SUMMER BRAIN GAMES

LET'S PLAY

museum of
science+industry
chicago

LET'S PLAY!

Summer Brain Games offers nine free and fun at-home science experiments designed to combat the "summer brain drain." Everything is easily done at home with kids of all ages (and a little adult supervision).

This year, Summer Brain Games invites you to play with science by making toys! Experience gravity with balancing birds and wobblers, make and play instruments to learn about sound vibrations, build your own kite to understand what makes it fly, and more. It's a great way for families with kids of all ages to stay active during the summer and play together.

FREE MUSEUM ENTRY VOUCHER

Register at **msichicago.org/summerbrain** and get one free MSI ticket per household.

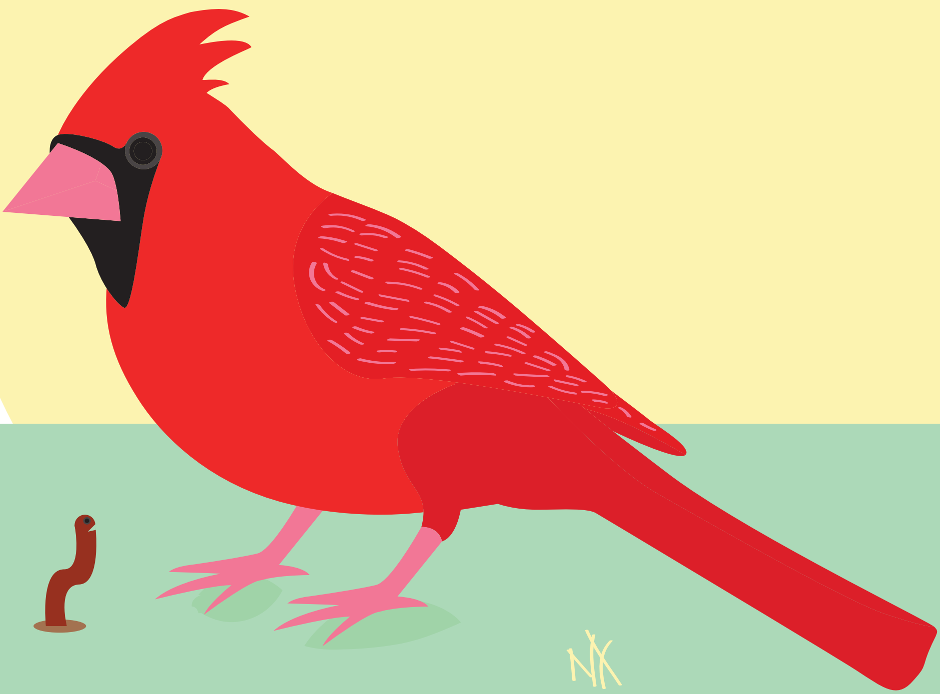
Summer Brain Games is sponsored by

WINTRUST
CHICAGO'S BANK™

Each game has one Illinois-native animal or insect who will join you and play along.

LET'S PLAY WITH...

BALANCING BIRDS



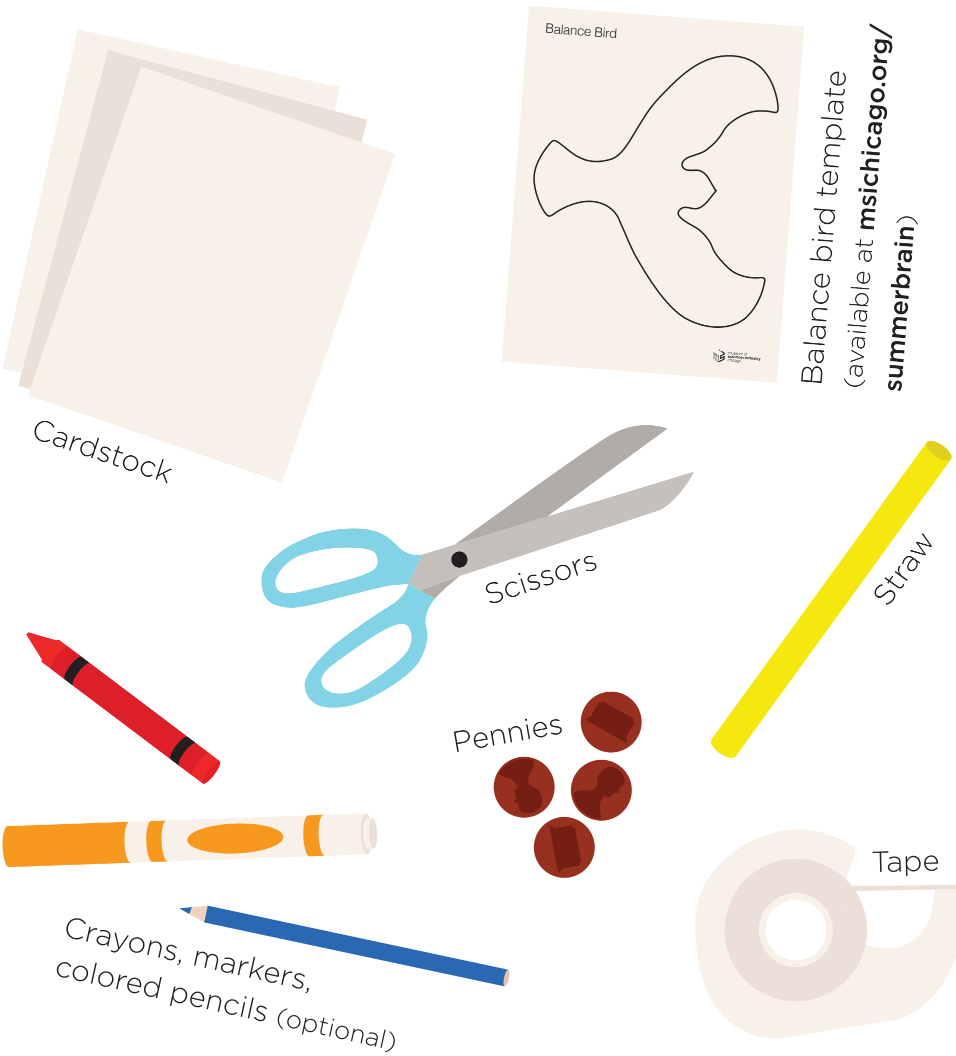
AND BALANCE LIKE THE

CARDINAL

BALANCE BIRD

Can you stand on one leg or spin around without falling down? Staying upright is all about balance. Make a balance bird to see some surprising feats of balance.

MATERIALS



INSTRUCTIONS

1. Download the balance bird template from **msichicago.org/summerbrain**. Print it on cardstock, or print it on regular paper and trace the shape onto cardstock. Cut the bird out along the outline. You can use a file folder or cardboard from a cereal box, just make sure the bird cutout doesn't have any folds or creases in it. If you'd like, you can color your bird.

2. Try balancing the bird by putting the beak on your finger. Does it stay?

3. Fold the straw in half and tape it to the underside of the bird so the center of the straw is just behind the head and the bent sides extend under the wings. Tape one penny near the tips of the wings on the underside of the bird. Try to put them the same distances from the edges on both sides.

4. Flip the bird over. Place the tip of the bird's beak on your finger and it should balance.

WHAT'S HAPPENING?

