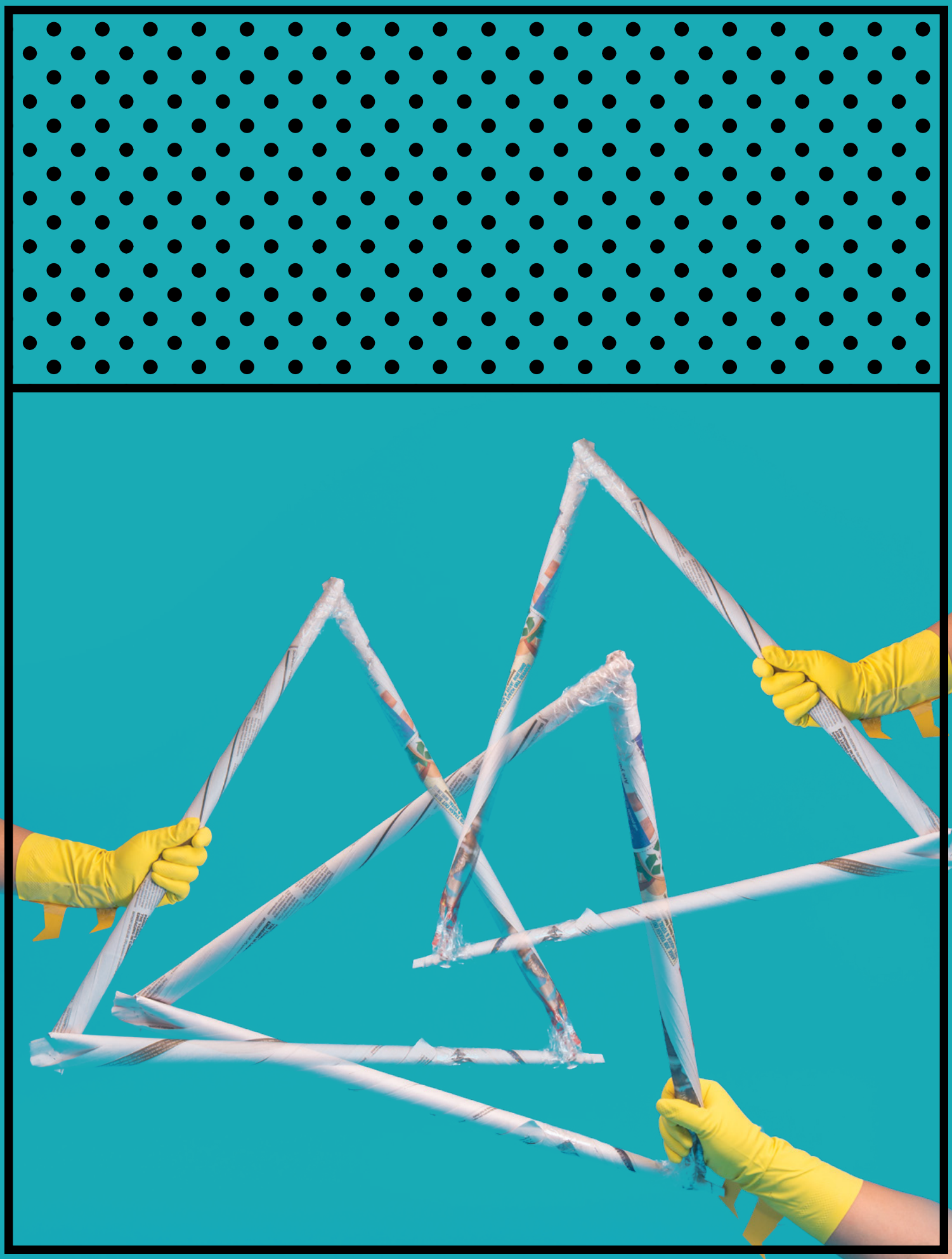
8 WEEKS of THRILL-PACKED ACTION!

SUMMER BRAIN GAMES

museum of science+industry chicago



SUPERHEROES UNITE!

A dreaded super villain returns this summer and the only thing that will stop him is science! The Museum of Science and Industry, Chicago's Summer Brain Games program calls on all kids to become superheroes and defeat the evil Dr. Brain Drain.

Summer Brain Games offers **EIGHT 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).

Dr. Brain Drain will be no match for our science superheroes as they experiment with chemistry, physics and other STEM subjects. Construct an air cannon that can knock down obstacles, read minds with a math-based predictive card trick, engineer an infallible fortress, create a foaming chemical reaction and more. It's a great way for families with kids of all ages to stay active and enthused as they learn more about the world around them.

FREE MUSEUM ENTRY VOUCHER

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

SUMMER BRAIN GAMES IS SPONSORED BY

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WEEK 1

The Original Reaction

Experiment: Elephant Toothpaste

Release the awesome power of oxygen with an oozing, foaming and safe chemical reaction. It makes a great origin story for how you got your superhero powers!

