SEASONAL

GRADES 2–5

STEM CHALLENGES

RESOURCE GUIDE

The Seasonal STEM Challenges cards are the perfect way to include STEM (Science, Technology, Engineering, and Math) learning in your classroom. Simply grab a card and go! The low-prep activities use common classroom materials and are achievable by all learners. Use the hints on the card backs when students are struggling with the task. Use the STEAM questions to extend learning once students finish a task. The short explanation of the science behind each task connects learning to your classroom and beyond. Refer to pages 3 through 5 for more tips and ideas for using the Seasonal STEM Challenge cards in your classroom.

The activities included in this Resource Guide will provide more formal connections to the science in each challenge. They are formatted like more traditional science experiments and can be done as a whole class before or after completing a STEM challenge to support your science curriculum. Or, make copies and send the experiments home to encourage a school-to-home science connection.

The Challenge Cards Are Perfect For

- Individuals
- Early finishers
- Science warm-ups
- After-school activities
- Small groups
- Indoor recess
- Centers
- Take-home activities

Current State ALIGNED Standards

Visit *carsondellosa.com* for correlations to Common Core, state, national, and Canadian provincial standards.

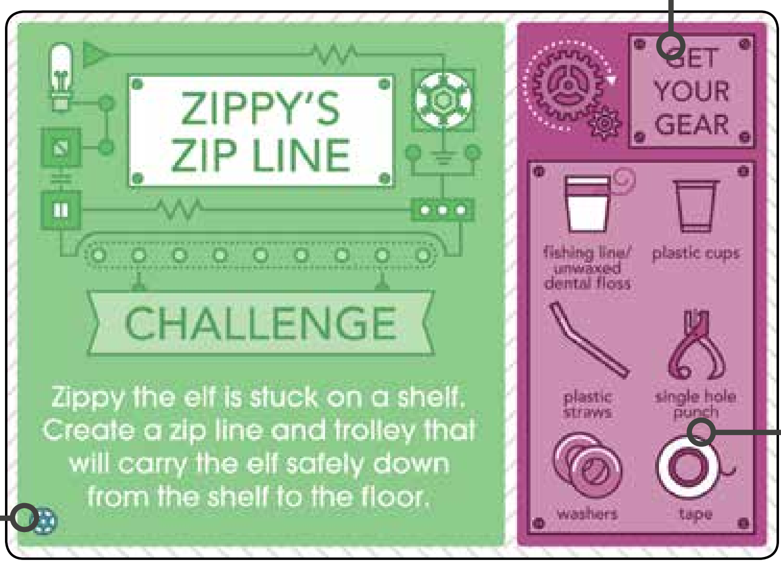
Table of Contents

Tips & Tricks for Using the STEM Challenge Cards

To keep the set organized, use the color and letter code on the front of each card to replace each card behind the correct divider.

Gather the supplies and place them in a plastic pencil box or shoe box, along with the challenge card, to create a grab-and-go kit for each card. Then, students can grab kits and take them to their desks for morning work, during free choice time, or after finishing a task early.

Or, place common supplies in a plastic drawer unit or tubs to allow students easy access to the materials they need to complete a chosen challenge.



You may want to include additional supplies such as hand wipes, a plastic tablecloth, etc., to help students keep their areas clean.

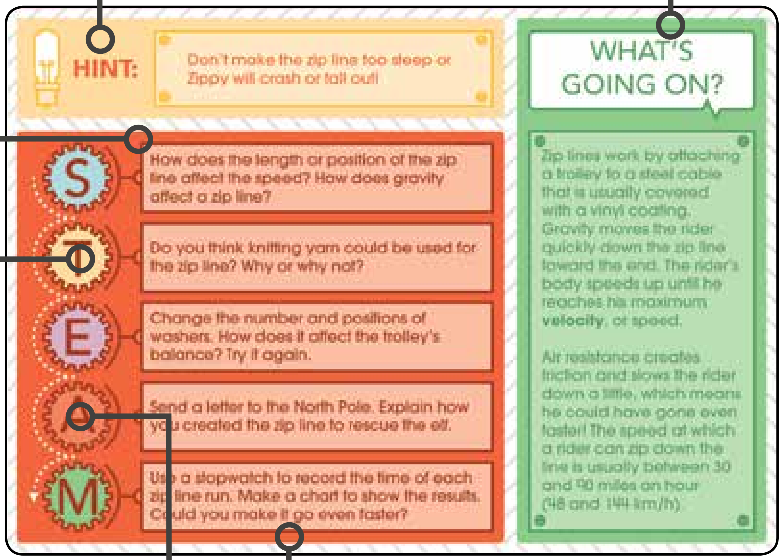
Tape, glue, and scissors are considered basic supplies and often aren't listed with the materials. They can be used to complete each challenge unless otherwise noted.

Tips & Tricks for Using the STEM Challenge Cards

This section often uses additional resources to extend learning, such as new materials or internet access. Make sure these items are available to students as needed.

To discourage students from using the hint immediately, place a piece of masking or paper tape over the Hint box.

Use the matching experiment in the resource guide to give students a more structured experience with the same scientific principles. Or, do the experiment first and let students use what they learned to complete the related STEM challenge.



With STEM, technology is not only calculators, computers, and software programs. Instead, it refers to using a tool to solve a problem or meet a need. For example, a paper clip can become a tool used to tighten a wheel on a vehicle.

Use the recording sheet on page 36 to guide students through completing each STEM challenge. It can also provide accountability if using the cards at home or as a self-directed activity.

Often, proponents change STEM to STEAM with the addition of art. The included art- and design-based questions and tasks will allow students to practice writing, visual arts, and more in the context of the original STEM challenge.

Tips & Tricks for Using the STEM Challenge Cards

Using the Challenge Cards

Decide how the STEM challenge cards would best fit into your classroom structure.

- **Whole Class** Incorporate STEM cards into your science curriculum. Use the challenges to introduce a topic and get students excited about it, or as a closing activity at the end of a unit of study. Choose a card that relates to your current science topic. Gather enough supplies and place students in small groups. Display the challenge and have groups work together to complete the challenge. Allow groups to share their final designs.
- **Morning Work or Early Finishers** As students arrive to school or finish their work early, allow them to choose a kit (see tip on page 3) or a card to work on. It may be helpful to designate a place where students can place works in progress. You may also choose to remove cards with activities that are messier or will take too much time or space to complete.
- **At-Home Activity** Send a card home with each student once a week or once a month. Encourage students to work with their families to complete a challenge and the related STEAM activities on the back of the card.
- **Indoor Recess** During indoor recess, allow students to choose a STEM challenge card to complete alone or with a small group of friends.
- **Science Centers** Choose cards related to your current topic of study in science. Place the cards and related materials in a science center. Allow students to choose a card and complete the challenge during center time.

Show and Share

Develop a way for students to share their creations.

- **Gallery Walk or STEM Museum** Have students display their projects with the related card. Have half of the class stay with their projects to describe them and demonstrate while the other half walks around and observes. Then, switch roles.
- **Dedicated Space** Create a special space in the classroom where students can display their projects. Have them label their projects with their name and the challenge. Allow students to visit the space during downtime, such as during morning arrival or after finishing work early.
- **STEM Day** Once a month or once a quarter, allow students who have completed a challenge to present their design to the class.

