

Mad Science® Presents:
STEM-tastic
After-School Science!



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Welcome to STEM-Tastic After-School Science!

Throughout this workshop you will discover the wonders of science through a hands-on and interactive presentation. Mad Science will show how to STEM-ify science activities in a way that's fun, exciting, and most of all, educational. The experiments presented will be simple to understand and even easier to reproduce.

Our Mission

Mad Science strives to spark the imagination and curiosity of children everywhere! Our goal is to provide children with fun, entertaining, and exciting activities that instill a clear understanding of what science is really about and how it affects the world around them.

Introduction to Mad Science

Our target age group is mainly children aged 5-12. We also offer preschool workshops for children aged 3-5. Our main areas of programming include after-school programs, summer camps, birthday parties, special events and a variety of in-class workshops that are correlated to state science standards and the NGSS.

Educator's Workshop Manual

This manual is filled with hands-on STEM experiments for budding scientists at any grade level. Today, we will be going through a number of them so you can understand the value of hands-on experimentation in the classroom, and see how easy it can be to implement these types of activities in your science program. Let's get started!

STEM – Science, Technology, Engineering, and Math.

What is STEM?

STEM is an acronym of the fields of Science, Technology, Engineering, and Math.

Science seeks to understand the natural world.

Technology means making modifications in the natural world to meet human wants and needs, from improving our health and comfort to moving us forward and doing things more efficiently.

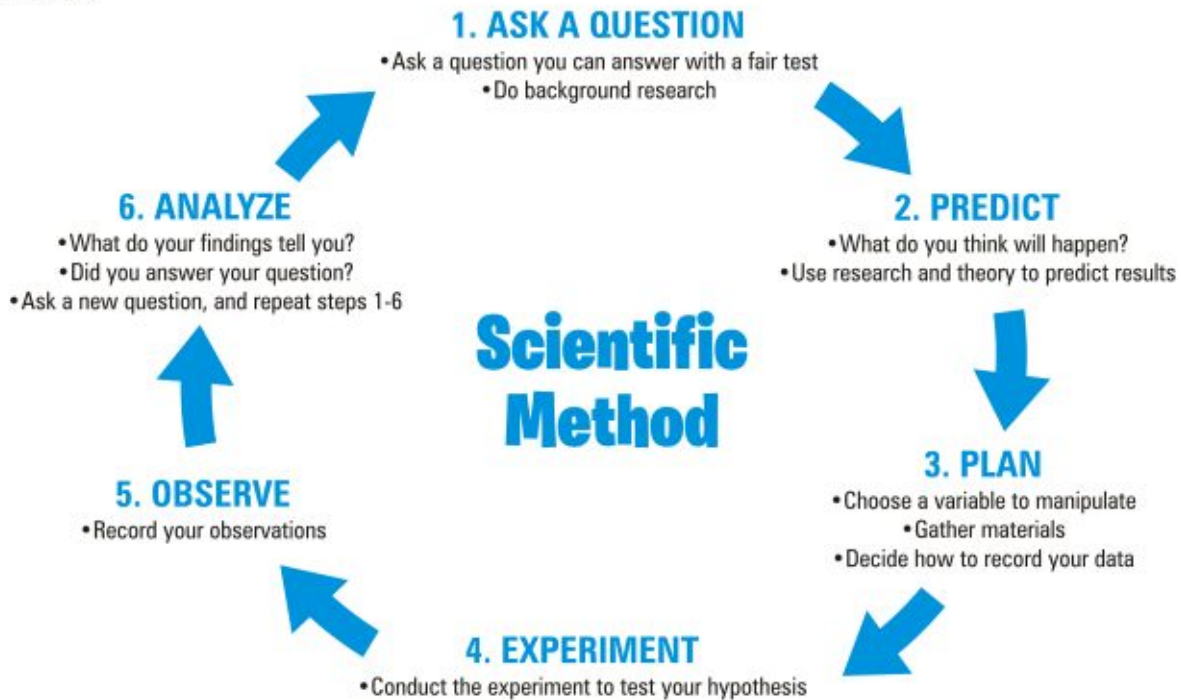
Engineering involves applying knowledge of math and science to design solutions for problems while taking constraints into consideration.