MATERIALS

- ☐ 3% hydrogen peroxide (household grade, the type used to clean minor cuts)
- ☐ Plastic bottle with a narrow opening, like one for water or soda
- ☐ Liquid dish soap
- ☐ Dry yeast
- ☐ Measuring cups and spoons
- ☐ Small cup
- ☐ Plastic table covering or large pan
- ☐ Water

INSTRUCTIONS

Pour one cup of hydrogen peroxide into the bottle. Add a good squirt (about one tablespoon) of dish soap and several drops of food coloring. Gently mix these ingredients by swirling the bottle.

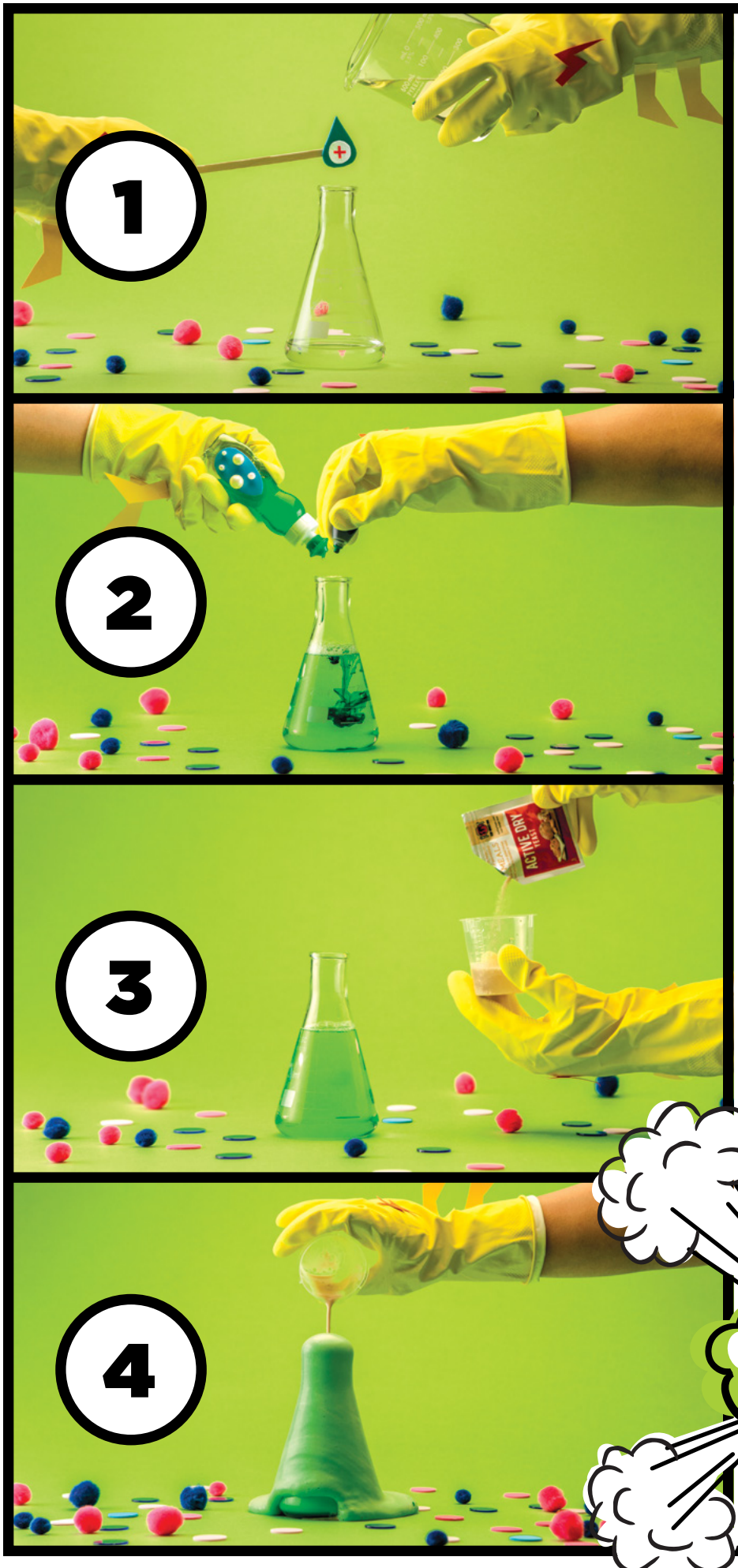
In a separate small cup, pour one pouch (about two teaspoons) of dry yeast and add two tablespoons of warm water. The temperature doesn't have to be exact, but the temperature you use for a hot bath is good. Mix together with a spoon.

The next step will make a bit of a mess, so protect your surface with a plastic table covering or large pan.

Pour all of the yeast mixture into the bottle containing the hydrogen peroxide solution. The peroxide should immediately create foam, filling the bottle and oozing out of the top.

WHAT'S HAPPENING?

Hydrogen peroxide is a molecule that has two hydrogen atoms and two oxygen atoms (H_2O_2). That means it's like water (H_2O) but has extra oxygen. That extra oxygen atom is released when exposed to an enzyme called catalase that's found in most living organisms. When you pour hydrogen peroxide on a cut and it foams, all those little bubbles are oxygen being released by the catalase enzyme found in bacteria and your own skin. The yeast in this experiment also has the catalase enzyme. Dish soap traps the oxygen bubbles and makes a foam. The more oxygen that is released, the more foam is made. Eventually the foam runs out of space and is forced to ooze out of the top of the bottle.



