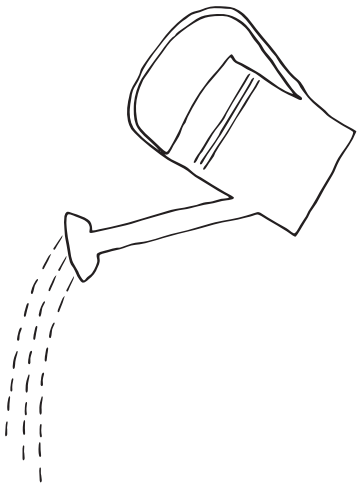
# summer BRAIN GAMES

museum of
**science+industry**
chicago


play along with us at
msichicago.org/summerbrain

Are you ready to stir up some fun?

# summer BRAIN GAMES

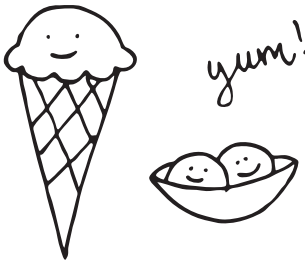


Calling all summer brainiacs! Summer's here and school's out, but that doesn't mean the time for fun and learning is over! Join the Museum of Science and Industry, Chicago in stopping the summer "brain drain" and immerse your kids in our Summer Brain Games. This program offers eight weeks of free and fun at-home experiments on "summery" science themes that can easily be done by kids of all ages (with a little adult supervision). So grab your friends, family or neighbors and dive into science this summer!

Play along with Summer Brain Games online at msichicago.org/summerbrain and you'll get tips, resources and other engaging tidbits about the science found around you all summer— and year—long.

Sign up with MSI online at msichicago.org/summerbrain and you'll receive a pass for a free admission to MSI and coupons for our store and restaurant. You'll also automatically be entered into a weekly drawing for a family membership. If you share your Summer Brain Games experience with us, you can enter to win a family tech prize package with an iPad, notebook computer and digital camera!

**Please note:** Activities should be done with adult supervision, and some should definitely be done outside. For safety, wear eye protection when launching things and take care near the solar oven, as it gets quite hot. Do not aim catapults or rockets at people or animals.




# Week 1: Watch Your Garden Grow

There's no better time than summer to explore nature. An ecosystem is a community of plants, animals and smaller organisms that live, feed, reproduce and interact in the same area. Ecosystems can be large like an ocean or small like your backyard. Make your own ecosystem for a bug's-eye view of science at work!

experiment

## WOODLAND TERRARIUM

### Materials

Clear container with a clear lid

Soil

Rocks

Activated charcoal (optional)

Spanish moss

Plant leaves

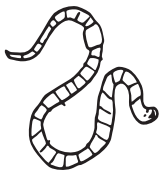
Low-growing woodland plants (like ivy, African violet, baby tears, moss)

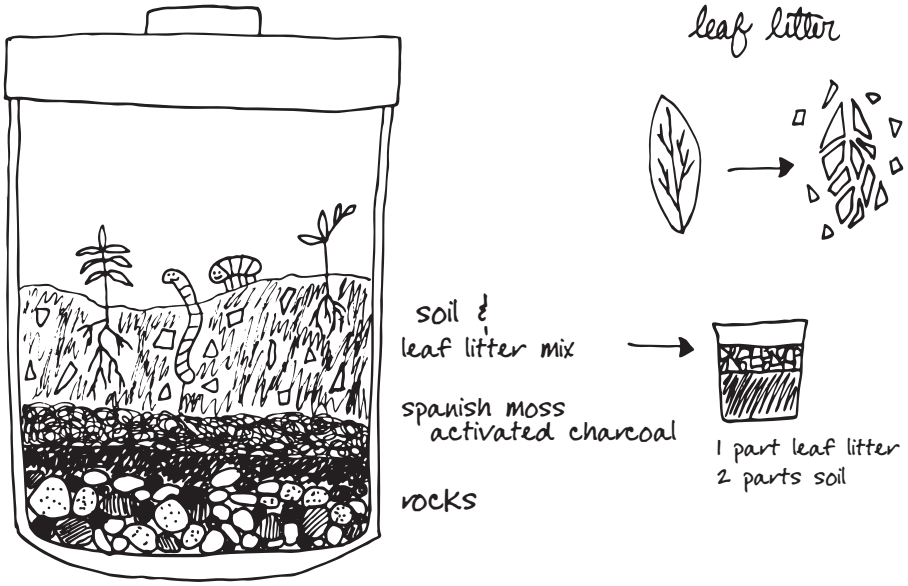
Earthworms and bugs (sow bugs, pill bugs)

