Friction Facts

You Will Need:

Your 2 hands

Instructions:

Have you ever wondered what heat is and where it comes from? Here is an easy experiment that will give you the answer—you don't need any equipment except your own 2 hands!

1. **Press your hands together, palms facing each other. Now rub them together quickly, letting your hands slide back and forth over each other several times. You will notice that your hands become warm. Can you explain why?**

This Is What Happens:

The act of objects in contact, resisting motion, is known as *friction.* You noticed friction between your two hands as you rubbed them together. This action—friction—created heat. The rubbing of molecules of air against each other creates heat also—the kind of heat that warms a room.

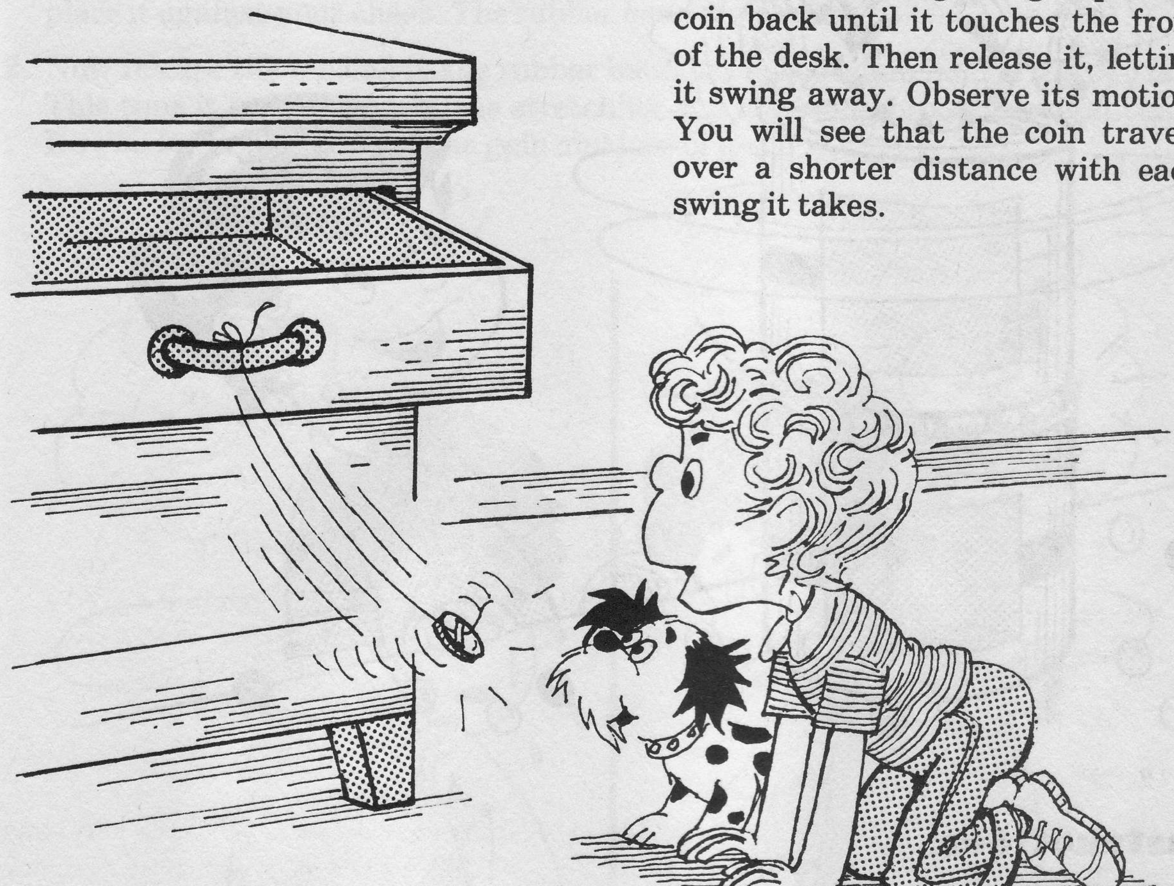
A Change of Pace

You Will Need:

Tape
String
Coin
Desk

Instructions:

1. Tape a piece of string to one side of a coin. Tie the free end of the string to the handle on an opened desk drawer.
2. Keeping the string straight, pull the coin back until it touches the front of the desk. Then release it, letting it swing away. Observe its motion. You will see that the coin travels over a shorter distance with each swing it takes.



This Is What Happens:

For any action, the energy *out* always equals the energy *in.* So, when you start the coin at the desk, it never swings higher because this would require more energy. But you would suspect that the coin should travel the same distance each swing. Why does it swing lower? Energy is never lost; however, some energy changes to a different form. The act of the coin rubbing against the air is called *friction,* and friction changes the energy of the swinging coin into heat. The surrounding air actually becomes warmer, but this change is so slight you don't notice a temperature increase.

Smooth Rider

You Will Need:

2 empty, dry paint cans, the same size
Marbles

Instructions:

1. Fill the groove that runs around the top of one paint can with marbles.
2. Now turn the other can upside down and set it on top of the first. The groove on this can should rest on top of the marbles. Rotate the upper can and notice how easily it turns.

This Is What Happens:

You have just constructed a simple model of *ball bearings,* which are used to reduce friction between two surfaces that rub against each other. Your bicycle probably has ball bearings, allowing the wheels to turn freely. The ball bearings in a wheel are made from finely polished steel.

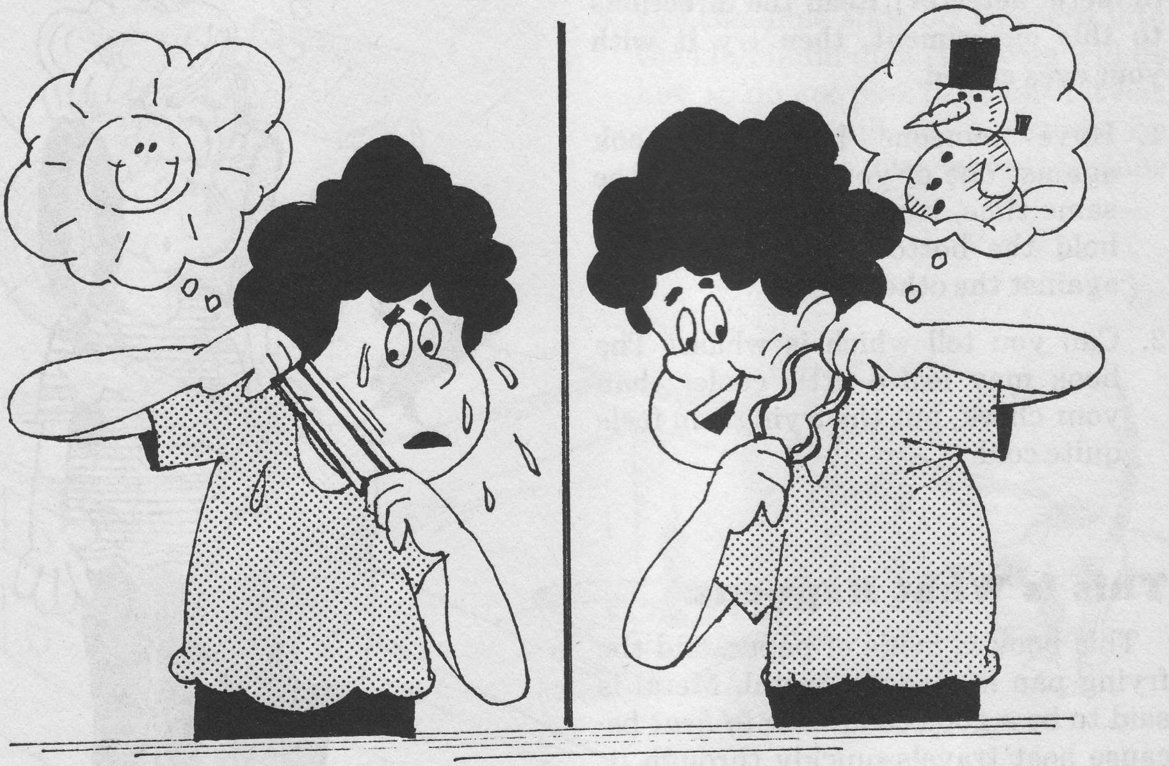
A Hot Mystery

You Will Need:

Heavy-duty rubber band, at least ¼ inch wide

Instructions:

1. Hold the rubber band between your two hands and stretch it tightly. Gently place it against your cheek. The rubber band feels warm.
2. Now release the tension in the rubber band, and once again hold it to your face. This time it is cool. Repeat the stretching and loosening process several times. Do you know what causes the gain and loss of heat?



This Is What Happens:

If you could not come up with an explanation for this experiment, don't worry. Scientists have several theories, but no one is sure which is absolutely correct! One idea is that when the rubber is stretched, the molecules bump into each other more frequently and this may raise the temperature.

Built-In Metal Detector

You Will Need:

A friend
This book
Frying pan

Instructions:

Did you know that you have a built-in metal detector? Read the directions to this experiment, then try it with your eyes closed.

1. Have someone hold this book against one of your cheeks. At the same time, have the person gently hold the bottom of a frying pan against the other cheek.
2. Can you tell which is which? The book may feel a little cooler than your cheek, but the frying pan feels quite cold.

This Is What Happens:

This book is made of paper, and the frying pan is made of metal. Metal is said to be a good *conductor of heat* because heat travels quickly through it. When the metal was held next to your cheek, the heat from your body was rapidly carried away and the frying pan felt cold. Paper, on the other hand, is not a good conductor of heat, so your cheek kept most of its heat and the book felt just a little colder than your skin.

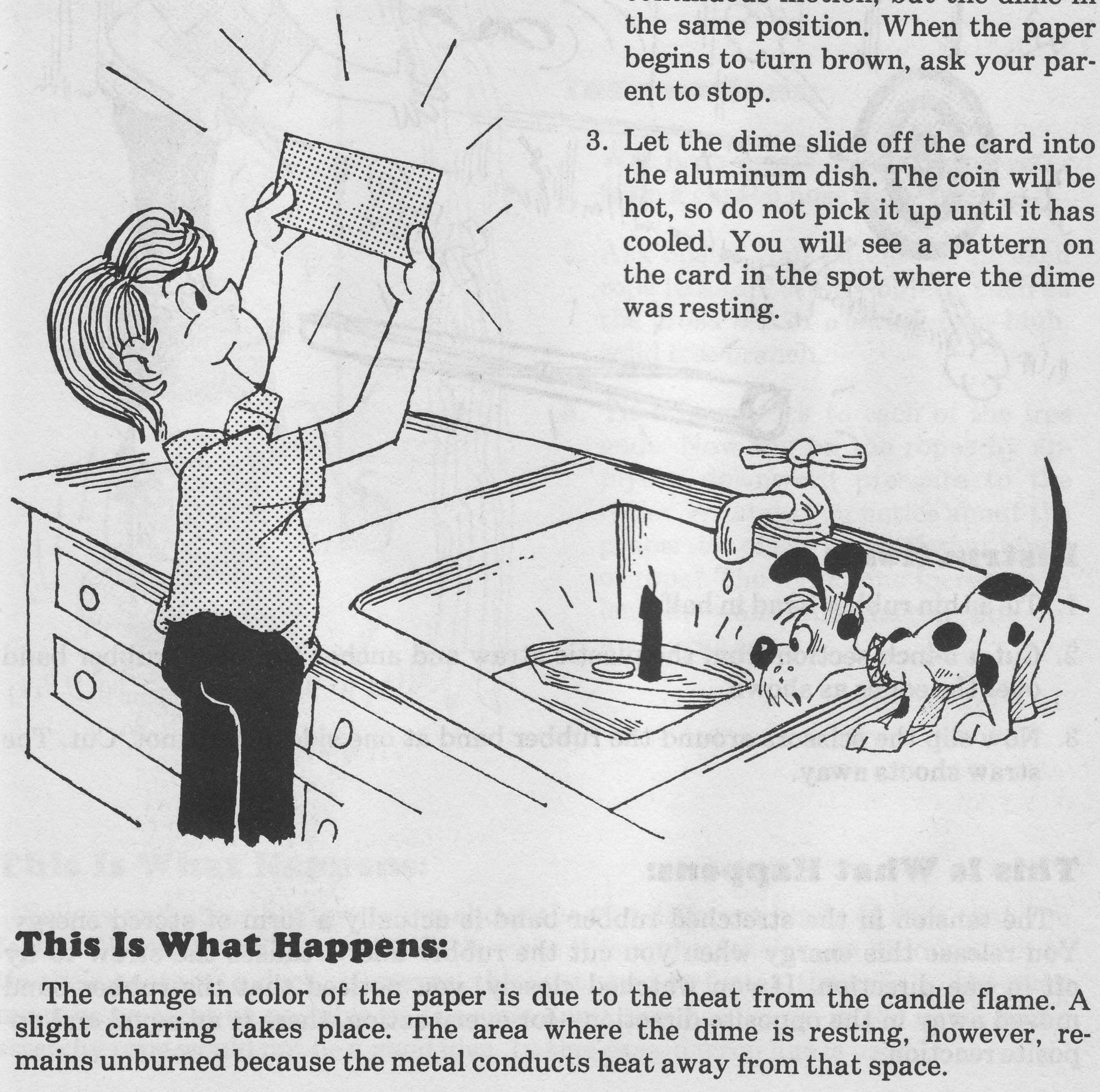
Dime Time

You Will Need:

Candle
Aluminum pie tin
Dime
Index card
Matches
THE HELP OF ONE OF YOUR PARENTS

Instructions:

1. Set the candle on the aluminum pie tin and place the tin in the sink.
2. Rest the dime in the center of the index card.
3. Ask one of your parents to light the candle and move the card over the tip of the flame, keeping the card in continuous motion, but the dime in the same position. When the paper begins to turn brown, ask your parent to stop.
3. Let the dime slide off the card into the aluminum dish. The coin will be hot, so do not pick it up until it has cooled. You will see a pattern on the card in the spot where the dime was resting.



This Is What Happens:

The change in color of the paper is due to the heat from the candle flame. A slight charring takes place. The area where the dime is resting, however, remains unburned because the metal conducts heat away from that space.

Sharp Shooter

You Will Need:

Rubber band
Plastic straw
Scissors

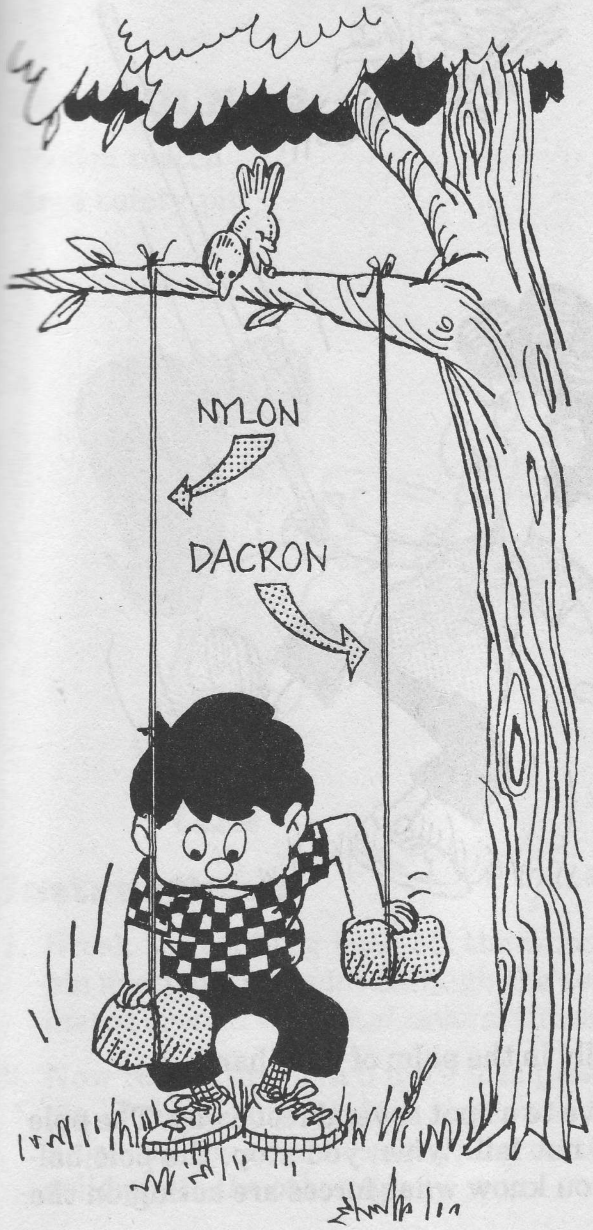
Instructions:

1. Tie a thin rubber band in half.
2. Cut a 5-inch section from the plastic straw and anchor the whole rubber band over the edges as shown.
3. Now slip the scissors around the rubber band at one side of the knot. Cut. The straw shoots away.