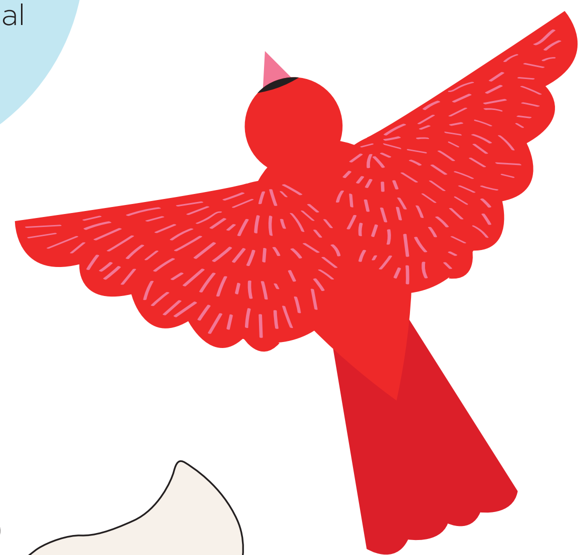
For an object to balance, it needs to be supported directly underneath its center of gravity. The center of gravity is the point where all weight is evenly dispersed and all sides are balanced. Without the pennies, the bird can't be balanced on its beak because the center of gravity is near the middle of the bird. When the pennies are put on the wings, the center of gravity is now located at the tip of the beak and it can be balanced on a fingertip.

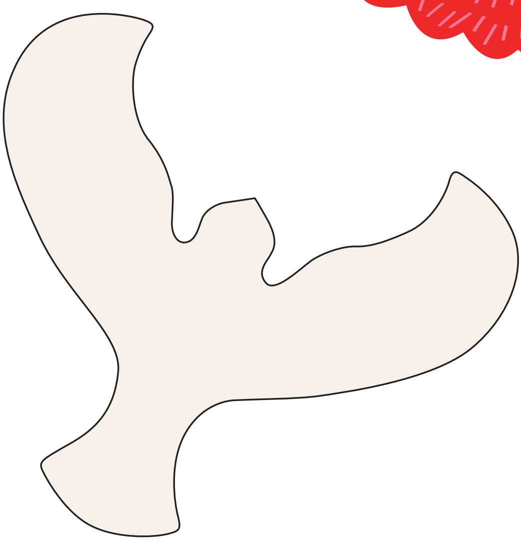
TIPS

If the bird is leaning to the side, check to make sure the shape, location of the pennies and cutout is symmetrical (or even) on both sides.

RECOMMENDED READING

Mirette on the High Wire by Emily Arnold McCully





LET'S PLAY WITH...

TEETERING TOADS

AND NEVER TIP OVER LIKE THE

AMERICAN TOAD

WOBBLER

Can you tip the toad over? Why or why not?
Watch as gravity and balance demonstrate equilibrium.

MATERIALS

INSTRUCTIONS

1. Make sure your cup is empty and clean. Remove the rounded lid, and use tape to cover the hole in the lid (where the straw goes in).
2. Mold the clay into a ball about one inch across, or a little smaller than a ping pong ball. Place the ball of clay inside of the lid, covering the hole that is taped shut. Place the weights directly into the center of the clay. Squish them down so they're secured tightly into the clay. If you're using multiple washers, tape them together so they stick together.
3. Keeping the lid upside down on a table, flip your cup over and carefully secure it into the lid. Don't compress the plastic lid—it needs to stay rounded and without any dents. Test it out! Gently push the wobbly cup and see if it stands back upright.
4. If you'd like, decorate your wobbler to make it into a silly creature. You can use stickers or colored paper, or lightweight items like ribbon.

WHAT'S HAPPENING?

Adding weight to the upside-down lid concentrates the mass in one spot, creating a low center of gravity. Gravity will pull the center of mass downward to the lowest possible point until the object is in equilibrium. Most of the wobbler's mass is in the washers or quarters, and the

only way for it to be in equilibrium is when the wobbler is vertical. The rounded bottom allows for the unique wobble motion as the toy reaches equilibrium.

TIPS

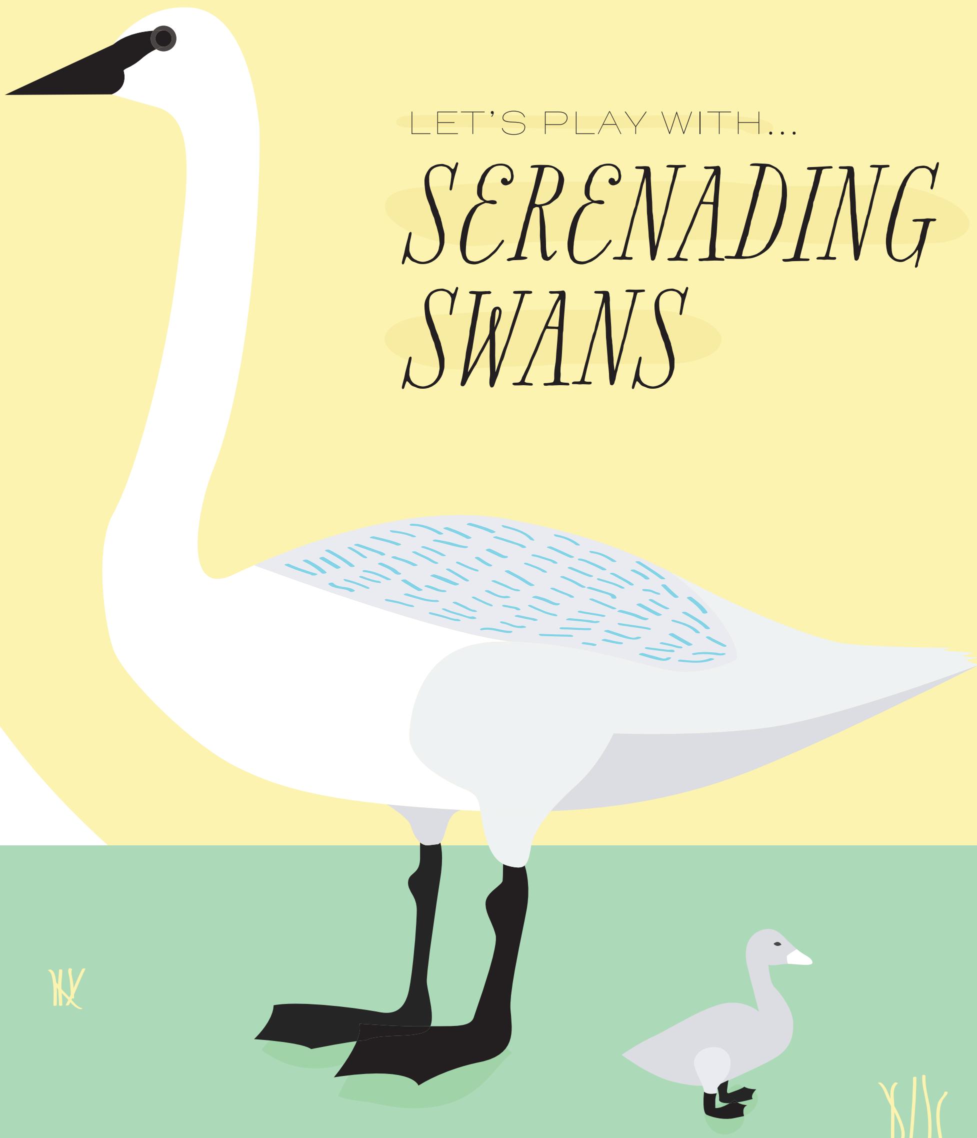
The weights you choose need to be dense, which is why metal washers work well. Be sure to keep the weights secured and in the center of the lid.