Thermometer

Ruler

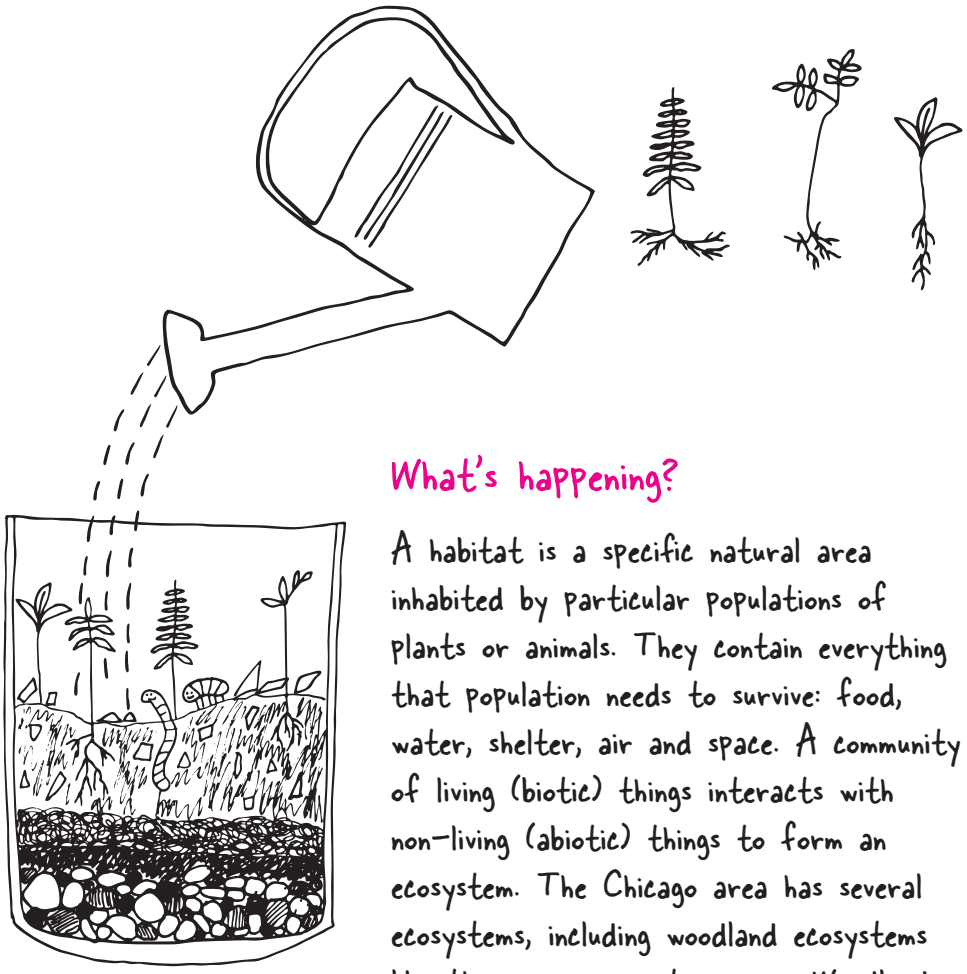
Small toys and figurines






Start with a layer of rocks in the container for drainage. Add a small layer of activated charcoal if you'd like the terrarium to last; it helps keep the water and air clean. Add a layer of Spanish moss so soil doesn't clog the drainage channels.

Collect some fallen leaves (moist is best) and break them into pieces. Mix one part of this leaf litter with two parts soil and add a layer that's several inches deep. If the container is large, landscape the soil into hills and valleys. Sprinkle some leaf litter on top (as shelter for the bugs). Plant the plants in the soil, and add the bugs and earthworms. If you'd like, make a scene by adding small toys or figurines. Water the plants with a few tablespoons of water and close the lid. Add a little water once a week, and use a thermometer and ruler to measure changes.



## What's happening?

A habitat is a specific natural area inhabited by particular populations of plants or animals. They contain everything that population needs to survive: food, water, shelter, air and space. A community of living (biotic) things interacts with non-living (abiotic) things to form an ecosystem. The Chicago area has several ecosystems, including woodland ecosystems like the one in your terrarium. Woodland ecosystems have dense tree growth and temperate deciduous forests (i.e., trees that lose their leaves in the fall). These ecosystems grow best with cold winters and hot, wet summers.

## Game on!

Predict how tall your plants will get by the end of summer and see if you're right. Keep a journal to track changes in your terrarium; make observations, drawings and track data collected with a thermometer and ruler.


check the temperature

measure your plants

## Tips

A container with a clear lid is best because the plants get the most sun. If you want to use something like a spaghetti jar, cover it tightly with plastic wrap and a rubber band instead of using the original lid.

Look for earthworms, sow bugs and pill bugs (also called roly-polys) in dark, damp places, like under rocks. If you put them in your terrarium, make sure it doesn't get too hot inside!

You can find activated charcoal at nurseries and garden stores.

## More ways to play with nature

Study a different ecosystem in your yard or local park, like a water shoreline. Pick a small area and record observations in a journal. Check back to note what's different.

Watch worms dig as they search for food by making your own worm farm. Get directions at msichicago.org/wormfarm

Discover vertical, rain and vegetable gardens in the garden outside MSI's *Smart Home* (msichicago.org/smarthome)

# Week 2: Ready, Aim, Splash!

They're not called lazy summer days for nothing. But if you have to do some work, look for a simple machine to help. Simple machines make work easier. There are six kinds of simple machines: lever, pulley, screw, wedge, inclined plane, and wheel and axle. You can combine simple machines into something more complex called a compound machine; for example, a bike is made up of screws, levers, a pulley and a wheel and axle. This week's "work" is actually a lot of fun—building a simple machine to launch water balloons!

