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Demystifying Science For Kids

A basic skill for engineers had its first impulse in mankind's earliest expressions; then it passed through the hands of the masters.

Aurora Lipper describes herself as a contract teacher or as the head of a company called Supercharged Science. Either way, she has made it her mission to take the knowledge of scientific principles to youngsters. Lipper's work is the subject of a feature by Jeffrey Winters in the January 2008 issue of *Mechanical Engineering*.

Here we present two articles written by Lipper, which describe various experiments that parents and others can do with children, not only to demonstrate physical principles, but also to engage the young in the pursuit of scientific knowledge.

The Editors

Top Ten Air Pressure Experiments to Mystify Your Kids-Using Stuff From Around the House

By Aurora Lipper

There's air surrounding us everywhere, all at the same pressure of 14.7 pounds per square inch. It's the same force you feel on your skin, whether you're on the ceiling or 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. (That means 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 area or surface.) This causes a less (or lower) pressure region wherever there is faster air movement.

Confused? Great! Let's try out some experiments 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. Voilà! 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 so 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 on hand a shallow dish with about ¼-inch of ice water (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 up a balloon so that it's 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 lowers 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 upward.

Kissing Balloons. Blow up two balloons. Attach a piece of string to each balloon. Have each hand hold one string so that the balloons are at nose level, 6 inches 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 ... the 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.

For a free Science Experiment Workbook, go to the Supercharged Science Web site:

<http://www.SuperchargedScience.com>.

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 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 contentedly 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 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 up each other.

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 five and 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 multifaceted? 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 a single-pane 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 and 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 filters) 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 of them. You can substitute two sunglass lenses—no need to pop out the lenses—or you can just use two pairs of sunglasses. 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.

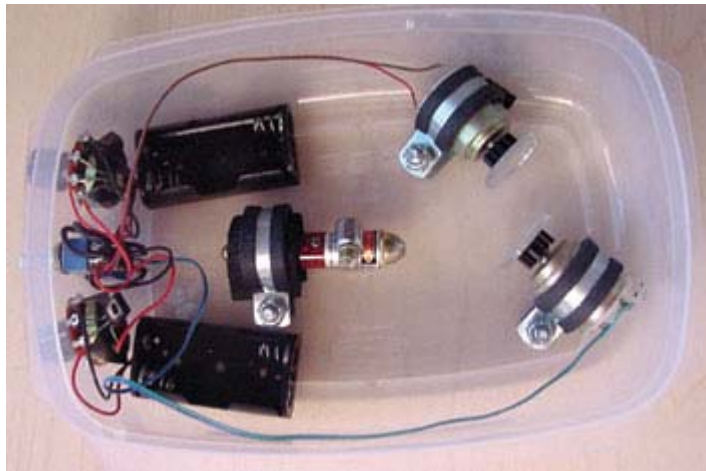
Laser Maze. Hot glue a 1-inch mosaic mirror (found at most craft stores) to each of several wooden cubes. In a pinch, you can use aluminum foil or Mylar instead of mirrors. Add a fog source, such as a fog machine or nearby dry ice. Just be sure to have proper ventilation, as you will also need the room to be very dark. Turn on the laser and adjust each cubes to aim the beam onto another 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?

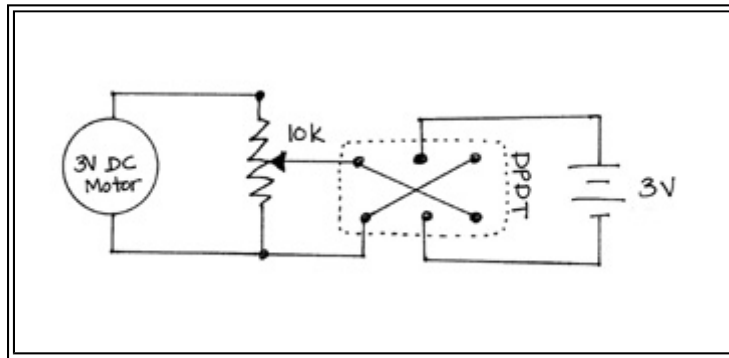
Prepare a mirror-motor assembly by cementing with epoxy the small gears onto the motor shaft (don't glue the shaft to the motor—you want the shaft to spin). Spend time making this connection solid, as the motors are going to twirl the mirrors around 3,000 rpm, and you don't want spinning glass around 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 container and mount your laser light show inside and cap it 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 wouldn't work well. Just be sure to put the lid on before you spin up. Enjoy!

Get a free Science Experiment Workbook from the Supercharged Science Web site:
<http://www.SuperchargedScience.com>.



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