This Is What Happens:

The tension in the stretched rubber band is actually a form of stored energy. You release this energy when you cut the rubber and it causes the straw to fly off in one direction. If you watched closely, you noticed that the rubber band moved away in the opposite direction—for every action, there is an equal and opposite reaction.

Tight Rope



You Will Need:

Nylon rope, or nylon clothesline, 6 to 8 feet long
Dacron, polyester, or dacron/polyester rope, 6 to 8 feet long
Water
2 big rocks
THE HELP OF ONE OF YOUR PARENTS

Instructions:

1. Wet both pieces of rope with water from a garden hose or in a sink.

2. Ask one of your parents to tie each rope to a tall, sturdy object, such as the cross bar of a swing or a high, solid tree branch.

3. Tie a large rock to each of the free ends. Now tug on the ropes by applying downward pressure to the rocks. What do you notice about the properties of the two different kinds of rope? The nylon line increases in length, while the dacron line remains the same.

This Is What Happens:

Sailors and other boaters know about the two different kinds of rope that you tested. Nylon line will stretch a little while it is under tension, so sailors use it to tie their boats to a dock. However, the lines used to fasten the sails to the mast must be as tight as possible so the sails don't flap needlessly in the wind, and a stretchy rope would not be a good idea. In this case, dacron line is used.

Pole Stroll

You Will Need:

A pole

Instructions:

1. Stand straight and balance a pole vertically in the palm of your hand.
2. Try to keep the pole in balance as you move to a spot several feet away. The pole will lean forward as you walk, but it will not fall. When you stop, the pole balances in the vertical position again. Do you know what forces are acting on the pole?

This Is What Happens:

There is only one force acting on the balanced pole when you are standing still—gravity. It pulls downward, so the pole must be perfectly upright in order to be balanced. As you walk to a point several feet away, however, your forward motion creates an additional force on the pole. Now the pole must be tilted in order to balance the two forces—downward gravity and forward motion.

The Match Game

You Will Need:

Wooden match
Large safety pin

Instructions:

1. Break the striking head off the wooden match and discard it. Open the safety pin and push its point through the center of the match. Close the pin. Move the match around the metal several times so that it rotates easily.
2. Now rotate the match until it is pressed against the other edge (on top) of the pin. Push firmly against the lower tip of the match, then quickly slide your finger off the edge in a snapping motion. The match seems to move through the solid pin to the other side.

This Is What Happens:

Of course the wooden match cannot pass through another solid material. When you pressed the tip of the match, this caused the stick to snap against the pin and bounce around in a full circle until it came to rest on the opposite side of the metal. This happened so fast that it appeared as if the match passed through the metal. Practice this trick several times and show it to your friends. They'll be amazed!

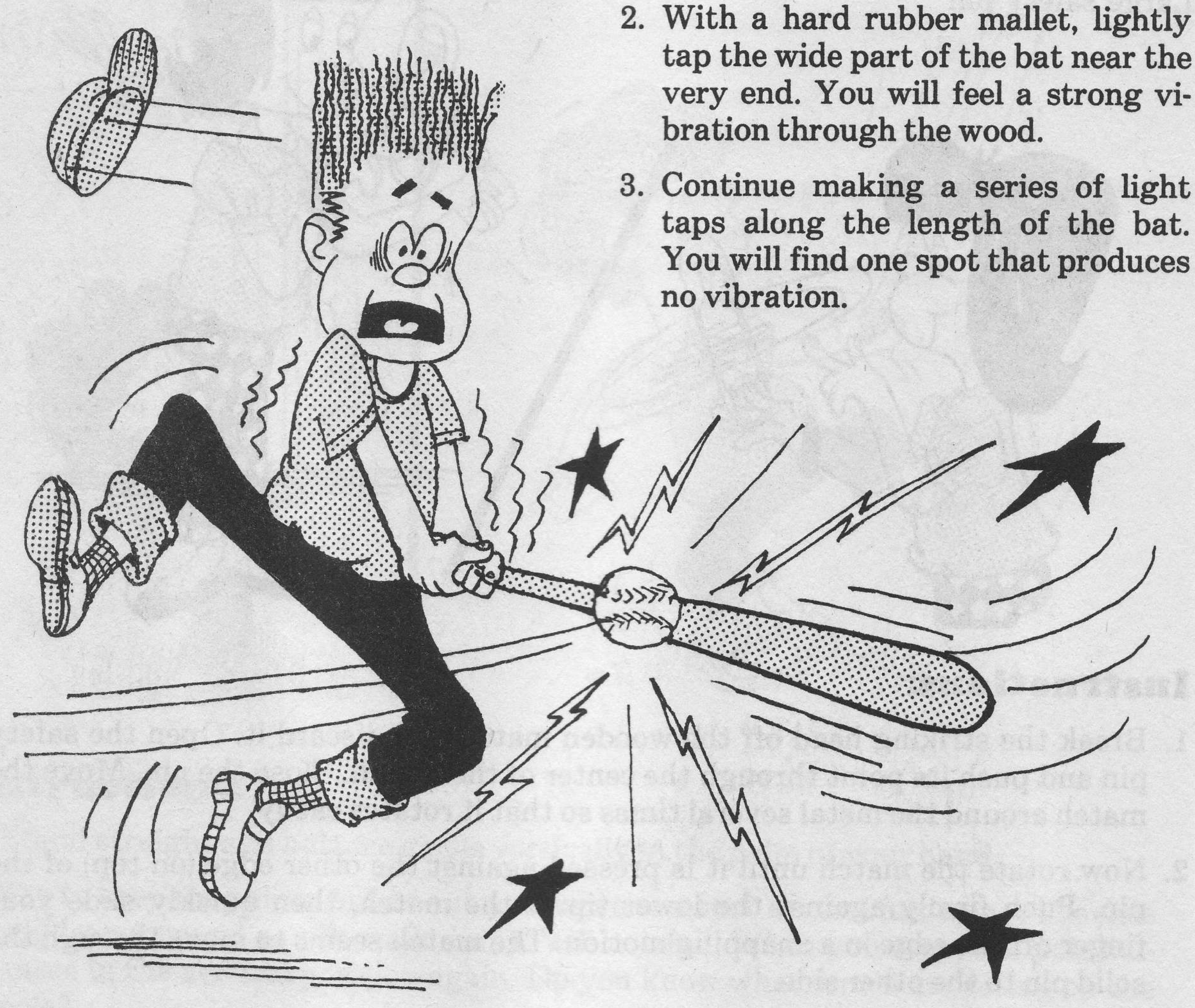
Strike 1

You Will Need:

Baseball bat
Hard rubber mallet

Instructions:

1. Grasp the handle of a wooden baseball bat between your thumb and index finger. Let the bat hang down loosely.
2. With a hard rubber mallet, lightly tap the wide part of the bat near the very end. You will feel a strong vibration through the wood.
3. Continue making a series of light taps along the length of the bat. You will find one spot that produces no vibration.



This Is What Happens:

When you swing a baseball bat, the ball must hit the wood in one special place in order to make a good hit. This spot is called the *center of percussion*, and you have just located it on your bat—the area that produced no vibration. Any other spot along the wood produces a vibration. That is why your hands may sting if you hit a ball too near the tip or the handle of the bat.

Strike 2

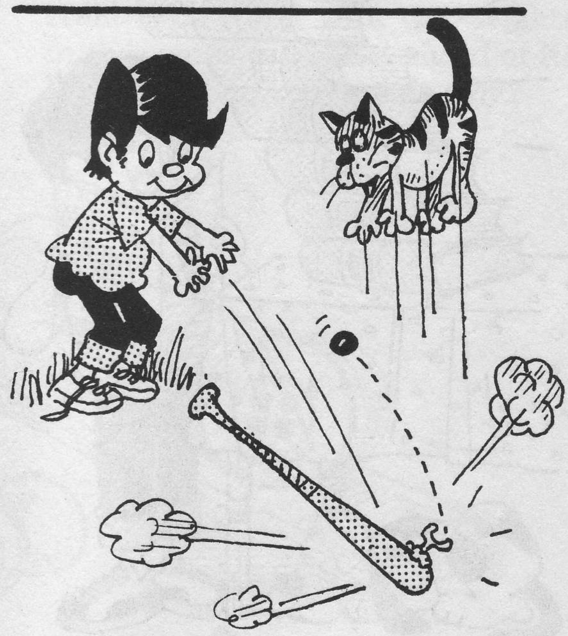
You Will Need:

Push-pull cap from dishwashing liquid
Baseball bat
Clay
Ball bearing or small marble

Instructions:

You learned about a bat's center of percussion in the last experiment. Here is another method to locate that spot on your bat.

1. Pull out the center piece of the push-pull cap and attach it to the end of your bat with a piece of clay.
2. Set a ball bearing or small marble on the plastic piece. (The ball should be small enough so that it rests securely inside the curve, but large enough to prevent it from dropping down the opening.)
3. Rest the handle of the bat on the ground and raise the wide end. Let the bat fall. Repeat the process several times, each time changing the placement of the ball and its holder along the length of the bat. What do you find?



This Is What Happens:

The freely falling object (the ball) falls at a constant speed. The end of the bat, however, falls faster than the handle. When the ball/cap device is stuck near the end of the bat, the end of the bat falls away from beneath the ball. You hear the click of the ball hitting the ground *after* the bat has hit. But when you place the ball at the center of percussion, the ball and the bat both drop at the same rate. There is no click!

Arch Starch

You Will Need:

6 or more identical books
Table or desk top

Instructions:

1. Obtain 6 or more books of the same size. Stack them together into an even pile near the edge of a table or desk top.
2. Slide the top book out as far as you can without letting it fall. It should hang over the table's edge by almost ½ its length.
3. Next, push the second book out as far as you can, allowing the top book to move along with it.
4. Move the third book, keeping the first 2 with it. Proceed in this fashion with each book in the stack, always keeping the same position of the upper books. With each new move that you make, you will find that you cannot slide the book quite as far as the previous one. Soon, you will develop a "feel" for how far you can slide a book without the ones above it falling.
5. When you have reached the bottom of the stack, stand back and look at your creation. You will be amazed to see a leaning tower extending far beyond the edge of the table. It looks like you have completed an impossible balancing task.

This Is What Happens:

When you slid the first (top) book out, the center of gravity remained above the second book. Otherwise, the book would have fallen. When you slid the second book, the center of gravity for the total weight of the first and second books was above the third book. For each move, you always maintained the center of gravity above the table. Even though individual books may protrude beyond the edge, the combined center of gravity for the entire stack rests securely on the table.

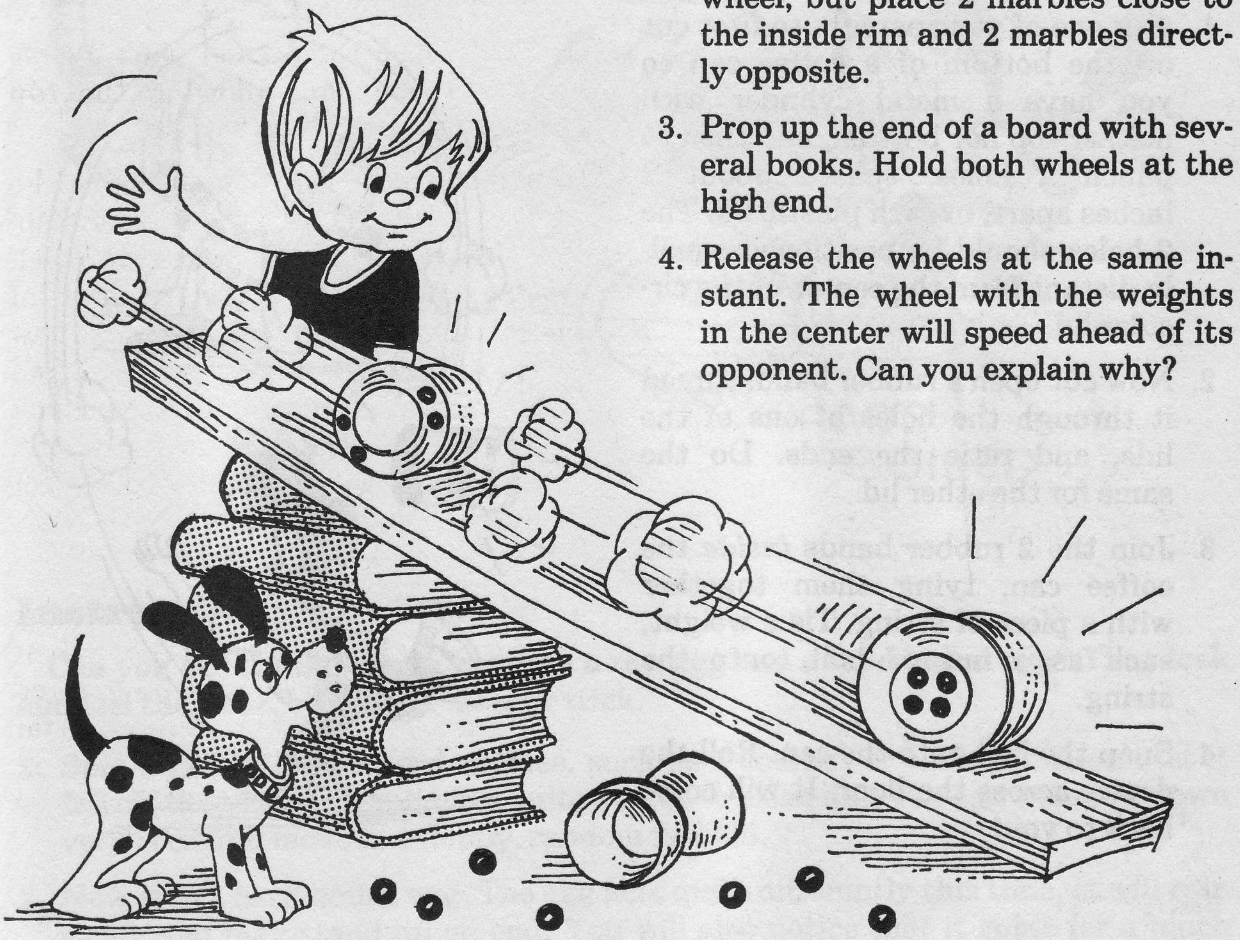
Speed Trap

You Will Need:

4 small plastic bowls
Strong plastic tape
16 marbles
3-foot, or longer, board
Several books

Instructions:

1. Tape 2 small plastic bowls together back to back, forming a wheel. Make another wheel with 2 more identical bowls.
2. Tape 4 marbles to the center of each side of one wheel. Then tape 4 marbles to each side of the other wheel, but place 2 marbles close to the inside rim and 2 marbles directly opposite.
3. Prop up the end of a board with several books. Hold both wheels at the high end.
4. Release the wheels at the same instant. The wheel with the weights in the center will speed ahead of its opponent. Can you explain why?



This Is What Happens:

The wheel with the marbles placed at the rim loses speed because energy must be used to move the weight of the marbles. The faster wheel, however, has the weight of the marbles at the exact center of rotation and does not waste energy spinning the marbles around the outer edge.

Can-O-Rama

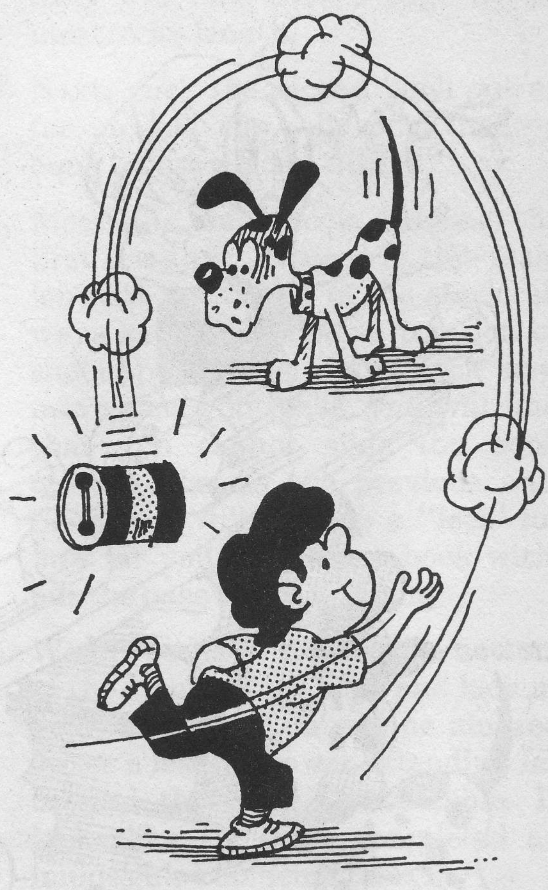
You Will Need:

Coffee can
2 plastic coffee can lids (both must fit the coffee can)
2 rubber bands
String
Nuts or bolts

THE HELP OF ONE OF YOUR PARENTS

Instructions:

1. Ask one of your parents to first cut off the bottom of a coffee can so you have a metal cylinder with neither top nor bottom, and then to punch 2 holes, spaced about 2 inches apart, in each plastic lid. The 2 holes should be positioned equally distant from the center of the circular lid.
2. Now cut open a rubber band, thread it through the holes of one of the lids, and retie the ends. Do the same for the other lid.
3. Join the 2 rubber bands *inside* the coffee can, tying them together with a piece of string. Tie a weight, such as a nut or bolt, onto the string.
4. Snap the lids onto the can. Roll the device across the floor. It will come back to you!