RECOMMENDED READING

The Marvelous Thing That Came from a Spring: The Accidental Invention of the Toy That Swept the Nation by Gilbert Ford

LET'S PLAY WITH...

SERENADING SWANS



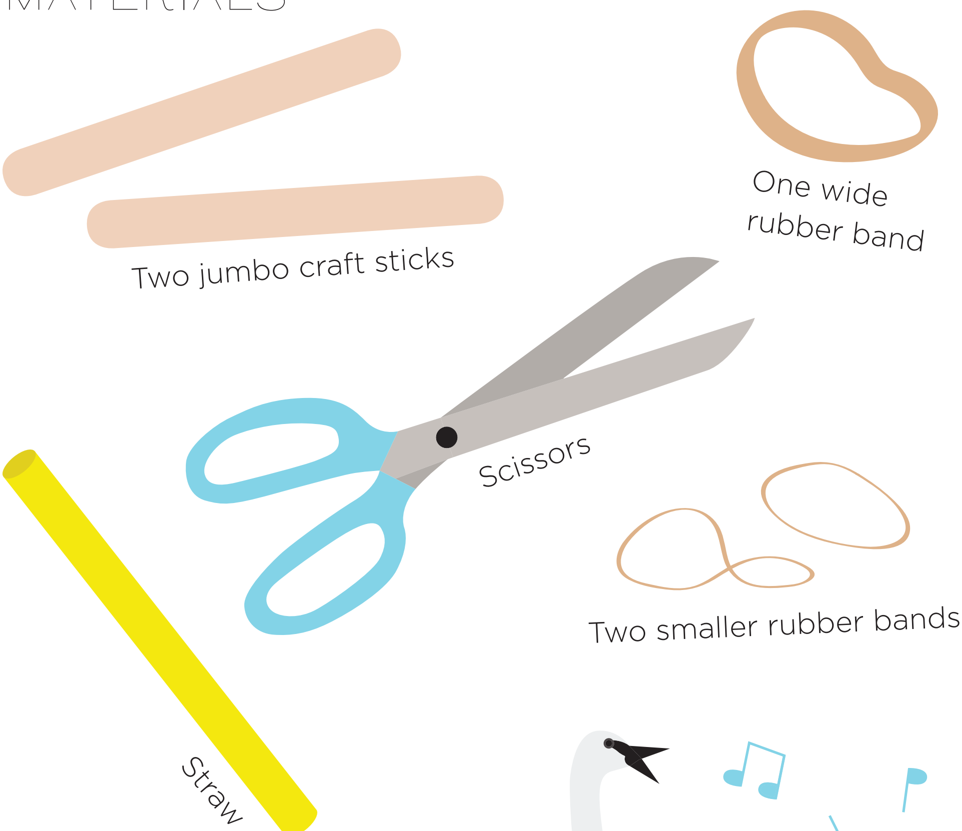
AND CRY LIKE THE

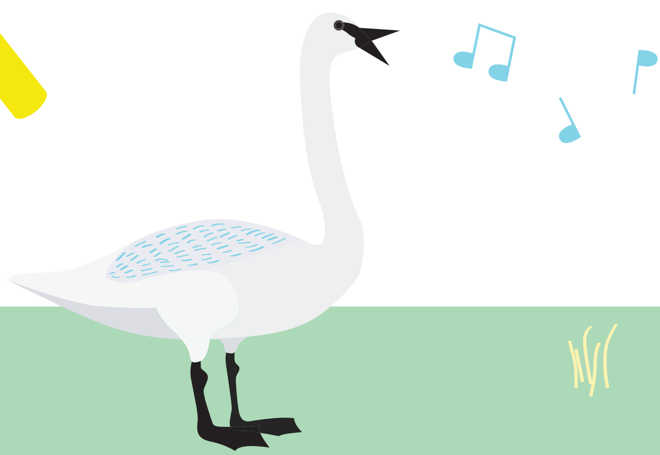
TRUMPETER SWAN

SOUND SANDWICH

When a swan sings or hums, air is passing over the vocal chords and making them vibrate, or move back and forth really fast. There are lots of musical instruments that work this way including this one! Try it yourself.

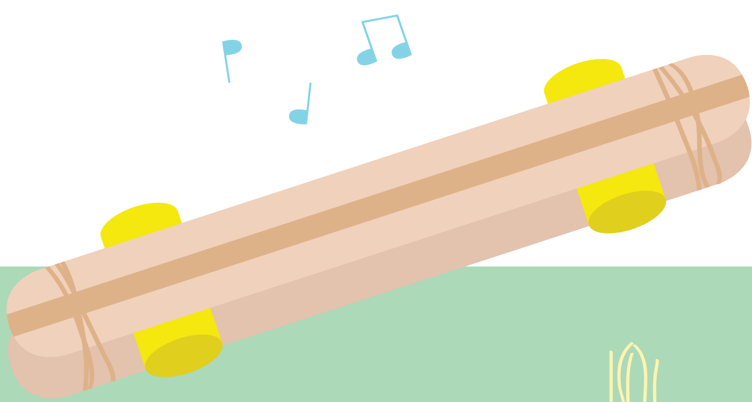
MATERIALS





INSTRUCTIONS

1. Place a wide rubber band lengthwise over one craft stick. Make sure it lays flat, with no twists.
2. Cut two pieces of straw that measure about 1 inch each.
3. Tuck two straw pieces underneath the rubber band and slide each straw to opposite ends of the craft stick, about 1 inch from the end.
4. Place another craft stick on top of the straws, like the top piece of bread on a sandwich.
5. Wrap a smaller rubber band around both of the craft sticks on one end of the sandwich to hold it together. Use another rubber band to do the same on the other end. The rubber bands should pinch the two craft sticks together, and there should be a small space between the two craft sticks created by the two pieces of straw.
6. Hold the sound sandwich up to your mouth and blow through the space between the sticks.



WHAT'S HAPPENING?

When you blow through the sound sandwich, can you feel it vibrating against your lips? You just felt sound! Sound is produced when a vibration is transmitted through a solid, liquid or gas. When you blew air through the space between the craft sticks, that air caused the rubber band to vibrate (move up and down quickly) between the two craft sticks. The vibration produces a sound.

Sound moves just like the rubber band, up and down in a wave. Sound waves can have different lengths, and different wavelengths result in different sounds. When the straws are placed closer together, the part of the rubber band that vibrates is shortened and moves more quickly, resulting in a higher pitched sound.

EXTENSIONS

What else can determine how fast a rubber band vibrates? What if you use a thinner or thicker rubber band?

LEARN MORE

Watch waves be created when you drop a pebble in a pool of water, or explore how waves interact in MSI's *Science Storms* exhibit.

RECOMMENDED READING

Sounds All Around by Wendy Pfeffer

Because by Mo Willems

LET'S PLAY WITH...

BEAMING BUTTERFLIES

AND SEE COOL PATTERNS LIKE ON THE

BLACK SWALLOWTAIL

KALEIDOSCOPE

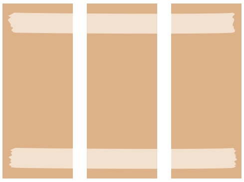
Chances are you looked in the mirror today, but have you ever thought about how your reflection appears? Reflections are visible when light bounces off a smooth, shiny surface and back into your eyes. But what happens when you look at the reflection of a mirror ... in another mirror? Let's build a kaleidoscope to find out!