SAVE THE DAY!

Try this experiment again with different colors of food coloring, or a larger bottle (be sure to adjust your measurements for a larger bottle). Or be creative—write the story of your superhero's origin, starting with what effect this chemical reaction has on your powers.

TIPS

This chemical reaction uses items that are all safe to touch skin. None of the ingredients are toxic, but they should not be ingested. Only use household-grade hydrogen peroxide (3%). Other grades of hydrogen peroxide, such as those used for bleaching hair, are more concentrated and can cause skin irritation.

LEARN MORE

Explore other chemicals and see what reactions they create with MSI's online goREACT game (msichicago.org/goreact).

RECOMMENDED READING

Crazy Concoctions: A Mad Scientist's Guide to Messy Mixtures, by Jordan Brown

Public School Superhero, by Chris Tebbetts

WEEK 2

Caped Crusader

Experiment:
Superhero Identity

Every superhero needs to be easily recognized. Things like masks, costumes and symbols help people in distress know who is there to save them. Create your own personal signal and mask.

SUPERHERO MASK MATERIALS

- ☐ Paper
- ☐ Cardstock paper or felt
- ☐ Mask template (available at msichicago.org/summerbrain)
- ☐ Scissors
- ☐ Pencil
- ☐ String or ribbon
- ☐ Ruler
- ☐ Tape or stapler
- ☐ Crayons, markers and other craft supplies

INSTRUCTIONS

Start by making a mock-up of your mask so you can get the fit right. Print out the mask template or draw the same outline shape on a piece of paper. Ask a friend to measure the distance between the centers of your eyes. Mark that distance on your mask mock-up, and adjust the location of the eye holes so the mask will fit your face. Cut out the mask and the eye holes and hold it up to your face to make sure it fits. If the mask is it too small or too big, make adjustments and try again.

Once you have a mock-up that fits, trace the shape onto the material you'll use to make your official superhero mask. Colorful cardstock or felt fabric work well. Decorate your mask with craft supplies, or add extra designs like your superhero symbol to make it unique. Use tape or a stapler to attach two pieces of string to each side of the mask near your ears so you can tie it on your head. Now go out and save the day!

SUPERHERO SIGNAL MATERIALS

- ☐ Paper towel tube
- ☐ Packing tape
- ☐ Paper
- ☐ Pen or pencil
- ☐ Rubber band
- ☐ Scissors
- ☐ Flashlight with single LED (phone flashlights work really well)

INSTRUCTIONS

Design a symbol that represents your superhero. Your symbol should be simple, easily recognizable and be representative of your superhero identity.

Cut a square piece of paper that is bigger than the open end of the paper towel tube. Draw your design in the center of that paper so that it's smaller than the diameter of the tube. Cut out your design. Keep your design from ripping by placing clear packing tape on both sides. Place the design over the end of the paper towel tube with the design centered. Hold it in place with a rubber band.

Turn off the lights and shine a flashlight through the other end to see your projection on the wall.

You can also do a reverse of your signal by placing packing tape on the paper that surrounded the design you cut out, so that the center shape is empty and the light shines through.

SAVE THE DAY!

Now that you've created your superhero character, introduce yourself to us! Record a short video clip (10 seconds would be perfect) telling us your name, powers and anything else about yourself. Share it with us at summerbrain@msichicago.org or facebook.com/msichicago.

LEARN MORE

Who are some everyday superheroes? Scientists, engineers, doctors and inventors are all helping to make the world a better place. Learn more about these science-based careers at MSI.

RECOMMENDED READING

The Astonishing Secret of Awesome Man, by Michael Chabon

Heroes and Hotshots in Your Hometown, by Joe Rhatigan

WEEK 3

Blown Over

Experiment: Air Cannon

Control the wind! Create a balloon-powered cannon that blasts a stream of air powerful enough to knock down obstacles.

MATERIALS (Small Version)

- ☐ 16-ounce plastic cup
- ☐ Large balloon (six inches or larger)
- ☐ Utility knife
- ☐ Dime
- ☐ Marker
- ☐ Scissors
- ☐ Tape
- ☐ Cotton balls or other lightweight items

MATERIALS (Large Version)

- ☐ Plastic trash can or pail
- ☐ Duct tape
- ☐ 2 bungee cords
- ☐ Trash bag or plastic shower curtain
- ☐ Electric jigsaw or utility knife
- ☐ Fog machine (optional)