Community Connection

Connect STEM to your community and the world beyond.

- **STEM Careers** Invite community members and other special guests with jobs in STEM fields to talk to the class about their careers and how they use STEM. Then, complete a related STEM challenge card as a class.
- **Family STEM Night** Invite families from all grades to the school for an after-school STEM carnival or fair. Have students run small science experiment booths for families to visit. Place STEM challenge cards on tables with the related materials and challenge families to work together to complete them. Create a STEM career dress-up area to encourage role-playing. It may be fun to host the event each quarter with a seasonally-appropriate theme.

FALL FOLIAGE FUN

QUESTION

Why do leaves change color?

MATERIALS

green leaves
jar
rubbing alcohol
spoon
plastic wrap
small bowl or pan
hot water
paper coffee filter

PROCEDURE

1. Break three or four leaves into small pieces and place the pieces in the jar.
2. Pour in just enough rubbing alcohol to cover the leaves.
3. Stir and mash the leaves with the spoon until the rubbing alcohol begins to turn green.
4. Cover the jar with plastic wrap.
5. Place the jar in a small bowl. Have an adult pour hot water into the bowl.
6. Set it aside for 30–60 minutes. Swirl the jar occasionally.
7. Cut a 2-inch long strip from the coffee filter and tape it to the edge of the jar, allowing the end to just touch the top of the dark green liquid.
8. As the rubbing alcohol evaporates off the coffee filter, what do you see on the coffee filter?

CONCLUSION

The coffee filter absorbed the pigment in the leaves, which is mostly green. While green was the dominant color on the coffee filter, you may also have seen yellow, red, or orange. These colors were always there but were hidden by the intense green color, which is produced by chlorophyll. Without chlorophyll, trees could not use sunlight to produce food. The green color dominates in spring and summer when the days are longer. The other colors in the leaves—which may be different depending on the type of tree—are hidden. But, as the days get shorter and nights get longer, trees produce less and less chlorophyll. Then the yellow, orange, red, and brown colors come through.

FIND A BALANCE

QUESTION

Where is the center of gravity in an object?

MATERIALS

wooden craft stick
chenille stem
2 clothespins
chopstick

PROCEDURE

1. Loop the chenille stem around the end of a wooden craft stick several times, making sure the ends that hang down are equal lengths.
2. Attach a clothespin to one end of the chenille stem, and another to the other end of the chenille stem.
3. Hold the chopstick horizontally and balance the end of the craft stick with the chenille loops on the chopstick, with the clothespins hanging down on either side. Does it stand up? If not, continue to adjust the chenille stems until it does.
4. Try moving the clothespins higher and lower on the chenille stems. How does that affect the craft stick? What happens if you added a chenille stem to each side to make the clothespins hang very low?

CONCLUSION

The center of gravity is the point on an object where the weight is balanced, or even on both sides. In regular, symmetrical objects, the center of gravity is usually right in the middle. In other, unevenly-shaped things such as the human body, the center of gravity is slightly away from the middle. In this experiment, the chenille stems and clothespins move the craft stick's center of gravity from the center of the stick toward the end with the loops. That way, it is easier to balance on a small point like the chopstick. In humans, the center of gravity is responsible for balance. It's why we stand up straight and don't lean left, right, back, or forward. Men and women have different centers of gravity. Children have different centers of gravity than adults.

LIFT OFF!

QUESTION

How can levers be used to lift things?

MATERIALS

large binder clip

wooden ruler, strip of foam board, or thin piece of wood such as basswood

weights or small objects such as pennies

small paper cups (optional)

PROCEDURE

1. Take the metal handles off of the binder clip. Place the binder clip flat side down so the point is facing upward.
2. Balance the wooden ruler on the binder clip to create a simple lever. The ruler is the beam, or arm, and the binder clip is the fulcrum.
3. Place a weight on one end. If using pennies, place them in small paper cups first to make them easier to add to the lever. What happens?
4. Move the binder clip closer to the end with the weight on it.
5. Place a light weight or a small object on the other end. What happens? Continue to adjust the position of the binder clip until the heavier end is raised up.

CONCLUSION

A lever is a simple machine. A typical lever has a beam that is long and unbending, such as a ruler. If placed on a pivot point, or *fulcrum* (such as a binder clip), the ends of the beam can balance or move up or down. The beam will balance on the fulcrum as long as it is equidistant from each end point to the fulcrum. This all changes once an item with weight is placed on either end. In order to lift the weight, the fulcrum needs to move or an object of greater weight must be placed on the other end.

UP, UP, AND AWAY!

QUESTION

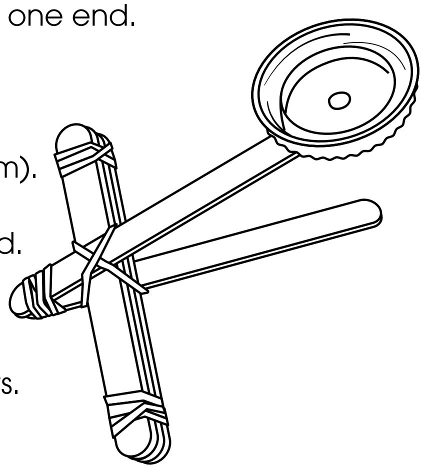
How does a catapult work?

MATERIALS

- 7 craft sticks
- 4 rubber bands
- a milk bottle or water cap
- hot glue and hot glue gun
- cotton ball
- penny, gumball, ping-pong ball (optional)

PROCEDURE

1. Stack five craft sticks together and wrap a rubber band around each end.
2. Stack two craft sticks together and wrap a rubber band around one end.
3. Spread apart the unwrapped end of the two craft sticks and place the stack of five craft sticks between the bound end.
4. Use the last rubber band to hold them all in place with the five-stack as far inside the two-stack as possible (see diagram).
5. Have an adult use the hot glue gun to glue a bottle cap on the far end of the top two-stack craft stick, cavity facing upward.
6. Place a cotton ball in the bottle cap. Press down on it, release, and see how far the cotton ball flies. Repeat a number of times. Be sure to keep the catapult aimed away from people, animals, and breakable objects like windows.
7. Follow the same procedure with a gumball, penny, or any small object. Observe the distance each item flies. What factor makes the biggest difference in distance?



CONCLUSION

A catapult is a simple machine: a lever with a fulcrum. Catapults do their jobs by releasing stored energy. In this experiment, the stretched rubber band at the end of the two-stack has potential energy, or stored energy. When the arm is pressed down, the rubber band stretches farther and creates more energy. When the arm is released, the rubber band releases its energy as kinetic energy and the object on the arm is propelled forward. The distance and speed at which the object flies depends on the force that is applied to the arm. Did you find that the weight of the object that was propelled was a factor?

Caution: *Keep small objects away from young children who might mistakenly or intentionally swallow them. Seek immediate medical attention if you suspect a child may have swallowed a small object.*

MOVE ME

QUESTION

Can one object attract or repel another without using magnets?