experiment

## WATER BALLOON CATAPULT

### Materials

Two identical gallon or half-gallon milk jugs with handles

Yardstick

20-inch dowel rod

Two large rubber bands

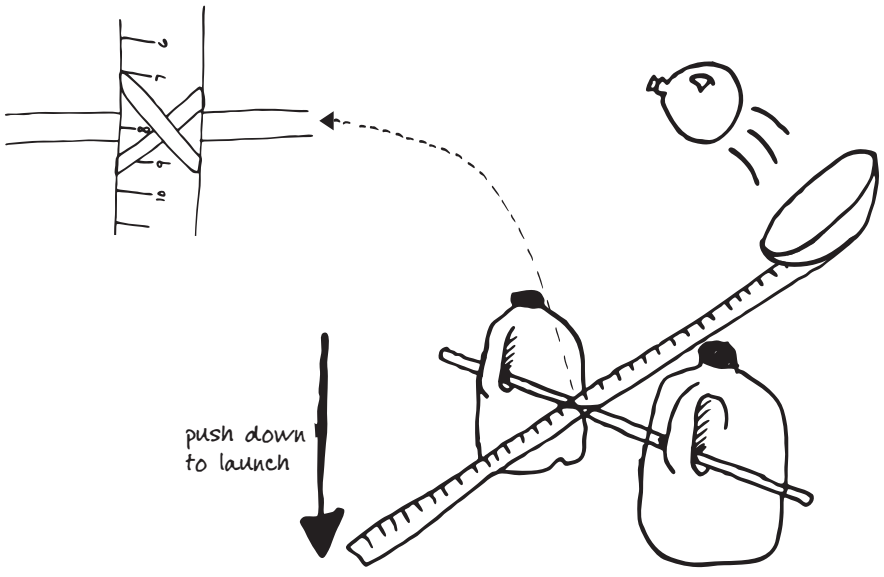
Paper bowl or cup

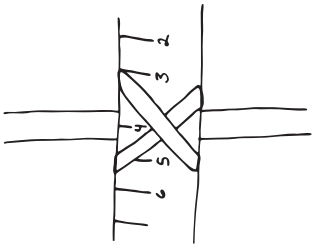
Duct tape

Water balloons

Water

Fill the jugs with water, cap them and put them on the ground or a table. Attach the yardstick perpendicular to the dowel using two rubber bands that make an X shape. Set the dowel at the 8-inch mark. Rest each end of the dowel inside the jug handles. Tape a paper bowl to the other end of the yardstick. Hold the bowl end down and load it with a small water balloon. To launch, just push down on the other end of the yardstick and get out of the way!





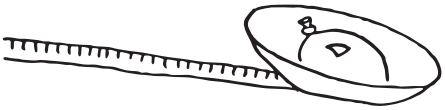
Make changes to your catapult to see if you get different results. What happens if you move the dowel to different spots on the yardstick? What happens if you change the position of the bowl? Try flinging other items, like cannonballs made of paper.

## Safety note

This is best done outside. Do not aim the catapult at anyone!

## What's happening?

A catapult is a type of simple machine called a lever. A lever is a bar centered on a turning point called a fulcrum that's used to raise or move weights. Levers make it easier to lift heavy things, like a person on a seesaw. In the catapult, the bar (yardstick) pivots on the fulcrum (dowel) in order to raise the bowl and toss the water balloon.



## Game on!

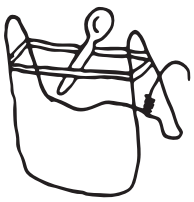
Make a target—with different point values in the target's rings—and see who gets the most points. Or play a game of battleship: Make two sets of ships out of cardboard that can stand on their own but fall over when hit (hint: tape them to a small cardboard base). Arrange the fleets and catapults opposite each other and take turns firing cannonballs at the enemy ships. Get a boat template at msichicago.org/summerbrain.

## Tips

If you don't have a dowel rod, try a round stick.

For best results, position the catapult near the edge of a table so the "load" end hangs off the table after it launches.

Make a simpler version with a wire hanger, thick rubber band and a spoon. Make the base by bending the curved ends of the hanger up. Loop the rubber band around the upright hanger ends. Place a spoon in the middle of the rubber band and twist it around a few times. Load some lightweight "ammo" in the spoon and let it go!



## More ways to play with machines

Help MSI's friend, Twitch, finish his tasks by using found objects to create simple machines in our online Simple Machines game at msichicago.org/simplemachines

Go on a simple machines scavenger hunt! Can you find all six simple machines at the playground or at home?

- ❑ Lever
- ❑ Wheel and axle
- ❑ Inclined plane
- ❑ Pulley
- ❑ Screw
- ❑ Wedge

# Week 3: Fireworks Fun


Ever wonder how Fourth of July fireworks work? It's all chemistry! A chemical reaction launches fireworks into the sky, and their colors are created when chemical elements and compounds are heated and emit different colors of light. Oooh and aaah over these fireworks-related activities—no fire needed!

experiment

## BOTTLE ROCKETS

### Materials

Small plastic bottle

Cork

Toilet paper or paper towel tube

Cardboard

Tape

Baking soda

White vinegar

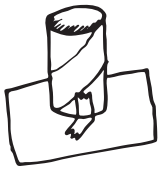
Toilet paper

Construction paper

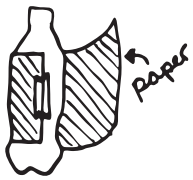
Scissors

Markers or crayons

Measuring cup and spoons

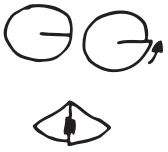


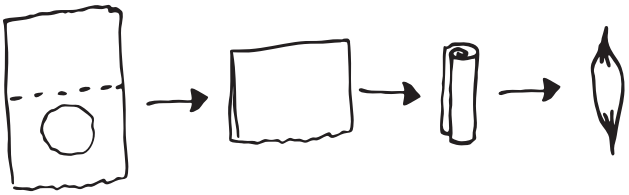
Make a launching pad by taping a toilet paper tube perpendicular to a piece of cardboard so it's pointing up.