Math is the study of patterns or relationships.

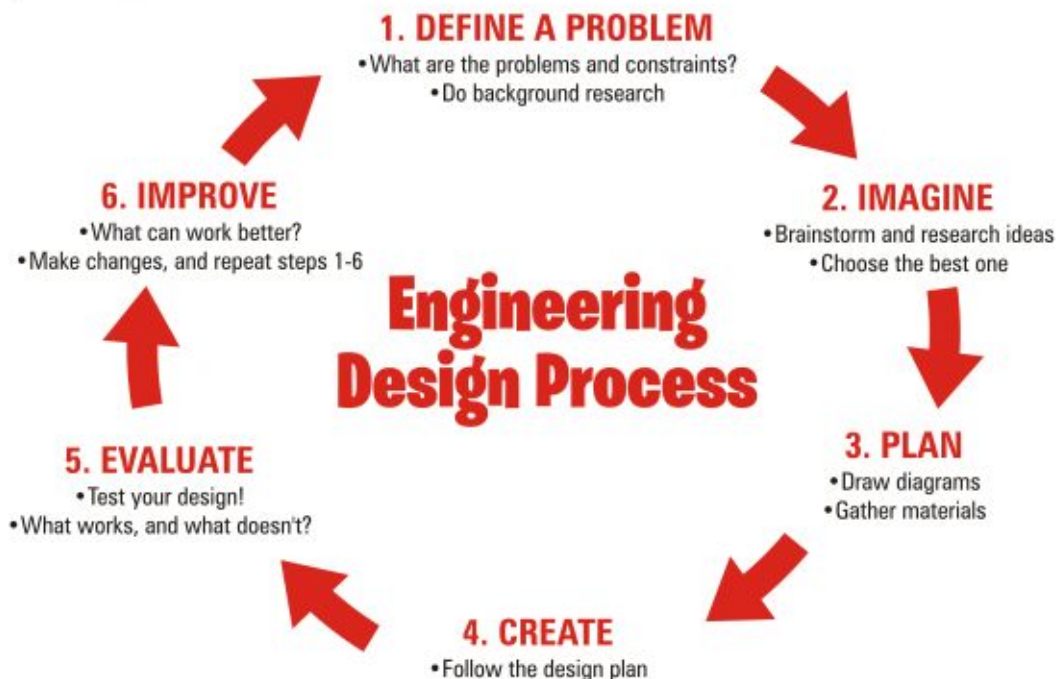
STEM can be seen as a framework for solving problems, by using science and mathematics to understand the universe, and using engineering and technology to interact with it!

The Difference Between Science and Engineering

Science is the study of how the world works. Scientists ask questions and seek answers, often using the Scientific Method:



Engineering is the practical application of scientific knowledge to design solutions to problems, often using the Engineering Design Process:



How to STEM-ify

How can you STEM-ify your educational programming? Focus on problem-solving, and have the children communicate and collaborate to come up with solutions using inquiry, logical reasoning, and strategically applied technology. Include real-world connections to keep it relevant for kids!

How can I include...

Science?

- Have the children ask questions, create and test hypotheses, observe, and use the Scientific Method.

Technology?

- Challenge the children to make changes to meet a need, or to use the best tools to meet their needs.

Engineering?

- Challenge the children to design a solution to a problem using the Engineering Design Process.

Math?

- Involve logical reasoning, patterns, relationships, sorting and measurement.

As you read through the experiments in this booklet, think about how you can use these ideas to add even more STEM power to your activities and lesson plans.

HANDS-ON – Activities to print and try with your students

Use these fun, hands-on activities to get elementary school children excited about science. Try adding some measurement, problem-solving, creative design, or technological tools to STEM-ify these activities!

Petal Press

What you need:

- Wide bowl filled with water
- Construction paper (standard paper will not work)
- Scissors
- Pencil

What you do:

Step 1: Cut the construction paper into a square that fits inside the bowl with the pencil.

Step 2: Fold the paper in half again to make a square. Make sure that you fold it in half again to make a triangle.

Step 3: Fold it in half again to make a triangle. Fold the corner that has been marked with the pencil down to the center and cut a petal shape.