MATERIALS

several books (enough for two tall stacks)
ruler
string
2 plastic combs
a piece of woolen cloth

PROCEDURE

1. Make two tall stacks of books on a table or desk. Use a ruler to make a bridge between the two stacks of books.
2. Tie one end of a piece of string around the center of the ruler. Tie the other end to one of the combs. Hang the comb between the stacks so that it does not touch the desk or books.
3. Rub one end of the second comb with a piece of wool several times.
4. Slowly bring the end of the comb that you rubbed close to the hanging comb. Observe what happens. (If nothing happens, rub the comb again with the wool.)
5. Turn the loose comb over in your hands several times. Bring it near the hanging comb again. What happens this time?

CONCLUSION

When you rubbed the comb with the wool, it built up a negative charge on the comb because the electrons from the wool moved to the comb. Charges can exert forces on other objects, like when the negative charge of the loose comb attracted the hanging comb. Static electricity is the build up of charges on an object. Most of the time positive and negative charges are balanced in an object. But, these charges can build up on the surface of an object until they find a way to be released or discharged. Opposite charges attract each other (negative to positive). Like charges repel each other (positive to positive or negative to negative). Think about what happens when you walk around in socks on a carpet, or rub your hair with a balloon. That is static electricity at work!

SEEN AND HEARD

QUESTION

How are vibrations related to sound?

MATERIALS

tuning fork
rubber mallet
clear cup of water
paper towels
1–2 feet of string
tape
ping-pong ball
rice, sand, or cereal (optional)
plastic container (optional)

PROCEDURE

1. Tap the tuning fork with the mallet. Observe what happens. Use your hands to stop the vibrations of the tuning fork. What kinds of sounds did you hear?
2. Next, place the glass of water on the paper towels. Tap the tuning fork again and lower it a few inches into the water. Be careful not to touch the tuning fork to the sides of the cup. Record what you see happening to the water in the glass.
3. Cut a piece of string about 1.5 feet long (46 cm) and tape or tie one end of it to the ping-pong ball. Hold the string away from your body and slowly move the tuning fork toward it. Hold the tuning fork in place once it touches the ping-pong ball. What happens?
4. To extend the experiment, pour materials such as rice, sand, and cereal into a plastic container. Tap the tuning fork with the mallet and touch it to the side of the container. Which materials can be moved with the vibrations from the tuning fork?

CONCLUSION

Vibrations are caused by the back and forth movement of an object. Sound is produced when an object vibrates. These vibrations in an object are usually too fast for us to see. Sound travels through air as vibrations or waves. We can't see air molecules vibrating to produce sound, but a different medium such as water can allow us to see the vibrations. When you place the vibrating tuning fork in the water, it created waves. When the tuning fork touched the ping-pong ball, its vibrations pushed the ball and caused it to bounce off. Sound waves move differently through different materials. It can travel faster or slower, or make it louder or softer.

THE STRENGTH OF IT ALL

QUESTION

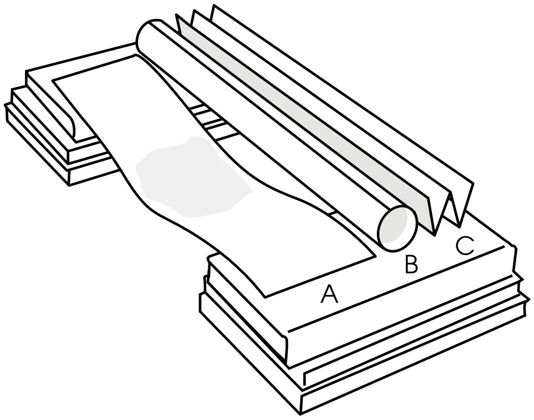
What is *bending stiffness* in paper?

MATERIALS

- four or six books of the same thickness
- ruler or measuring tape
- construction paper
- tape
- heavy objects like counters or pennies (optional)

PROCEDURE

1. Create two or three stacks of two books each. Place them about two feet (61 cm) apart on a flat surface.
2. Line two pieces of construction paper end to end, so the short edges overlap by about 1/4 inch. Tape the pieces of paper on the top and bottom of this seam to make one "bridge." Repeat to create two more bridges.
3. Take one of the bridges and place the ends on the piles of books, with about half an inch of overlap on each side (see diagram A). What happens to the paper?
4. Tightly roll another bridge into a long tube and use a few pieces of tape to hold the tube shut. Place the tube on top of the books again (see diagram B). What happens?
5. Fold the last bridge into a "W" shape lengthwise (see diagram C). Place it on the books. What happens?
6. Try placing weight on each bridge using pennies or other similar objects. Record the results of the experiment in a chart. Which bridge stayed up the best? Collapsed the fastest? Held the most weight?



CONCLUSION

If you try to bend a sheet of paper, it will bend very easily. The *bending stiffness* of a material is how hard or easy it is to bend. A stiffer material, like wood, is more difficult to bend. A lighter material, like paper, is easier to bend. But, if you change its shape into a tube or an accordion, it becomes much harder to bend. Changing a material's shape can affect how easily it bends. Flat pieces of paper bend very easily and sag under their own weight. Bending or rolling the pieces of paper, however, increases their bending stiffness, allowing them to form a stable bridge between the stacks of books.

CAN YOU SEE ME NOW?

QUESTION

How and why does camouflage work?

MATERIALS

- newspaper
- construction paper
- scissors
- glue stick
- tape (optional)

PROCEDURE

1. Cut 3-inch (8 cm) squares of construction paper in different colors. Then, cut several same-size squares of newspaper, being careful to avoid photographs or colored sections.
2. Spread out a full sheet of newspaper and use the glue stick to attach all of the squares from step 1 in random places on the newspaper. Do not use tape or wet glue to attach the squares to the newspaper since they may give clues to the location of each square.
3. Place the newspaper on a table, or use tape to display it on a wall. Invite people to look at the paper for about 10 seconds and count the squares they see. Discuss what they saw. Did they see the colored squares first? Did they notice any of the newspaper squares? Were they able to find all of the squares? Why or why not?

CONCLUSION

The newspaper squares blended into the rest of the newspaper because they had the same colors and patterns. It made them more difficult to find. The colored squares stood out, so they were easier to see. Living things adapt and survive by blending into their environments to hide from their predators. This is known as camouflage. Animal camouflage takes many forms, including colors, patterns, and mimicking other objects in nature. For example, chameleons have the ability to change their colors so that they blend into their habitats and become almost invisible. Many animals that live in snowy areas are white, like the polar bear. Animals that live in deserts are often the color of sand. Patterns, like stripes or spots, can also help camouflage an animal.

THE GREAT EGG DROP

QUESTION

What happens when inertia meets with another force?

MATERIALS

- pitcher of water
- large drinking glass
- large eggs (hardboiled to avoid messes)
- disposable metal pie pan
- empty cardboard toilet paper roll
- large tray (optional)
- paper towels (optional)

PROCEDURE

1. Fill the glass about three-quarters full with water. It may be helpful to place a large tray under the water to contain any spilled water later.
2. Place the pie pan on top of the glass. Make sure it is centered.
3. Place the cardboard tube upright on the pie pan, directly over the middle of the glass.
4. Set the egg on top of the cardboard tube. Careful!
5. Stand behind the objects. Hold out your hand out to the side of the pie pan, about 6 inches from the edge.
6. Without touching the egg, the cardboard tube, or the glass, smack the pie pan hard enough to knock the cardboard tube and the pie pan out from under the egg. (Be careful not to swing your hand up or down.) Did the egg drop into the glass of water? If not, try again! This activity can take several tries to get the correct force.