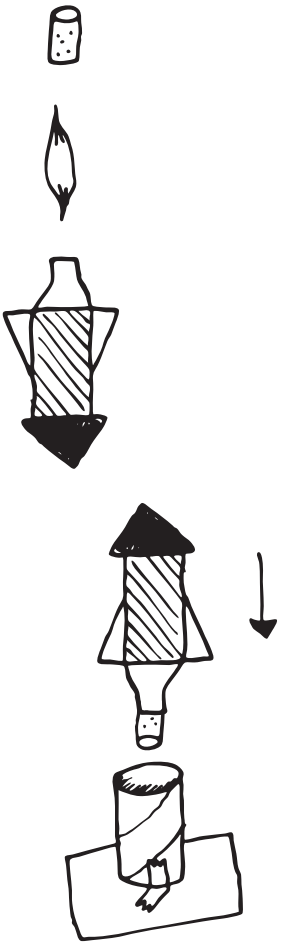

Turn a plastic bottle into a rocket by wrapping a piece of construction paper around it, creating a tube, and taping it into place. Make sure there's no paper around the opening of the bottle, which is the base of your rocket.

Tape triangular fins near the rocket base, and make the top by cutting a circle and taping it into a cone shape. Use markers or crayons to decorate the rocket if you'd like. Wrap tape around a cork so that the cork fits into the bottle opening.





Pour 1/4 cup of vinegar into the bottle. Put 1 teaspoon of baking soda on two squares of toilet paper and make a "sausage" by rolling it up and gently twisting the ends.



To launch, place the launching pad on the ground outside and put on your eye protection. Drop the fuel "sausage" into the bottle, insert the cork, turn the bottle upside down and place it on the toilet paper tube. Step away and watch it fly!

## Safety note

Do this experiment outside, and wear eye protection. Step away quickly once you've placed the rocket on the launching pad.

## What's happening?

When you combine the baking soda and the vinegar, the chemical reaction created a gas called carbon dioxide. Carbon dioxide is invisible, except as the bubbles of gas you may have noticed when the vinegar and baking soda mixture began to fizz. As the gas is formed, pressure builds up, causing the cork to pop out and send the bottle rocket shooting upward.

## Game on!

Challenge friends to see whose rocket can launch the highest. Experiment with different amounts of vinegar and baking soda to see what happens.

## Tip

Fresh baking soda works best.

## More ways to play with fireworks

Make milk fireworks: Pour some milk onto a plate, add drops of food coloring, dip a toothpick into dish soap and touch it to the center of the plate. The dish soap disrupts the milk's equilibrium. The food coloring shows how the milk molecules are rearranging themselves as they try to return to equilibrium.

Design and explode virtual fireworks in the Fire Colors interactive in MSI's *Science Storms* (msichicago.org/sciencestorms)

Learn fireworks history and science at pbs.org/wgbh/nova/fireworks/

## Are you a summer brainiac?

Send us your Summer Brain Game photos and you can win a family tech package! Visit msichicago.org/summerbrain to enter.

# Week 4: Boy, oh Buoyancy

There's more to water science than water's circulation between air, land and sea. Water lets you see energy moving from place to place as demonstrated by waves. Floating in water lets you explore the relationship between three physics concepts: density (the amount of matter in an object), buoyancy (a force that makes something float) and gravity (a force that causes two objects to pull together). So get your hands wet by experimenting with physics in the water.

experiment

## FLOAT YOUR BOAT

### Materials

Small container with lid, like a pill container or film canister

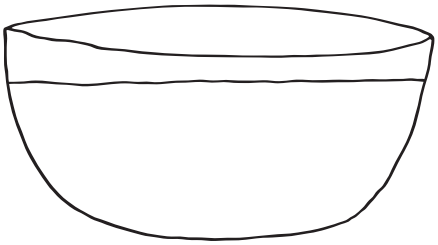
Small, heavy objects (coins, marbles, screws, etc.)

Small, light objects (paper clips, fabric, beads, etc.)

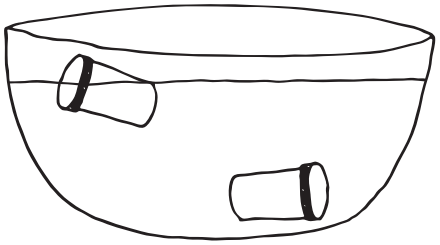
Aluminum foil

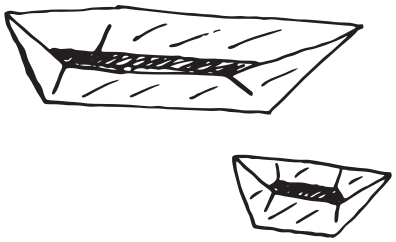
Water

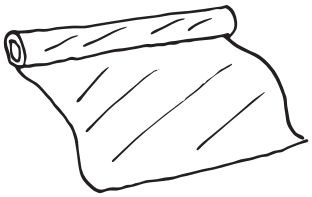
Large bowl, sink or tub



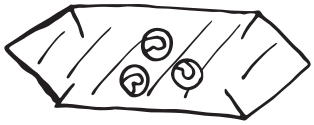
Fill a large bowl, sink or tub with water. The small container—like a pill container or film canister—is your submarine. Figure out how to make it float on top of the water and sink to the bottom using any of your objects. Finally, see if you can make your submarine hover in the middle of the water—no part of it can be touching the bottom or poking out the top.

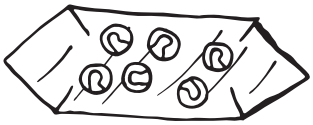


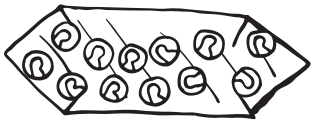




Put the submarine aside. Take a square piece of foil and make it into a boat. Test to see if it floats. Start placing objects in your boat (pennies work great). How many can it hold before it sinks?

