UV sunglasses are). Look through both lenses, then rotate one pair 90^o. The lenses should block the light completely at 90^o and allow light to pass-through when aligned at 0^o. Think of your sunglasses as light filters. They allow some light to pass through but not all. When you rotate the lenses to 90^o, you block out all visible light.

More About Polarization You use the filter principle in the kitchen. When you cook pasta, you use a filter (a strainer) to get the pasta out of the water. That's what the sunglasses are doing – they are filtering out certain types of light. Rotating the lenses 90^o to block out all light is like trying to strain your pasta with a mixing bowl. You don't allow anything to pass through. You can make sunglasses tinted darker or lighter by adjusting the amount of rotation between the two lenses before you glue them together into one lens. Astronomers use polarizing filters to look at the moon. Ever notice how bright the moon is during a full moon, and how dim it is near new moon? Using a rotating polarizing filter, astronomer can adjust the amount of light that enters into their eye.

Roller Coaster Physics Experiment You Can Do With Your Kids

By Aurora Lipper

The reason why things bounce, fly, zoom, and splat are described by the Laws of Physical Motion most kids learn in their high school physics class. But you don't have to wait until your kid hits puberty to have fun with physics – you can start right now. Kids across the globe use the law of gravitation everyday to put the zing in their games, from basketball games to skateboarding. Let's find out how they do it.

Let's take a look at the first law of motion. When you place a ball on the floor, it stays put. A science textbook will tell you this: *An object at rest tends to stay at rest unless acted upon by an external force.* Your foot is the external force. Kick it!

What about when the ball whacks into something? Checking back in with the science textbook: *An object in motion tends to stay in motion unless acted upon by an external force.* After you kicked the ball (external force), it flies through the air until it smacks into something.

But there are two other forces acting on the ball that you can't see. One force is air resistance. The ball is hitting the air molecules when it flies through the air, which slows it down. The other force is gravitational. Gravity is inherent in anything that has mass (including you!), but you need something the size of a planet before you can begin to see the effects it has on other objects. If you tossed your ball in space (away from any nearby gravitational pulls like black holes or galaxies), it would continue in a straight line forever. There aren't any molecules for it to collide with, and no gravitational effects to pull it off-course.

There is one more idea that you'll need to understand… acceleration. A ball at rest has a position you can chart on a map (latitude, longitude, and altitude), but no velocity or acceleration. It's not moving. When you decide to stir things up and kick the ball, that's when it gets interesting. The second your toe touches the ball, things start to change. Velocity is the change in position. If you kick the ball ten feet, and it takes five seconds to go the distance, the average speed of the ball is 2 feet per second (about 1.4 MPH).

The trickier part of this scenario has to do with acceleration, which is the change of velocity. When you drive on the freeway at a constant 65 MPH, your acceleration is zero. Your speed does not change, so you have no acceleration. Your position is constantly changing, but you have constant speed. When you get on the freeway, your speed changes from zero to 65 MPH in ten seconds. Your acceleration is greatest when your foot first hits the gas – when your speed changes the most.

There's an interesting effect that happens when you travel in a curve. You can feel the effect of a different type of acceleration when you suddenly turn your car to the right – you will feel a *push* to the left. If you are going fast enough and you take the turn hard enough, you can get slammed against the door. So - who pushed you?

Think back to the first law of motion. An object in motion tends to stay in motion unless acted upon by an external force. This is the amazing part – the *car* is the external force. Your body was the object in motion, wanting to stay in motion in a straight line. The car turns, and your body still tries to maintain its straight path, but the car itself gets in the way. When you slam into the car door, the car is turning itself into your path, forcing you to change direction.

This effect is true when you travel in a car or in a roller coaster. It's the reason the water stays in the bucket when you swing it over your head. Physical motion is everywhere, challenging toddlers learning to walk as well as Olympic downhill skiers to go the distance.

Let's try these ideas out.

