Inventor's Workshop

By Jill Frankel Hauser

Previously published as *Gizmos & Gadgets* by Williamson Books, an imprint of Ideals Publications.

Illustrations: Michael Kline Illustration
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Printed in the United States of America

My Father's World
PO Box 2140, Rolla, MO 65402
www.mfwbooks.com
February 2024

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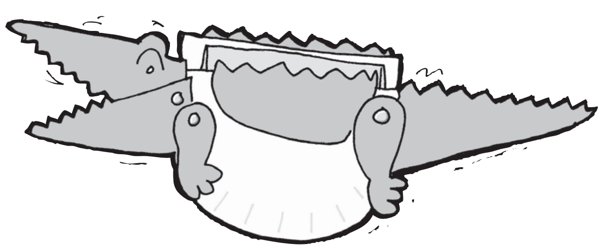
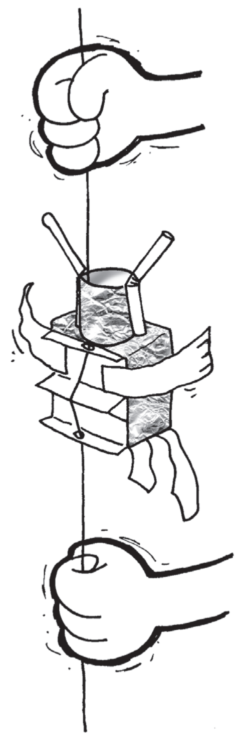




Laws of Motion

Hold everything! Stand still. How long can you keep that pose? It's hard, isn't it? Motion is so much a part of our lives that we hardly know it's there … until we have to stop, that is! All day long, we're moving from here to there.

Can you believe there are rules, called scientific laws, to explain all motion? Although you're just thinking about fun when you shoot a marble or dive into a pool, you can't make a move that goes against the rules of science. As you make these gizmos that cause a commotion, you'll discover the laws of motion!

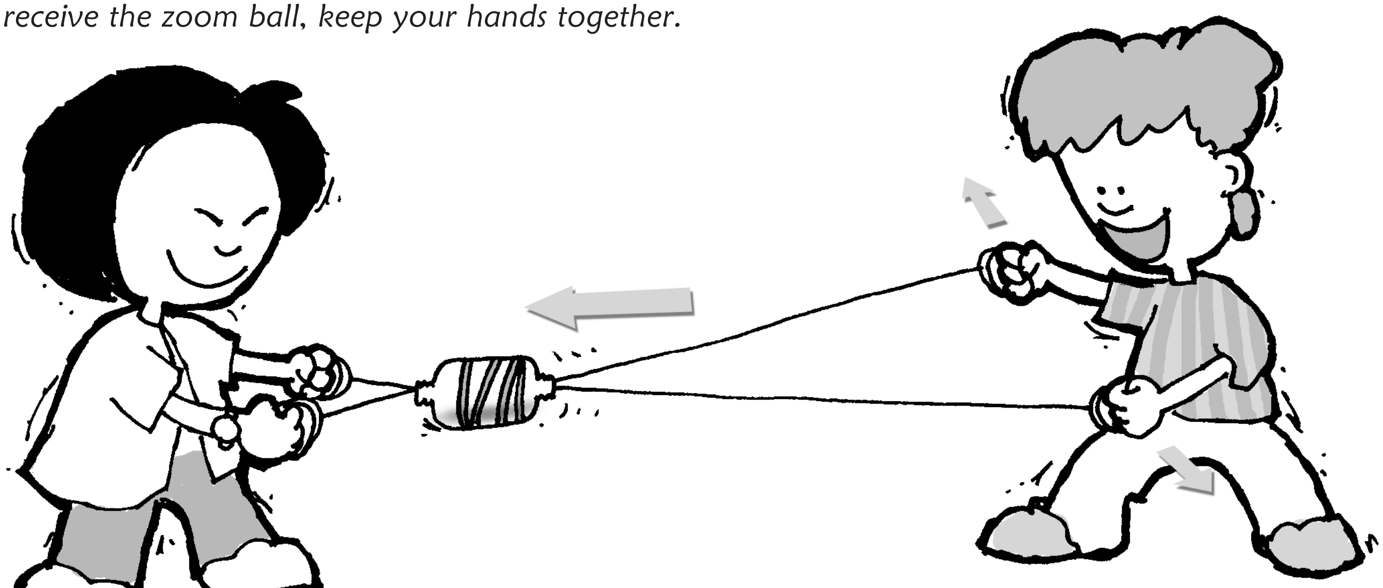
Where's the motion? Look around. Cars, airplanes, and trucks are big movers, but what else can you spot that's on the go? There's you and the trillions of other living creatures! What about leaves swaying in the breeze? A fly creeping across the wall? A second hand ticking? You turning the pages of this book?