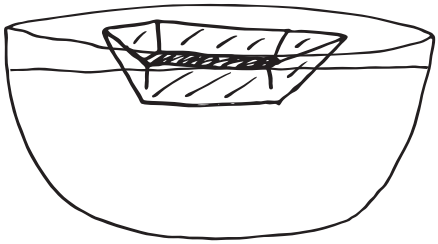






## What's happening?

In the water, gravity is pulling down on the submarine while a buoyant force is pushing up. Adding or removing objects to the container changes the density of the sub and the boat. If the density of the sub or boat is more than the water's density, the vessel will sink. If the sub's density is less than the water's density, it will float. If the densities are the same, the vessel will hover.



## Game on!

See whose vessels can hold the most weight before sinking. Make a boat with a smaller piece of foil, like 9" by 9", and see if it can hold the same weight as your larger boat. If not, can you change its shape so that you're successful?

## More ways to play with water

Try these simple density experiments: Put an orange in water with and without its peel (the trapped air pockets in the peel allow it to float). Float a can of diet vs. regular pop and see what happens (the sugar in regular pop makes it more dense, so it sinks).

Float in a pool or tub and let your arms relax and float at your sides. You can actually feel the water pushing back up on them, making them buoyant.

Explore buoyancy on a big scale with MSI's *U-505 Submarine* (msichicago.org/u505).

## How many pennies can your boat hold?

| | # of pennies | sink | float |
|---|---|---|---|
| design #1 | 0 | | |
| | 5 | | |
| | 10 | | |
| | 15 | | |
| design #2 | 0 | | |
| | 5 | | |
| | 10 | | |
| | 15 | | |

# Week 5: Solar Snacks

Soak in the summer sun! Almost all the energy on Earth comes from the sun. Solar energy is absorbed by the land, water and atmosphere and is converted into heat that creates winds and currents in our atmosphere and oceans. Heat, or thermal energy, can be focused to create a solar oven that can cook food.

experiment

## SOLAR OVEN

### Materials

Pizza box

Aluminum foil

Plastic wrap

Tape

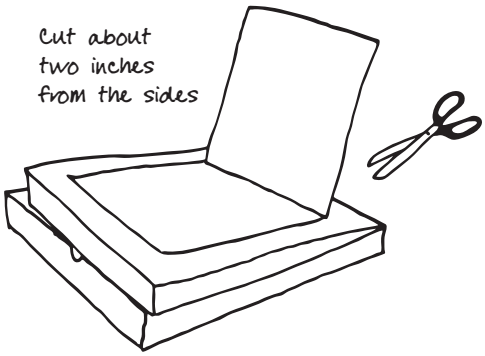
Scissors

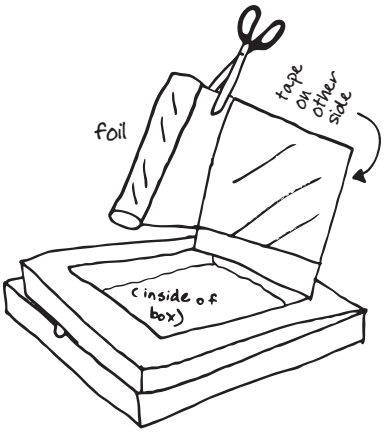
Ruler

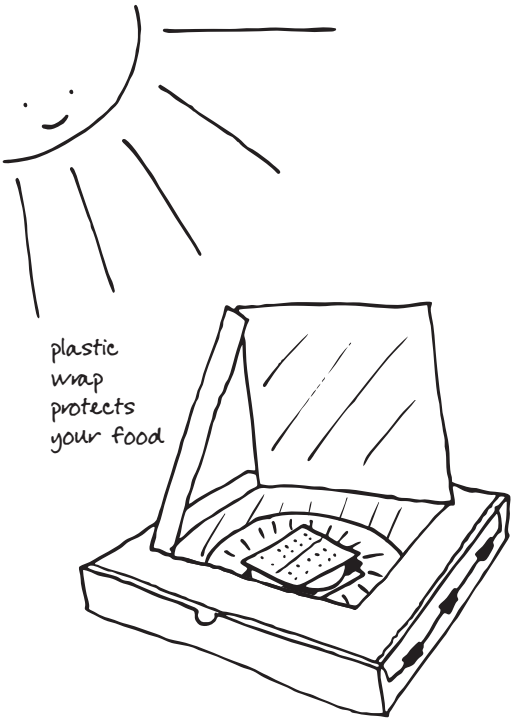
Paper plate

Food (try making s'mores!)

Cut out three sides of a square on the pizza box lid about two inches from the sides. Fold back the flap and cover the inside with foil (shiny side out), taping it in place. Open the box and cover the bottom and sides with foil. Cover the hole in the box lid that the flap made with plastic wrap, taping it in place. Put food on a paper plate and place it inside the box on the foil bottom.




Close the lid, fold back the flap and prop it open with a ruler. Put the box outside, with the flap facing the sun. Be patient! It may take an hour or longer to cook your food.

## Safety note:

The solar oven can get very hot. Use caution when handling.

## What's happening?

The sun's light rays are collected by the foil flap and concentrated inside the box. The rays are transformed into thermal energy that slowly raises the temperature inside the box, causing the food to cook.

## Game on!

Who can make the yummiest food in their solar oven? What food cooks the fastest? Change the shape and size of your solar oven—try using a smaller or larger box, or making the shape of a parabola (a curved shape that focuses the sun's rays onto one point) with lots of tin foil.

## More ways to play in the sun

Go outside with color-changing UV beads. See what happens if you cover them in sunscreen or put them in water. You can find UV beads online at Amazon or science supply stores.