CONCLUSION

The egg will sit on top of the cardboard tube indefinitely if no force is applied to it. This is called *inertia*. When something is resting, it will stay resting. If something is moving, it will continue moving at the same speed and direction unless another force acts on it. Once the egg started to fall, it continued to fall until something stopped it. In this case, the egg was pulled straight down by the force of gravity, but was slowed down and stopped (gently and safely) by the water in the glass.

VROOM!

QUESTION

How does the angle of a ramp affect speed and distance?

MATERIALS

- toy cars
- blocks of different shapes and sizes (including flat pieces)
- cardboard or foam board (optional)
- masking tape
- stopwatch
- ruler or measuring tape

PROCEDURE

1. Build a ramp with two blocks. Depending on the shapes of your blocks, you may need to use a flat surface as the ramp, such as a piece of cardboard or foam board.
2. Get your stopwatch ready. Place your car at the top of the slope and let it go. Click the stopwatch again when the car stops.
3. Mark how far the car went by placing a piece of tape where it stopped. Record how long the first run lasted and the distance from the end of the ramp.
4. Adjust your blocks or add others to make a difference in the slope of your ramp. Place your car on the slope and let it go. Place a new piece of tape and record the time and distance each time you release a car.
5. Repeat step 4. Continue adjusting your ramp to get the maximum roll. Which factor(s) made the biggest difference?

CONCLUSION

When you place a car on top of a ramp, the force of gravity will pull it down the slope. Speed, or *velocity*, is a measure of how fast an object moves in one direction. You have seen that when the angle of the ramp is increased, the car moved faster and farther. It is also important to understand that moving objects have *momentum*, another force. Momentum can be increased by increasing an object's weight or its speed. In this case, you increased the momentum when the speed was increased. What do you think would have happened with a heavier toy car?

THE GREAT BALLOON SHOOTOUT

QUESTION

What is the difference between kinetic and potential energy?

MATERIALS

heavy plastic cup (see step 1)
balloon
ping-pong ball
mini marshmallow
pom-pom (optional)

PROCEDURE

1. Have an adult cut off the bottom third of a heavy plastic collectible cup from a movie theater, fast food restaurant, or sports event. Retain the tube-like top and discard the bottom.
2. Tie the balloon shut without any air in it.
3. Cut off the top inch of the balloon and discard it (the side opposite of the opening and knot).
4. Stretch the open end of the balloon around the wider end of the cup so that it is somewhat taut across the top with the knot of the balloon in the center.
5. Drop a ping-pong ball into the cup.
6. To shoot, pull back on the balloon knot and let go! Be sure not to aim at people or animals.
7. Repeat steps 5 and 6 with a mini marshmallow or pom-pom. Which object goes the farthest? The fastest?

CONCLUSION

The ping-pong shooters are a perfect example of potential and kinetic energies. When you stretch the balloon, you have created potential energy. There is nothing happening yet . . . but action is possible. When you release the balloon, kinetic energy is transferred to the ping-pong ball or other objects. The relationship between potential energy (amount of stretch) and kinetic energy (forward motion of the object) is obvious as you watch a non-moving object turn into a moving projectile.

FLOAT OR SINK?

QUESTION

Why do some things sink in water and other things float?

MATERIALS

tall wide-mouthed vase
water
oranges

PROCEDURE

1. Fill the vase halfway to the top with water.
2. Predict what will happen when the orange is placed in the water. Will it sink or float? Place it in the water and observe what happens.
3. Next, peel the orange. Predict what will happen when the peeled orange is placed in the water. Will it sink or float? Observe what happens.
4. What conclusions can you draw from your observations?

CONCLUSION

Buoyancy is the tendency for objects to float or sink in water or other liquids. Two forces are at work in this experiment. It is basically a tug-of-war between the force of gravity (trying to pull the orange down) and the force of buoyancy (trying to lift the orange up with a force equal to the amount of water it displaced). When the unpeeled orange is dropped into the water, the buoyant force wins because the orange has displaced a larger amount of water and because of the air pockets in the skin. Air is less dense than water. So, it floats. When the peeled orange is dropped in, it displaces less water and has fewer air pockets. So, it sinks.

DON'T LET THE COLD IN!

QUESTION

What makes an igloo weatherproof?

MATERIALS

8 cups of flour
1 cup of baby or cooking oil
blue oil or gel-based food coloring (optional)
ice-cube trays
shallow tub or tray (optional)
different sized bowls (optional)

PROCEDURE

1. Make a batch of cloud dough. Mix 8 cups of flour with 1 cup of oil. Add blue food coloring to the oil first if you would like to tint the "snow" a light blue. This recipe can be scaled up or down, as long as you keep a ratio of 1 to 8 (oil to water): 1/2 cup oil to 4 cups flour, 2 cups oil to 16 cups flour, etc.
2. Decide what kind of winter structure you want to build. An igloo? An ice fort? Square or round? Will it have doors, windows, or a chimney hole?
3. Make lots of "snow" blocks by pressing the dough into the ice-cube tray.
4. Think about the design and building of your structure. Plan a pattern of block laying to make the structure a success.
5. Build a structure with the blocks. You may want to build in a tray or shallow tub to contain any mess. Use loose cloud dough to fill in the gaps between blocks and "cement" them together. It may be helpful to place a bowl upside down inside the structure to help form and support the dome.
6. Evaluate your structure when it is finished: Is it airtight? Will the people inside stay warm? Would you sleep in it in -20-degree weather? What would you do differently next time?

CONCLUSION

The traditional shape of an igloo is a dome, or half-sphere. The shape helps to make the igloo energy efficient because there are no corners for heat to get lost in. The material used to make an igloo is perfect: snow. There is plenty of it and it is white, making it a poor radiator and a poor conductor of heat. It is a good insulator, so it keeps the heat inside. An igloo must also be airtight, so the regular pattern and design of the snow blocks is crucial to its success. Are your blocks laid in a consistent pattern or are they laid haphazardly? During the day, the sun will slightly melt the snow blocks. After the sun goes down, they refreeze. Eventually they turn into blocks of ice, which increases the strength and insulation of the structure. How strong was your structure? Why?

RAMP IT UP!

QUESTION

How does friction affect speed and movement?

MATERIALS

- sheet of plywood (2' x 4') or 4 flat cardboard strips
- kitchen towel
- sandpaper
- shelf liner
- masking tape
- small toy car
- tape measure

PROCEDURE

1. Cover 1/4 of the plywood or 1 cardboard strip with a kitchen towel from top to bottom, using the tape to secure the edges. On the next section or cardboard strip, tape a long strip of shelf liner from top to bottom. Beside it, place three 6-inch strips of sandpaper in a line intermittently from top to bottom. Leave one section blank.
2. Use tape to create a starting line across the top of each ramp. Be sure to place each strip at the same distance from the edge.
3. Rest the top end of each ramp on a stack of books or anything that is 6–8 inches high to make a ramp. Place the toy car at the top of the plain ramp behind the starting line. Let it go without pushing it.
4. Use the tape measure to see how far it went beyond the ramp. Record the distance. Then, try it again several times.
5. Repeat steps 3–4 with each ramp. Compare all of the distances. How did the friction caused by each material affect how far the car moved?