Bucket Splash Fill a bucket half-full with water. Grasp the handle and swing it over your head in a circle in the vertical direction. Try spinning around while holding the handle out in front of your chest to swing it in the horizontal plane. Vary your spin speed to find the minimum!

Marble Vortex Curl a sheet of paper into a cone, leaving a small hole open at the bottom. Place a marble in the cone and find the speed you need to circle the cone in order to keep the marble in the cone. NOTE: This is an excellent demonstration of satellites. The satellite is the marble and the cone apex is the earth. If the marble moves too fast, it will fly out of the cone (which is equivalent to the satellite flying out of orbit and into space). If the marble speed is too slow, it will fall into the bottom of the cone (translation: satellite crashes into earth). There is a very specific speed the satellite must maintain to remain in orbit.

Ping Pong Curves Attach a clear, plastic cup to the end of a long dowel so that the bottom of the cup rests along the length of the dowel, near the end (when the dowel is lying flat on the ground, the cup points up). Insert a ping pong ball in the cup and grab the free end of the stick with your hand. Swing it partway through a circle and suddenly STOP. The ball should pop out of the cup in a line tangent to your circle at the point you stopped. Why does the ball not continue in a circle or stay in the cup?

> *Answer:* An object in motion (the ball) wants to stay in motion (a straight line) and is free to do so when you stopped. Initially, it goes in a straight line tangent to your arc, but then gravity takes over and down it goes to the floor.

Cork Accelerometer Fill an empty soda bottle to the top with water. Modify the soda bottle cap as follows: attach a string 8-10" long to a clean wine cork. Hot glue the free end of the string to the inside of the cap. Place the cork and string inside the bottle and screw on the top (try to eliminate the air bubbles). The cork should be free to bob around when you hold the bottle upside-down.

> *To use the accelerometer:* invert the bottle and try to make the cork move about. Remember – it is measuring acceleration, which is the change in speed. It will only move when your speed *changes*.

Roller Coaster Physics This is the best way to learn about physics. All you need is a handful of marbles, several pieces of ¾" foam pipe insulation, a few rolls of masking tape, and a crowd of participants.

To make the roller coasters, you'll need foam pipe insulation, which is sold by the six-foot increments at the hardware store. You'll be slicing them in half lengthwise, so each piece makes twelve feet of track. It comes in all sizes, so bring your marbles when you select the size. The ¾" size fits most marbles, but if you're using ball bearings or shooter marbles, try it out at the store. (At the very least you'll get smiles and interest from the hardware store sales people.) lit most of the track lengthwise (the hard way) with scissors. You'll find it is already sliced on one side, so this makes your task easier. Leave a few pieces uncut to become "tunnels" for later roller coasters.

The next step is to join your track together before adding all the features like loops and curves. Join two tracks together in butt-joint fashion and press a piece of masking tape lengthwise along both the inside and the underside of the track. A third piece of tape should go around the entire joint circumferentially. Make this connection as smooth as possible, as your high-speed marble roller coaster will tend to fly off the track at the slightest bump.

Roller Coaster Maneuvers

Loops Swing the track around in a complete circle and attach the outside of the track to chairs, table legs, and hard floors with tape to secure in place.

Loops take a bit of speed to make it through, so have your partner hold it while you test it out before taping.

Start with smaller loops and increase in size to match your entrance velocity into the loop. Loops can be used to slow a marble down if speed is a problem.

Camel-Backs Make a hill out of track in an upside-down U-shape. Good for show, especially if you get the hill height just right so the marble comes off the track slightly, then back on without missing a beat.

Whirly-Birds Take a loop and make it horizontal. Great around poles and posts, but just keep the bank angle steep enough and the marble speed fast enough so it doesn't fly off track.

Corkscrew Start with a basic loop, then spread apart the entrance and exit points. The further apart they get, the more fun it becomes. Corkscrews usually require more speed than loops of the same size.

Jump Track A major show-off feature that requires very rigid entrance and exit points on the track. Use a lot of tape and incline the entrance (end of the track) slightly while declining the exit (beginning of new track piece).