Convert sunlight into heat, electricity and rainbows in MSI's *Science Storms* exhibit. (msichicago.org/sciencestorms)

Explore the sun up close at nasa.gov/vision/universe/solarsystem/sun_for_kids_main.html.

Count five ways you have interacted with the sun's energy today.

1. _____
2. _____
3. _____
4. _____
5. _____

## Solar oven recipe ideas

Make up your own recipes for the solar oven.

_____

_____

_____

_____

_____

_____

# Week 6: Take Flight

Get blown away this week with the physics of flight. Flight is a balance of four forces: lift (up), weight (down), thrust (forward) and drag (backward). An airplane moves through the air based on the strength and direction of these four forces. These activities explore the different ways to fly parachutes, helicopters and planes.

experiment

## FLY AWAY

### Materials

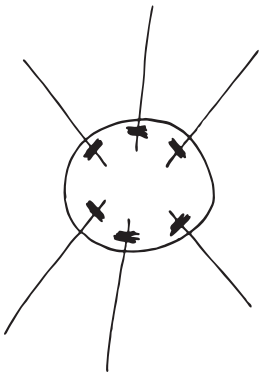
Parachute materials (coffee filters, fabric, tin foil, napkins, string, yarn, lightweight toys)

Tape

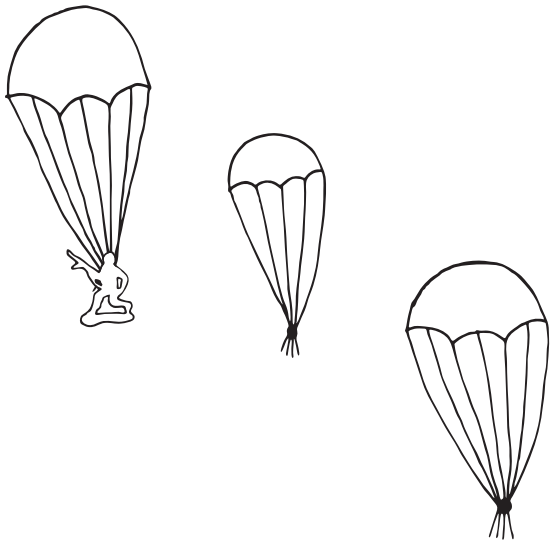
Paper clips

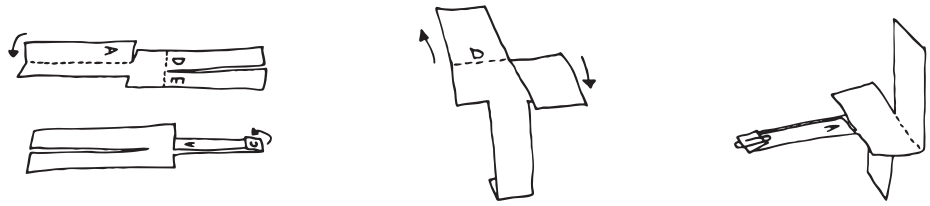
Scissors

Templates for paper airplane and helicopter (at msichicago.org/summerbrain)

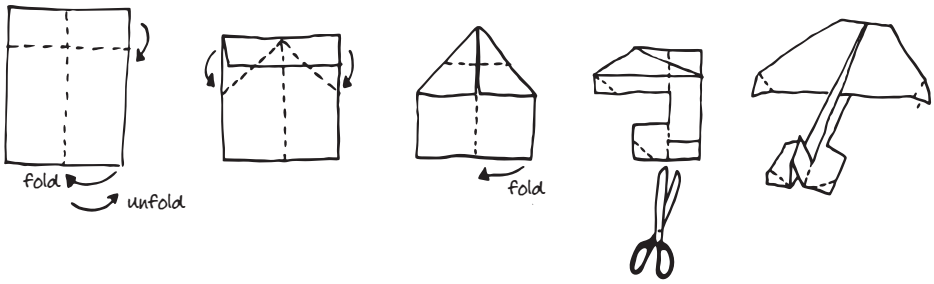


Part 1: Parachute – Have a variety of materials on hand so there's a lot of options to test. Try lightweight materials (like napkins, coffee filters or garbage bags) and tape four to six pieces of string or yarn to the underside of the parachute. Try securing a lightweight toy as a passenger. Drop the parachute from up high and see how long it takes to land. Experiment with materials, number and length of string, parachute sizes and other variables.





Part 2: Helicopter – Print the helicopter template and cut on the solid lines. Fold flaps A and B toward each other so they overlap. Fold flap C up. Fold flaps D and E in opposite directions to form the blades. Drop the helicopter and see how it flies. Experiment by adding paper clips to the stem, changing the shape or size of the blades or making the stem shorter.




Part 3: Plane – Print the plane template and decorate and personalize it. Fold in half lengthwise and unfold. Fold the top down and fold the corners in to the center. Fold the point down to meet the edge made by the folded corners. Fold the plane in half (image on the outside) and cut on all solid lines. Fold wings and horizontal stabilizers down so they're perpendicular to the plane body. To make loops, bend the ailerons down and elevators up and launch straight up. For rolls, bend both ailerons and elevators up on one side and down on the other and launch straight ahead.

## What's happening?

Air has mass and takes up space. When you drop a parachute or helicopter, or launch a plane, they push the air around them out of the way in order to move. By experimenting with the weight, shape and size of your aircraft you change how fast and how much air is pushed out of the way, which affects how they move.

## Tips

Make sharp creases when folding planes and helicopters.

## More ways to play with flight

Go fly a kite! A kite flies when all forces—lift, weight, thrust and drag—are balanced.

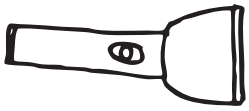
Challenge what you know about flight by trying to launch an airplane from a conveyor belt in *MythBusters: The Explosive Exhibition* at MSI.