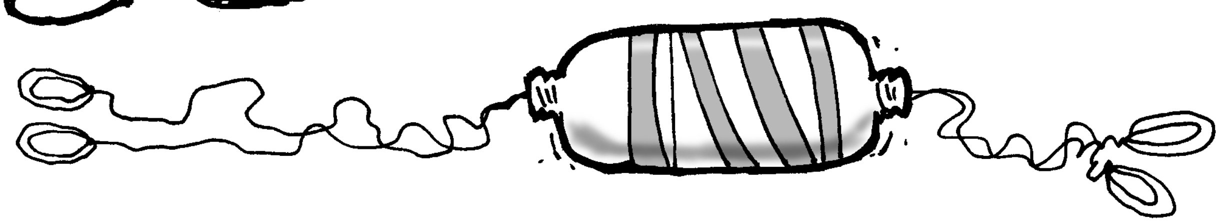
Inertia Zoom Ball

Find a friend to play inertia zoom ball. Each player holds onto two handles and moves away from the other player until the strings are tight. Slide the zoom ball to one end. If you are the player closest to the zoom ball, snap your hands apart to send the zoom ball to your friend. To receive the zoom ball, keep your hands together.

What You Need

- Scissors
- Two 1-quart or 2-liter plastic soda bottles
- Masking tape
- Colored construction paper and contrasting ribbons (optional)
- Two 6-foot (1.2-m) strings
- Two plastic-ring six-pack holders (optional)

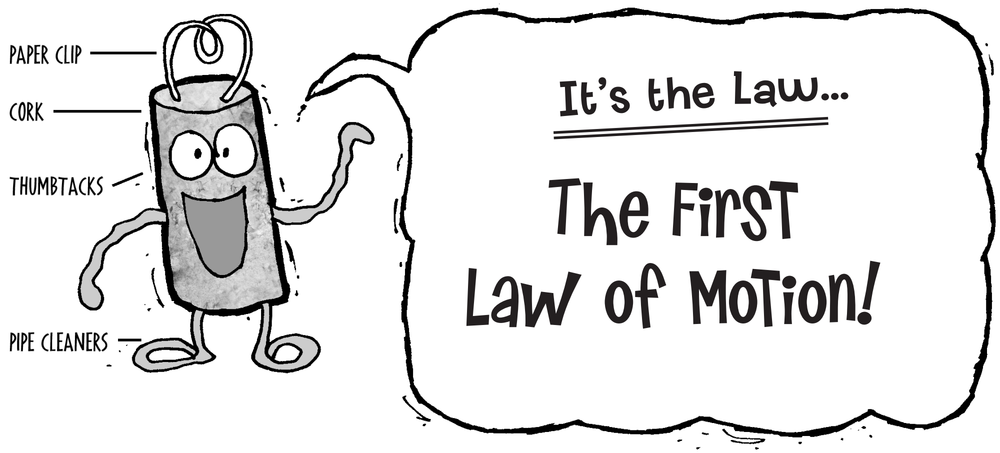




1. With a grown-up's help, cut the bottoms from two soda bottles. Tape the bottles end to end so they form a football shape. Cover them with a sleeve of colored paper, if desired, and wrap a contrasting colorful ribbon in a spiral pattern over the sleeve. Tape in place.
2. Thread the two strings through the necks.
3. Optional: Cut the six-pack holder rings apart to form four two-loop handles. Tie a set of handles to the ends of each string.
4. Now, zoom!