CONCLUSION

Gravity will move an object down a slope every time. The *velocity*, or speed, of the object down the slope depends on how much resistance, or *friction*, is created by the surface of the slope. Friction is a force that occurs when one object is moving on another. In this experiment, four different surfaces created four different amounts of friction, or resistance. The increased friction of the towel, for instance, made it harder for the car to move down the ramp. So, the car moved with less speed, allowing it to travel less distance. How would you categorize the other three runs?

CAST A SHADOW

QUESTION

Can light travel through all materials?

MATERIALS

- shapes cut from card stock (rectangle, triangle, star, circle, etc.)
- clothespins or large paper clips
- white paper
- flashlight
- plastic wrap
- book

PROCEDURE

1. This experiment needs to be done in a dark room and with a partner. But first, clip each shape behind a sheet of paper.
2. Call in your partner and have him/her hold the flashlight.
3. Turn off the lights. Hold up the first sheet of paper with a shape clipped behind it. Ask your partner to shine the flashlight on the front of the paper and guess what shape it is.
4. Then, clip a shape behind a piece of plastic wrap. Repeat step 3.
5. Next, clip a shape behind a book. Repeat step 3.
6. Continue holding different shapes behind the three types of items and shining a flashlight on them. What did you learn?

CONCLUSION

Different materials allow different amounts of light through them . . . or no light at all. Materials like books do not allow any light to pass through and are called *opaque*. Some materials, such as paper, allow some light to pass through and are called *translucent*. Other materials let all of the light through, such as plastic wrap, and are called *transparent*.

IT'S A STRETCH

QUESTION

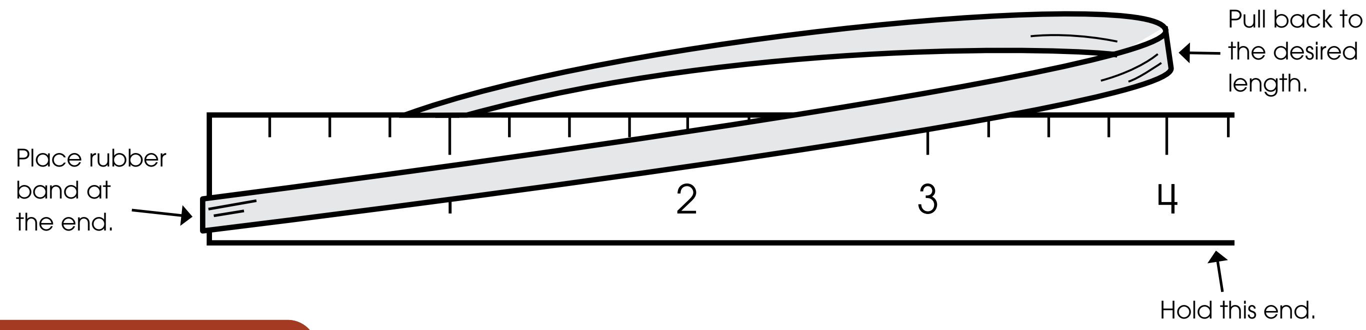
What makes a rubber band fly through the air?

MATERIALS

- masking tape
- variety of rubber bands (large, small, thick, thin, colors, etc.)
- ruler
- yardstick or tape measure
- markers

PROCEDURE

1. Choose a starting point. Mark the spot with tape.
2. Place a rubber band on the end of a ruler (see diagram). Predict how far the rubber band will fly if it is pulled back 6 inches and released. Let it go. Observe what happens.
3. Use the yardstick to measure the distance from the starting point to the landing point. Record the distance for that rubber band at 6 inches.
4. From the starting point, pull the same rubber band back 12 inches. Release it. Observe what happens. Measure the distance it flew and record it.
5. Repeat steps 2–4 with various rubber bands. Note what happens with different lengths and thicknesses of rubber bands. Does the color of the rubber band make a difference?



CONCLUSION

Objects get *mechanical energy*, or the energy of movement, when someone or something performs some kind of work on it. Work happens when a force causes an object to move, change shape, displace, or do something physical. A pitcher's windup gives mechanical energy to the softball. Winding a clock gives the clock the energy to run. When you stretch a rubber band, you are performing work on it. You are giving it potential mechanical energy. When you release the rubber band, its stored energy is released as kinetic mechanical energy and it flies!

SINK OR SWIM?

QUESTION

Why do some materials sink and other materials float?

MATERIALS

1-cup clear measuring cup
water
food coloring
spoon
vegetable oil
corn syrup
10 small objects (penny, grape, cork, paper clip, quarter, pencil-top eraser, marble, small plastic cap, etc.)

PROCEDURE

1. Add 1/3 cup of water to the cup.
2. Add 2–3 drops of food coloring to the water and mix it with a spoon.
3. Predict what will happen when you add corn syrup to the mix. Then, carefully and slowly add 1/3 cup of corn syrup. Observe what happens. You may need to wait for the liquids to settle first. It may also help to pour the liquids down the side of the container instead of into the middle of the liquid in the cup.
4. Predict what will happen when you add vegetable oil to the mix. Then, add 1/3 cup of vegetable oil. Observe what happens.
5. How many layers do you have? Which layer is on the bottom? On top? In the middle?
6. Finally, take turns carefully dropping one small object into the cup at a time. Note what happens with each object. How far does it sink? Or, does it float?

CONCLUSION

Density is one of many characteristics of a substance. Different materials have different densities, depending on two things: the mass of the substance, and how much space it takes up. In this experiment, each of the three liquids had a different density. They separated out into layers because of their different densities. The most dense liquid was at the bottom, and the least dense liquid was at the top. You may have seen some air bubbles rise to the top as the liquids settled, because air is less dense than all of the liquids. As you dropped each object into the cup, it sank until it reached a liquid that was denser than it was.

POP GOES THE BEAN

QUESTION

How do levers work?

MATERIALS

- wooden craft stick
- pencil
- large dried bean
- ruler
- quarter or half-dollar
- fat marker

PROCEDURE

1. Place the pencil under the wooden craft stick. Notice how each side tips up or down on the craft stick.
2. Place the dried bean on one end of the craft stick.
3. Place a ruler so it stands vertically beside the end with the bean, with the 0 end touching the table. From a height of 2–3 inches (6 cm), drop the coin on the other end of the wooden craft stick. How high did the bean jump? Record the height.
4. Place the bean on the end of the lever again. This time, drop the coin on the middle of the craft stick, over the fulcrum (the pencil). How high did the bean jump this time? Record the height.
5. Replace the pencil with the fat marker. Repeat steps 3 and 4. How did changing the fulcrum's height change how high the bean jumped?
6. Experiment with the fulcrum at different positions. Which position gives the bean the most height?

CONCLUSION

A lever is a simple machine. It has two parts: the fulcrum (the pencil or marker), or balance point; and the arm (the wooden craft stick). In order to do work and lift the load, (the bean), energy is applied to one end of the lever. By changing the position of the fulcrum, you have changed how much more or less force is needed to do work and move the bean.