Learn more with NASA's beginners guide to aerodynamics at grc.nasa.gov.WWW/K-12/airplane.

## Game on!

Make a helipad (or download our template at msichicago.org/summerbrain) and try to get your parachute to land on it. Give your parachute some extra oomph and launch it with a hair dryer set on cool (make sure the parachute doesn't touch the hair dryer).

# Week 7: Light up the Night



Flashlight tag can be a fun part of warm summer night. The glow from a flashlight can do more than help us see in the dark—it can change direction when it travels from one medium (such as air) to another (such as glass), or when it bounces or reflects off an object. See how many times you can make light bend by playing a game of Light Leapfrog!

experiment

## LIGHT LEAPFROG

### Materials

Flashlight

Index card

Scissors

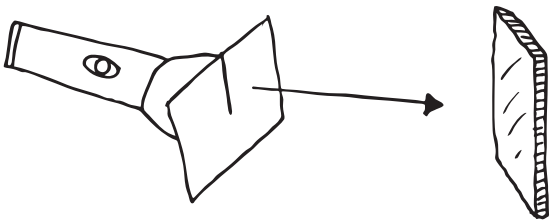
Tape

Six 4" by 4" mirrors (or a variety of hand-held mirrors)

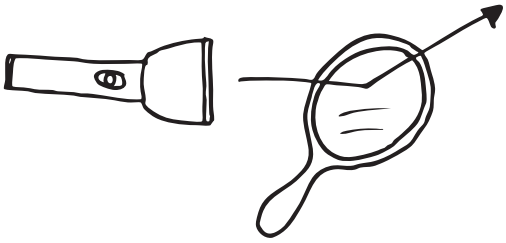
Game die 

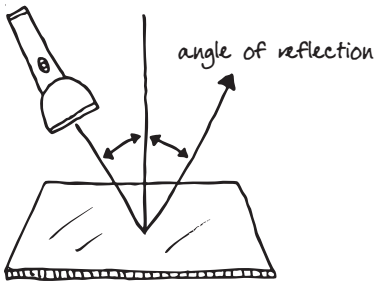
Light Leapfrog game board (at msichicago.org/summerbrain)

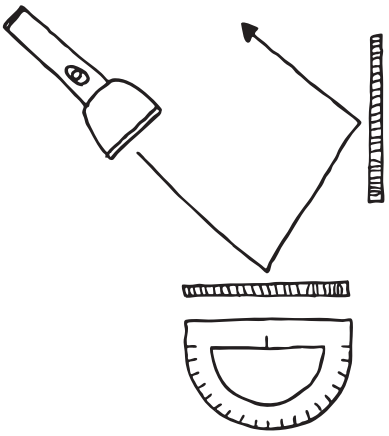
Paper protractor (optional) (at msichicago.org/summerbrain)



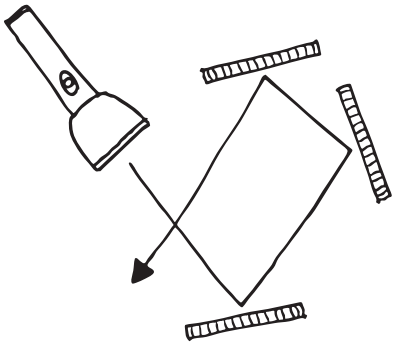
Cut a slit in the index card and tape it over the front of a flashlight. In a dark room, shine the narrow beam from the flashlight at a mirror. Aim the beam of light in different directions and notice how the light bends. The light aimed at the mirror bounces off or reflects at the same angle at which it came in. If you'd like, place the paper protractor perpendicular along the edge of the mirror and measure the angles of the incoming light (called the angle of incidence) and the reflected light (called the angle of reflection).







To play Light Leapfrog, place the flashlight on the game board (available to download at msichicago.org/summerbrain) and roll the die to find out which number on the board the light needs to hit. Roll the die again to see how many mirrors you must use to reach your goal!



## What's happening?

Smooth surfaces such as mirrors reflect light in a predictable way known as specular reflection. When a light wave strikes a smooth surface, it then reflects at the same angle. This is known as the law of reflection. Rough or uneven surfaces, such as a sidewalk or brick wall, have diffuse reflection, which results in the scattering of the reflected light beams.

## Game on!

Play several rounds and see if you can bend the light to reach your goal every time. Is it easier with fewer or more mirrors? Try timing yourself or racing against someone to see how quickly you can win.

## Tips

Find 4" by 4" mirrors at art and craft stores. You can also use a variety of hand-held mirrors.

## More ways to play with light

Try these fun flashlight games. In Firefly Flashlight Tag, the "firefly" gets a head start and tries to evade capture but must flash a flashlight every time she counts to 60! In Light Limbo, point two flashlights at each other to make a "bar" that you have to limbo under!

Mix the colors from glow sticks together and see what happens! Get the directions at msichicago.org/threecolors.

## Don't forget to send us photos of your Summer Brain Games!

You can win a family tech package! Visit msichicago.org/summerbrain to enter.