Pretzel The cream of the crop in maneuvers. Make a very loose knot that resembles a pretzel. Bank angles and speed are the most critical, with rigid track positioning a close second. If you're having trouble, make the pretzel smaller and try again. You can bank the track at any angle because the foam is so soft. Use lots of tape and a firm surface (bookcases, chairs, etc).

Troubleshooting Marbles will fly everywhere, so make sure you have a lot of extras! If your marble is not following your track, look very carefully for the point of departure – where it flies off.

- Does the track change position with the weight of the marble, making it fly off course? Make the track more rigid by taping it to a surface.

- Is the marble jumping over the track wall? Increase your bank angle (the amount of twist the track makes along its length).
- Does your marble just fall out of the loop? Increase your marble speed by starting at a higher position.
- When all else fails and your marble still won't stay on the track, make it a tunnel section by taping another piece on top the main track. Spiral-wrap the tape along the length of both pieces to secure them together.

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Get the free Science Experiment Workbook from the Supercharged Science website: http://www.SuperchargedScience.com.

Quick and Easy Simple Machine Experiments to Share with Your Kids

By Aurora Lipper

Pulleys and levers are simple machines, and they make our lives easier. They make it easier to lift, move and build things. Chances are that you use simple machines more than you think. If you have ever screwed in a light bulb, put the lid on a jam jar, put keys on a keychain, pierced food with a fork, walked up a ramp, or propped open a door, you've made good use of simple machines.

Mechanical advantage is like using brains instead of brawn (using your mind instead of brute muscular strength). With pulleys and levers, you use your 'mechanical advantage' to leverage your strength and lift more than you normally could handle, but it comes at a price. You trade force for distance. When you are using a pulley system, you can thread it up to lift ten people with one hand. Here's the trade-off: You will have to pull ten feet of rope for every one foot they rise up.

To figure out the mechanical advantage in a pulley system, count the number of strings in your system. (This will make much more sense after you build the pulley experiments). If there are seven strings, you can pull with seven times your normal strength.

With levers, it's a little easier to figure out the advantage, mostly because there are no strings to count or get tangled up. You're just using fulcrums. (Think of the pivot point in a see-saw.) By moving the fulcrum of levers around, you can dramatically change how much you can lift.

Let's get started!

Second Class Levers Lay a 2" x 4" x 10' length of wood on the ground. Have a smaller kid sit in the middle of the beam, holding on as you (the larger kid-adult) lift up one end. Leave the other corner resting on the ground – you can even ask a big adult to sit on it so it doesn't slide around. This end is your fulcrum. Have the kid move further back toward the fulcrum, and lift up the beam again. Experiment with both the kid position and effort you exert to lift the beam. Find out where you need to sit to have the kid lift you. They usually can, if you sit in the right position!

Third Class Levers Switch places with the smaller kid so that the lightweight child sits on the end of the beam, a big adult on the other end (still your fulcrum), and you lift in the middle. Lift the beam in the middle so that the child's end comes up off the ground. What is the furthest point from the child that you can lift? (If at all?)

First Class Lever Use a strong chair, rock, or log as your fulcrum in the middle of the beam. Turn your lever into a see-saw, or teeter-totter. Put a big adult on one end and a lightweight child on the other. Where does the fulcrum need to be in order to balance the two people?

Here's another example of how to use first class levers: Find a strong dowel the same height as a heavy desk or table and stand it up vertically from the floor close to the desk. Find another stick and rest it horizontally atop the first, placing one end under the top ledge of the desk. Push down on the opposite end of the stick, and the desk comes up easily. Notice that you moved your hand further downward than the desk moved upward.

Block and Tackle refers to pulleys and rope (in that order). One kid can drag ten adults across the room with this simple setup. (If you can't find pulleys or rings, try the next pulley experiment instead.) Using pliers or vice grips, open the end of a shower curtain pulley and attach to the metal curtain ring. (You can alternatively you can use S-hooks and close them with pliers to prevent the system from separating while you work.)