MATERIALS

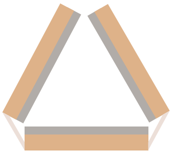
INSTRUCTIONS

1. Cut a piece of cardboard into a 6-by-6-inch square. Cut the Mylar into a 6-by-6-inch square.
2. Determine which side of the Mylar is shinier, and glue the dull side to the cardboard. Try to have as few wrinkles as possible.
3. Cut the cardboard Mylar into three rectangles that are each 2 inches by 6 inches.

4. Line up the cardboard pieces next to each other on a table so the long edges are touching and the Mylar side is facing down. Space them so there is a small gap in between each rectangle (about one-eighth of an inch between each one). Tape the rectangles together along the long edges. Make sure there is still a small gap between each.



5. Flip the cardboard Mylar over, so the shiny Mylar side is now facing up. Keep the middle rectangle flat, and fold the left and right rectangle up from the tape seams so they make a triangle. Tape those two sides together to hold that triangle shape.



6. Use markers to draw a design on a piece of white paper that is a little bigger than the open end of the cardboard triangle.

7. Cover one end of the kaleidoscope with the paper so the design faces inside and tape it in place. Look through the other end of the kaleidoscope. What patterns do you see?

WHAT'S HAPPENING?

Everything that we can see either produces or reflects light. Without light, vision wouldn't be possible. When light hits an object, it is either absorbed, reflected, or travels straight through the object. If an object is rough, the light is reflected in all different directions. When light hits a very smooth object, like a mirror, most of it bounces back. When you look in a mirror the light bouncing off of your face hits the smooth surface of the mirror and bounces directly back into your eyes. This is how you see your reflection!

TIPS

The smoother an object is, the clearer the reflection will be. Mylar sheets reflect better than aluminum foil, but mirrors reflect light even better. Mylar sheets are sold at craft stores. Some stores sell “cuttable” plastic mirrors or even pre-cut rectangular glass mirrors. Using those options will produce an extremely clear, reflective surface for the kaleidoscope.

LEARN MORE

Check out some cool reflections at the Cloud Gate sculpture in Millennium Park.

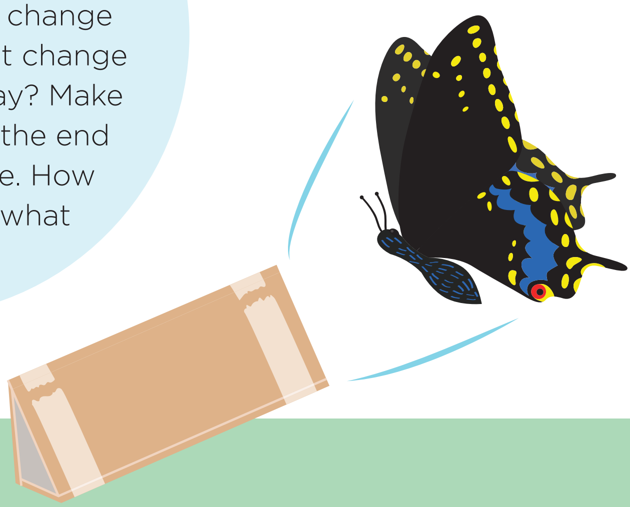
RECOMMENDED READING

A Ray of Light: A Book of Science and Wonder by Walter Wick

Yayoi Kusama: From Here to Infinity by Sarah Suzuki

EXTENSIONS

Test different lengths for your kaleidoscope by cutting larger pieces of cardboard and Mylar. How does the length of your kaleidoscope change the reflections? Does it change the patterns in any way? Make different designs for the end of your kaleidoscope. How does that change what you see?



LET'S PLAY WITH...

SPIRALING SNAILS

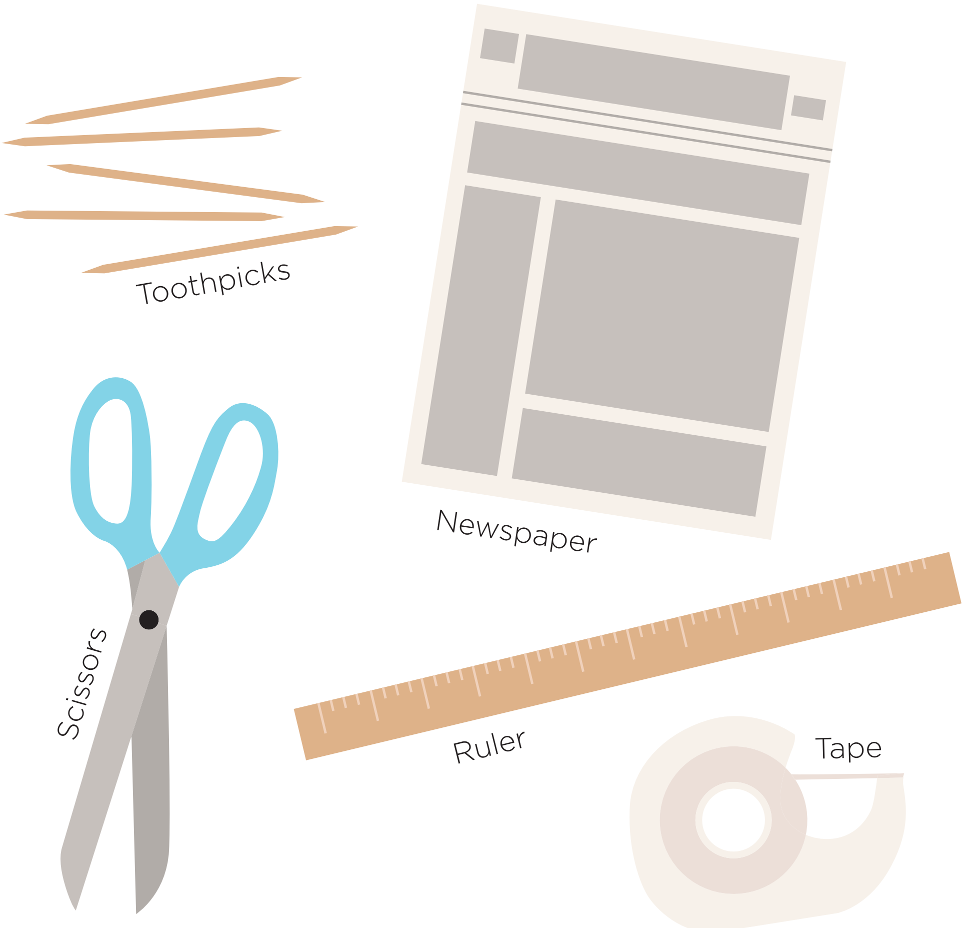
AND TWIST LIKE THE SHELL OF THE

TOOTHED GLOBE SNAIL

What's the best design for a spinning top? Does it matter where the weight is distributed or how far off the ground it is? Make two different spinning tops and try some experiments to see which one will spin the longest.