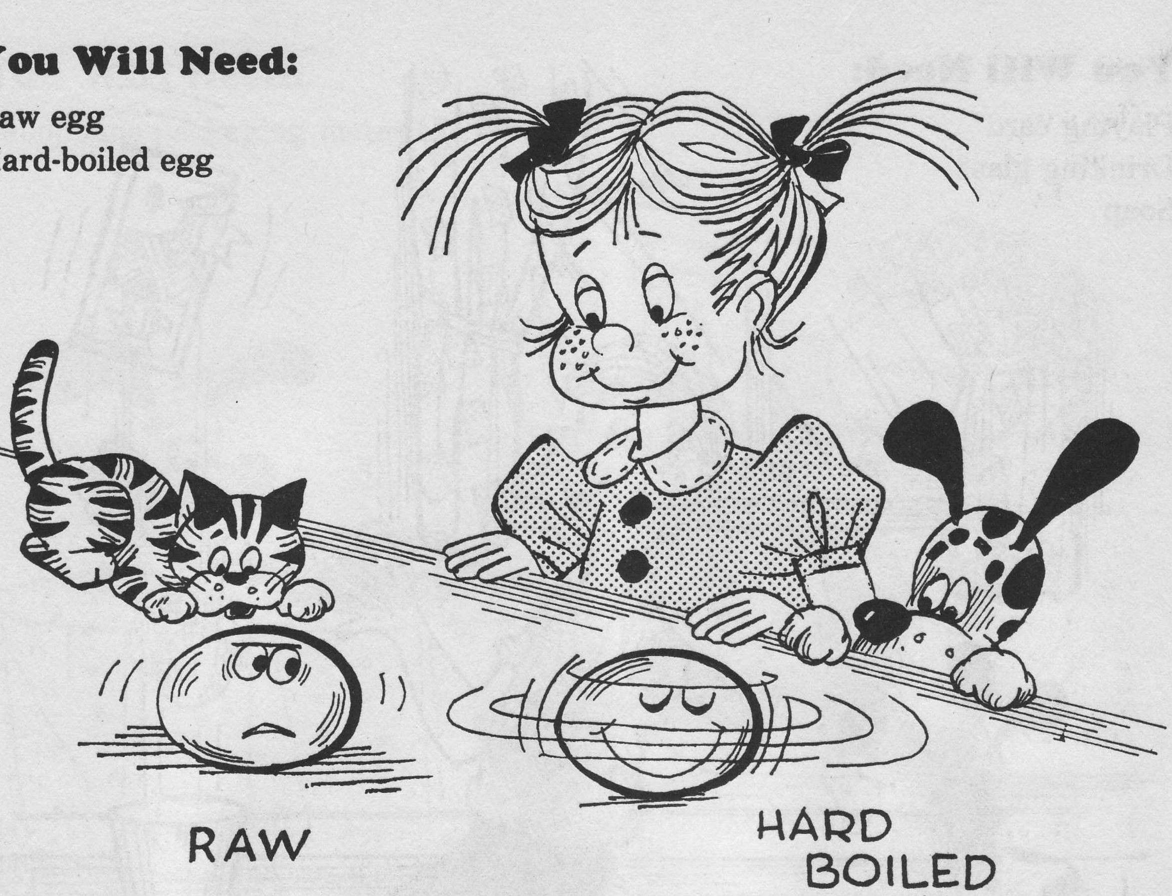
This Is What Happens:

As the can rolls across the floor, the outer portion of the rubber bands roll along, identical to the lids' movement. However, the weight inside the can prevents the inner portion from turning. As a result, the rubber bands become twisted. This twisted condition stores some of the energy from the rolling motion. When the can stops, the stored energy is then released as the rubber bands unwind and the can rolls back to its owner.

Over Easy, Please

You Will Need:

Raw egg
Hard-boiled egg



Instructions:

Can you tell the difference between a raw egg and a hard-boiled egg? They look and feel the same, but here is an easy trick.

1. **Spin a raw egg on a hard surface, such as a counter or tabletop. (Don't let it fall off the table or you'll have quite a mess to clean up!) The egg will slow down very soon and move in a floppy, random fashion.**
2. **Now spin a hard-boiled egg. The egg acts quite differently this time. It will spin easily and may stand up on end. You will also notice that it spins for a much longer period of time.**

This Is What Happens:

The hard-boiled egg is of nearly uniform density throughout its interior. The raw egg, on the other hand, has a loose, runny composition, and the shifting contents slow down the motion of the egg.

Jack in the Glass

You Will Need:

Playing card
Drinking glass
Soap

Instructions:

1. Select a card from a deck of playing cards. Then obtain a drinking glass with slightly tapered sides. The glass opening should be larger than the width of the card.
2. Rub some soap along the inside surface of the glass.
3. Now push the card vertically into the glass. The card will rise.

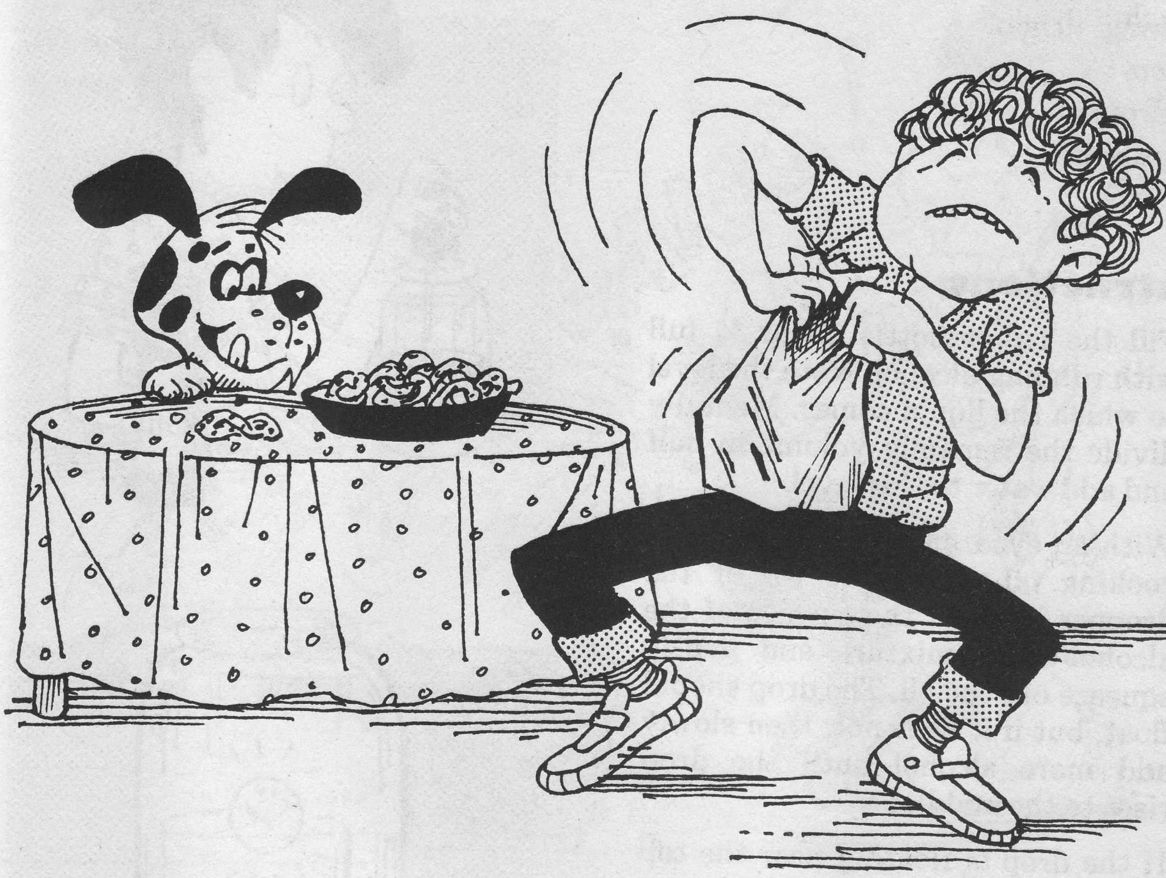
This Is What Happens:

When you push the card to the bottom of the glass, the edges bend in slightly. This creates a force that pushes against the slippery walls of the glass and allows the card to slide back up.

Keep It Going

You Will Need:

Cellophane packaging material



Instructions:

1. Save the plastic wrapper from a packaged food item, such as a bag of pretzels.
2. Try to make a rip in the cellophane by poking your fingers into it, then pulling it apart. You will find that it is very hard to start a tear, but it is easy to keep it going after it has started.

This Is What Happens:

When you pull against opposite ends of the plastic, your force is spread over a large area. The plastic may stretch, so starting a tear is very hard. Once a tear has begun, however, most of the stress is concentrated at this single point, and you do not have to pull very hard to continue the tear.

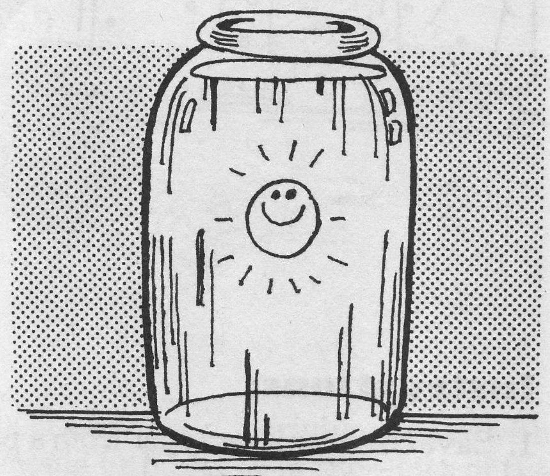
Nobody's Perfect

You Will Need:

Small, clear glass jar or bottle
Rubbing alcohol
Water
Eyedropper
Cooking Oil

Instructions:

1. Fill the jar or bottle about ⅔ full with rubbing alcohol. Note the level to which the liquid comes. Mentally divide the remainig volume in half and add water to this level.
2. With an eyedropper, draw up some cooking oil. Place the tip of the dropper beneath the surface of the alcohol/water mixture and gently squeeze out the oil. The drop should float, but if it does not, then slowly add more alcohol until the drop rises to the middle.
3. If the drop *is* floating near the top as predicted, add water, a little at a time, until the drop is suspended in the center. Stand back. You will see a perfect sphere mysteriously hanging in mid-solution.



This Is What Happens:

The water/alcohol solution has a density greater than alcohol alone, but it is less dense than pure water. You created an environment in which the density of the oil drop was approximately the same as its surrounding medium—the water/alcohol solution. Thus the drop had no forces pulling it one way or another and remained hanging in mid-solution. That is also why the drop kept its perfectly round shape. The forces in nature are not usually balanced like this. For example, a raindrop is rarely round. As it falls to the ground, it flattens out into a hamburger shape.

It's in the Bag

You Will Need:

Small paper bag (lunch bag)
Pail
Water
String

Instructions:

1. Set the bag into a pail filled with water.
2. Allow the bag to fill with water, then tie it closed with a piece of string. The bag will drift in the water without any harm.
3. Now raise the bag from the water by pulling on the string. The paper will burst open immediately. Can you explain why?

This Is What Happens:

While in the pail, the paper is surrounded on all sides by a uniform medium. That is, all forces are balanced and there is no strain in any particular spot. However, as the bag is raised, the air is less dense than the water inside the bag. Gravity pulls downward on the water, and the bag is not able to withstand this force.

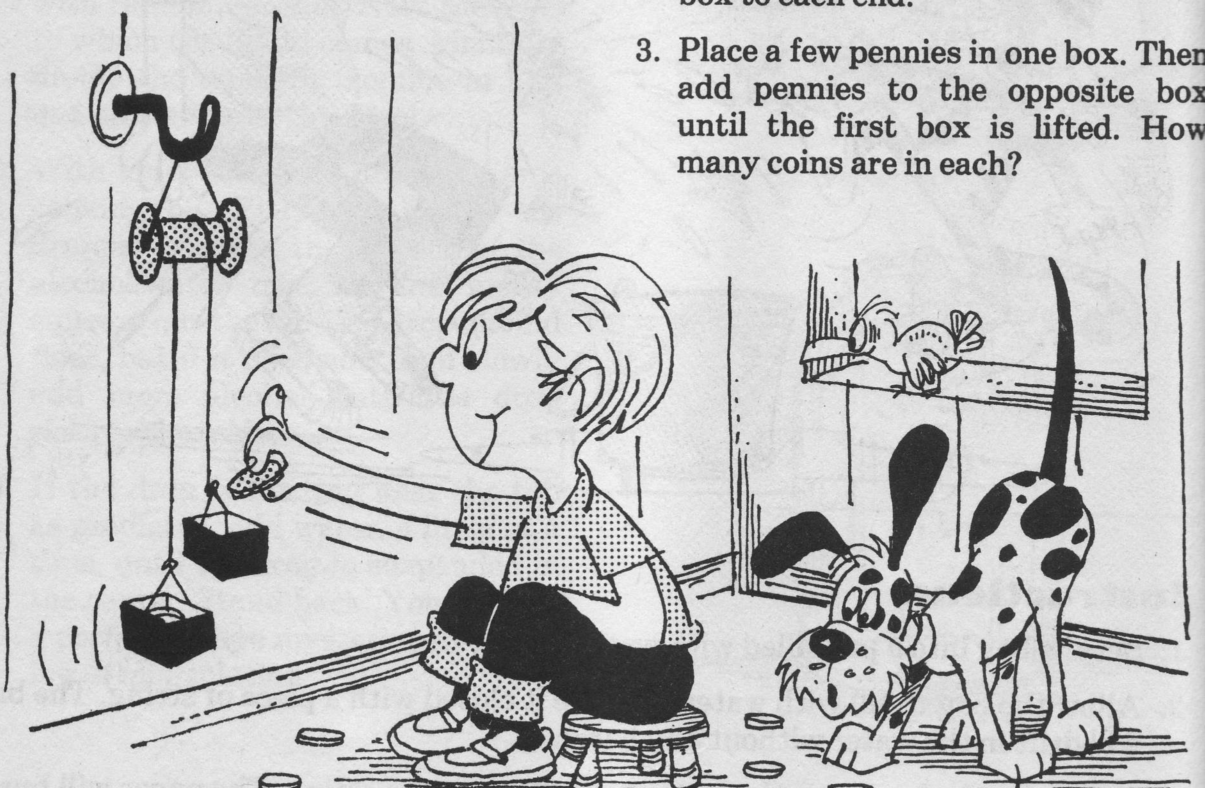
Oh, Say Can You See a Pulley

You Will Need:

Wire
Empty spool
String
2 boxes of the same size, such as jewelry or cuff link boxes
Pennies

Instructions:

1. Insert a piece of wire through the spool and twist the ends together. Hang the spool on a hook.
2. Drape a piece of string over the spool so that it hangs several feet on each side. Tie a small cardboard box to each end.
3. Place a few pennies in one box. Then add pennies to the opposite box until the first box is lifted. How many coins are in each?



This Is What Happens:

An equal number of pennies is needed to lift the first box. You have just constructed a simple *pulley*, which is a device that changes the direction of a force. When you pull one box down, the other box rises the same distance. Many devices use pulleys. Look at the flag in front of your school. Does someone climb the pole each morning to put it there? Most likely the flagpole has a pulley on it. When one side of the rope is pulled down, the flag can be raised.

A Block of Strength

You Will Need:

2 adults
2 broomsticks
Rope

Instructions:

1. Ask 2 adults to stand several feet apart and give each of them a broomstick. Tie one end of a rope to one of the broomsticks.
2. Weave the rope back and forth between the sticks several times.
3. Tell the adults to try to pull the broomsticks apart—while you easily move the 2 poles together by pulling on the free end of the rope.