FOLLOW YOUR RAINBOW

QUESTION

How are rainbows created?

MATERIALS

clear glass of water
sheet of white paper
masking tape
flashlight

PROCEDURE

1. Use two pieces of masking tape to cover the outer edges of the head of a flashlight. About a half-inch strip of space should remain between the two sections of masking tape.
2. Place the glass of water on the sheet of paper.
3. Turn the lights off to the room so it is completely dark. You may need to find a room with no windows, such as a closet.
4. Turn the flashlight on. Shine it into the glass of water from the top and then at other angles through the glass from the side. Vary the position of the flashlight until you see a good rainbow appear on the paper. (If you have difficulty finding the rainbow, lift the glass about 6 inches, or 15 cm, above the paper.)

CONCLUSION

What color is light? White? Light is made up of different colors we can't usually see. Rainbows are created when beams of light (or a flashlight) hit a raindrop (or a glass of water) at an angle so that it separates into its different colors. This is called *refraction*. The angle causes the white light to refract, or bend, into the separate bands of color, which we see as a rainbow. A perfect rainbow shows stripes of red, orange, yellow, green, blue, indigo, and violet (in that order).

WALKING WATER

QUESTION

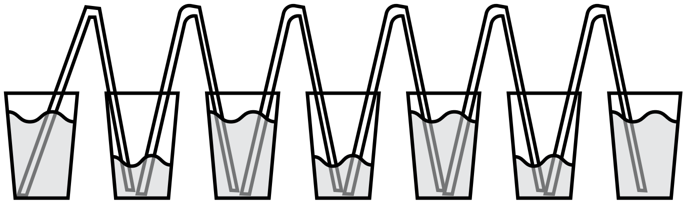
How do plants get water to their petals and leaves?

MATERIALS

- 7 clear cups (not too tall)
- sticky notes (optional)
- water
- food coloring
- spoons
- paper towels

PROCEDURE

1. Place the seven cups on a table in a straight line, horizontally. Mentally number the cups 1–7 from left to right. Or, use sticky notes to label each cup with a number as described.
2. Fill cups 1, 3, 5, and 7 with water to about 1 inch (2.5 cm) below the top of each cup.
3. Fill cups 2, 4, and 6 with about 1.5 inches (3.8 cm) of water.
4. Add 5–10 drops of red food coloring to cups 1 and 7. Add 15 drops of yellow food coloring to cup 3. Add 5–10 drops of blue food coloring to cup 5. Use a spoon to mix up each cup.
5. Fold a paper towel in half widthwise several times until it is about 2 inches (5 cm) wide. Fold it in half lengthwise. Repeat until you have 6 folded paper-towel strips.
6. Place one end of a paper-towel strip in cup 1 and the other end in cup 2. Repeat so that each cup has a paper-towel strip coming and going (see diagram).
7. Predict what will happen next. Observe what happens. Be patient and wait until all of the paper towels show a rainbow hue. (You may have to wait overnight.)



CONCLUSION

Capillary action is when a liquid moves through a solid such as a hollow tube or spongy material. The water can even move up, against gravity, like when it moved up the paper towel or up a plant's stem. The forces of cohesion, adhesion, and surface tension work together to accomplish this. These forces cause water molecules to stick to each other and to solid substances so they can "climb" up. Paper towels have many small air pockets that the water can climb up through, which made the water "walk" to different cups.

FEATHER THE NEST

QUESTION

What materials do birds prefer to use to make their nests?

MATERIALS

- index cards
- hole punch
- yarn
- dried grasses
- small strips of cotton fabric
- thread
- animal or other hair, including human
- feathers
- string or ribbon
- cotton balls (pulled apart)

PROCEDURE

1. Punch five or six holes in an index card. Make sure one hole is at the top of the card.
2. Tie a 12-inch (30.5 cm) piece of string or ribbon through the top hole punch and tie the ends together to make a loop to hang the card from.
3. Stuff wads of dried grasses through the other holes.
4. Repeat steps 1–3 on additional index cards. Stuff other materials in the holes of each, such as hair, fabric, thread, cotton balls, etc. It may be helpful to label each hole with the material it holds, for reference in step 6.
5. Hang the cards on trees or bushes.
6. Check back frequently to see which materials are the most popular with the birds in your area. Record your observations each day. Try to find time to observe quietly for a longer period of time. Note which material particular birds took if you are lucky enough to catch a glimpse.

CONCLUSION

The most common nest is called a cup nest because it is shaped like a cup or bowl. Birds use many kinds of materials to make cup nests, such as moss, fur, feathers, fabric, animal hair, twigs, leaves, and grass. They often place the rough, tough materials (such as twigs) on the outside and line the inside of the nest with the soft cozy materials (such as fur, moss, or hair). They use various materials that act as glue, such as mud, spider webbing, caterpillar silk, rotten wood, or dung. All nests are built to shelter and protect eggs and baby birds. Some are as big as a car (eagle's nest) or as small as a thimble (hummingbird's nest).

Caution: *Before beginning any nature activity, ask families' permission and inquire about students' plant and animal allergies. Remind students not to touch plants or animals during the activity.*

FREE FLIGHT

QUESTION

How do different designs affect how paper airplanes fly?

MATERIALS

- internet access or paper airplane book
- paper
- tape
- paper clips
- scissors
- masking tape
- tape measure

PROCEDURE

1. Look online or in a paper airplane book to find at least 3 different paper airplane designs to create.
2. Follow the directions to create each airplane. Label each plane with a different letter, or give each plane a name.
3. Place a piece of masking tape on the floor to create a starting line. Stand behind the line and throw the first paper airplane.
4. Use the tape measure to find out how far the plane flew. Record the distance in a chart.
5. Repeat steps 3 and 4 to get three distances for each plane.
6. Look at your chart to compare the distances. What do you notice about each plane and how far it flew? What about each design do you think affected the distances it flew?
7. Try even more designs, or tweak your current designs by making the wings or flaps larger, smaller, or even different shapes. How does each change affect the flight?

CONCLUSION

How well a paper airplane is balanced is one thing that affects its flight. If it was folded sloppily, it won't be balanced and won't fly well. Like with real airplanes, aerodynamic forces—lift, weight, thrust, and drag, affect how well a paper airplane flies. Paper airplanes only weigh as much as the paper, although some designs add weight to the nose to help it fly farther. The design of the wings, such as their final shape and any flaps you created, will affect the lift, or the force pulling a plane up. You controlled the thrust by how fast, how hard, and the angle at which you threw the planes. Pointier planes can reduce drag because they don't catch as much air. Can you use what you learned to create a better paper airplane design?

LOOPY AIRPLANES

QUESTION

What four forces combine to make an airplane fly?