Attach three pulleys to each ring. Make two or four sets of pulley-ring systems. Take two 18" lengths of dowel and slide one pulley-ring set onto each dowel. Thread a length of rope (about 35') through zigzag fashion first through one pulley on the first dowel, then through a pulley on the second dowel, then an open pulley on the first, then another free pulley on the second, etc… Knot the end to one of the dowels. Attach a kid to the free end of the rope by adding a handle. You can thread a rope through a 6" piece of PVC pipe and tie the rope back on itself. Attach adults to the wood dowels, each adult holding onto the dowel near the ends, straight out in front of their chest. The adults' job is to resist the pull they will feel as the kid walks with his end of the rope.

Simple Tug-Of-War Pulley System This is a much simpler setup than the first experiment. Have two people face each other and each hold a smooth pipe or strong dowel (about 18" long) horizontally straight out in front of their chest. (You can also use broomstick handles.) Tie a length of strong nylon rope (slippery rope works best to minimize friction) near the end of one dowel. Drape the rope over the second dowel, loop around the bottom, then back to the top of the first dowel. You're going to zigzag the rope back and forth between the two dowels until you have four strings on each dowel.

Attach a third person to the free end of the rope. The two people hold the dowels will not be able to resist the pull you give when pulling on the end of the rope!

Return Pulley System This is a great addition to any tree house or playground structure! Hang a loop of rope from a tree branch. Connect two pulleys to the loop on the tree with S-hooks. Connect one pulley to the basket handle with an S-hook or short piece of rope. Tie a length of rope to the basket handle, then up through one tree pulley, down through the basket pulley, and up through the second tree pulley. Thread a 6" length of PVC pipe onto the end and tie the rope back onto itself to form a handle.

Exponential Friction Find a smooth, cylindrical support column, such as those used to support open-air roofs for breezeways and outdoor hallways (check your school). Wind a length of rope one time around the column, and pull on one end while three friends pull on the other in a tug-of-war fashion. Experiment with the number of friends and the number of winds around the column.

Simple Balance Suspend a flat ruler from its center-point with a 12" piece of rope from a low tree branch (or stack a big pile of books on a table, and place a ruler between books near the top so part of the ruler sticks out, and you can suspend the balance from it). When the ruler is in balance, add to identical baskets to each end and place objects in the baskets (or directly on the ruler). Make one basket slightly heavier than the other, and slide it toward the fulcrum until the ruler is in balance again.

Slingshot Block Nail three nails in a triangular pattern into a scrap piece of wood. Stretch a rubber band around two of the nails. Loop a small piece of string around the middle of the rubber band and knot to the third nail. (See image above.) Place the entire block on a bed of naked straws. Place a projectile (such as a good size rock) in the slingshot and cut the string. The projectile goes one way and the nail-block another.

Inclined Plane Cut a right triangle out of paper, about 11" on its base, the short side 5 ½". Find a short dowel (or use a cardboard tube from a coat-hanger. Roll the triangular paper around the tube beginning at the short side and roll toward the triangle point, keeping the base even as it rolls. Notice that the inclined plane (hypotenuse) spirals up as a tread as you roll. Remind you of screw threads? Those are included planes. So are jar lids, spiral staircases, light bulbs, and key rings. These are all inclined planes that wind around themselves. Some inclined planes are used to lower and raise things (like a jack or ramp), but they can also used to hold objects together (like jar lids or light bulb threads).

Wedge Make a simple wedge from a block of wood and drive it under a heavy block (like a tree stump or large book) with a kid on top. A wedge is a double inclined plane (top and bottom surfaces are inclined planes). You have lots of wedges at home: forks, knives, and nails just name a few. When you stick a fork in food, it splits the food apart.

Simple Catapult Use a spoon and a quarter (placed at the end of the handle).Show yourself that the longer end of a lever (spoon handle) travels faster and further than the shorter end. Think about the position of the fulcrum – what happens when the fulcrum is not at the center?