This Is What Happens:

This setup is called a *block and tackle*. The force of your strength is increased each time the rope is looped around the poles, and so you appear to be stronger than 2 adults! Block and tackles are used to lift heavy items like machinery and pianos.

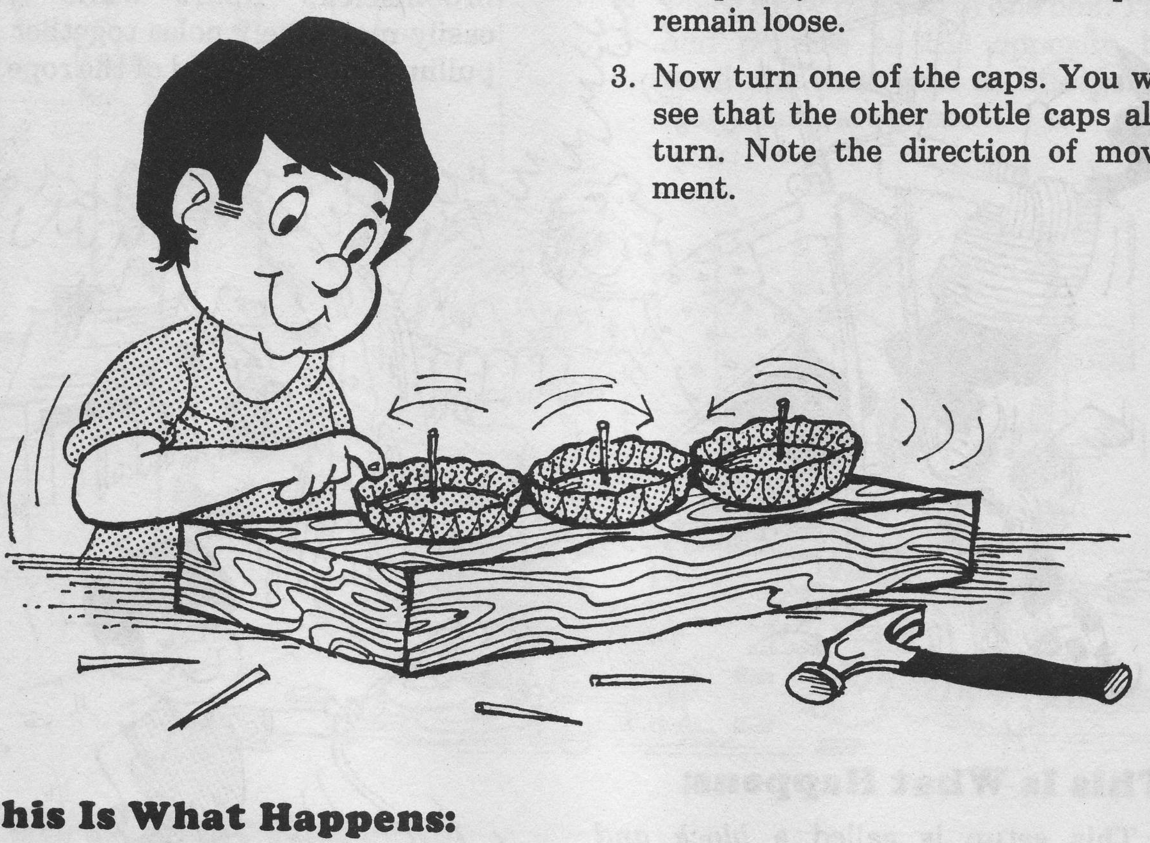
As the Gears Turn

You Will Need:

3 bottle caps (the kind with fluted edges)
Block of wood
3 nails
Hammer
THE HELP OF ONE OF YOUR PARENTS

Instructions:

1. Place 3 bottle caps, face up, on a small block of wood, side by side and touching.
2. Ask one of your parents to place a nail in the center of each cap and pound each nail into the wood. The nail should not be pounded in completely—allow the bottle caps to remain loose.
3. Now turn one of the caps. You will see that the other bottle caps also turn. Note the direction of movement.



This Is What Happens:

You have just constructed a set of *gears*. The pointed edges of one cap interlock with the edges of the neighboring cap and cause it to turn in the opposite direction. For example, if you turned the first cap clockwise, the cap above it turns counterclockwise. This principle is used when shifting an automobile into reverse. The engine continues to produce a force in the same direction as always, but the arrangement of gears causes the wheels to turn in the opposite direction.

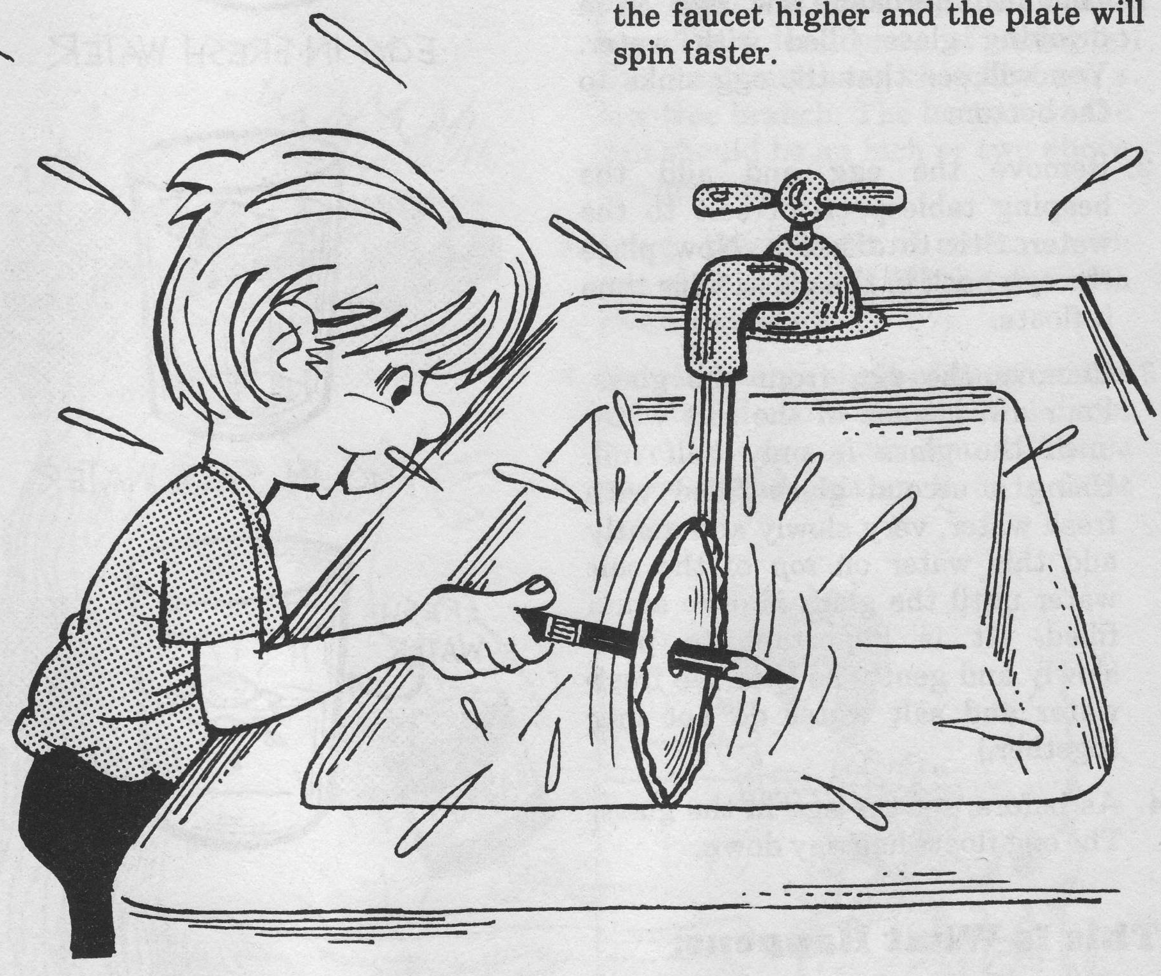
Turn, Turn, Turn

You Will Need:

Pencil
Paper plate with ridges along the edges
Water faucet

Instructions:

1. Push a pencil through the center of the plate, wriggling the pencil back and forth to make the hole loose.
2. Turn on the tap water to produce a steady stream. Hold the pencil so that one edge of the plate touches the water. The plate will spin. Turn the faucet higher and the plate will spin faster.



This Is What Happens:

You have just built a waterwheel. Waterwheels many times the size of your model are used in large rivers and near waterfalls. The water causes the waterwheel to turn, and the turning motion generates electricity. We call the energy that is made this way *hydroelectric power*.

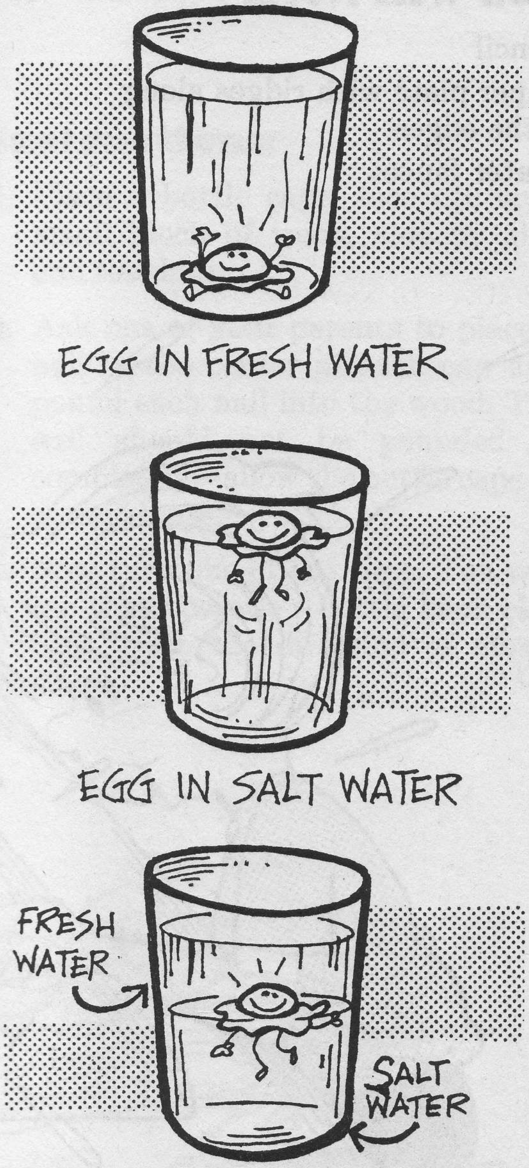
Buoy, Oh Buoy

You Will Need:

Raw egg
2 drinking glasses
Water
1 heaping tablespoon salt

Instructions:

1. Set an unbroken raw egg in a drinking glass filled with water. You will see that the egg sinks to the bottom.
2. Remove the egg and add the heaping tablespoon of salt to the water. Stir to dissolve. Now place the egg back in the glass. This time it floats.
3. Remove the egg from the glass. Pour away some of the salt water until the glass is only half full. Using a second glass filled with fresh water, very slowly and gently add this water on *top* of the salt water until the glass is once again filled. (It is important to pour slowly and gently so that the fresh water and salt water do not mix together.)
4. As before, set the egg in the glass. The egg floats halfway down.



This Is What Happens:

Buoyancy is the power of a liquid to exert an upward force on an object placed in it—the force, equal to the weight of fluid that is pushed aside. The egg sinks to the bottom of fresh water because the weight of water that the egg pushes aside is less than the weight of the egg itself. However, salt water is heavier than fresh water. An equal amount of salt water produces a greater upward force and this keeps the egg floating. When you have a layer of fresh water above the salt water, the egg floats between the two, buoyant over the salt water.

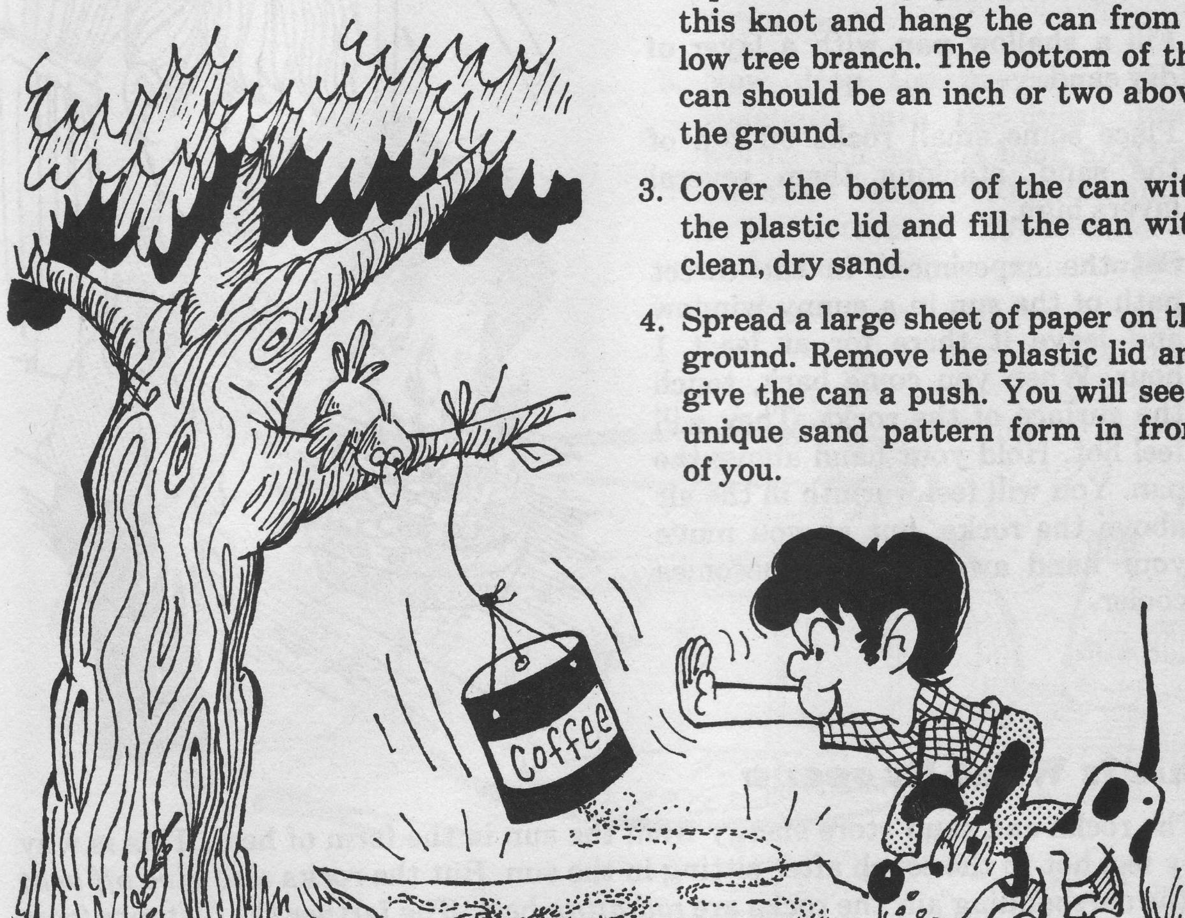
Sand Painting

You Will Need:

Coffee can with plastic lid
Hammer
Small nail
String
Sand
Large sheet of paper
THE HELP OF ONE OF YOUR PARENTS

Instructions:

1. Ask one of your parents to punch a hole in the bottom of the coffee can with a hammer and a small nail, then make 3 equally spaced holes around the top edge of the can.
2. Tie a piece of string, approximately 6 inches long, through each hole, and knot the ends together at the top. Tie a long piece of string to this knot and hang the can from a low tree branch. The bottom of the can should be an inch or two above the ground.
3. Cover the bottom of the can with the plastic lid and fill the can with clean, dry sand.
4. Spread a large sheet of paper on the ground. Remove the plastic lid and give the can a push. You will see a unique sand pattern form in front of you.



This Is What Happens:

You have just made a pendulum. Its action is traced by the escaping sand. The two parts of the swinging motion—vertical and horizontal—are combined into the pattern that you see on the paper.

Hot Rocks

You Will Need:

Shallow pan, such as an old baking pan
Sand
Small rocks
Sunny window

Instructions:

1. Fill a shallow pan with a layer of dry sand.
2. Place some small rocks on top of the sand, stacking them several layers high.
3. Set the experiment in the direct path of the sun in a sunny window and leave it there for at least 1 hour. When you come back, touch the surface of the rocks. They will feel hot. Hold your hand above the pan. You will feel warmth in the air above the rocks, but as you move your hand away, the air becomes cooler.