MATERIALS

computer paper
scissors
clear tape
straws (longer ones with no bending neck)

PROCEDURE

1. Cut 2 strips of paper. One strip should be 1/2-inch wide and 9 inches long (1.3 cm x 22.9 cm). The second strip should be 1/2-inch wide and 7 inches long (1/3 cm x 17.8 cm).
2. Tape the ends together on both strips of paper to create 2 loops.
3. Tape the large loop to the straw about inch from its end. Tape the smaller loop about 1 inch from the other end the straw. Make sure both loops are taped to the same side of the straw. The plane will not fly as well if the loops do not stand up straight on the straw. (If you have trouble taping the loops to the straw you can also overlap the 9-inch strip one inch and tape the ends together so that a straw can slip in between the overlapped edges. Repeat with the 7-inch strip as well.)
4. Place your pointer finger over the back end of the straw (where the largest loop is located).
5. Hold the straw between your thumb and another finger. Push your pointer finger forward with a quick motion to make your plane fly. If built correctly, the loop airplane should fly about 20 or 30 feet. If it doesn't fly far enough, try moving the loops closer together. Then, try moving the loops further apart.
6. To extend the experiment, try making the loops larger, thinner, or wider to see if they will fly further. What happens when you tape 2 or 3 straws together with additional loops?
7. Record how many feet each type of plane traveled.

CONCLUSION

Four forces are acting on loop airplanes as they fly through the air. The four forces are gravity, lift, thrust, and drag. The force of *gravity* is always pulling airplanes toward Earth. The *lift*, provided by the loops on this airplane, provides the force that keeps it in the air. The *thrust* is provided by your finger as you push the straw at the back of the loop airplane. The *drag* is the resistance pulling back on your airplane as it flies through the air.

PINWHEEL POWER

QUESTION

Which pinwheel configurations are the most sensitive to a wind source?

MATERIALS

2 pinwheels, 7 or 8 blades each
2 stacks of books
measuring tape
sticky notes
hair dryer
scissors

PROCEDURE

1. Prop up one of the pinwheels between two tall stacks of books in a room that is draft-free.
2. Pull out several feet of the measuring tape and lock it. Place it on the floor so it extends from the base of the pinwheel.
3. Label the sticky notes from 0–7 or 8, depending on how many blades your pinwheel has.
4. Stand in front of the pinwheel with the hair dryer. Turn the hair dryer on low and hold it level with the pinwheel. Be sure it does not touch the pinwheel to avoid burning it. Slowly back up until the pinwheel stops turning. Turn off the hair dryer. Mark the distance at which the pinwheel stopped turning by placing the sticky note on the floor at that distance. Use the sticky note that corresponds to how many blades the pinwheel has (7 or 8).
5. Have an adult cut a blade off the pinwheel.
6. Reposition your pinwheel between the stacks of books. Repeat steps 4–5 until there is only one blade left. Keep the pinwheel as symmetrical as possible each time you remove a blade. Record your measurements in a table and remove the sticky notes.
7. Repeat steps 3–6 with the other pinwheel, this time turning the hair dryer on high power. What do you notice? As more blades were cut off, what happened to the measurements? Did using high or low power affect the distance? Did being symmetrical (even number of blades) or asymmetrical (odd number of blades) affect the distances?

CONCLUSION

The pinwheel represents the visible part of a wind turbine. Turbines use the spinning to create power or do work. The two most important factors of a wind turbine's operation are the design and configuration of its blades. The blades are shaped like an airplane wing, with the rear side being much more curved than the front side. About 90 percent of today's wind turbines have three rotor blades. A one-bladed turbine is the most efficient, but it is not very practical because it can be unstable. Turbines with two blades offer the next best design, but often wobble. A turbine with three blades has very little vibration, so it has the best combination of high speed and minimum stress.

LOADED WITH ENERGY!

QUESTION

How does stored energy become energy in motion?

MATERIALS

- 2 clear plastic cups
- 4–5 standard rubber bands

PROCEDURE

1. Wrap a rubber band around one cup, from top to bottom.
2. Wrap a second rubber band around the cup in the same way, crisscrossing the other band. There should now be an "X" on the open end of the cup.
3. Use the remaining rubber bands to wrap around the body of the cup, securing the first two in place. This cup will be the rocket. The second cup will be the launch pad.
4. To launch the rocket, place the plain cup (launch pad) on the ground or table with the open side down. Place the rubber-banded cup (rocket) on top of the "launch pad" so that the rubber bands at the open end of the cup rest on the solid bottom of the launch pad.
5. Holding the sides of the rocket, push the cup down over the launch pad, stretching the rubber bands. Observe how the rubber bands stretch over the cup. Then, release the rocket!
6. Do you think the rocket would go farther or faster using different-sized cups or different amounts or configurations of rubber bands? Try it and see what happens.

CONCLUSION

When the cup was pushed over the other cup, the x-shaped rubber bands acted like springs to launch the rocket. When you pushed the cup over the other cup, you exerted a force. When a rubber band is stretched, it is ready to do something. That stretching involves work and increases the potential energy stored in the rubber bands. Many objects are designed specifically to store elastic potential energy, such as an archer's stretched bow, the twisted rubber band which powers a toy airplane, or a bouncy ball (compressed until the moment it rebounds off the sidewalk). After they are released, the potential energy changes into kinetic energy, or the energy of motion. When you released the cup, the rubber bands sprang back into place, forcing the cup to fly up like a rocket.

CRAZY CAN CONVERSION

QUESTION

How does changing energy from potential to kinetic and back create movement?

MATERIALS

- cardboard oatmeal canister
- nail
- rubber band
- 9-volt battery
- 2 paper clips
- tape

PROCEDURE

1. Place the lid of the can on the bottom.
2. Have an adult use the nail to make a hole in the middle of the bottom of the can (through both the lid and can itself). Separate the lid from the can.
3. Tape the middle of a rubber band to one end of a 9-volt battery. Make sure both parts of the rubber band are taped to the end of the battery. The battery should hang down from the rubber band. Do not tape it in the middle of the battery.
4. Push one end of the rubber band through the hole in the bottom of the can. Secure it by attaching it to one of the paperclips and taping the paper clip to the bottom of the can.
5. Stretch the rubber band across the length of the inside of the can and pull the end through the hole in the lid. Again, secure the rubber band with a paper clip and tape it flat against the lid. The battery should be hanging down in the center of the can, but not touching the can. If the battery touches the can, use a shorter rubber band.
6. Set the can on its side on a hard surface and roll it. Once it stops, it will roll back to you. Does how hard you roll it make a difference? Try harder and gentler pushes. What happens?

CONCLUSION

When you roll the can, it has kinetic energy. As it slows down, the energy is transferred into potential energy in the twisted rubber band inside the can. The rubber band's potential energy is then transferred back to the can in kinetic energy as it unwinds. This energy transfer comes from the battery that is taped to the rubber band inside the can. Gravity pulls the battery down, so it stays in place and twists the rubber band. As long as the force of gravity on the weight is greater than the twisting rubber band's force on the weight, the rubber band will keep twisting. Once all of the kinetic energy from the rolling can has been exhausted by converting to heat (friction) or potential energy (the twisted rubber band), the can stops rolling and the weighted rubber band is able to unwind. Because of the weight in the middle of the rubber band, only the ends of the loop are able to unwind and the can rolls backward. So, energy is never just gone. It converts to different forms, which in this case keep the can rolling.

TAKING THE TEMPERATURE

QUESTION

What kind of material makes the best insulator?