The Principle of the Thing

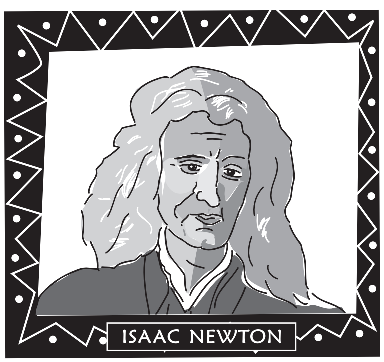
Yank the strings outward and the zoom ball goes flying. Why? The pushing action of the strings sets it in motion. When the zoom ball reaches the other end of the strings, an opposite pushing action (your friend's string-snapping motion) stops the ball for a moment and then sends it flying in the reverse direction.



Congratulations! You've just demonstrated the first law of motion, also called the *law of inertia* (in-ER-shuh). It states that **without a force like a push or pull, an object won't budge. And once it's going, it won't stop moving in a straight line unless it's forced to change its movement by another push or a pull**. You and your friend have overcome the zoom ball's *inertia* (how boring) with your *forceful* tugs (how moving)!

Keep on doin' what you're doin'. Do you ever feel as if you've got inertia when your alarm goes off in the morning? How about when you're running a race or working on your favorite gizmo? You just don't want to change what you're already doing!

Presenting Sir Isaac Newton!



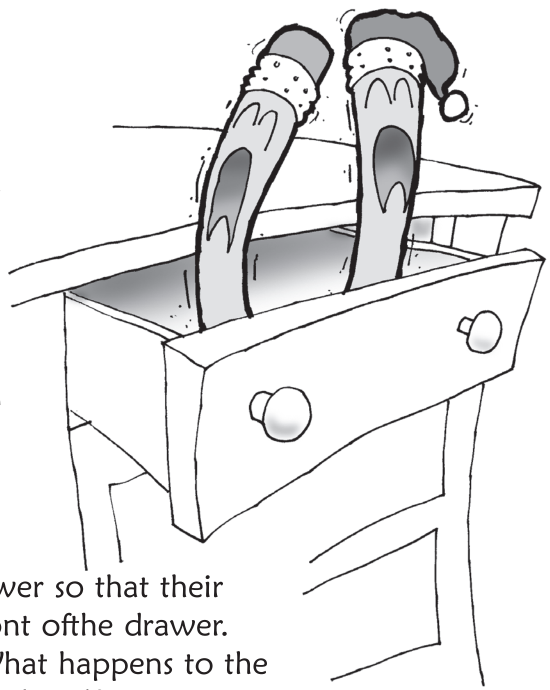
Have you ever wondered about motion? Well, Sir Isaac Newton sure did. He came up with three simple laws that explain the fantastic process of moving from here to there. And you've just figured out the first one! Look for clues to the others as you make more gizmos.

Newton's questioning mind made him one of the greatest scientists of all time. He looked for answers to what seemed like simple questions. When he was 23 and a student at Cambridge University in England, the school was closed because of the plague. But Newton's mind remained open. He studied on his own at his mother's farm. There, he made amazing discoveries we still rely on today.

During his lifetime, Newton described the laws of motion, solved mysteries of color and light, explained how gravity keeps the planets orbiting around the sun, and invented calculus (a kind of math) to explain his discoveries. His questioning mind helped him find the answers!