This Is What Happens:

The rocks and sand store energy from the sun in the form of heat. This is why they feel hot to the touch after sitting in the sun. But the rocks also *give off heat* to the surrounding air; the rocks are *radiating* heat. The farther the distance from the source of heat—the rocks—the lesser the warmth from radiation. The whole earth acts in the same way: It collects heat from the sun during the day, then the ground radiates the heat and warms the air above it at night. But the higher you go from the earth's surface, the less heat there is. That is why a mountaintop is very cold—it is high above the ground, very far from where most heat is radiated. The upper atmosphere surrounding the earth has very little heat at all for the same reason.

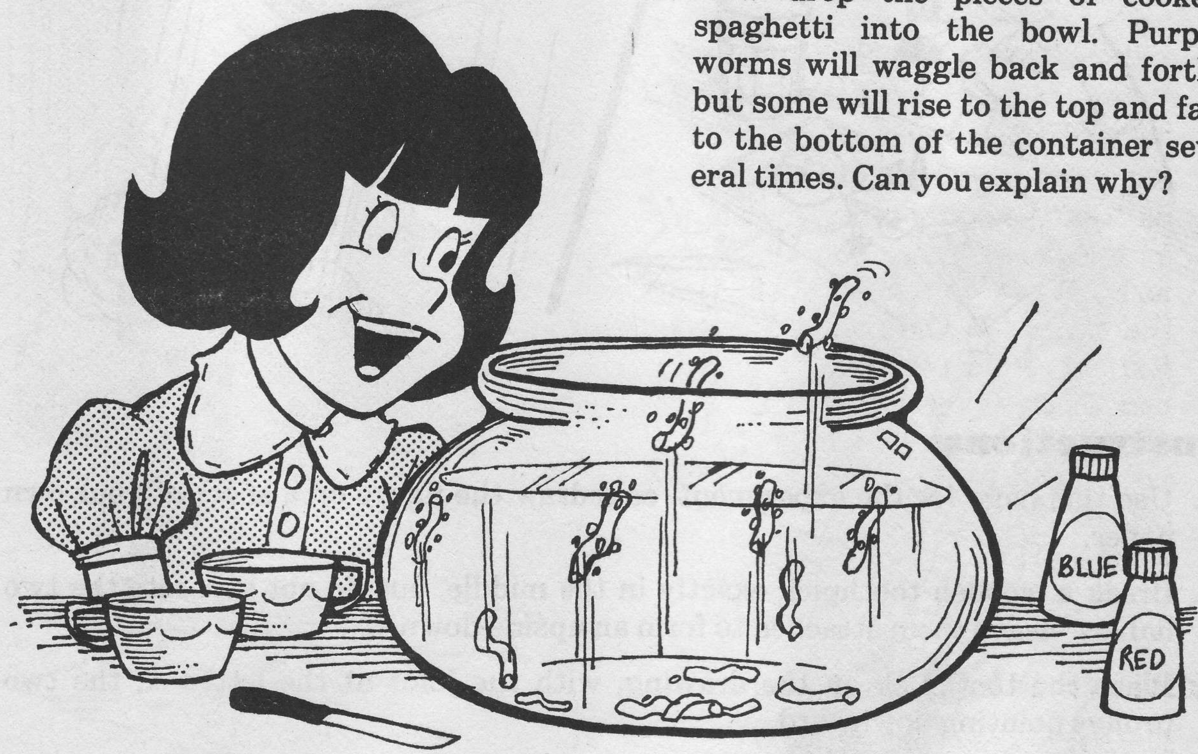
Waggling Worms

You Will Need:

Knife
Cooked spaghetti
Fish bowl
1 cup vinegar
1 cup water
Red and blue food coloring
2 tablespoons baking soda
THE HELP OF ONE OF YOUR PARENTS

Instructions:

1. The next time you have spaghetti for dinner, ask one of your parents to cut a few strands of the cooked spaghetti into 1- to 2½-inch pieces.
2. In a fish bowl or other large container, mix the cup of vinegar and the cup of water. Then add a few drops of red and blue food coloring. *Slowly* add the 2 tablespoons of baking soda.
3. Now drop the pieces of cooked spaghetti into the bowl. Purple worms will waggle back and forth, but some will rise to the top and fall to the bottom of the container several times. Can you explain why?



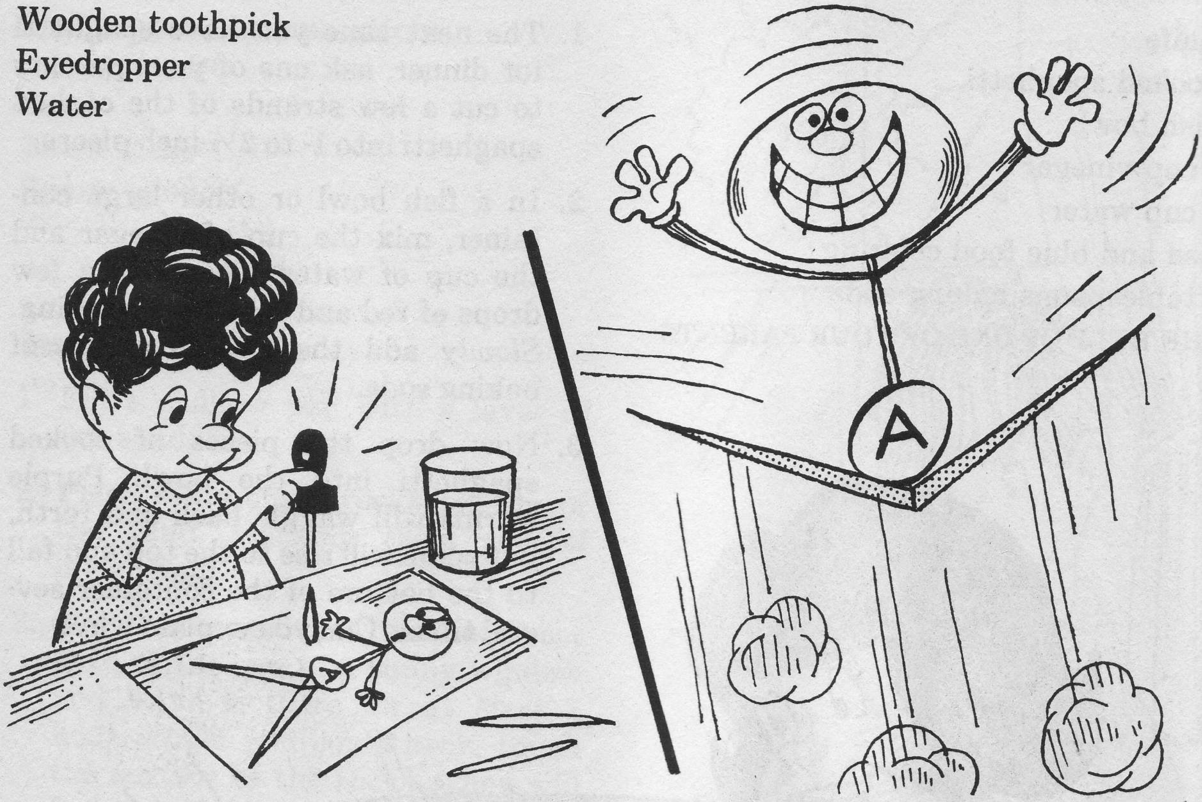
This Is What Happens:

The vinegar and baking soda form gas bubbles, which collect on the spaghetti. Because the gas bubbles make the spaghetti lighter, the pieces rise and drift in the solution. The gas bubbles of those pieces that rise to the top of the container break open at the surface, causing the pieces to fall to the bottom, where more gas bubbles collect on the spaghetti, and the process is repeated.

Leapin' Leo

You Will Need:

Wooden toothpick
Eyedropper
Water



Instructions:

1. Use this page for the experiment, or redraw the figure on a sheet of your own paper.
2. Break a wooden toothpick exactly in the middle, but do not separate the two halves—leave them attached to form an upside-down 'V'.
3. Place the toothpick on the drawing, with the joint at the letter A, the two prongs pointing downward.
4. Use an eyedropper to transfer one drop of water to the joint. Watch the gymnast leap up and spread his legs apart.

This Is What Happens:

When you placed the drop of water onto the toothpick, some of the water soaked into the wood. This moisture caused the wood fibers to expand and the toothpick straightened out.

Wriggling Fish

You Will Need:

Thin cellophane
Scissors

Instructions:

1. Cut a fish shape ¾ inch wide and 2 inches long from a piece of thin cellophane. (Make sure that you use cellophane and not clear plastic. You can tell the difference by the crackling noise cellophane makes when it is crumpled.)
2. Hold the cellophane in the palm of your hand for a couple minutes. Suddenly you will see the fish wriggle up!

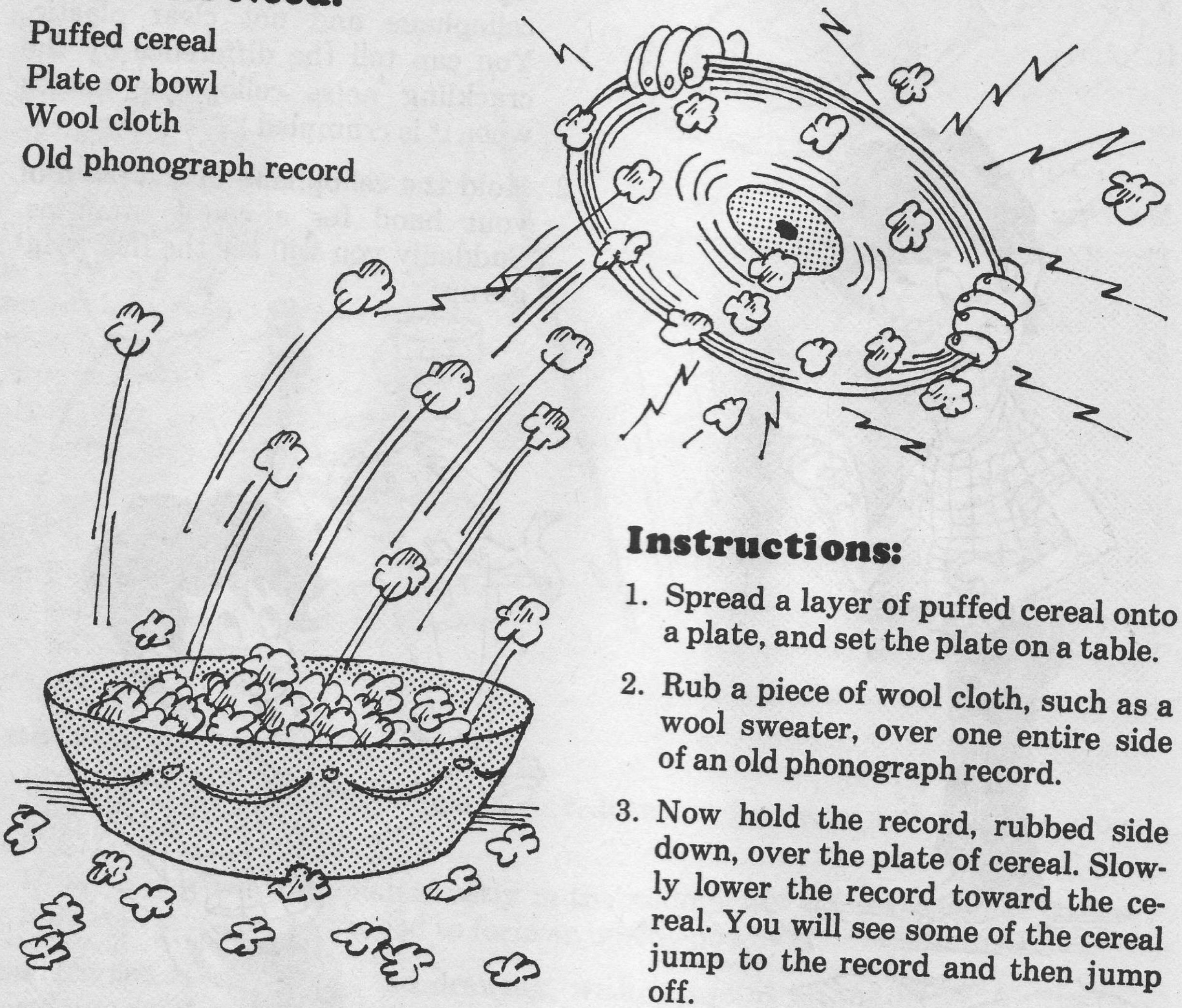
This Is What Happens:

Of course you know that the shape cannot actually come to life. The palm of your hand gives off perspiration, and this moisture is absorbed by the cellophane, causing it to swell. The side touching your skin absorbs more moisture than the dry side (the upper side), and this difference causes the curling action.

Snap, Crackle, Jump

You Will Need:

Puffed cereal
Plate or bowl
Wool cloth
Old phonograph record



Instructions:

1. Spread a layer of puffed cereal onto a plate, and set the plate on a table.
2. Rub a piece of wool cloth, such as a wool sweater, over one entire side of an old phonograph record.
3. Now hold the record, rubbed side down, over the plate of cereal. Slowly lower the record toward the cereal. You will see some of the cereal jump to the record and then jump off.

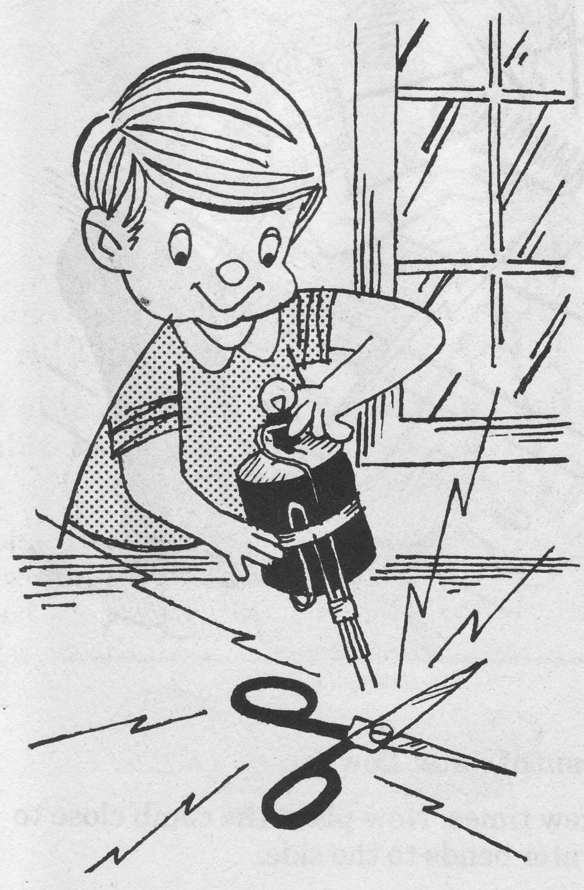
This Is What Happens:

Rubbing the record with wool causes its surface to pick up electrical charges. These charges are particles called *electrons*. The record surface does not conduct electricity, so it simply holds the electrons in place, even though the electrons tend to repel each other. When the "charged-up" record is held above the light, dry cereal, the electrons attract the puffy pieces. Then some electrons stick to the cereal. Now the record and the cereal both have electrons. These negative charges repel each other and the cereal is pushed away.

Conduct Yourself Properly

You Will Need:

Insulated wire (the kind with the plastic coating)
Flashlight bulb
D-size battery
Masking tape
THE HELP OF ONE OF YOUR PARENTS



Instructions:

An *electrical conductor* is a material through which electricity flows. You can build a device that will test different materials to find out whether or not they are electrical conductors.

1. Ask one of your parents to do the following: Cut two 9-inch lengths of insulated wire. Strip about 3 inches of coating from one end of one piece of wire and wrap this tightly around the base of a flashlight bulb. Strip about ½ inch of coating from the remaining ends.
2. Place the flashlight bulb at the pointed tip of a D-size battery. Tape one end of the loose wire at the flat end of the battery. Tape the remaining wire in place on the battery as shown.
3. Now tape the two free wire ends ½ inch apart, placing the tape on the coated portion of the wire, leaving the bare ends free.

To operate your tester, press the bulb firmly against the battery. Touch the two bare wires to the object being tested. If the material is a conductor, the bulb will flash. Try testing a pair of scissors, this book, and your bicycle!