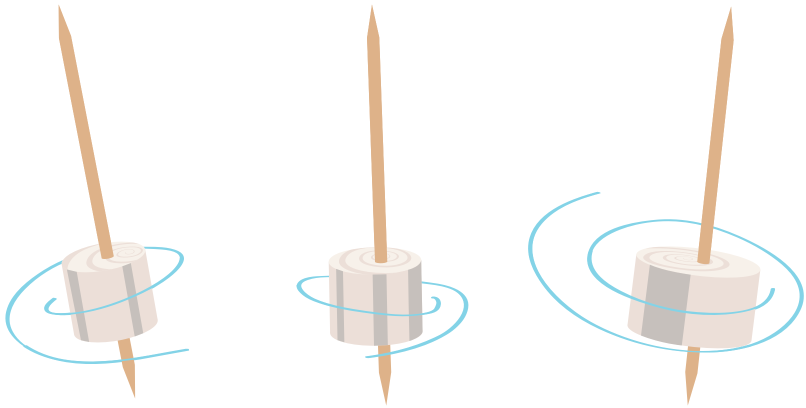
TOOTHPICK TOPS

MATERIALS



INSTRUCTIONS

1. Cut long strips of newspaper that are a half-inch wide.
2. Tape the strips together to make one strip that is at least three feet long.
3. Tape one end of your long paper strip close to one end of a toothpick, making sure the pointy tip is still exposed.
4. Wind the paper around the bottom of the toothpick, pulling the paper continuously to tighten it as you form a thick paper disc.
5. When you wind the last of the long paper strip, tape the end down.
6. Spin the paper-covered toothpick just like a top. How long does it spin? Try making a toothpick top with more or less paper and see how that affects the way it spins.



CIRCLE SPINNERS

MATERIALS

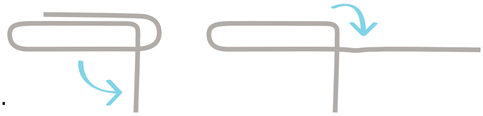
INSTRUCTIONS

1. Cut the front or back off a cereal box to make a large, flat piece of cardboard. It should be smooth and not creased or folded.

2. Use a drawing compass to make a circle that is at least 6 inches in diameter. You could also trace around a large, round container that's approximately 6 inches to make a circle.

3. Cut out the circle. Find the center of the circle by using a pencil to mark the point where two diameters (the longest lines that can be drawn across a circle) intersect.

4. Partially unfold a paper clip so that it's shaped like the number 4. The outer loop of the paper clip should unbend 180 degrees and stick out straight, and the shorter inner loop should unbend 90 degrees and point down.

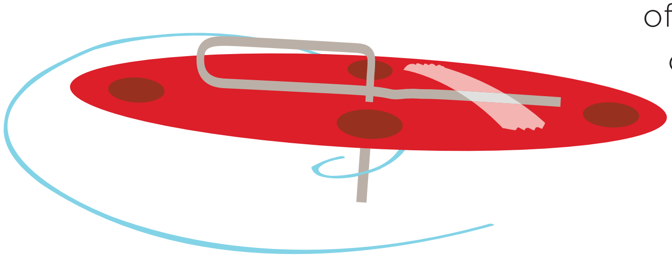


5. Poke the short arm of the paper clip through the center of the cardboard disc. This point is what your top spins on. Tape the longer paper clip arm in place. If you'd like, decorate your cardboard disc.

6. Grab the paper clip loop on top of the disc and give it a spin! Tape four pennies to the edge of the disc so they are across from each other and the same distance from the center. Spin and observe what happens.

WHAT'S HAPPENING?

Newton's First Law of Motion states that an object in motion tends to stay in motion, until friction or another force slows it down. This is inertia. These spinning toys demonstrate that concept with rotational motion. An important part of how an object spins is how much mass it has and how far that mass is from the center, or axis of rotation. Which top has most of its mass near the center? Which top spins longer and is more stable?



TIPS

All of the mass has to be evenly distributed around the center of the top. If the circle spinner wobbles or doesn't spin for long, make sure your circle of cardboard is perfectly round and the hole for the paper clip is in the exact center. If there are weights on it, make sure they are the same distance from the center.

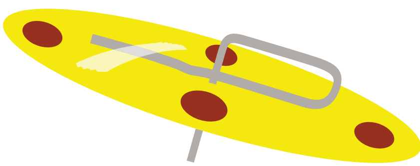
LEARN MORE

Spin an eight-ton disk of granules to watch how solid matter behaves in MSI's *Science Storms* exhibit.

RECOMMENDED READING

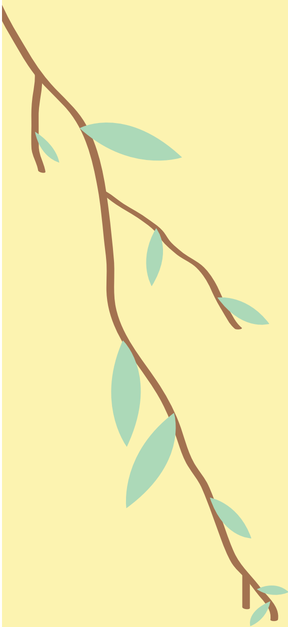
The Hula Hoopin' Queen by Thelma Lynne Godin

Fantastic Optical Illusions: Exciting Visual Illusions, Color Tricks, Perplexing Puzzles, and More! by D.K. Publishing



EXTENSIONS

Use your circle spinner as a spinner for a game. Draw an arrow pointing out on the disc and spin it on a piece of cardboard with a small hole for the paper clip to sit in. Put numbers around the edge of the cardboard base for the arrow to point to. You can also make a circle spinner show optical illusions. Draw a spiral on the disc and watch it spin. Or see black and white lines turn into color with the template at **msichicago.org/summerbrain**.



LET'S PLAY WITH...