Fast Catapult Stack five large popsicle sticks (the tongue-depressor size from the doctor's office) together and wrap the ends tightly with rubber bands. Stack two large popsicle sticks and wrap one end tightly with a rubber band. Open the ends apart to form a V and insert the five-stack, pushing it right up to the rubber band end, maximizing the V-angle. Wrap a rubber band around the intersection to secure. Hot glue a milk jug cap open-end up an open end of the V. This holds your ping pong ball (or other projectile).

Simple Gears Punch holes in the centers of bottle caps. Flatten out the cap edges as well as you can (you can place it between two boards and hammer) while keeping the circular shape intact. Nail the caps to a small wood board so the teeth-edges mesh and the gears turn freely.

Belts and Pulleys Take a rubber band and a roller skate (not in-line skates, but the old-fashioned kind with a wheel at each corner.) Lock the wheels on one side together by wrapping the rubber band around one wheel then the other. Turn one wheel and watch the other spin. Now crisscross the rubber band belt by removing one side of the rubber band from a wheel, giving nit a half twist, and replacing it back on the wheel. Now when you turn one wheel, the other should spin the opposite direction.

Wheels and Bearings Stand on a cookie sheet or cutting board which is placed on the floor (find a smooth floor with no carpet). Ask someone to gently push you across the floor. Notice how much friction they feel as they try to push you. Now place three or four dowels parallel about six inches apart between the board and the floor. Smooth wooden pencils can work in a pinch, as can the hard cardboard tubes from coat-hangers. Ask someone to push you. Is there a direction you still can't travel easily? Replace the dowels with marbles. What happens? Why do the marbles make you do in all directions? What direction(s) did the dowels roll you in?

Ball Bearings Get two cans (with a deep groove in the rim, such as paint cans) and stack them. Turn one (still on top of the other) and notice the resistance (friction) you feel. Now sandwich marbles all along the rim between the cans. Place a heavy book on top and note how easily it turns around. Oil the marbles (you can spray with cooking spray, but it is a bit messy) and it turns more easily yet.

Simple Homemade Pulleys Cut a wire coat-hanger at the lower points (at the base of the triangular shape) and use the hook section to make your pulley. Thread both straight ends through a thread spool, crossing in the middle, and bend wire downwards to secure spool in place. Be sure the spool turns freely. Use hook for easy attachment.

Quick and Easy Slime Experiments You Can Share With Your Kids

by Aurora Lipper, Supercharged Science

When you think of slime, do you imagine slugs, snails, and puppy kisses? Or does the science fiction film "The Blob" come to mind? Any way you picture it, slime is definitely slippery, slithery, and just plain icky. Which is a perfect forum for learning real science. But which ingredients work in making a truly slimy concoction, and *why* do they work? Here's a closer look at the real thing.

Imagine a plate of spaghetti pasta. The noodles slide around and don't clump together, just like the long chains of molecules (called polymers) that make up slime. They slide around without getting tangled up. The pasta by itself, fresh from the boiling water, doesn't really hold together until you put the sauce on, right? Slime works the same way.

Long, spaghetti-like chains of molecules don't clump together until you add the sauce – something to cross-link the molecules strands together. In the case of the first slime (Bouncy Putty), the borax-water mixture is the "spaghetti" (long chain of molecules), and the "sauce" (cross-linking agent) is the glue-water mixture. You need both in order to create a slime worthy of Hollywood filmmakers. Let's give it a try.

Bouncy Putty Slime Combine ½ cup water with one teaspoon of Borax in a cup and stir with a popsicle stick. In another cup, mix equal parts white glue and water. Add in a glob of glue mixture to the borax. Stir for one second with a popsicle stick, then quickly pull the putty out of cup and play with it until it dries enough to bounce on table (3-5 minutes). Pick up an imprint from a textured surface or print from a newspaper, bounce and watch it stick, snap it apart quickly and ooze apart slowly…

Mucus Slime Pour 1 tablespoon polyvinyl alcohol (PVA) into a cup. In a fresh cup, mix 1 tablespoon of water with 1 teaspoon of borax. Measure ¼ to ½ teaspoon of borax solution into the PVA cup and stir.