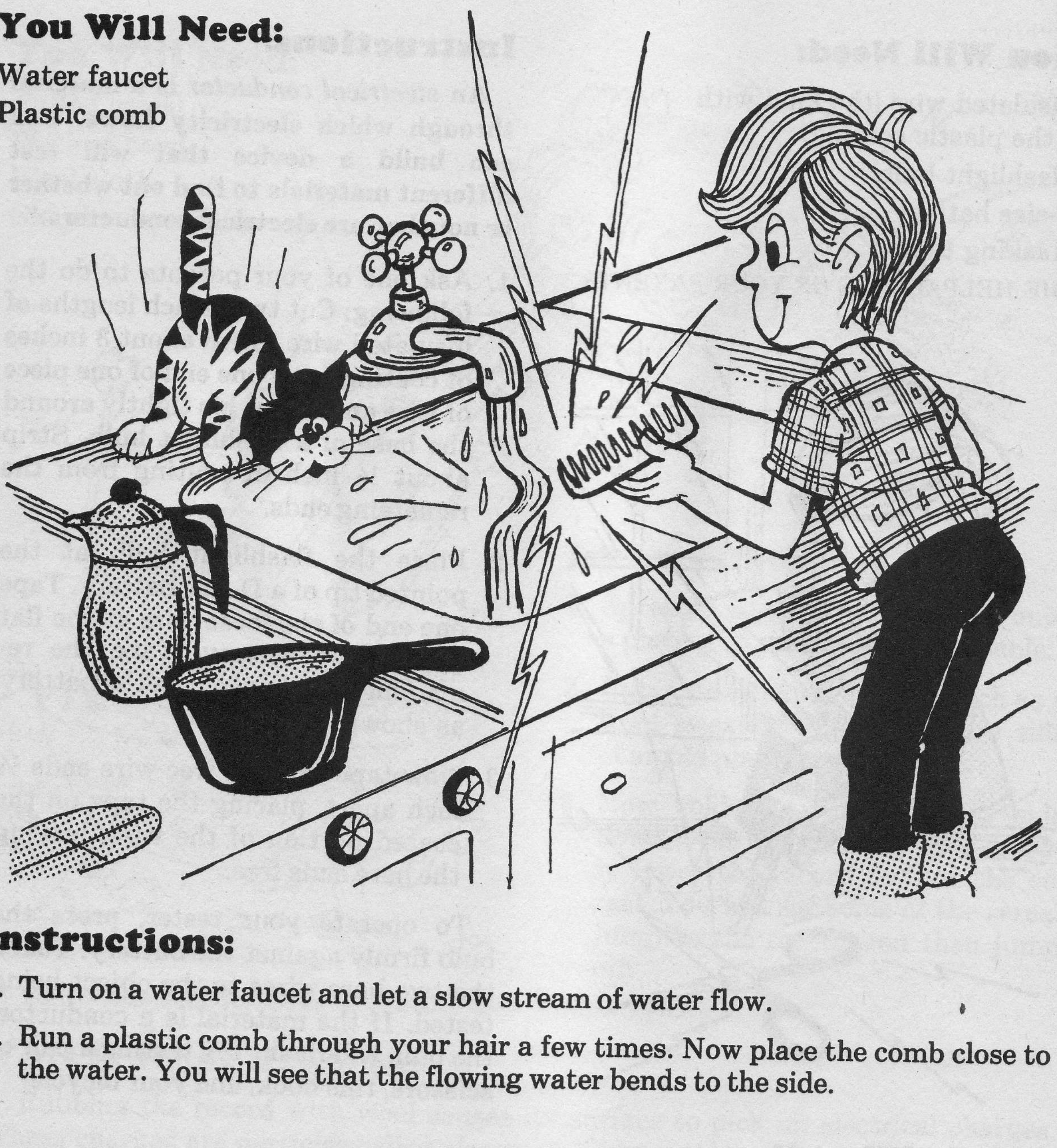
This Is What Happens:

Electricity is generated in the battery and this flows into the wires. When you touch the ends to a conductor, a *circuit* is completed. This means that the electricity can now flow through a complete path. So the electricity flows through the wires, the object, and the bulb, and the bulb lights up.

Please Comb Here—Opposites Attract

You Will Need:

Water faucet
Plastic comb



Instructions:

1. Turn on a water faucet and let a slow stream of water flow.
2. Run a plastic comb through your hair a few times. Now place the comb close to the water. You will see that the flowing water bends to the side.

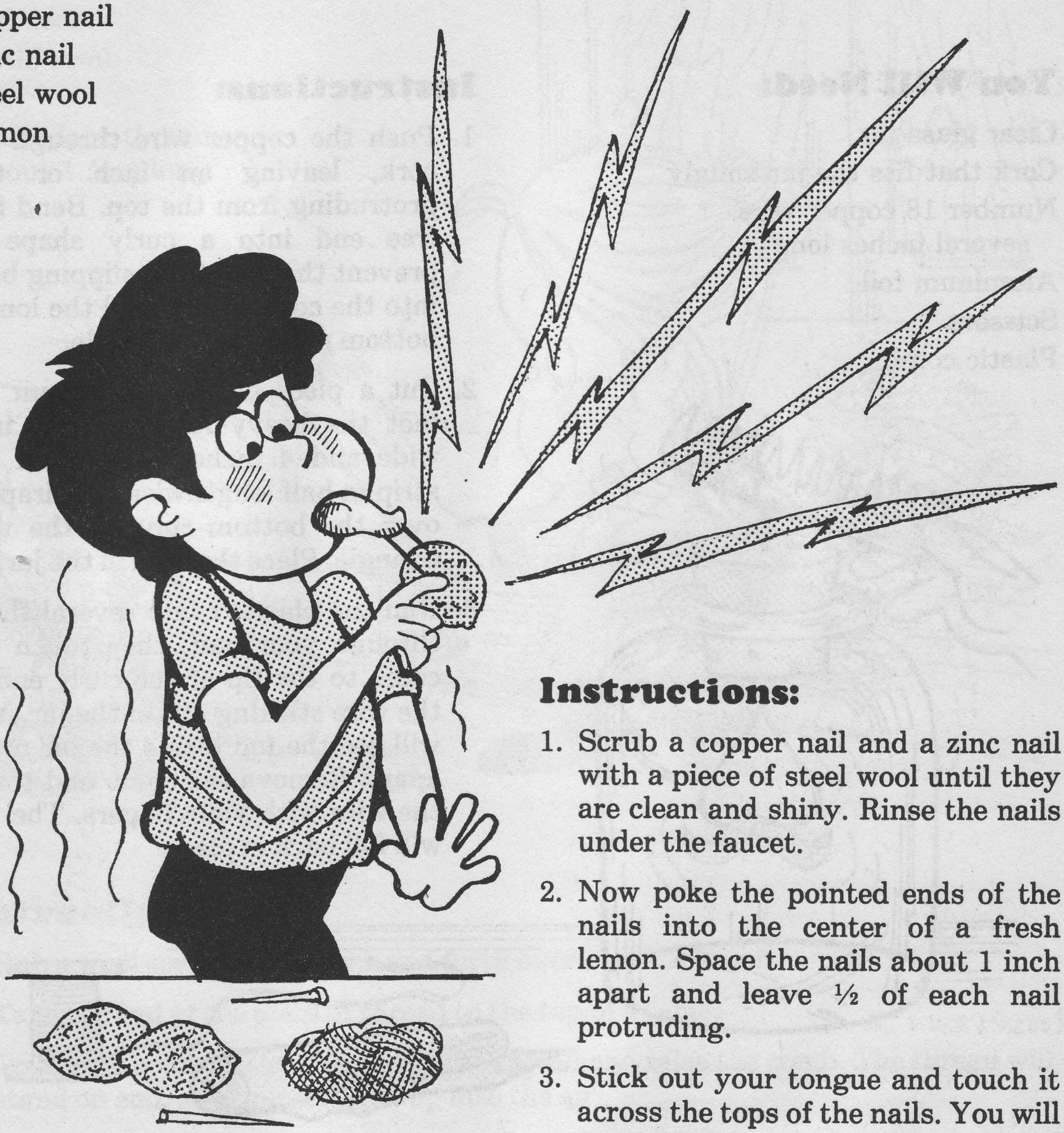
This Is What Happens:

As the plastic teeth of the comb pass through your hair, they gather charges of static electricity. These electrical charges attract those water molecules that are oppositely charged, and the stream bends in that direction.

Lemon Battery

You Will Need:

Copper nail
Zinc nail
Steel wool
Lemon



Instructions:

1. Scrub a copper nail and a zinc nail with a piece of steel wool until they are clean and shiny. Rinse the nails under the faucet.
2. Now poke the pointed ends of the nails into the center of a fresh lemon. Space the nails about 1 inch apart and leave ½ of each nail protruding.
3. Stick out your tongue and touch it across the tops of the nails. You will feel a tingle.

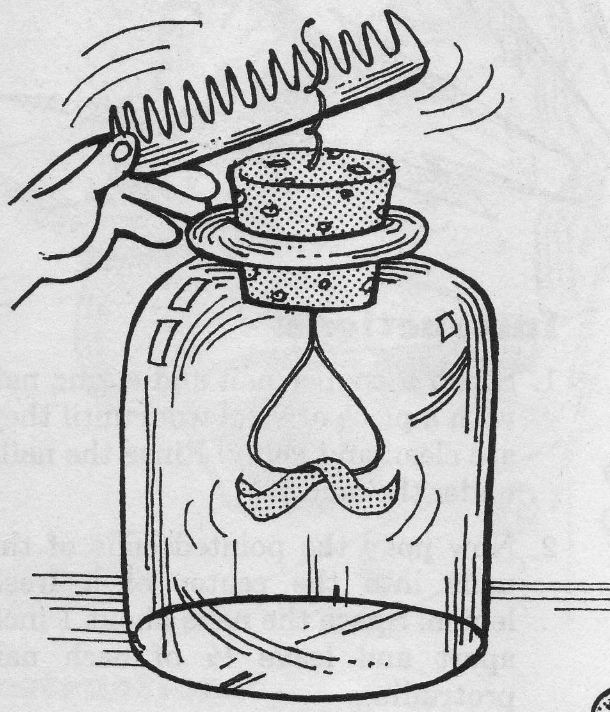
This Is What Happens:

You have just made a chemical battery and the tingle on your tongue was electricity. The lemon contains acid and water, which reacts with the metals copper and zinc to produce a slight current that passes over your tongue.

Curses, Foiled Again!

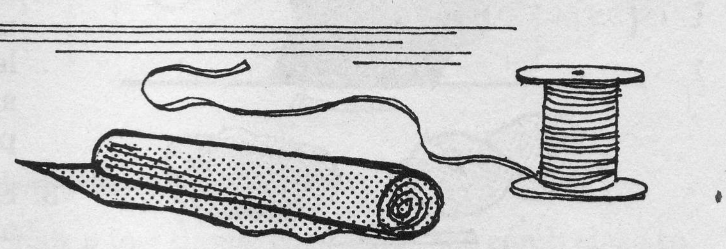
You Will Need:

Clear glass jar
Cork that fits the jar snugly
Number 18 copper wire, several inches long
Aluminum foil
Scissors
Plastic comb



Instructions:

1. Push the copper wire through the cork, leaving an inch or two protruding from the top. Bend this free end into a curly shape to prevent the wire from slipping back into the cork. Then bend the longer bottom piece into a triangle.
2. Cut a piece of thin aluminum foil (not the heavy-duty kind) ½ inch wide and 4 inches long. Fold the strip in half lengthwise and drape it over the bottom rung of the wire triangle. Place the cork in the jar.
3. Run the plastic comb several times through your hair, then touch the comb to the tip of the curly end of the wire sticking out of the jar. You will see the foil inside the jar move apart. Remove the comb and touch the wire with your fingers. The foil will fall back in place.



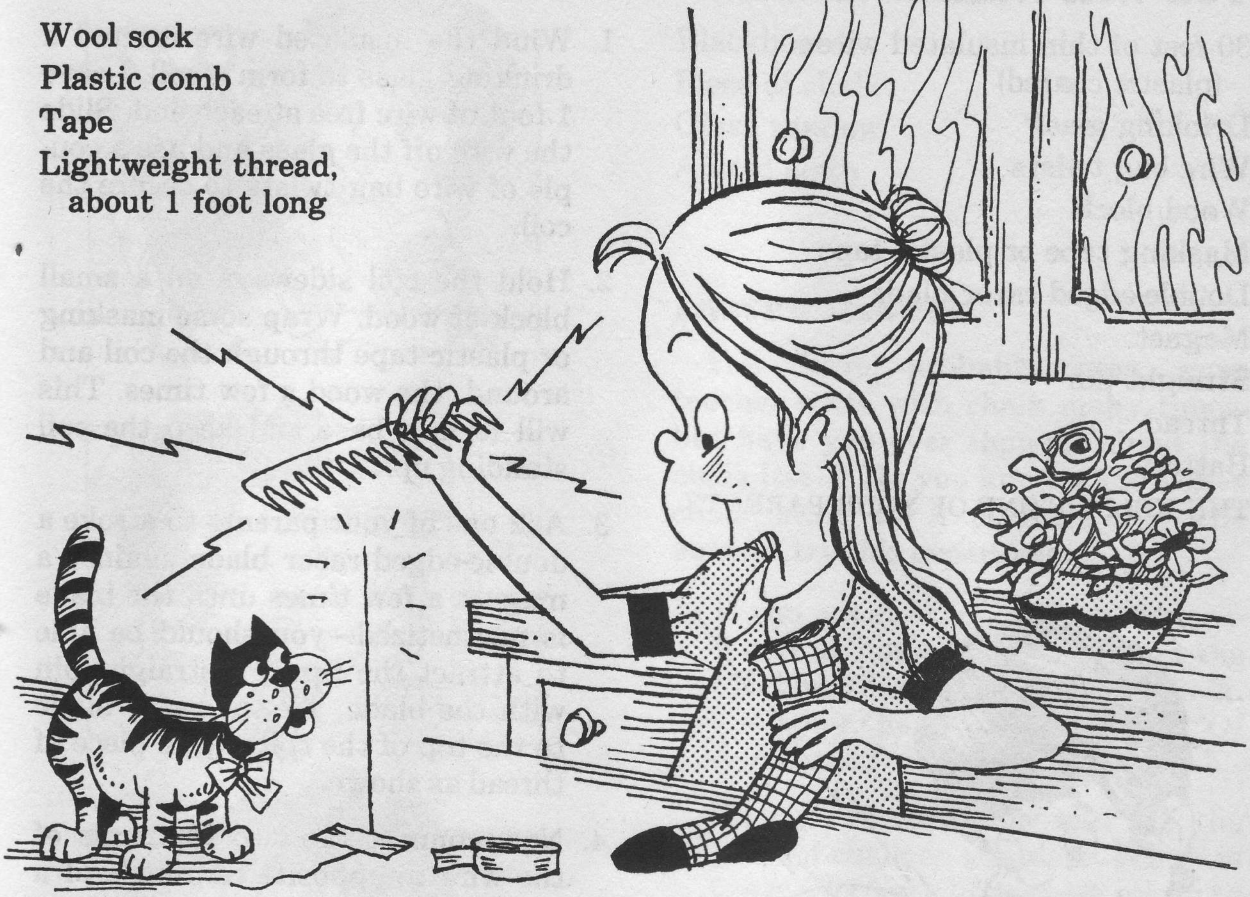
This Is What Happens:

Running the comb through your hair picks up tiny charged particles of electrons. When you touch the "charged" comb to the wire, the electrons travel along the length of the wire into the two flaps of aluminum foil. Because "like" charges of electricity repel each other, the ends of the foil separate. When you touch the wire with your finger, you reverse the flow of electrons and remove the charge, so the foil is free to fall back into its normal position.

Down, Boy!

You Will Need:

Wool sock
Plastic comb
Tape
Lightweight thread, about 1 foot long



Instructions:

1. Rub a wool sock rapidly back and forth over a plastic comb.
2. Tape the end of the piece of thread to the top of a table.
3. Touch the comb to the free end of the thread and raise the comb. The thread will stand on end, sticking straight up into the air.

This Is What Happens:

When you rub the wool sock over the comb, you give the comb an electrical charge. The charge on the comb attracts the thread because the thread carries an opposite charge. The two differently charged objects cling together, and the thread is carried upward with the comb.