INSTRUCTIONS

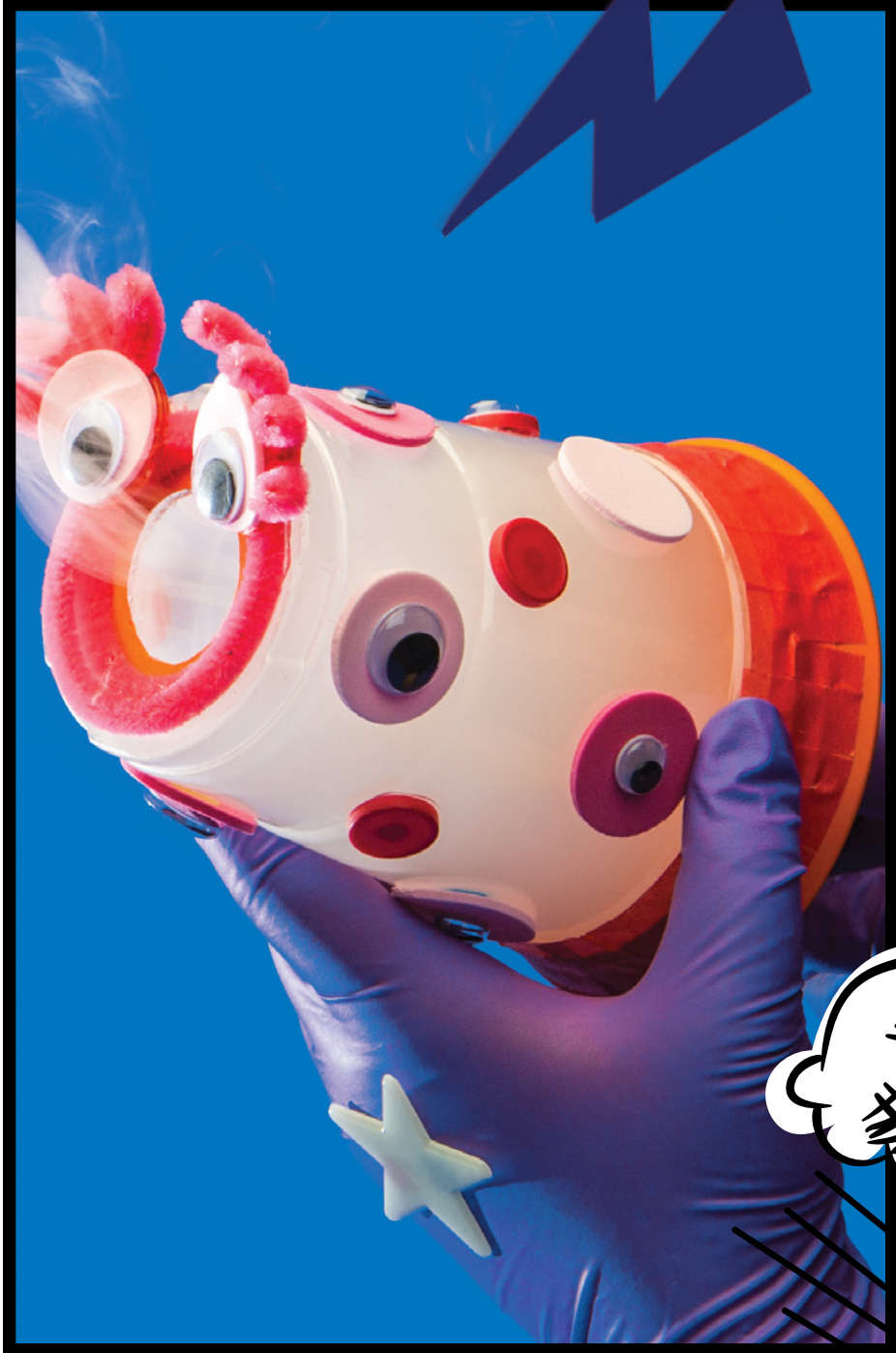
Place the cup upside down on your work surface and put the dime on the bottom of the cup in the middle. Draw a circle around the dime. Carefully cut the circle out using a utility knife.

Fully inflate the balloon once or twice to stretch it out, but do not tie it off. This will make it easier to stretch later. Use scissors to cut off the neck of the balloon. Stretch the balloon over the top of the cup and tape it in place around the perimeter. You should be able to pull the middle of the balloon back. When you let go of the balloon, a puff of air should shoot out the hole. This puff of air will travel straight for several feet.

Set up some lightweight targets and see if you can blow them away. Make a pyramid with plastic cups or a tower of empty boxes. What's the heaviest thing you can knock over with the power of wind? Place cups in a line—can you aim the air cannon at one and knock it over without moving the others?

To make the optional large version, use a large, plastic trash can and cut a round hole in the bottom with a diameter of about one-third the diameter of the bottom of the can. Measure and draw the circle first, and, depending on the material of the can, use a jigsaw or utility knife to cut the hole. Cut the trash bag into a circle that's bigger than the opening of the trash can. Place the bag over the opening and tape the edges to the sides of the can. It should be a little slack.

Stretch the bungee cords across the opening of the trash can in an X shape and hook them to the edges of the can. Tape the ends of the bungee cords to the can to keep them in place. To shoot the air cannon, turn the can on its side, pull the bungee cords back and let them go. If you have a fog machine, fill the trash can with fog and you can see the shape of the wind that's released.



SAVE THE DAY!

Use your newfound power over the wind and show us what you can do! Record a short video clip of you using your air cannon to knock down a tower, surprise someone with a puff of air or other creative idea. Share it with us at summerbrain@msichicago.org or facebook.com/msichicago.