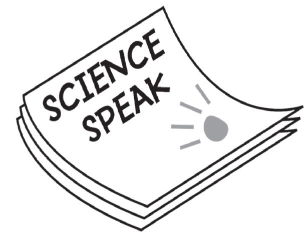
More to Explore

Lazy Pencils



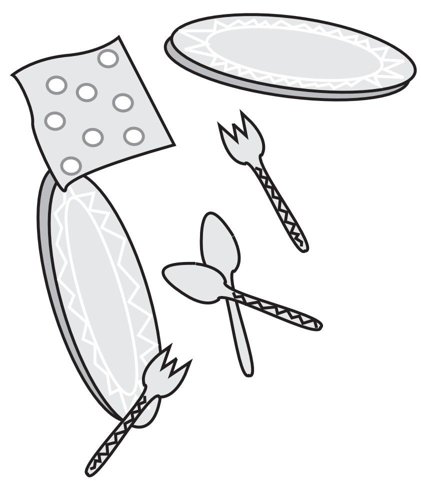
Place round pencils in a drawer so that their long sides are against the front ofthe drawer. Open the drawer quickly. What happens to the pencils? Can you figure out why? (See answer below.)

> **!?** Imagine a force so powerful it can overcome the inertia of a critter at rest, causing it to leap more than 130 times its own height! It's flea power! A flea's mighty muscles send it soaring 8 inches (20 cm) upward — and right onto Rover!

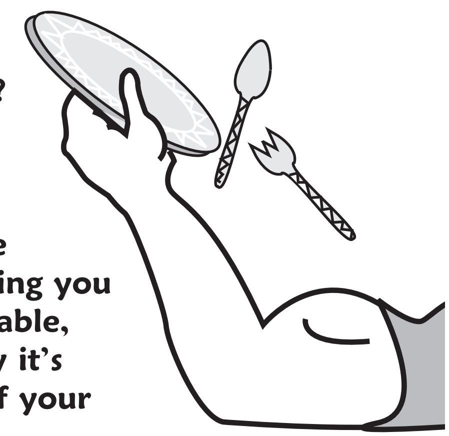


All matter (see page 44) — a rock, a house, even you — has *inertia*. It does whatever it's already doing, whether it's in motion or still, unless it's *forced* to change. Some sort of force, either a push or a pull, is needed to

- ***set an object in motion***
- ***make a moving object change direction***
- ***make a moving object move faster***
- ***make a moving object come to screeching stop!***



What pushes you into action? You may think it's that sweet voice in the kitchen asking you to set the table, but actually it's the force of your muscles!

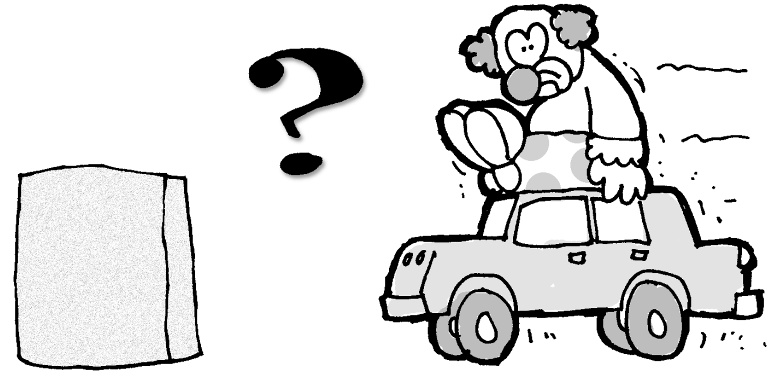


***Answer:** The pencils are at rest. When the drawer moves underneath them, they try to stay put (inertia at work), which makes them end up in the back of the drawer.*

Safety First

Set a small doll on top of a toy car. Set up a heavy block (no higher than the car) a few feet away. Now, push the car into the block. Crash! What happens to the car and the doll? Using Newton's first law of motion, figure out why.

You know that an object in motion stays in motion unless stopped by a force. A force (the block) stopped the car, but not the doll. It stayed in motion … until gravity (see page 43) forced it to bonk its head on the pavement! Seat belts, anyone?



Coins and Inertia

These coins may seem to behave in strange ways, but they're just following the laws of the universe! Challenge your friends to predict what they think will happen when you explain what you plan to do. Then, amaze them with your tricks.