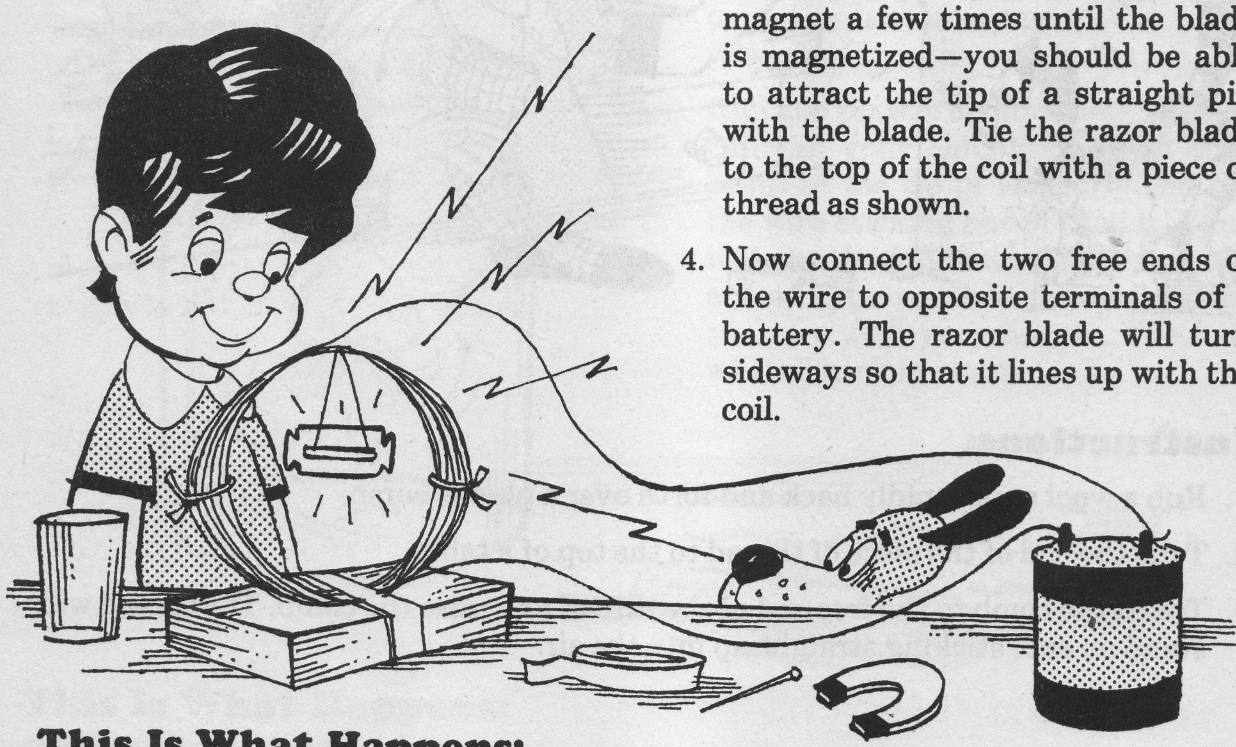
I Detect Electricity

You Will Need:

30 feet of thin insulated wire (plastic coated)
Drinking glass
Wire bag twists
Wood block
Masking tape or plastic tape
Double-edged razor blade
Magnet
Straight pin
Thread
Battery
THE HELP OF ONE OF YOUR PARENTS

Instructions:

1. Wind the insulated wire around a drinking glass to form a coil. Leave 1 foot of wire free at each end. Slide the wire off the glass and use a couple of wire bag twists to secure the coil.
2. Hold the coil sideways on a small block of wood. Wrap some masking or plastic tape through the coil and around the wood a few times. This will form a base and keep the coil standing up.
3. Ask one of your parents to stroke a double-edged razor blade against a magnet a few times until the blade is magnetized—you should be able to attract the tip of a straight pin with the blade. Tie the razor blade to the top of the coil with a piece of thread as shown.
4. Now connect the two free ends of the wire to opposite terminals of a battery. The razor blade will turn sideways so that it lines up with the coil.



This Is What Happens:

You have just made a *galvanometer*. This is a device that will detect or measure small amounts of electricity by movements of a magnetic needle or by a coil in a magnetic field. An electric current flows from the battery through the coil. This creates a magnetic field around the coil. The razor blade reacts to this magnetic field, because it has been magnetized itself, lining up inside the coil.

Chalk It Up

You Will Need:

Blackboard
Piece of chalk
Glass window
An old cloth

Instructions:

You have probably seen your teacher write with chalk many times, but have you ever thought about the chalk itself? Do you know what makes chalk stick to a surface? For the answer, try this experiment.

1. If you are at school or have a blackboard at home, draw a line on the blackboard with a piece of chalk. Did you have any trouble? Of course not.
2. Now go to a window and rub the piece of chalk on the glass. Where is the mark? Very little chalk sticks to the glass.
3. Rub the piece of chalk on an old cloth. You will find that some chalk marks will stick to the cloth, but seeing letters is difficult. Try rubbing the chalk on other substances, then read the explanation below.

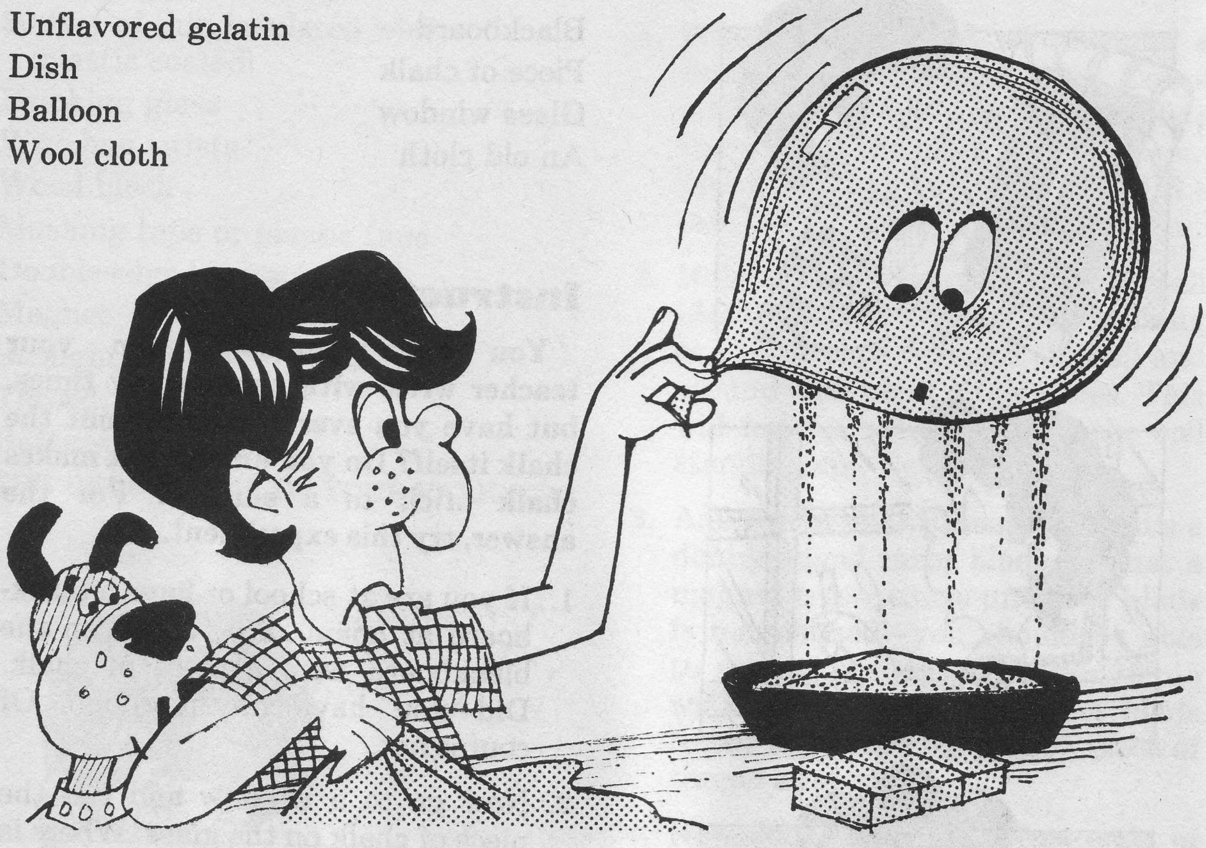
This Is What Happens:

When you rub a piece of chalk against something, the chalk breaks apart into separate particles at the point of contact. Each of these tiny particles carries an electrical charge, and it is this charge that determines what substance the particles will cling to—a blackboard surface and chalk particles will cling together tightly; a glass surface, however, provides a poor area for the chalk particles to stick. A cloth is better than glass, but still not as good as a blackboard.

Balloon Cave

You Will Need:

Unflavored gelatin
Dish
Balloon
Wool cloth



Instructions:

1. Pour an envelope of unflavored gelatin into a dish.
2. Blow up a balloon and tie the opening closed. Rub a piece of wool cloth, such as a wool sweater, on the balloon.
3. Gently touch the balloon to the surface of the gelatin. Now slowly raise the balloon. Columns of gelatin will form between the balloon and the dish. These look like the stalagmites and stalactites—deposits of calcium carbonate resembling icicles—of a cave.

This Is What Happens:

You deposit electrical charges on the balloon when you rub it with wool. These charges attract the particles of gelatin to the balloon's surface, where they stick. Additional particles accumulate on top of these, so when you pull the balloon away from the dish, the gelatin separates into columns.

The Invisible Leg

You Will Need:

An old nylon stocking
Plastic sandwich bag

Instructions:

1. With one hand, hold the toe of a nylon stocking (the shiny kind works best) on the edge of a table. Slip your other hand into the plastic sandwich bag and grip the stocking, starting at the toe and pulling along the entire length, up to the thigh. Repeat this process several times, stroking the nylon in the same direction.
2. Holding the top edge of the stocking, lift it from the table. Let go with the bagged hand. Suddenly the stocking will appear as if there were a leg in it.

This Is What Happens:

When you stroked the nylon with the plastic bag, these two materials acquired opposite electrical charges. Because the stocking material became all the same charge and because like charges repel each other, the sides of the stocking pushed away from each other, taking on the shape of a real leg.

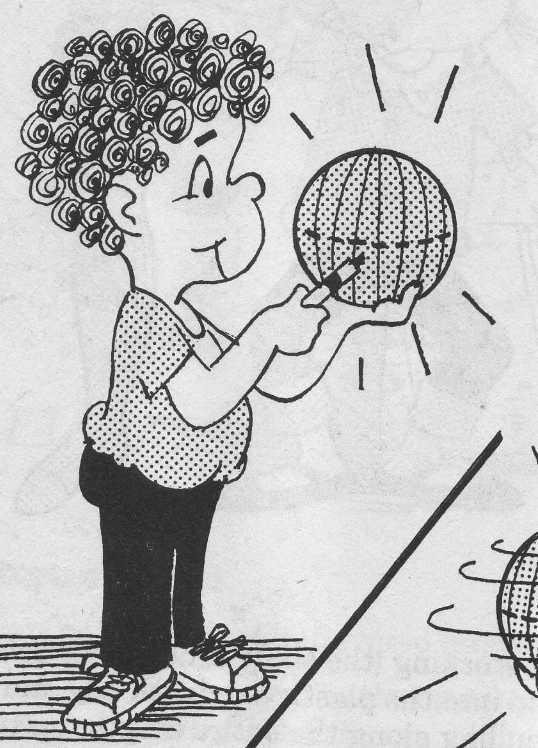
Sweet Time

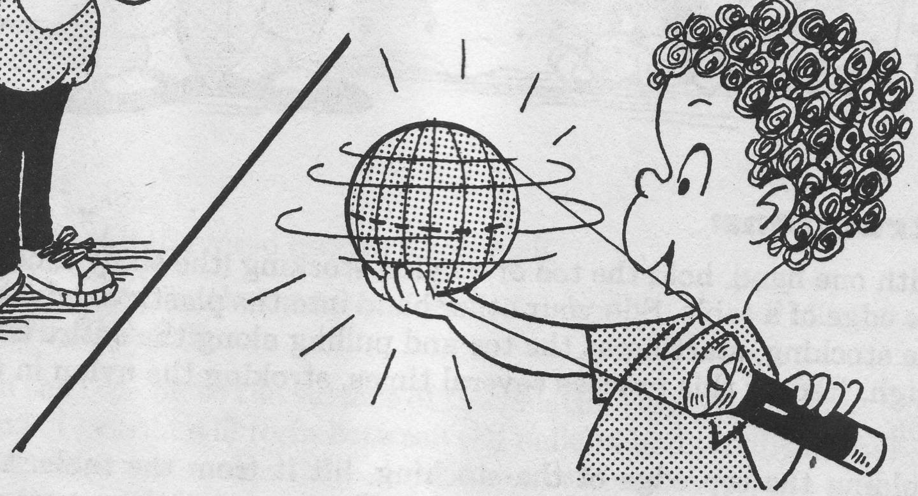
You Will Need:

Large orange, about 12 inches around
String
Ruler
Thin-point felt marker
Flashlight

Instructions:

1. To measure the orange, hold a piece of string around the orange, and then lay it out flat against a ruler.
2. With a thin-point felt marker, make a mark every ½ inch around the middle of the orange, for a total of 24 marks.
3. Now make a line from the top of the orange, through one mark in the middle, to the bottom of the orange. Do this for all 24 marks.
4. Shine a flashlight straight at the orange. Rotate the orange and notice how the boundary between the light and dark areas crosses each of the lines you have made.

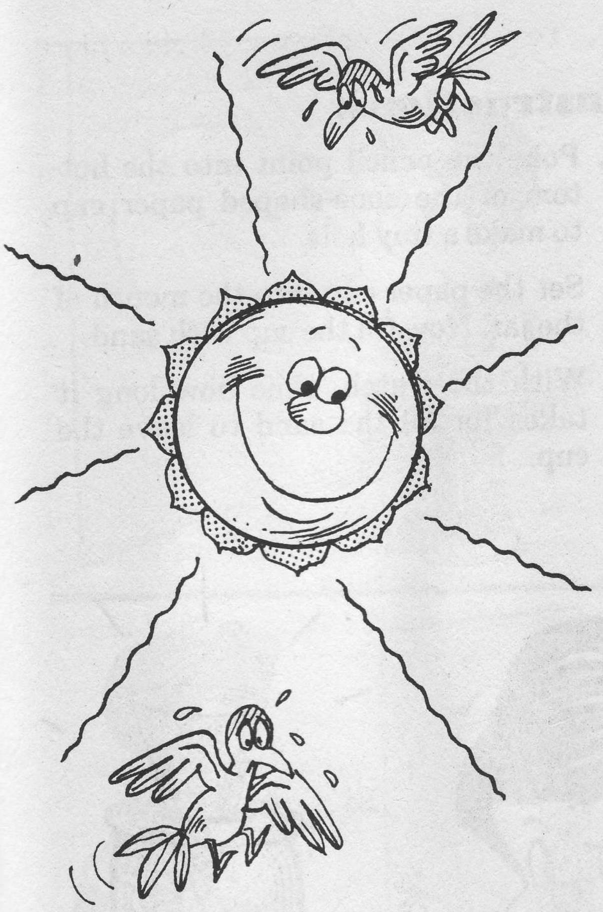




This Is What Happens:

You have just made a model of the earth. Long ago, everyone agreed to divide up the earth into 24 sections, just like you have done with the orange. Of course the lines are only imaginary. They are called *meridians*. Pretend your flashlight is the sun. Can you see that it is daytime on one part of the earth and nighttime on the other?

Shadow Clock



You Will Need:

A sunny day
Compass
Pencil

Instructions:

1. On a sunny day, take a compass and pencil outdoors. Allow the compass needle to come to rest, then place the pencil's eraser at the 'S'. Tilt the pencil at a 45° angle in line with the needle.

2. Imagine the compass face as the dial of a clock. 'N' is 12 o'clock, 'E' is 3 o'clock, 'S' is 6 o'clock, and 'W' is 9 o'clock. You can tell the approximate time by observing where the shadow falls.

This Is What Happens:

Long ago, people did not have clocks or watches. They knew how late in the day it was by the position of the sun in the sky. Then someone discovered that he could tell time more precisely by observing where the sun cast a shadow on a round disk. This was called a sundial. You just made a type of sundial with the compass and pencil. The hour that you read on your compass is Standard Time. If Daylight Savings Time is in effect where you live, add one hour to your reading.