SINGING CICADAS

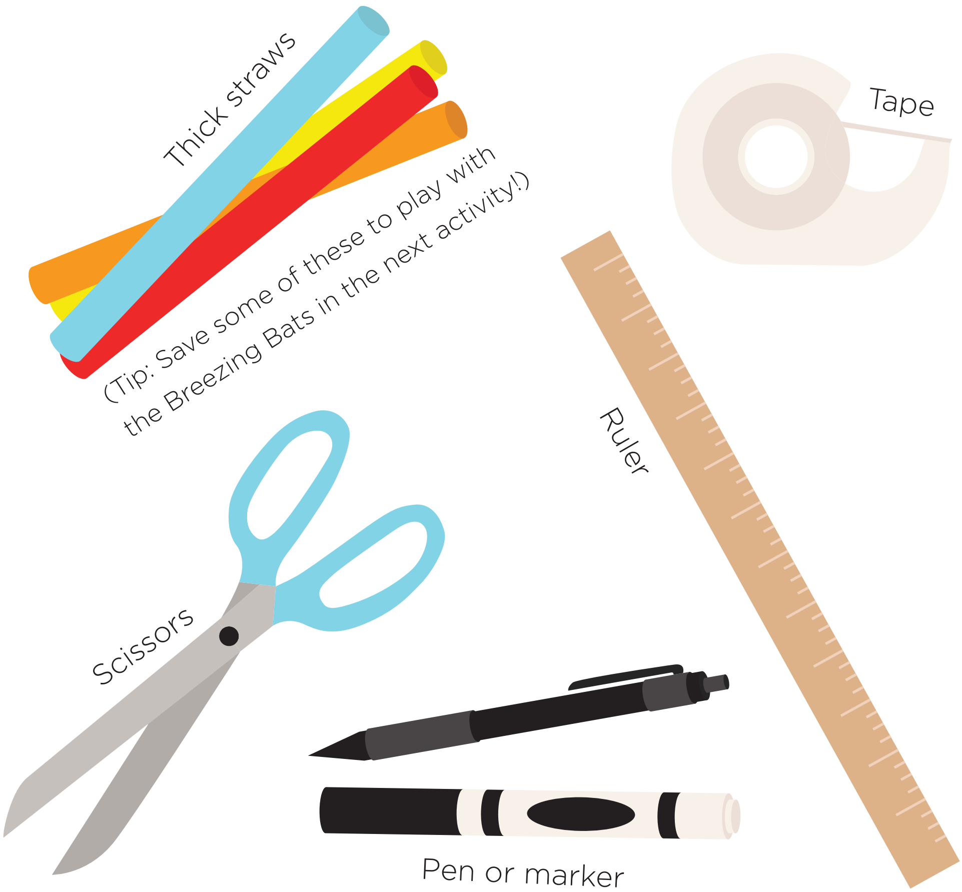
AND MAKE SOUND IN A RESONANCE CHAMBER LIKE THE

NORTHERN ILLINOIS BROOD CICADA

STRAW PIPES

Sound always comes from a vibration. The speed of that vibration determines the pitch, or how high or low the sound is. Experiment with pitches by making different straw pipes. You can even play a song much like the cicadas we hear in the summer!

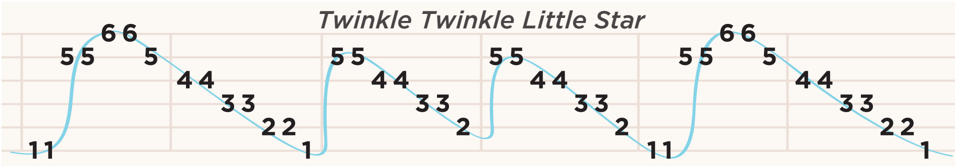
MATERIALS

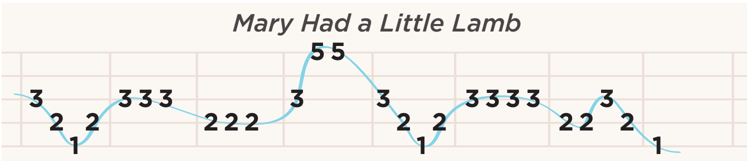


INSTRUCTIONS

1. Seal one end of a straw by folding it over about one inch from the bottom and taping the end of the straw back on to itself. Tape the fold tightly so the fold stays in place. Check to see that the fold is airtight by blowing into the straw from the other end. Do this for three straws.

2. Cut the straws to different lengths.
3. Cut two pieces of straw that are 1-inch long. These are the spacers.
4. Place a 5-inch piece of tape on the table with the sticky side up. Lay the straws down on the tape in order from shortest to longest with a spacer straw in between each one. The tops of the straw pipes should extend a little above the tape line. Once all straws are in place, secure them with tape.
5. Place the straws so they vertical and the open end is resting on your bottom lip. Briskly blow over the open ends of each straw, experimenting with the angle to get the best sound.
6. Make a scale by cutting the straws to specific lengths. Fold and tape the ends of eight new straws. Measuring from the fold, cut the straws to the following lengths: 19.5 cm, 17 cm, 15.5 cm, 14.5 cm, 13 cm, 11.5 cm, 10 cm and 9.5 cm. Number the straws from 1 to 8 with 1 being the longest straw and 8 being the shortest.
7. Try playing a song following the "notes" on the next page. Or, make up your own song!





WHAT'S HAPPENING?

As air is blown over the open end of the straw, it vibrates. The pitch, or frequency, is determined by the length of the tube, which acts as a resonating chamber. The longer the length, the lower the pitch or note. A long straw produces a low note, while a short straw produces a high note.

TIPS

Blow over the open ends of the straws the same way you blow over a soda bottle. These pipes work better with wider openings. If you use regular straws, it takes better aim to get the sound to produce. Wider straws are often sold as smoothie or jumbo straws and can be found at superstores or purchased online.

LEARN MORE

Find mathematical patterns when you make music using symmetry in *Numbers in Nature: A Mirror Maze* exhibit at MSI.

RECOMMENDED READING

Ada's Violin: The Story of the Recycled Orchestra of Paraguay by Susan Hood

I Am Pan! by Mordicai Gerstein

LET'S PLAY WITH...

BREEZING BATS

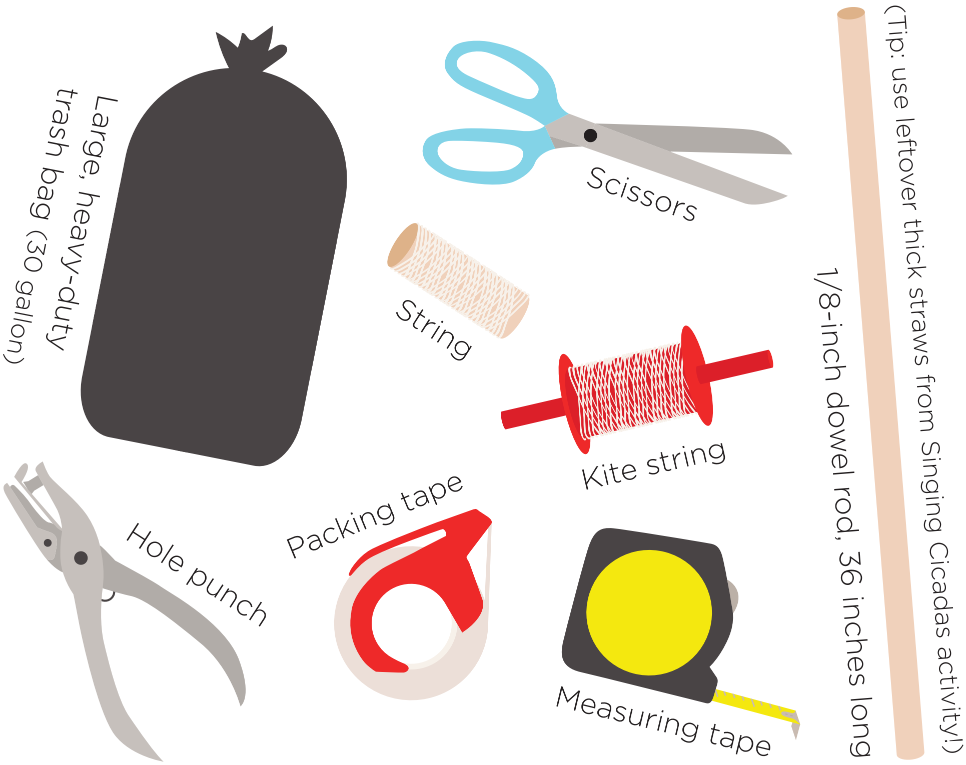
AND GLIDE LIKE THE

LITTLE BROWN BAT

KITE

Build your own kite and explore engineering! See how your experimentation and creative ideas can make this basic design even better.

MATERIALS

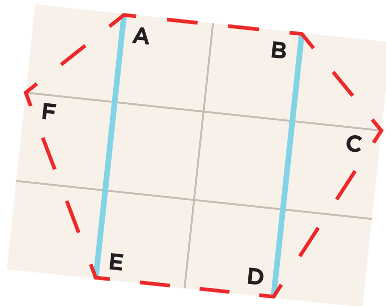


INSTRUCTIONS

This basic kite can be made in different sizes, it just needs a ratio of width to height that's four to three. These instructions are for a 24-inch-by-18-inch kite, which can be made from a 30-gallon trash bag.