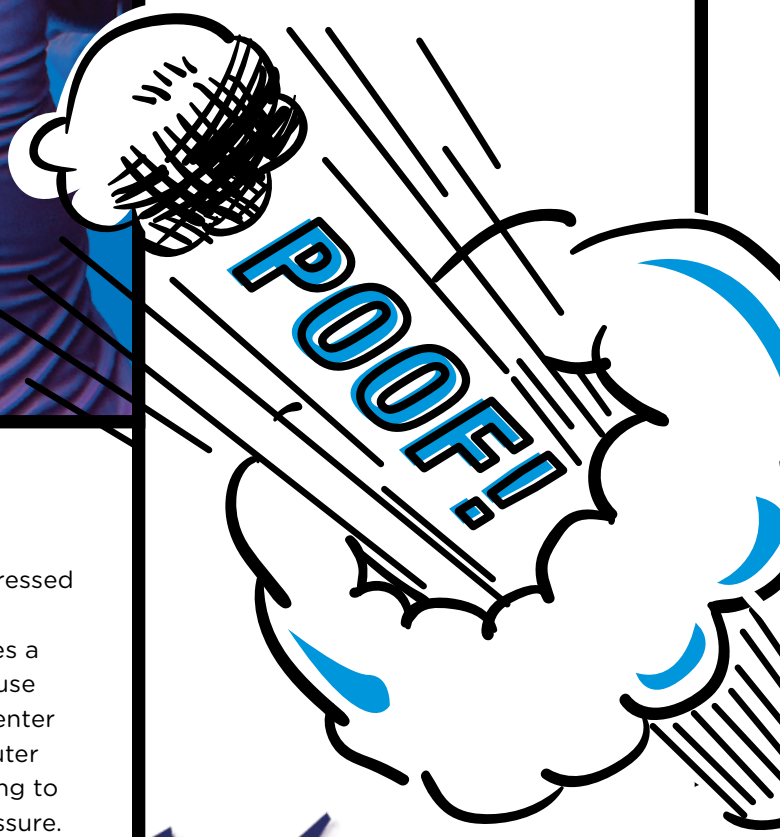
LEARN MORE

Explore the powers of wind and air in MSI's *Science Storms* exhibit.

RECOMMENDED READING

The Boy Who Harnessed the Wind, by William Kamkwamba

I Face the Wind, by Vicki Cobb



WHAT'S HAPPENING?

When you snap the balloon, the air inside the cup is compressed and the only place for it to go is through the hole on the opposite end. As the air is forced through the hole, it makes a doughnut shape called a torus. This shape is created because the air leaves the hole at different speeds—the air at the center travels faster than the air at the outer edge, causing the outer edge of the moving air to roll backwards on itself. According to Bernoulli's principle, the faster air moves, the lower its pressure. The torus has higher pressure on the outside of the ring, which holds the shape together until it loses energy.

WEEK 4

Amped Up Energy

Experiment: Comeback Can

Amaze your friends by making them think you can control objects with the power of your mind! Understand how potential and kinetic energy work to make a can change its course in a predictable manner.

MATERIALS

- ☐ Round can with a lid (like a coffee tin or oatmeal can)
- ☐ Twist tie or short pipe cleaner
- ☐ Hex nut (about 1 inch wide)
- ☐ Large rubber bands
- ☐ Scissors
- ☐ Hole punch
- ☐ Nail (if the can is metal)
- ☐ Paper, markers and craft supplies

INSTRUCTIONS

Use a hole punch to make two holes in the lid. The holes should be near the middle and about an inch apart. Make two similar holes in the bottom of the can. If the can is metal, use a nail to make the holes.

Cut the rubber band so it is one long strip. Thread the rubber band through the holes in the bottom of the can so that both ends are inside the can. Thread the rubber band through the holes in the lid and tie the loose ends together. If one rubber band isn't long enough to reach through the can, tie several together until they're the proper length.

Wrap the pipe cleaner or twist tie through the center of the hex nut and around an edge. You should have two "bunny ears" of equal length sticking up when you're done.

Ask a friend to hold the lid away from the can to stretch the rubber band. Wrap each "bunny ear" around one of the rubber bands that runs through the inside of the can. The hex nut should hang from the middle of the rubber bands.

Put the lid back on. If the rubber bands are loose, pull them through the can and retie them so they are tighter. Decorate the outside of the can creatively.

Place the can on the floor and gently roll it away from you. Watch what happens!

If you time it just right, you can figure out when the can will start to roll back to you. Then you can "tell" the can to come back, so that it looks like the can is doing what you tell it to do!

WHAT'S HAPPENING?

To understand how the comeback can works, you have to understand energy. Energy comes in many forms. One form of energy is motion, called kinetic energy. Another form is stored, or potential energy. The comeback can uses both forms.

When you push the can, you give it kinetic energy and it moves away from you. The hex nut holds one length of rubber band still while the rolling can causes the other rubber band to twist around it. The can rolls until the rubber band is completely twisted. This is when kinetic energy becomes potential energy—the can is not moving, but it has the ability to do so. Potential energy is stored in the twisted rubber band. As the rubber band unwinds, the potential energy again becomes kinetic energy and the can rolls back to you.

SAVE THE DAY!

Have a friend make their own comeback can and challenge them to see whose can rolls the farthest before it returns. Try making a comeback can using different materials. Does changing the thickness of the rubber band, the weight of the hex nut or size of the can affect how far it rolls before coming back to you?