# Week 8: Two Scoops of Science

A warm summer afternoon is perfect for a picnic and ... food science? You bet! Food encompasses many different fields of science, from the botany of growing food to the chemistry of cooking to the biology of eating and digesting. Create a little food chemistry this week by making your own ice cream.

experiment

## MAKE YOUR OWN ICE CREAM

### Materials

Ice

Salt

Sugar

Vanilla

Milk (you can also use cream or half and half)

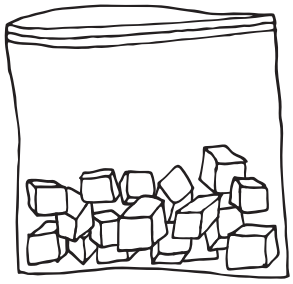

Flavors like chocolate syrup or fruit juices (optional)

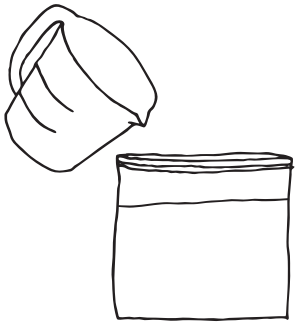
Zippered plastic bags in gallon and pint sizes

Measuring cups and spoons

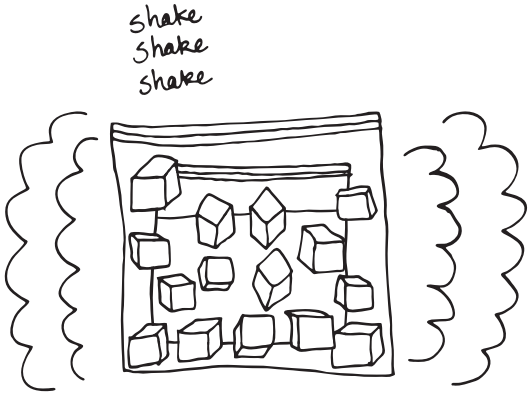
Towel

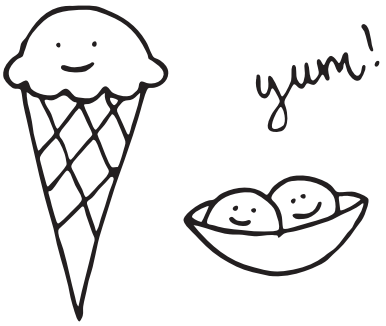
Thermometer





Fill a gallon-sized plastic bag halfway with ice, add 6 tablespoons of salt and shake gently. In a measuring cup, combine 1/4 cup milk, 1 tablespoon sugar and 1/4 teaspoon vanilla and stir. Add additional flavors like syrup, fruit juice or candy if you'd like. Pour the milk mixture into a pint-sized bag, seal it (getting as much air out as possible), put it inside the bag of ice and seal it. Shake the bag for at least five minutes, wrapping it in a towel when it gets too cold, until it's frozen.






To understand what's happening, use a thermometer to record temperatures. Check the temperature of the bag of ice before you add the salt and again after you add salt and the ice begins to melt. Check the temperature of the milk mixture bag before you add it to the bag of ice and again after it freezes into ice cream.

## What's happening?

Water freezes and ice melts at a temperature of 32 degrees Fahrenheit; this is called the freezing point. Salt can lower the freezing point of water to −22 F, meaning it needs to be colder than 32 degrees for water to freeze. That's why we put salt on icy sidewalks and roads in the winter—salt encourages the melting process. When you added salt to the bag of ice, it lowered the freezing point and the ice started to melt. When you added the milk mixture bag to the bag of ice, heat left the milk bag and the temperature of the milk got lower. Eventually the milk mixture froze into ice cream!

## Game on!

Play a game of "cold" potato—each person in a circle shakes the bag 10 times and passes it to the next person. Whoever notices when the milk turns to ice cream gets the first taste!

## More ways to play with your food

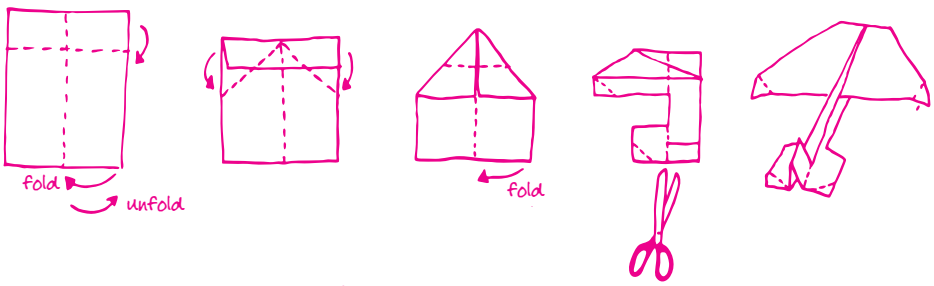
Extract DNA from strawberries at msichicago.org/dna and analyze the colors in candy at msichicago.org/candy

Learn what's REALLY in your favorite foods—play MSI's new online game, "Would You Eat That?," at msichicago.org/wyet

Find more kitchen chemistry activities at http://pbskids.org/zoom/games/kitchenchemistry/

## My yummiest ice cream recipes

Make up your own ice cream recipes.




Take a flight with us on page 14.

## Inspiring the Inventive Genius in Everyone

The Museum of Science and Industry, Chicago (MSI) offers thousands of fun and interactive exhibits and one-of-a-kind, world-class experiences to inspire the inventive genius in everyone. Come visit and find your inspiration! MSI is open every day except Thanksgiving and Christmas Day, and summer hours are 9:30 a.m. to 5:30 p.m. every day. The Museum is supported in part through the generosity of the people of Chicago through the Chicago Park District. For more information, find MSI online at msichicago.org or call
(773) 684-1414 or (800) GO-TO-MSI outside of the Chicago area.

Through its Center for the Advancement of Science Education, MSI also aspires to a larger vision: to inspire and motivate children to achieve their full potential in science, technology, medicine and engineering. The Center's programs are designed to extend the content of Museum exhibits through strategies that empower teachers, engage the community and excite students and Museum guests. Learn more at msichicago.org/CASE.

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