1. Cut the trash bag so it's flat and is only one layer (if it's a two-ply bag). Measure and cut out a 24-by-18-inch rectangle. Cut the corners off according to the diagram so that your kite is a diamond shape with

a flat top and bottom. It's easiest to fold the kite in half before making the cuts. This way the cuts are the same on each side.



2. Cut the dowel rod into two pieces that are each 18 inches long. Referring to the diagram, place the dowels along lines AE and BD. Tape along the entire length of the dowel. Use a three-inch piece of tape to reinforce the corners F and C so the plastic around the hole that is about to be made doesn't tear.

3. Use a hole punch to make a hole through the reinforced corners F and C. Cut a piece of string that is 80 inches long. (If you're making a kite that's a different size than 24-by-18 inches, make sure the string is at least three times as long as your kite is wide.)

4. Tie one end of the string through the hole on corner F and the other through the hole on corner C. Find the center of the string and tie a knot so there is a small loop at the center. Connect a roll of kite string to that loop, and go fly your kite!

WHAT'S HAPPENING?

This kite is designed to catch the wind and bend around like a parachute. All kites catch the wind in some way or another. This is called drag. It is very important for the left and right sides of the kite to be symmetrical or the drag will be uneven and the kite will twist around in circles. To get lift, the string must be tight, or under tension. The tension forces the kite upward when the wind blows against the kite.

TIPS

If the kite keeps twisting in one direction, check to make sure both sides are exactly the same shape. You can do this by folding the kite in half down the middle and comparing the two sides. Also make sure the length of string from the corners to the center knot are the same length.

LEARN MORE

Your kite uses the same forces to fly as an airplane: lift, thrust, drag and weight. Try flying paper airplanes, or throwing a Frisbee!

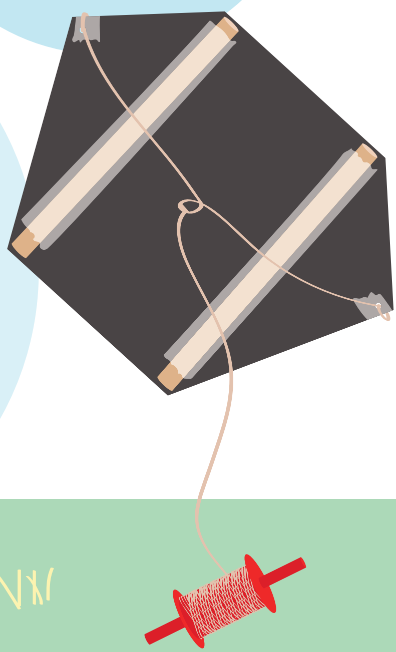
RECOMMENDED READING

Kite Flying
by Grace Lin

The Magnificent Book of Kites: Explorations in Design, Construction, Enjoyment & Flight
by Maxwell Eden

EXTENSIONS

Try adding a vent or triangle-shaped hole near the center of the kite to see if it changes how it flies. Adding tails made of ribbon or one-inch wide strips of fabric at the bottom of the dowels also change how it flies, add some and see what happens. Can you make a bigger kite? Or one using other materials, like newspaper or wrapping paper?



LET'S PLAY WITH...

FLYING FOWLS

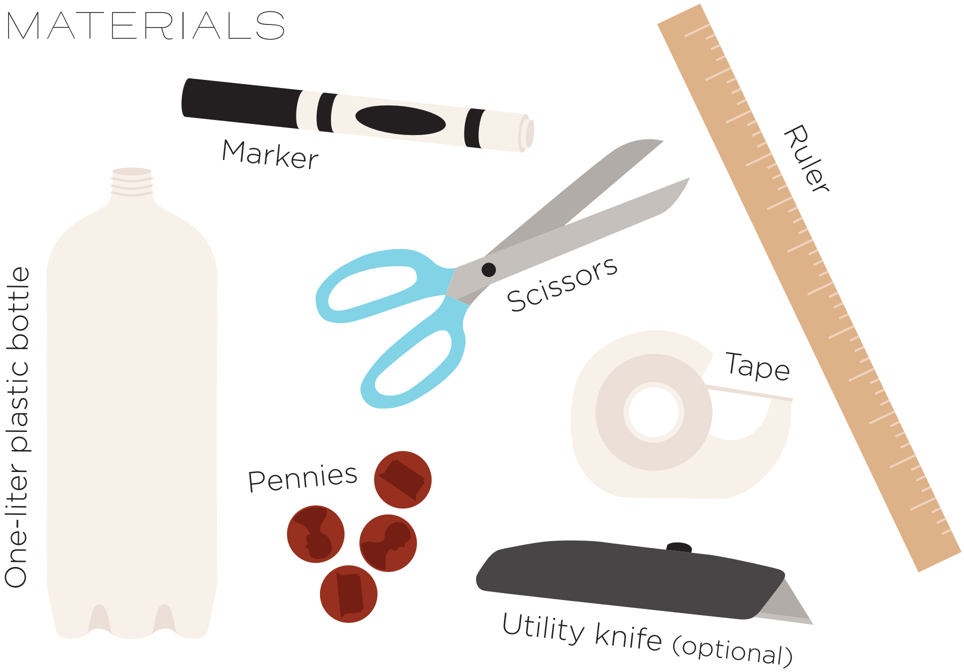
AND STAY AS STABLE AS THE

GREATER PRAIRIE CHICKEN

FLYING GYROSCOPE

How can a simple plastic tube fly so far? With science! Or more specifically, with rotational inertia. This deceptively simple-looking toy flies a lot farther than expected. How far can you throw it?

MATERIALS



INSTRUCTIONS

1. You'll need a one-liter bottle with straight (not curved) sides, or at least a three-inch section where the bottle is a perfect cylinder.

2. Draw a straight line all the way around the bottle near the bottom. Be sure the line is on a part of the bottle that has straight vertical sides.

3. Poke a hole on the line with the sharp point of the scissors or a utility knife. Cut all the way around the bottle, discarding the bottom.

4. Measure three inches from the first cut and draw another line around the bottle.

5. Poke a hole on this line with the scissors or a utility knife. Cut all the way around the bottle, discarding the top. You should be left with the middle piece of the bottle that's a cylinder or tube with straight sides. Use tape to cover any rough edges made by cutting.

6. Next, you'll tape four pennies on one end of the tube so they are equally spaced apart. Start by taping one penny in place on the inside of the tube using a small piece of tape.

7. Place the tube on its side and, without creasing the plastic, gently squish the tube and mark the spot on exact opposite of the penny. Tape another penny there.

8. Place two more pennies on the edge of the cylinder exactly between the two pennies already in place. The distance between all four pennies should be the same. Alternatively, the placement of the pennies can be more accurately determined by dividing the circumference of the tube by four and placing each penny that distance apart.

9. To fly the gyroscope, hold it like a football. Throw it penny-side forward and give it a spin, the same way a football is thrown. You can also throw it underhand—grab it by the non-weighted end, throw it penny-side first and put a spin on it. It may take you a few tries to get the hang of it! Make sure the gyroscope spins as it flies, that's what will help it travel farther.