LEARN MORE

Go on a hunt for potential and kinetic energy. Check out the *Idea Factory* or *Swiss Jolly Ball* at MSI for some fun examples.

RECOMMENDED READING

Unmasking the Science of Superpowers! by Jordan D. Brown

The Thrills and Chills of the Amusement Parks, by Jordan D. Brown

WEEK 5

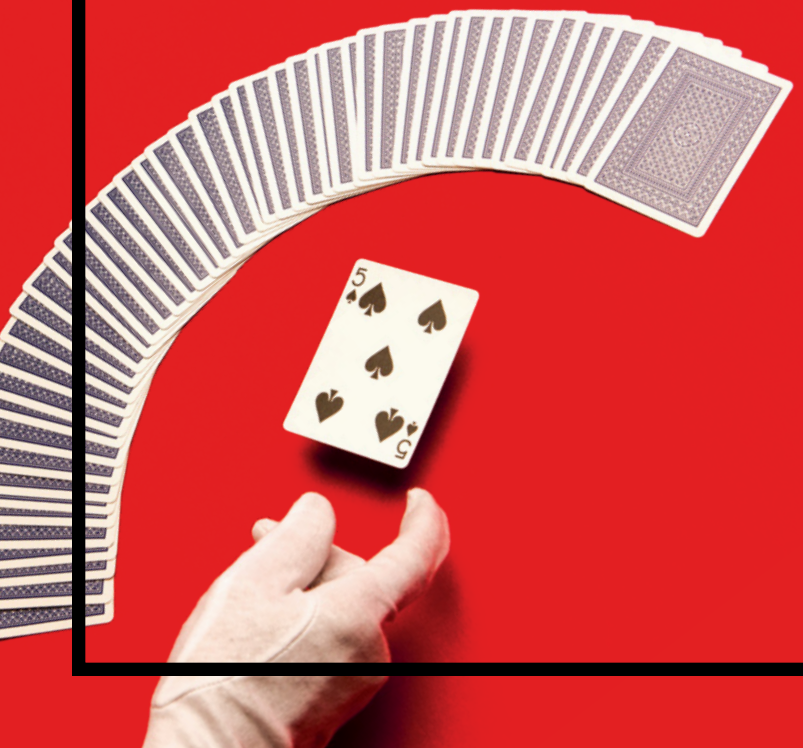
Mind Reader

Experiment:
Card Trick Algorithm

Superheroes with the power to read minds always know what their enemies are up to. You can amaze your friends with your own mind-reading powers using this math-based predictive card trick.

MATERIALS

- ☐ Deck of playing cards
- ☐ A friend



INSTRUCTIONS

Count 21 cards from the deck and set the rest aside. Ask your friend to pick a card from the deck of 21 cards and remember it, but not tell you what it is. Have your friend shuffle the deck of 21 cards and return it to you.

Deal the cards face up into three columns moving from left to right, with the cards overlapping. You should have seven cards in each column when you're done. Ask your friend to point to the column their card is in: left column, middle column or right column. Slide each column of cards together so they're in three stacks, keeping the cards in order as you slide them.

Make the three stacks into one deck again but in a specific order—make sure that the stack your friend pointed to is always collected second! This is very important to remember. This ensures that the column they pointed to is always placed in the middle of the deck.

Repeat the process. Deal the cards into three columns and ask your friend to point to the column with their card. Make the columns into three stacks, and pick up the stacks into one deck making sure to pick up your friend's column second. Repeat twice more, for a total of four times.

Reveal that your friend's card is the fourth card down in the middle column. It will be there every time!

SAVE THE DAY!

To see how this works more clearly, set up the deck so each column has cards of the same suit only. Pick up the columns and deal them out again. How are the suits distributed now? Pick a card, collect the columns and deal them again and watch where your card is after each set of steps.

LEARN MORE

Discover the mathematical patterns that abound in the natural world (including a giant mirror maze!) in MSI's *Numbers in Nature: A Mirror Maze* exhibit.

RECOMMENDED READING

Mathemagic!: Number Tricks, by Lynda Colgan

Zero the Hero, by Joan Holub

WHAT'S HAPPENING?

This trick uses an algorithm, or a specific set of steps that reach a predictable outcome. You deal the cards out in a way that organizes them and forces the selected card into a predictable position. When you repeat this pattern four times, the selected card always ends up in the exact middle of the deck. When dealt into columns, the card in the exact middle of the deck always ends up the fourth card down in the middle column.

Examples of algorithms can be found in many different natural environments, from the way that ants behave when foraging for food to the way enzymes work in our own bodies. Natural processes that follow a set of steps to result in a predicable outcome are examples of natural algorithms. Look for their results in patterns of plant growth, animal coloration patterns and the way water flows.

WEEK 6

A Hero's Home

Experiment:
Newspaper Fortress

Every hero needs a fortress, either for solitude or for super cool superhero parties. Use some basic engineering skills to build a surprisingly strong fort out of seemingly flimsy materials like newspapers and masking tape.