MATERIALS

- 7 identical drinking glasses
- warm water (about 98°)
- thermometer
- 6 different materials (denim, linen, cotton, lace, leather, fleece, nylon, wool, silk, felt, craft foam, aluminum foil, etc.)
- tape (optional)
- rubber bands (optional)

PROCEDURE

1. Fill each glass with warm water of the same temperature. Use a thermometer to get the beginning temperature and record it.
2. Wrap each of 6 glasses with one of the materials. It may be helpful to use tape or rubber bands to secure each wrap. Leave one glass of water unwrapped. Number each glass from 1–6. After each number, write the type of material covering the glass.
3. Wait 15 minutes. Then, check the temperature of each glass. Record the current temperature of the water for each glass.
4. Check your notes. Which materials increased the water temperature? Did any of them decrease the water temperature? Did any of them stay the same? Which fabrics would make good insulators?

CONCLUSION

Materials that keep heat from passing through them are good insulators. They are called thermal insulators. Good thermal insulators will keep hot objects hot and cold objects cold. Some materials are better than others as thermal insulators, as you saw in your experiment. You probably noted that heavier, denser materials such as leather or denim kept the water at the same temperature. Lighter, more porous materials such as lace or cotton may have allowed the water to cool. Did any of the fabrics cause the temperature to rise? You can think about this the next time you dress for cold weather!

HOT ENOUGH TO FRY AN EGG

QUESTION

Can the power of the sun cook an egg?

MATERIALS

- 2 eggs
- aluminum foil
- flat and level cement pad or sidewalk
- hot, sunny day (at least 90°F or 32°C)

PROCEDURE

1. Find a spot on the sidewalk or driveway outside in direct sunlight.
2. Crack the first egg directly onto the cement.
3. Lay a sheet of aluminum foil (about the size of a frying pan), shiny side up, directly next to the egg on the cement. Curl up the edges of the foil so that the second egg does not run off of it. Crack the second egg onto the foil.
4. Observe what happens to each of the eggs. Create a chart with four times in thirty-minute intervals. Describe what each of the eggs look like at each timed interval. Which egg is done first? Record the results in the chart.
5. Discard the eggs. Do not eat the eggs that were used in this experiment.

CONCLUSION

The change in the egg's form from a fluid to a solid or semi-solid form happens because of temperature. Egg whites begin to solidify at 144°F (62°C), while the yolk begins to solidify at 149°F (65°C). The egg cooks faster on the aluminum foil because the foil's reflective surface concentrates the solar energy back onto the egg instead of through the cement. The heat and light energy of the sun is enough to cause a chemical change in the egg.

Caution: *Before beginning any food activity, ask families' permission and inquire about students' food allergies and religious or other food restrictions.*

OH, BUOY!

QUESTION

How does the density of water help an object float?

MATERIALS

- table salt
- 2 clear medium-sized bowls (third bowl optional)
- water
- measuring cups and spoons
- 2 eggs
- miscellaneous objects, like pennies, erasers, action figures, washers, etc. (2 of each object)
- baking soda (optional)

PROCEDURE

1. Pour 2 cups of water in each bowl.
2. Dissolve 1/3 cup of table salt in one of the bowls. (Use warm water to more easily dissolve the salt.)
3. Carefully place an egg into each bowl. What happens? Does the egg sink or float in the salt water? Does the egg sink or float in the fresh water?
4. Remove the eggs. Continue dropping different objects into the two bowls. Make a chart to record which items floated or sank in each bowl.
5. To extend the experiment, try dissolving 1/3 cup of baking soda in a third bowl of warm water. Repeat the procedure. Does baking soda produce the same results as salt?

CONCLUSION

As the salt water dissolves in the warm water, it adds mass to the water. This makes the water denser and allows some objects to float higher than in plain water. Objects also float higher in baking soda water because baking soda is a kind of salt. It dissolves in water to make the water denser just as salt does. However, baking soda has another property that reacts to form carbon dioxide gas. If you look carefully, you can see tiny bubbles rising from the bottom of the cup.

DON'T BURST MY BUBBLE!

QUESTION

How are bubbles formed?

MATERIALS

- 9 oz. plastic cup
- 8 oz. of warm distilled water
- granulated sugar
- dish soap
- tablespoon
- plastic wrap
- scissors
- hollow coffee stirrer or plastic pipette
- smooth, clean work surface

PROCEDURE

1. At least a day before the activity, prepare the bubble solution. Pour eight ounces of warm distilled water into the plastic cup. Add one tablespoon of granulated sugar to the water. Add two tablespoons of dish soap to the water. Stir the solution gently until the sugar dissolves. Cover the bubble solution with plastic wrap for 24 hours.
2. For the bubble wand, use a hollow coffee stirrer. Or, cut a half-inch off the bulb end of a pipette.
3. Spread the bubble solution in a 10-inch circle on a clean and smooth work surface.
4. Dip one end of the coffee stirrer or the cut end of the pipette into the solution so that is covered completely. Then, blow in the other end to create a large bubble on the bubble solution on the work surface. (The bubble will be in the shape of a hemisphere.)
5. Coat and dip the coffee stirrer or pipette again in the bubble solution. Gently push it inside the first bubble. If the length of the coffee stirrer or pipette is not covered in bubble solution, it will pop the original bubble. Slowly, blow a second bubble on the surface inside the first bubble. Try for a third or a fourth bubble by repeating the process!
6. Observe how the outer bubbles change as you blow each new bubble inside. Pay attention to the colors and patterns on the surface of each bubble. Do they change before the bubble is about to pop?

CONCLUSION

Water is made up of tiny molecules that attract and stick to each other. The molecules on the very top of water and other liquids stick together very closely to create surface tension. Blowing bubbles with regular water will create small, weak bubbles that do not last very long. Adding dish soap to water changes the surface tension. Adding other things such as sugar or corn syrup improves the chances of better, stronger bubbles. In the experiment, when you blew a bubble inside a bubble, the outer bubble expanded a little to accommodate the inner bubble's volume. The combination of soap and sugar in the bubble solution formed bonds in the water that could stretch, allowing you to blow bubbles inside bubbles.

Name ______________________________ Date ______________

STEM Challenge Recording Sheet

CARD	TITLE

Did you complete the challenge? Why or why not?	Explain how your creation works. Why is your design the best?

Use each space to answer the question, plan for a design or change, or reflect on the information given.

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Name ______________________________ Date ______________

STEM Design Process

Ask

What do you already know? What do you need to know to get started? Where can you find the information you need?

____

____

____

Imagine

What are the possibilities? Come up with several different options.

____

____

Plan

Choose an idea. Draw a model and label it. Consider making different models for each stage of construction or separate diagrams of more complex parts.

What are your steps? Use your drawing to guide your plan. Number your steps and write clearly so that others can understand them.

____

____

____

Create

Follow your plan to create your model. What worked? What didn't? What did you need to change as you went through your plan? Why?

Improve

How could you improve your model? Do you need to start over, or can you redo a single part? If it works, can it work even better?

Communicate

How well did it work? Is the problem solved? Write a statement to describe how your model meets the guidelines of the task and why it is successful.

Reflect

Did your design meet the challenge? Are you happy with how it turned out? What would you tell someone else before they start this challenge? Why?