Starch Slime Measure 1 tablespoon of liquid starch into paper cup. Stir in glob of glue mixture (equal parts of white glue and water), stir for a second. Pull it all out and play with it until it dries in hands. How is this different from Bouncy Putty?

Sewer Sneeze Slime Fill a cup with 7 tablespoons of cold water. Stir in 1/4 teaspoon of guar gum, stir with a popsicle stick 10 times and stop, leaving the stick in. Cautiously dip a pinky into the cup, then rub it in their fingers. Does it smell? Leave it for 2 minutes to thicken before adding this final ingredient: ½ teaspoon of the Borax Solution (Borax Solution: 1 teaspoon borax in one tablespoon water). Stir and it will form a gel that looks like real boogers!

Corny Slime Fill a large bowl with two cups of cold water. Mix in one cup of cornstarch. The faster you stir, the harder it is to stir. Go *s l o w l y*. Grab it with your hand – it should form a hard ball that you can't squish. When you relax your grip, the ball should melt and drip between your fingers as if liquid. If this is not what's happening for you, adjust the amounts of cornstarch and water you have in your bowl.

Squishy Slime Mix 1 cup sugar, 12 cups water, and 3 cups cornstarch in a saucepan. Stir constantly until thickened, about 5 minutes. Place a glop in each of several bowls along with drops of food coloring in each. Place a dollop of each color into a plastic sandwich bad and zip it shut. You can squish and squeeze without getting your hands slimy.

Gelatinous Slime Combine two cups cold water with one cup cornstarch or white flour. Cook in a saucepan over medium heat, stirring until boiling. When thickened, remove from heat, let cool, add food coloring, and serve.

Amoeba Slime This is always the biggest hit at the birthday party. After kids are finished making the above slimes, I leave out all the ingredients and ask them to make the best slime ever. Stand back and get ready with a hose. Best done outdoors. Kids always get to take home samples in empty film canisters (photo below).

Kitchen Wizard Chemical Reactions You can produce a number of fun chemical reactions with things you already have: a raw potato slice and hydrogen peroxide; chalk and vinegar; baking soda and vinegar; Alka-Seltzer and water; raisins and 7-Up.

TIP: Never polish your tarnished silver-plated silverware again by safely dipping it in a self-polishing solution in a saucepan lined with aluminum foil heating a solution of water, one teaspoon of baking soda and one teaspoon salt.

Since 1996, Aurora Lipper has been helping families learn science. As a pilot, astronomer, mechanical engineer and university instructor, Aurora can transform toilet paper tubes into real working radios and make laser light shows from Tupperware.

If you enjoyed this experiment and want more, jump online to get your free copy of the Science Workbook at:

www.SuperchargedScience.com

Top Ten Air Pressure Experiments to Mystify Your Kids

by Aurora Lipper, Supercharged Science

There's air surrounding us everywhere, all at the same pressure of 14.7 psi (pounds per square inch). It's the same force you feel on your skin whether you're on the floor, under the bed or in the shower.

An interesting thing happens when you change a pocket of air pressure - things start to move. This difference in pressure that causes movement is what creates winds, tornadoes, airplanes to fly, and some of the experiments we're about to do right now.

An important thing to remember is that higher pressure always pushes things around. (Meaning lower pressure does not "pull", but rather that we think of higher pressure as a "push".)

Another interesting phenomenon occurs with fast-moving air particles. When air moves fast, it doesn't have time to push on a nearby surface, like an airplane wing. It just zooms by, barely having time to touch the surface. The air particles are really in a rush.

Think of really busy people driving fast in their cars. They are so busy doing other things and driving fast to get somewhere that they don't have time to just sit and relax.