Step 4: The corner at the triangle that has been marked with the pencil is the corner that will make a flower.

Step 5: Use a pencil to cut the petals of the flower so that it looks like a flower.

Step 6: Drop the flower into the water and watch the petals. What happens?

What's going on:

You used capillary action to make your flower bloom! Water acts like a skeleton, allowing the leaf to hold itself up. When leaves are on a plant and become dry, they lose pressure. The plant is not dead when this happens, but the stem of a plant is a transportation system that carries molecules of water and the sides of capillaries in the stem up the paper to make your flower bloom!

Now try this:

Try this experiment with other flower designs, like shapes and numbers of petals. What happens on newspaper or tissue paper?

Thaumatrope

What you need:

- String
- Printed Thaumatrope images – bird and cage, fish and bowl
- Sharp pencil
- Glue stick
- Over stick

What you do:

Step 1: Cut out one set of two circles – either the bird and cage or the fish and bowl. Keep the two circles attached to each other.

Step 2: Use the pencil to punch holes through the two small circles marked at the edges on each of the two paper circles. Make sure to line up the holes.

Step 3: Spread glue on the blank side of one paper circle. Fold the other paper circle down to glue the two paper circles together. Make sure to line up the holes.

Step 4: Cut two short lengths of string, each about 30cm (12") long.

Step 5: Tie one string to each hole. This is your thaumatrope!

Step 6: To see your thaumatrope, hold one string in each hand, and spin the thaumatrope like a skipping rope. Gently pull the strings to unwind them and look at the center of the spinning thaumatrope. What happens?

What's going on:

The name thaumatrope ("THAW-ee-trope") has Greek roots. In English, it means, "wonder tamer". If you spin the thaumatrope quickly, you see the bird inside the cage, or the fish inside the fishbowl. If you spin it more slowly, you will see more flicking between the two pictures. Your eyes see two images as one image if they move fast enough. You see the same thing happen when you watch a movie – this is due to a phenomenon called "persistence of vision".

Now try this:

You can draw your own images to create a new thaumatrope! Draw two images that will overlap, or draw two halves of a picture that will make a whole. Make sure that one image is upside-down relative to the other image. Put the two images back-to-back and look at them against a light. They should line up! Here are some examples of pictures you can try out:

- Flowers in a field
- Head with a tail
- Bug in a jar
- Car on a road
- Leaves on a tree
- Spider on a web

Bobble Ball

What you need:

- Balloon
- Modeling clay
- Bucket

What you do:

Step 1: Roll a piece of clay into a long string, like a snake, and drop it into the balloon.

Step 2: Roll the balloon between your hands to form a ball of clay inside the balloon.

Step 3: Inflate the balloon and tie it.

Step 4: Place the bucket about 10 steps away from you. Try to toss the balloon into the bucket. What happens?

What's going on:

You changed the balloon's center of gravity! The center of gravity is the place where an object's weight is balanced. If an object is made up of one kind of material, like wood or stone, the center of gravity is usually in the middle of the object. A balloon's center of gravity is near its middle too, but you changed this by adding the clay. The clay is heavier than the balloon, and it bounces around inside. This is why the balloon moves in such a strange way.

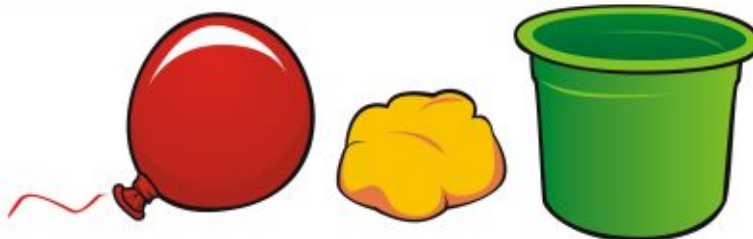
Now try this:

What happens if you change the shape of the clay ball or add two clay balls to the balloon?

Bobble Ball

What you need:

- Balloon
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- Bucket



What you do:

Step 1: Roll a piece of clay into a long string, like a snake, and drop it into the balloon.

Step 2: Roll the balloon between your hands to form a ball of clay inside the balloon.