WHAT'S HAPPENING?

Two things help the flying gyroscope move so well: the shape and the weight from the pennies. As the tube flies through the air, there is very little air resistance caused by its shape—the air goes right through the middle. That reduced friction helps the tube maintain its forward speed. The weight from the pennies affects how it spins. The spinning weight located on the leading edge keeps the gyroscope from tumbling. Imagine throwing a Frisbee without spinning it. It would tumble and fall quickly to the ground. The spinning motion, or rotational inertia, stabilizes it and keeps the Frisbee flat. The spinning weight on the flying gyroscope does the same thing and keeps it stable as it flies through the air.

LEARN MORE

The gravitron you can make in MSI's *Toymaker 3000* exhibit is a gyroscope!

TIPS

Be careful cutting the plastic bottle, and try using pointy nail scissors to start the cut. Fly it in an open space where people won't be hit by the gyroscope if it doesn't move exactly where you intended.

EXTENSIONS

What happens if you add more pennies? Does it fly differently if the pennies are located in the middle? Make a plastic tube that's longer or shorter to see how it flies.

RECOMMENDED READING

Abuela
by Arthur Dorros

The Flying Machine Book: Build and Launch 35 Rockets, Gliders, Helicopters, Boomerangs, and More
by Bobby Mercer

LET'S PLAY WITH...

SPEEDING SQUIRRELS

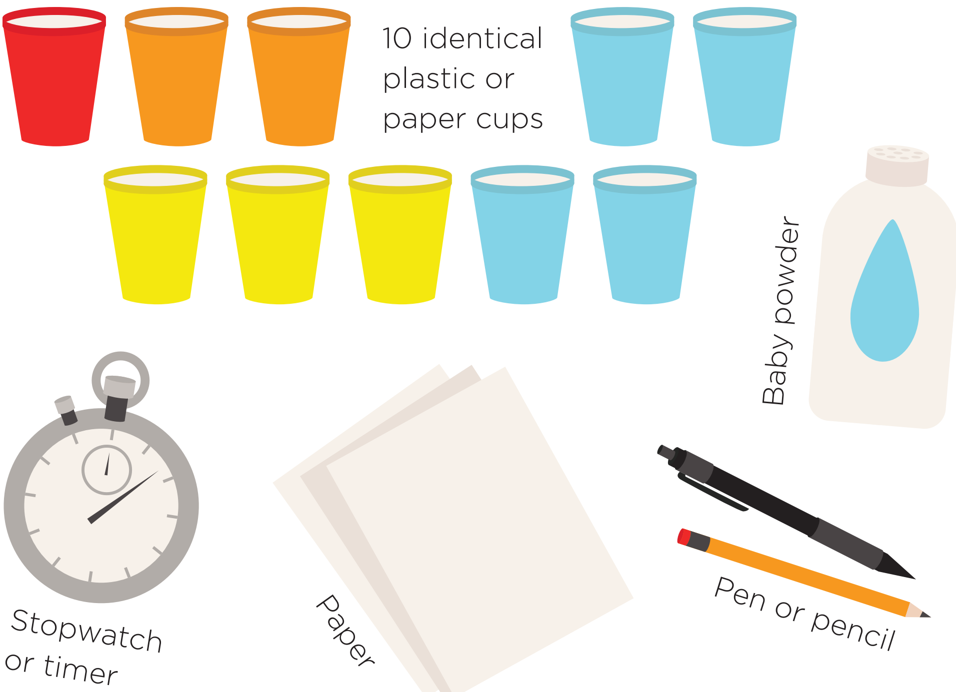
AND BE AS DEXTEROUS AS THE

FOX SQUIRREL

CUP STACKING

Ever try to get really, really fast at a game? Chances are the first time you tried a new thing, it wasn't perfect. Take our cup stacking challenge to learn how taking a scientific approach can help you get better at games.

MATERIALS



INSTRUCTIONS

1. The goal of the game is to take 10 cups and make them stack into a pyramid shape with four levels (four cups on the bottom, then three cups, then two cups, and one cup on top) as fast as you can.

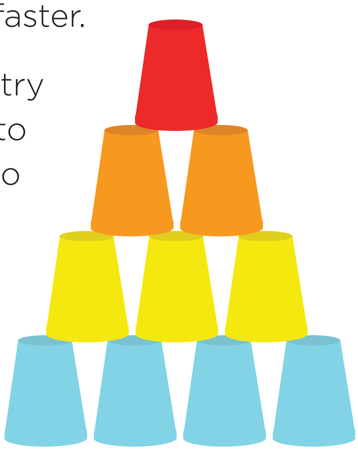
2. Use a stopwatch or timer to see how long it takes you to make the pyramid the first time. Practice a few times to get the hang of it.

3. Observe as you stack the cups, looking for things that slow you down or are tricky. Stop for a minute and think. What parts of the process are slow? Do the cups stick to each other? Is there suction when the cups separate? Do your hands bump into each other and knock the cups over?

4. Pick one thing to try to improve. If the cups are sticking to each other, does adding baby powder reduce friction? What else could you do to reduce friction?

5. Time yourself a few more times to see if your modifications make you go any faster.

6. Pick something else to improve, try it a few times and time yourself to see if you got any faster. It's up to you to creatively figure out new ways to get better at the game, using critical-thinking skills. What is the fastest time you can get?



7. Invite your friends or family to a cup stacking challenge! Who can get the fastest time? Does anyone have a new idea for improving the process?

WHAT'S HAPPENING?

Observing a process, analyzing what's happening, and making improvements is a scientific approach to problem solving. This is the same approach that scientists and engineers use to do their work. To work like a scientist, be sure to test one variable at a time, use a timer to collect data, and collect evidence about what helps or hurts your time.

TIPS

An important part of scientific research is to find out what others changed to be successful. By communicating and sharing your success with your friends, everyone can improve even if you are trying to get the best time. Researchers share information all the time so they can learn from each other and make new scientific discoveries.

EXTENSIONS

Try other dexterity games to see if you can improve your time after observing and modifying your methods. How many pennies can you stack in one minute, using only one hand? How long does it take you to move six ping-pong balls from one bowl to another bowl, using a spoon that you hold in your mouth?

LEARN MORE

Through the Welcome to Science Initiative, MSI helps teachers and students harness the power of critical thinking and a scientific approach to problem solving.

msichicago.org/ welcometoscience

RECOMMENDED READING

Just Like Rube Goldberg: The Incredible True Story of the Man Behind the Machines by Sarah Aronson

The Museum of Science and Industry, Chicago (MSI), one of the largest science museums in the world, offers world-class and uniquely interactive experiences that inspire inventive genius and foster curiosity. From groundbreaking and award-winning exhibits that can't be found anywhere else, to hands-on opportunities that make you the scientist—a visit to MSI is where fun and learning mix. Through its Welcome to Science Initiative, the Museum offers a variety of student, teacher and family programs that make a difference in communities and contribute to MSI's larger vision: to inspire and motivate children to achieve their full potential in science, technology, medicine and engineering.

Come visit and find your inspiration! MSI is open 9:30–4 p.m. every day except Thanksgiving and Christmas Day. Extended hours, until 5:30 p.m., are offered during peak periods. The Museum is grateful for the support of its donors and guests, who make its work possible. MSI is also supported in part by the people of Chicago through the Chicago Park District. For more information, visit msichicago.org or call (773) 684-1414.