Air pressure works the same way. When the air zooms by a surface (like an airplane wing) like fast cars, the fast air has no time to push on the surface and just sit there, so not as much air weight gets put on the surface.

Less weight means less force on the area. (Think of "pressure" as force on a given surface.) This causes a less (or lower) pressure region wherever there is faster air movement.

Confused? Great! Let's try some experiments out to straighten out these concepts so they make sense to you.

Magic Water Glass Trick Fill a glass one-third with water. Cover the mouth with an index card and invert (holding the card in place) over a sink. Remove your hand from the card. Voila! The card stays in place because air is heavier than water, and the card experiences about 15 pounds of force pushing upward by the air and only about one pound of force pushing downward from the water - hence the card stays in place. (Try this trick over someone's head when you get good at it.)

Plumber Magic Take two clean old-fashioned, red rubber-and-wood-stick plungers and stick them together (you may need to wet the rims first). Try to separate them. Why is it so hard? When you rammed them together, air was forced out of the cavity that the insides make when pushed together, leaving you with a lower air pressure pocket inside, compared to the surrounding air pressure of 14.7 pounds per square inch (psi) outside the plungers. Higher pressure always pushes and thus is keeping the plungers together.

Magic Egg Trick Remove the shell from a hard-boiled egg and use a bottle with a neck large enough that the egg can be squeezed through (without squashing it) – old fashioned milk bottles work great. Light a match and toss it in, quickly setting the egg (small-end down) on the mouth of the bottle. The air inside gets used up by the flame, lowering the air pressure inside the bottle. The higher pressure, now outside the bottle, pushes on the egg and pops it in. (To remove the egg, turn the bottle upside down and get the egg to be small-end down inside the bottle near the mouth. Blow hard into the mouth of the bottle.)

Fountain Bottle Seal a 2-liter soda water bottle (half-full of water) with a lump of clay wrapped around a long straw, sealing the straw to the mouth of the bottle. Blow hard into the straw. As you blow air into the bottle, the air pressure increases. This higher pressure pushes on the water, which gets forced up and out the straw.

Ping Pong Funnel Insert a ping pong ball into a funnel and blow hard. (You can tilt your head back so that the ball end points to the ceiling. Can you blow hard enough so when you invert the funnel, the ball stays inside? Can you pick up a ball from the table? As you blow into the funnel, the air where the ball sits in the funnel moves faster and generates lower air pressure than the rest of the air surrounding the ball. This means that the pressure under the ball is lower than the surrounding air which is, by comparison, a higher pressure. This higher pressure pushes the ball back into the funnel… no matter how hard you blow or which way you hold the funnel.

Squished Soda Can Heat an empty soda can (large beer cans actually will work better if you have one) in a skillet with a few tablespoons of water in the can over a hot stove. Have a shallow dish with about ¼ inch of ice water handy (enough water to make a seal with the top of the can). When the can emits steam, grab the can with tongs and quickly invert it into the dish. CRACK! The air in the can was heated, and things that are hot tend to expand. When you cool it quickly by taking it off the stove onto a cold plate, the air cools down and shrinks, creating a lower pressure inside. Since the surrounding air outside of the can is now higher, it pushes on all sides of the can and crushes it.

Squished Balloon Blow a balloon up so that it is just a bit larger than the opening of a large jam jar and can't be easily shoved in. Light a small wad of paper towel on fire and drop it into the jar. Place the balloon on top. When the fire goes out, lift the balloon… and the jar goes with it! The air gets used up by the flame and lower the air pressure inside the jar. The surrounding air outside, now at a higher pressure than inside the jar, pushes the balloon into the jam jar.

The Million Dollar Bet Take an empty water or soda bottle and lay it down horizontally on a table. Carefully set a small wadded up ball of paper towel in the mouth of the bottle. (The ball should be about half the size of the opening.) I bet you a *million dollars* that you can't blow hard and get the paper to go into the bottle! Why is this so impossible? You're trying to force more air into the bottle, but there's no room for the air already inside to go except back out the mouth of the bottle, taking the paper ball with it.