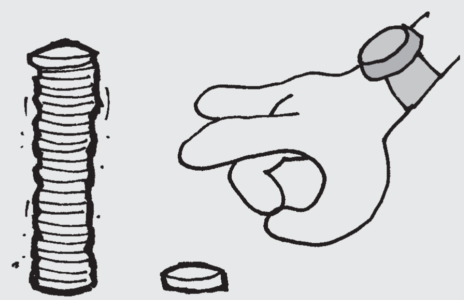
Money Pyramid

Stack a nickel, penny, and dime by size, largest to smallest, on a quarter base. Set the pyramid on a strip of paper that hangs over a table edge. Hold onto the end of the strip, keeping the paper straight or level, and quickly snap the paper away. What happens to the pyramid? If you're fast enough, the structure stays put because of inertia.

Tower Power

Make a tower of nickels. Try to knock it down, one nickel at a time, by using the tower's inertia. Flick a nickel sharply at the bottom coin. What happens?

The bottom coin moves away, while the tower stays standing.



Independent Penny

Set an index card or paper over the mouth of a bottle. Set a penny on the card directly over the mouth. Flick the card with your finger. Where does the penny go? The penny's inertia keeps it in place so that it plops right into the bottle's mouth!

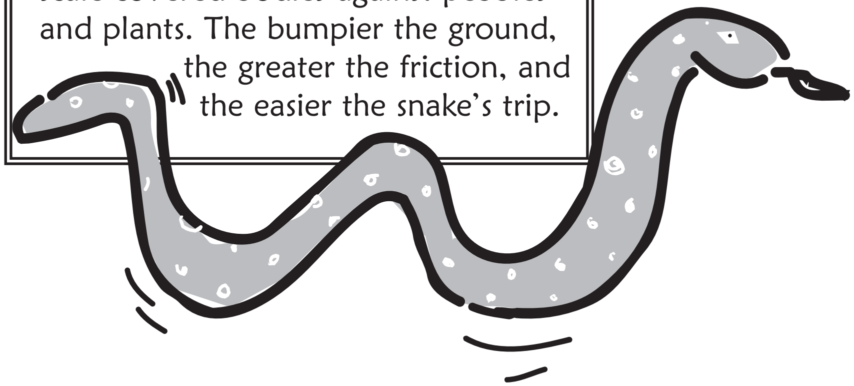
Friction

Kick a ball, roll down a grassy slope, or coast on your bike. Why don't you, the ball, and the bike just keep moving forever? After all, we just got moving with Newton — "an object in motion remains in motion …"

It's the gripping force of **friction** in action! When things rub together, like the ball or you on some grass, friction works to bring them to a stop. So whether you're swimming through water, parachuting from a plane, or simply walking along, friction is there to slow you down. What a rub!

The gizmos in this chapter work by adding friction … or by taking it away. Explore this amazing force by making contraptions that stop and go according to their "friction condition"!

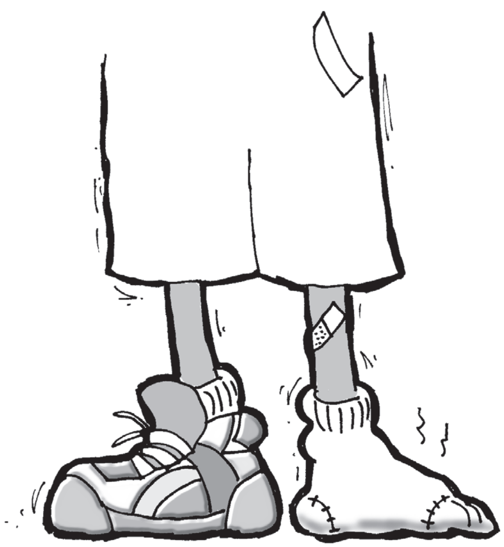
!? Which footless, legless critters rely on "muscle friction" to get around? Snakes, of course! Snakes move in a slow, wavy pattern by pushing their scale-covered bodies against pebbles and plants. The bumpier the ground, the greater the friction, and the easier the snake's trip.



!? Even a violinist uses friction. Rubbing the bow with rosin causes it to grip the strings as it moves, producing a sweet sound! And, friction is a music maker for crickets, too. Rubbing their wings together makes a chirping summer serenade.