MATERIALS

- ☐ Lots of newspaper, about two full papers (traditional broadsheet size, like the *Chicago Tribune*)
- ☐ Masking tape
- ☐ Stapler
- ☐ Sheet or plastic table cloth (optional)
- ☐ Pipe cleaners (optional)
- ☐ Craft sticks (optional)

INSTRUCTIONS

Make newspaper rolls from two sheets of flat newspaper. Use open, two-page spreads, not single sheets. Roll them tightly from corner to corner; the tighter the roll, the stronger the support. Secure the end with tape.

Use three newspaper rolls to make a triangle, attaching at each corner with staples. Each triangle should be strong and not bent or folded. These triangles will be the basic units that you will use to construct your fortress.

Before building your fortress, decide what you want it to look like. It might help to draw out a design. How big will it be? Will you be able to go inside? Will the walls be covered? How many triangles will you need?

The newspaper triangles can be connected to each other in a lot of different ways using tape and staples. Try building flat walls, or putting four triangles together to form a pyramid with triangle sides (a shape called a tetrahedron). You can make a pentagram by attaching five triangles so that their bottom edges form a line, then standing the row up and forming the five-sided shape.

Once you get good at making triangles and tetrahedrons you can put them together in infinite ways to make whatever type of fortress you want! Ask one or more people to help hold the pieces in place as you slowly construct your fortress. The structure will become sturdy and upright as you add layers and secure corners with tape, pipe cleaners or even craft sticks.

WHAT'S HAPPENING?

Triangles are considered the strongest shape because they can handle heavy loads without collapsing. Hold one of your newspaper triangles and apply some force on the sides; the triangle should feel sturdy and hold its shape. If you put force on a square or rectangle, the shape can tilt or collapse. The triangle's strength is why architects use it often in structures.

Bridges are made up of trusses, which are triangles that share sides and connections. Look for triangles the next time you see a bridge or a building being built. You can also find them in a geodesic dome, which is a spherical or partially spherical structure formed from triangles. You can find geodesic domes on playgrounds as climbing structures. Another example is the giant sphere at Epcot.

SAVE THE DAY!

Make several newspaper fortresses of different designs to create a superhero city. Give a tour of your fortress—record a short video clip and share it with us at summerbrain@msichicago.org or facebook.com/msichicago.

LEARN MORE

Try your hand at architecture and building challenges in MSI's LEGO®-themed *Brick by Brick* exhibit.

RECOMMENDED READING

The Savage Fortress,
by Sarwat Chadda

The Three Little Pigs and the Somewhat Bad Wolf,
by Mark Teague

WEEK 7

Need for Speed

Experiment: String Vehicle

Not all superheroes can fly or teleport, sometimes you just need to hop in the car to go save the world. Build a vehicle and see how fast you can race it along a string path.

MATERIALS

- ☐ 30-foot piece of string (or longer)
- ☐ Paper towel tube
- ☐ Four 16-ounce plastic cups
- ☐ Scissors
- ☐ Markers
- ☐ Art and craft supplies
- ☐ Small boxes, cups or other lightweight items (optional)

INSTRUCTIONS

Start by decorating the paper towel tube and making it a vehicle fit for a superhero. Add wheels, rocket fins or whatever creative touches you want, just make sure both ends of the tube are uncovered.

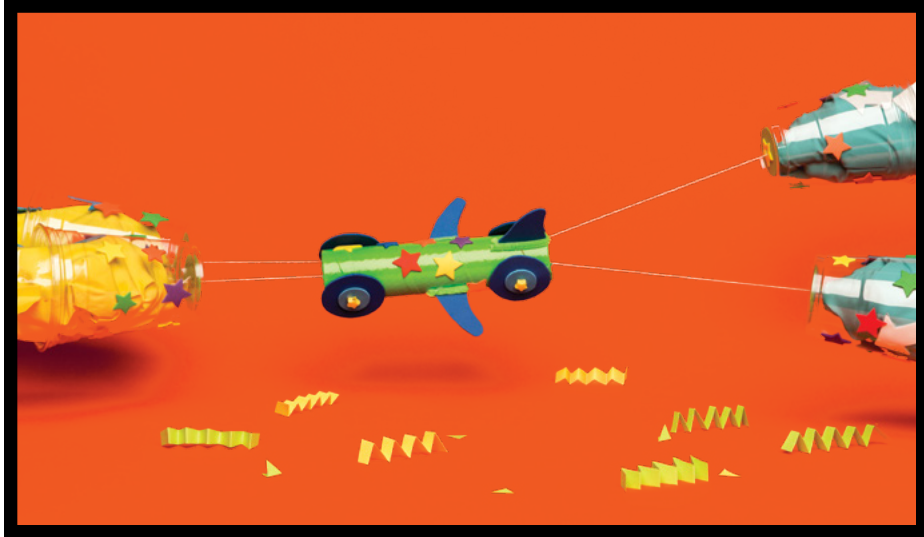
Make the hand guards. Use scissors to poke a hole in the bottom of each 16-ounce cup. The cups should be large enough that your hand can fit inside. You'll need a friend for this activity, so make four hand guards.

Fold the string in half and cut it so you have two equal pieces. Thread both strings through the paper towel tube. Insert the end of one piece of string through the hole in one of the cups so that the string is inside the cup. Tie a knot (or add tape on the end) to prevent the string from slipping through the hole. Do this for each cup.