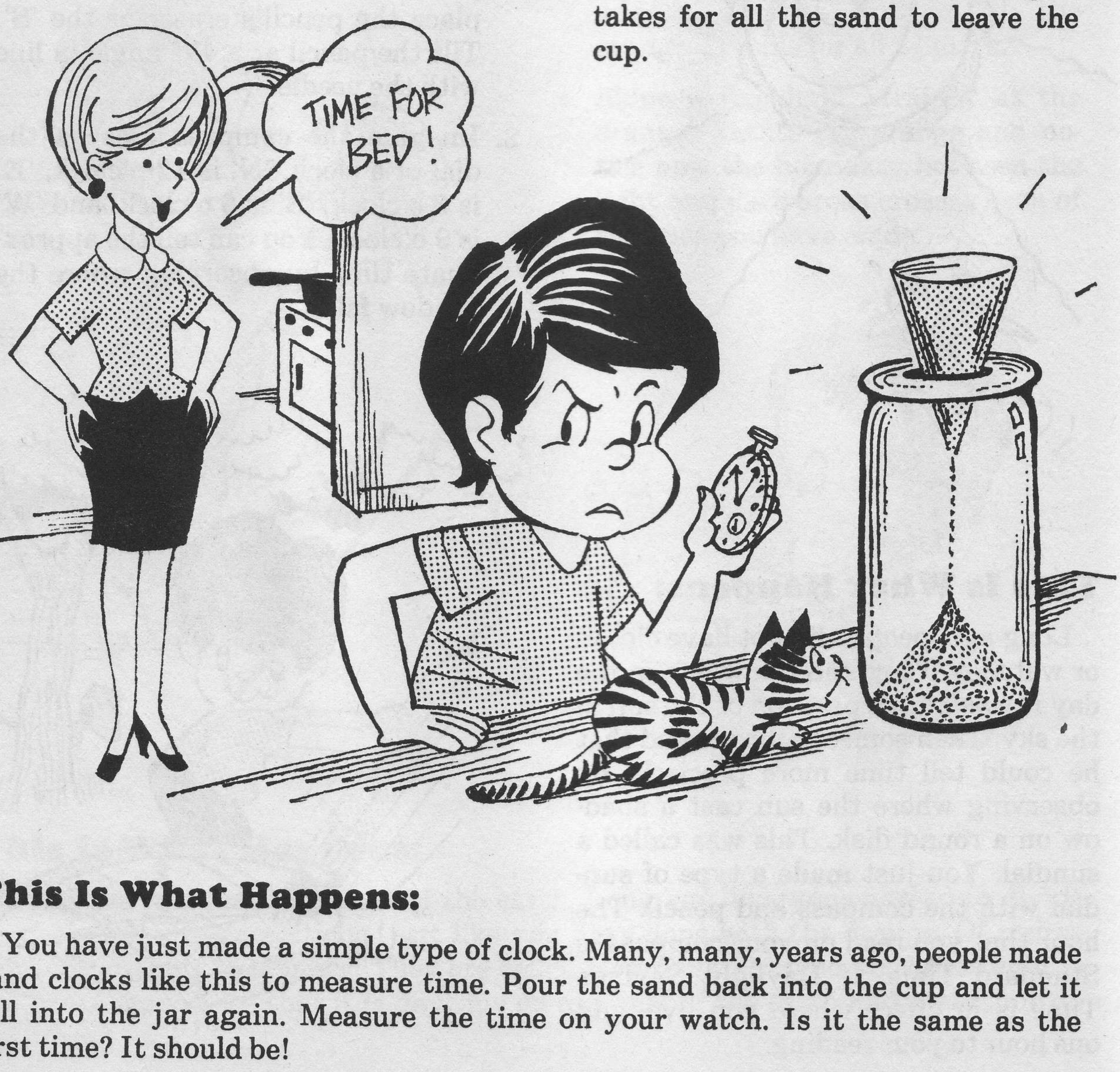
The Sands of Time

You Will Need:

Pencil
Cone-shaped paper cup
Jar
Sand
Watch with a second hand

Instructions:

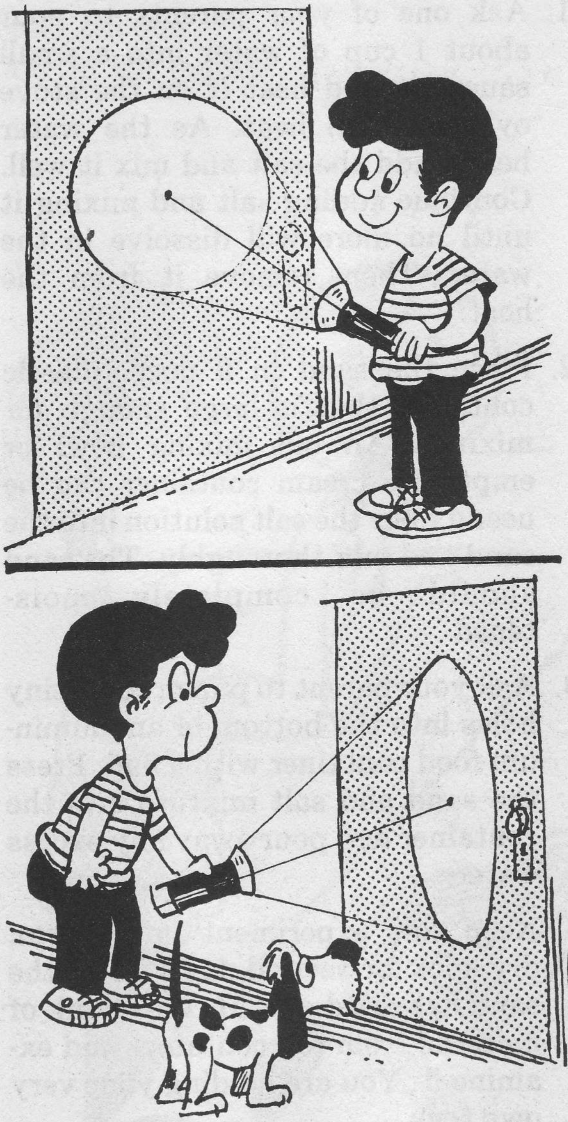
1. Poke the pencil point into the bottom of the cone-shaped paper cup to make a tiny hole.
2. Set the paper cup into the mouth of the jar. Now fill the cup with sand.
3. With the watch, time how long it takes for all the sand to leave the cup.



This Is What Happens:

You have just made a simple type of clock. Many, many, years ago, people made sand clocks like this to measure time. Pour the sand back into the cup and let it fall into the jar again. Measure the time on your watch. Is it the same as the first time? It should be!

Shine On



You Will Need:

String, about 40 inches long
Tape
Flashlight
A dark room

Instructions:

1. Tape one end of the string to a flashlight.
2. Go into the room you have chosen and close the door. Tape the other end of the string to the center of the door at waist height, then turn off the light. (The room must be totally dark.)
3. Hold the flashlight in one hand. Step back until the string is tight, then shine the light directly on the door. A circle of light will form. Notice its size.
4. Now move to the side, keeping the string tight, and shine the flashlight in the same spot. The circle of light will become larger, forming an oval shape. Can you compare this to something you know about the earth and the sun?

This Is What Happens:

As you move to the side, the light hits the door at an angle and covers a greater area. Since the *same amount* of light covers a larger area on an angle, that area receives less intense light. The same thing happens when the sun strikes the earth's surface at different times during the year. In the summer, we receive the sun's rays more directly, and they, therefore, produce more heat. In the winter, however, we receive the slanted rays of the sun, and the ground and air stay colder.

Rock Me

You Will Need:

Water
Small saucepan
Salt
Spoon
Fine sand, about 1 quart
Plastic or cardboard container
Aluminum food container
Nail
THE HELP OF ONE OF YOUR PARENTS

Instructions:

1. Ask one of your parents to pour about 1 cup of water into a small saucepan and heat it on the stove over medium heat. As the water heats, add the salt and mix it well. Continue adding salt and mixing it until no more will dissolve in the water. Then, remove it from the heat.

2. Place the sand in a deep, plastic container that is large enough for mixing. (An old mixing bowl or empty ice cream container can be used.) Pour the salt solution into the sand and mix thoroughly. The sand should be completely moistened.

3. Ask your parent to punch some tiny holes into the bottom of an aluminum food container with a nail. Press the sand and salt mixture into the container and pour away any excess water.

4. Keep this experiment in a warm, dry spot for several days. After the sand has dried out, lift the chunk of material from the container and examine it. You are holding your very own rock.

This Is What Happens:

You have made a sandstone rock in much the same way that nature makes one. The salt clings to the particles of sand and holds them together. If you find a sandstone rock in nature, you may see that it is made up of several layers. This occurs when a sandy sediment settles on top of another one. These different layers press together and form one mass.

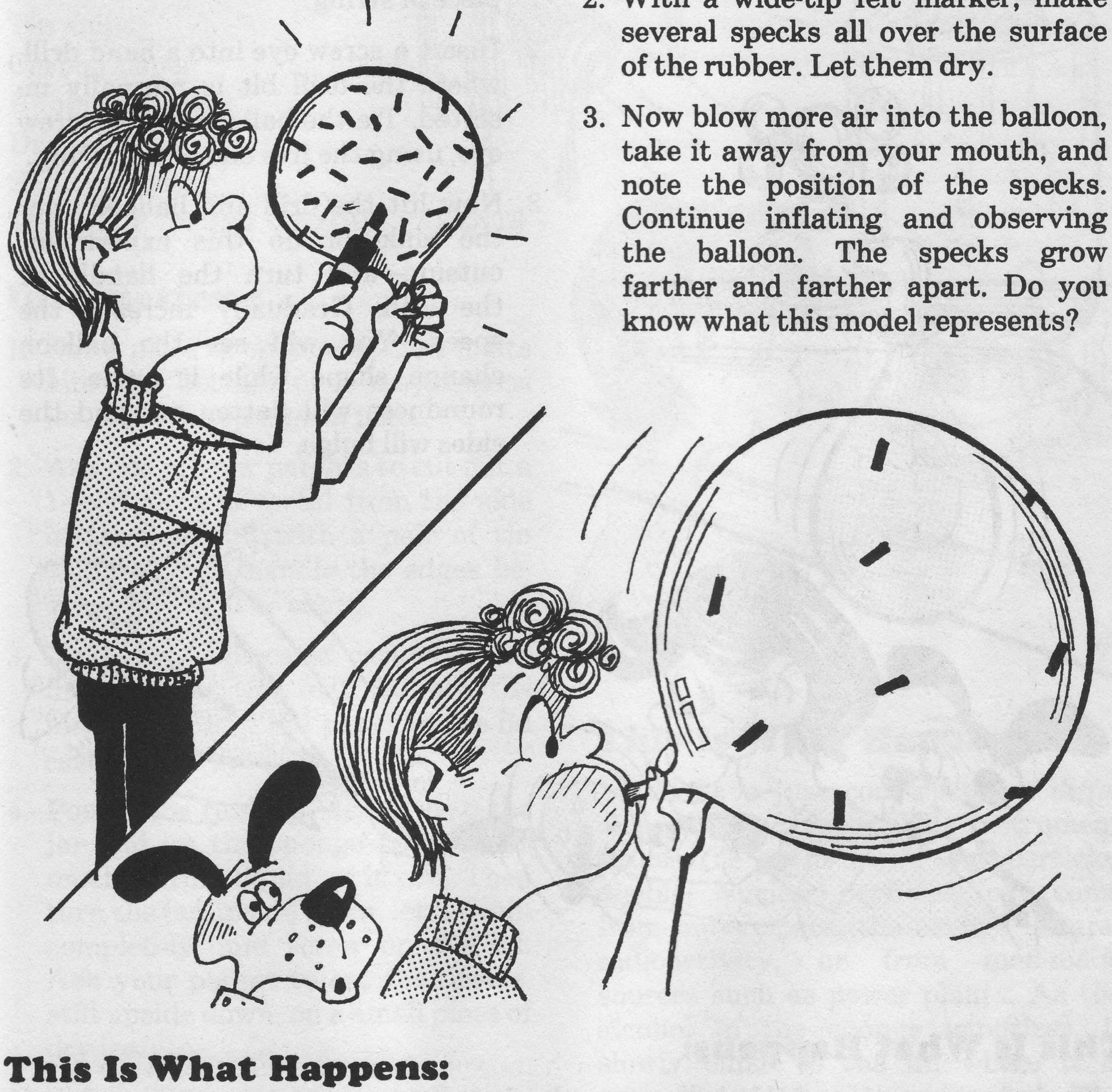
Star Gazer

You Will Need:

Round balloon
Wide-tip felt marker

Instructions:

1. Inflate a round balloon partially full with air. Pinch the neck closed with your thumb and forefinger, but do not tie it closed.
2. With a wide-tip felt marker, make several specks all over the surface of the rubber. Let them dry.
3. Now blow more air into the balloon, take it away from your mouth, and note the position of the specks. Continue inflating and observing the balloon. The specks grow farther and farther apart. Do you know what this model represents?



This Is What Happens:

The balloon is really a model of space, and each of the spots is a galaxy of stars. Our Sun and the planet Earth are part of the Milky Way galaxy. Scientists believe that the universe is expanding in just the same way as you saw on the balloon. The galaxies are drifting apart, leaving greater distances between them.

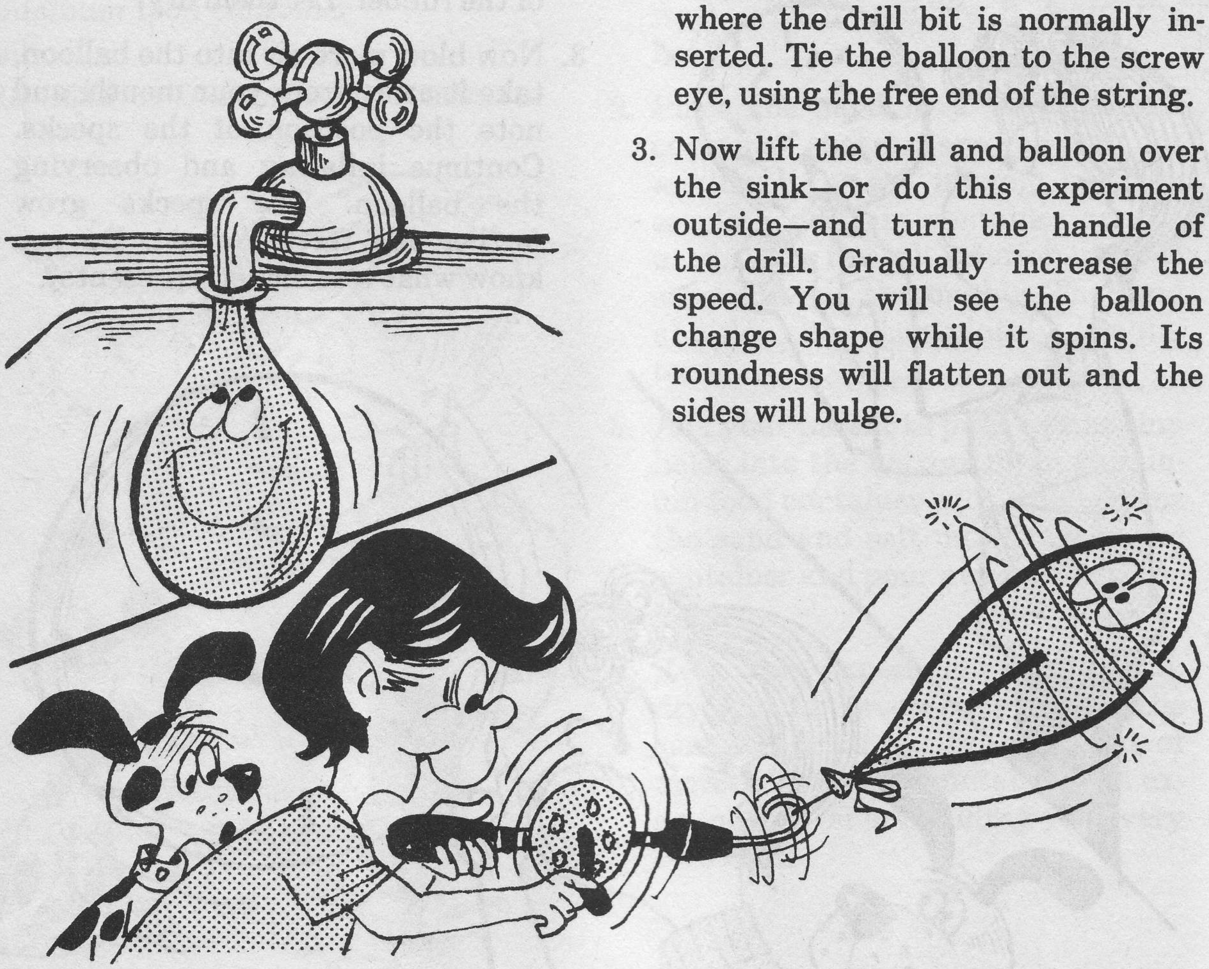
The Fat Earth

You Will Need:

Round balloon
Water
String
Hand drill
Screw eye

Instructions:

1. Fill a round balloon with water by slipping the opening onto the faucet and letting a slow stream of water flow into it. Tie the opening of the balloon firmly closed with a piece of string.
2. Insert a screw eye into a hand drill, where the drill bit is normally inserted. Tie the balloon to the screw eye, using the free end of the string.
3. Now lift the drill and balloon over the sink—or do this experiment outside—and turn the handle of the drill. Gradually increase the speed. You will see the balloon change shape while it spins. Its roundness will flatten out and the sides will bulge.



This Is What Happens:

The spinning action of the drill causes the drops of water to move outward, and this results in the bulging sides of the balloon. This kind of shape is called an *oblate spheroid*. The earth also has this shape, although not as extreme as what you produced.