More to Explore

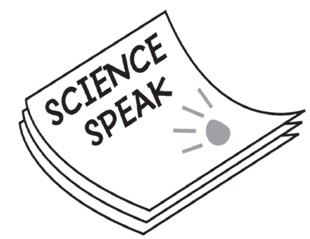
More or Less?



Put a sneaker on one foot and a sock on the other. Slide each foot across a bare floor. Compare the action. Sometimes, more friction is better. The rough tread on the bottom of your sneaker is designed to increase friction, keeping you from slipping as you run.

Other times, less friction is best. Touch the bottom of a snow ski. Can you feel the smooth surface designed to limit friction for a longer glide?

Rough materials produce more friction than smooth. But even the smoothest objects (like a marble on a polished floor) have microscopic "bumps" that rub against each other and slow movement to a stop, eventually.



***Friction* is a force that slows the motion when one solid object rubs against another, or when a solid object moves through liquids (like a boat moving through water) or gases (like a parachute moving through air).**

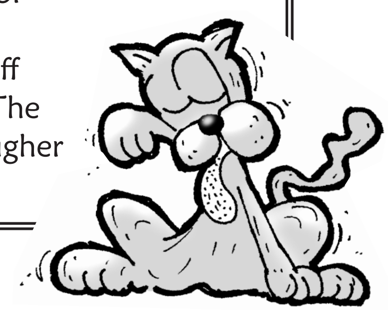
A Gripping Invention

Those burrs that sometimes cling to your socks after an outdoor walk are real grippers. Most folks would be annoyed by all that friction. Not George de Mestral.

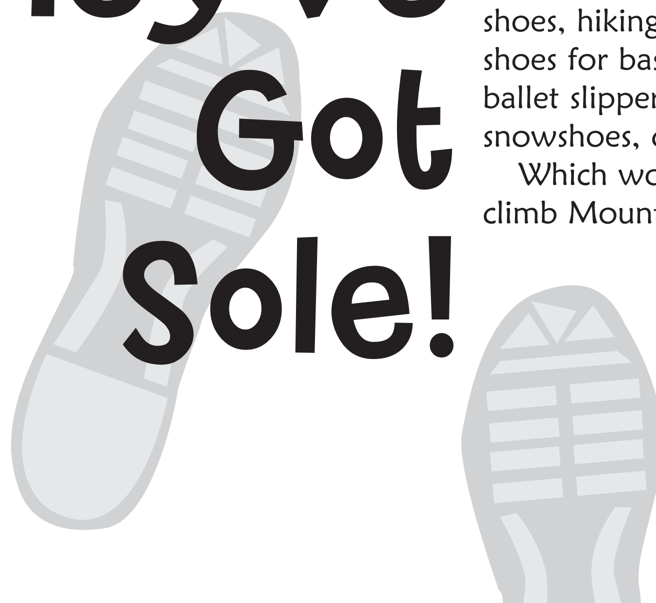
About 50 years ago, picking burrs from his socks only made him curious. How do these things stick so securely? Careful observation under a microscope gave him the answer: tiny hooks! Could he somehow apply a principle of nature ("sticker hooks") to a different situation — such as keeping his clothes together? Persistence paid off! After many years of work, he invented a totally new product that keeps clothing fastened tight: Velcro! The word is French for *velours* (velvet) and *crochet* (hook).

Think of de Mestral's inventive mind the next time you close your coat sleeve with Velcro!

!? If a cat's kiss feels like sandpaper, then a panther's kiss could tear your skin! What causes feline tongues to make so much friction? They're covered with a field of tiny spikes. They sure come in handy for brushing fur, slurping water, and cleaning off bones. But, beware. The larger the cat, the rougher the tongue. Meow!



They've Got Sole!



You can learn a lot about friction by exploring the soles of footgear. Check these out and think about their uses: basketball shoes, hiking boots, cleated shoes for baseball and soccer, ballet slippers, rain boots, skates, snowshoes, crampons.

Which would *you* choose to climb Mount Everest?