With your friend, stand across from each other and hold an end of the string in each hand, with your hands inside the cups for protection. Try not to cross or twist the stings. Hold the string so it's almost tight and parallel to the floor. Your hands should be next to each other, with little to no space between them.

Position the paper towel tube vehicle so it's closest to the handles on one end. To make it go, move your hands apart quickly—the vehicle should zip forward on the string. The faster the strings are pulled apart, the quicker the vehicle will go! By alternating turns, the vehicle can move back and forth between people.

If you are trying this by yourself, don't cut the string. Instead, fold it in half and tie the folded end to something firmly anchored like a doorknob on a closed door. Stand back with the string tight and parallel to the floor, and make the vehicle move away from you by quickly pulling your hands apart.



WHAT'S HAPPENING?

When the strings are pulled apart on one end, they create a triangle shape in front of the paper towel tube because the opposite end of the string is still held together. Once the strings are pulled apart wider than the paper towel tube, the tube vehicle is forced to move forward. The string pushes on the tube to create a force. A force is a push or pull and can be used to create motion. The quicker you pull the strings apart, the greater the force that is put on the tube and faster it moves forward.

SAVE THE DAY!

Build a city of small boxes or set up a stack of cups around the path of the string. Make your vehicle zip through the obstacles and knock them down. Or try altering your vehicle's body to see if you can make it travel farther. What happens if you add fins, or use a plastic bottle for the body?

LEARN MORE

Explore the history and science of transportation in MSI's Transportation Gallery.

RECOMMENDED READING

All Kinds of Cars, by Carl Johanson

Batmobiles and Batcycles: The Engineering Behind Batman's Vehicles, by Tammy Enz

WEEK 8

Tools of the Trade

Experiment: Utility Belt

Sometimes a hero needs a few tools to help them save the day. Here are some simple gadgets you can make and keep on a utility belt ... just in case!

COMPASS MATERIALS

- ☐ Metal sewing needle
- ☐ Magnet
- ☐ Paper clip
- ☐ Cork
- ☐ Utility knife
- ☐ Pliers
- ☐ Duct tape
- ☐ Bowl
- ☐ Water
- ☐ Marker or pen

COMPASS INSTRUCTIONS

The first step is to magnetize the sewing needle. Rub a magnet on the needle in one direction only (not back and forth) multiple times. A strong magnet will magnetize the needle more quickly. Test to see if the needle is magnetized by touching it to a non-magnetic steel surface, like a paper clip. It should stick slightly. Set the needle aside.

Use a utility knife to carefully cut a cork so you have a disc that is about one-quarter to one-half inch thick. Get an adult to help with this next step. Use the pliers to carefully push the needle through the cork disc; the needle should bisect the widest part of the cork. Cover the sharp tip of the needle with a tiny piece of duct tape.

Fill a bowl with water. Place the cork-and-needle compass into the water so it floats. The needle should move and point to the north. If you bring a magnet near the bowl of water, the compass will move towards the magnet.

WHAT'S HAPPENING?

A compass works because its needle is magnetic and responds to the Earth's magnetic pole. All magnets have a north pole and a south pole, and opposite poles are attracted to each other. The Earth is a magnet, too. When you have a magnetized piece of metal that can easily move around (like the compass), it will point to the Earth's north pole.

Some types of metal, like iron, can be turned into a magnet. When a strong magnet is rubbed on a piece of iron, tiny magnetic domains in the atom's electrons align to the magnetic field of the strong magnet. Those particles will stay aligned and create a weak magnetic field. This turns the iron into a permanent magnet. The magnetic domains can lose their alignment if the material is heated or struck with a strong force like a hammer.

STETHOSCOPE MATERIALS

- ☐ 10-inch round balloon
- ☐ Scissors
- ☐ Funnel with a 4-inch opening
- ☐ Paper towel tube
- ☐ Tape
- ☐ Craft supplies

STETHOSCOPE INSTRUCTIONS

Cut the neck off the balloon and keep the rest. Stretch the balloon tightly over the open end of the funnel and tape the balloon in place. Place the opposite end of the funnel into one end of a paper towel tube and tape it in place. Decorate the tube if you'd like.

To use the stethoscope, place the funnel end on someone's chest and the open tube against your ear. You should be able to hear their breathing and heartbeat. What else can you hear?

WHAT'S HAPPENING?

Sound travels as sound waves through solids, liquids and air. When a sound wave hits the stretched-out balloon on the end of the stethoscope, it makes the balloon vibrate. Those vibrations redirect the sound so it travels down the tube and into your ear.

SAVE THE DAY!

It's time for the final chapter of your superhero saga! Record a short video clip showing you using your tools to capture a foe or save the day. Share it with us at summerbrain@msichicago.org or facebook.com/msichicago.

LEARN MORE

Simple machines–such as a lever, pulley, screw and more–make work easier. Explore how they function in MSI's Simple Machines online game at msichicago.org/simple-machines.

RECOMMENDED READING

Nick and Tesla Series, by Steve Hockensmith

Monkey With a Tool Belt, by Chris Monroe

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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 Center for the Advancement of Science Education (CASE), 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 a.m.–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.

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