Flying Papers Hold a regular sheet of paper to your bottom lip (you may have to play a bit to find the exact location) and blow hard across the sheet. The sheet flies up! This is the same reason airplanes can fly. As you blow across the top of the sheet, you lower the air pressure (because the air is moving faster), and thus the pressure on the underside of the sheet is now higher, and higher air pressure pushes the sheet upwards.

Kissing Balloons Blow up two balloons. Attach a piece of sting to each balloon. Have each hand hold one string so that the balloons are at nose-level, 6" apart. Blow hard between the balloons and watch them move! The air pressure is lowered as you blow between the balloons (think of the air molecules as ping pong balls … they balls don't have enough time to touch the balloon surface as they zoom by). The air surrounding the balls that's not really moving is now at a higher pressure, and pushes the balloons together.

Since 1996, Aurora Lipper has been helping families learn science. As a pilot, astronomer, engineer, rocket scientist, and university instructor, she can build laser light shows from tupperware and working radios from toilet paper. Visit our website: *www.SuperchargedScience.com* for your copy of our free Science Workbook!

Quick and Easy Volcano Experiments to Share with Your Kids

By Aurora Lipper, Supercharged Science

If you've ever wondered what makes the Earth burp and spit magma, you're in the right place. This article is for those who want to shake up volcanoes using chemical reactions and air pressure.

The first thing to do is to mix up your own volcano dough. You can choose from the following two mixtures. The Standard Volcano dough is akin to "play dough", and the Earthy Volcano dough looks more like the real thing. Either way, you'll need a few days on the shelf or a half hour in a low temperature oven to bake it dry. You can alternatively use a slab of clay if you have one large enough.

Standard Volcano dough Mix together 6 cups flour, 2 cups salt, ½ cup vegetable oil, and 2 cups of warm water. The resulting mixture should be firm but smooth. Stand the water or soda bottle in the roasting pan and mold the dough around it into a volcano shape.

Earthy Volcano Dough Mix 2 ½ cups flour, 2 ½ dirt, 1 cup sand, 1 ½ cups salt and water. You mix all the dry ingredients together and then add water by the cup until the mixture sticks together. Build the volcano around an empty water bottle on a disposable turkey-style roasting pan. It will dry in two days if you have the time, but why wait? You can erupt when wet if the mixture is stiff enough! (And if it's not, add more flour until it is.)

To make Soda Volcanoes, fill the bottle most of the way full with warm water and a bit of red food color. Add a splash of liquid soap and ¼ cup baking soda. Stir gently. When ready, add vinegar in a steady stream and watch that lava flow!

Building Air Pressure Sulfur Volcanoes takes a bit more work. Wrap the dough around the tubing into an ice-cream-cone-shape and slap the ice-cream-end down into your roasting pan tray. Push and pull the tube from the bottom until the other end of the tube is just below the volcano tip.

Using your fingers, shape the inside top of the volcano to resemble a small Dixie cup. Your solution needs a chamber to mix and grow in before overflowing down the mountain. The tube goes at the bottom of the clay-cup space. Be sure the volcano is SEALED to the cookie sheet at the bottom. You won't want the solution running out of the bottom of the volcano instead of popping up out the top!

Make your chemical reactants.

> Solution 1: In one bucket, fill halfway with warm water and add one to two cups baking soda. Add one cup of liquid dish soap and stir very gently so you don't make too many bubbles.
>
> Solution 2: In a different bucket, fill halfway with water and place one cup of aluminum sulfate (find this at the gardening section of the hardware store). Add red food coloring and stir.

Putting it all together: Practice your breathing: count ONE (and pour in Solution 1), TWO (inhale air only!), and THREE (pour in Solution 2 as you put your lips to the tube and puff as hard as you can!). Lava should not only flow but burp and spit all over the place!

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