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What happens?

Step 1:



Step 2:



Step 3:



Step 4:



What's going on:

You changed the balloon's center of gravity! The center of gravity is the place where an object's weight is balanced. If an object is made up of one kind of material, like wood or stone, the center of gravity is usually in the middle of the object. A balloon's center of gravity is near its middle too, but you changed this by adding the clay. The clay is heavier than the balloon, and it bounces around inside. This is why the balloon moves in such a strange way.

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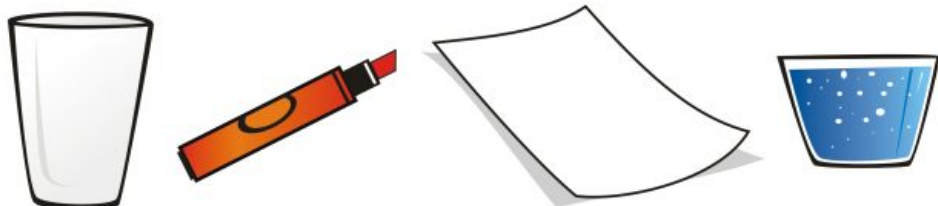
What happens if you change the shape of the clay ball or add two clay balls to the balloon?



Water Arrow

What you need:

- Thick walled drinking glass
- Marker
- Paper
- Water



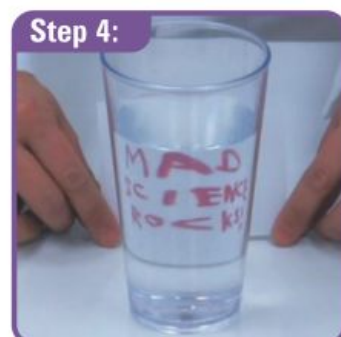
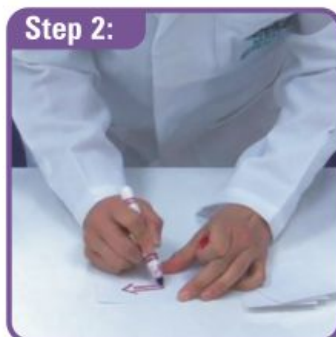
What you do:

Step 1: Fill a drinking glass with water.

Step 2: Use the marker to draw an arrow on the paper. Make sure the arrow is no wider than the glass.

Step 3: Look through the water in the glass. Move the paper behind the glass. What do you notice?

Step 4: Write a backward message on the back of the paper. Move the message behind the glass. What do you read?



What's going on:

The arrow points in the other direction behind the glass! This is because of something called refraction. Refraction refers to the way light rays bend. When light moves from the air to the water and back, it bends. The light rays bend at an angle when they move into the water from the air. The rays cross each other inside the glass. This is why you see a mirror image of your arrow through the glass.

Now try this:

It's time to play with light! Change the distance between your arrow and the glass. Does this make a difference in what you see through the glass? Try this refraction experiment with different shapes!



Balancing Act

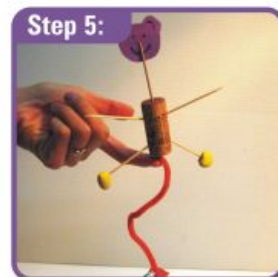
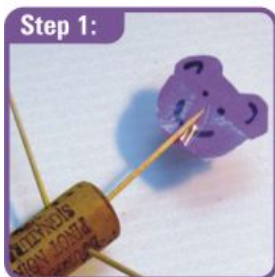
What you need:

- Bottle cork
- Construction paper
- Markers
- Scissors
- Tape
- Modeling clay
- 5 toothpicks
- Pipecleaner
- Steel washer



What you do:

- Step 1:** Draw and cut out an animal head from the construction paper. Tape the head to a toothpick and stick it into the top of the cork.
- Step 2:** Stick the other four toothpicks into the cork to make arms and legs. Wrap the ends of the toothpick with modeling clay to make feet.
- Step 3:** Try to balance your animal on your finger. Poke your animal. Does it stay balanced?
- Step 4:** Wrap one end of the pipe cleaner around the washer.
- Attach the other end to the cork to make a tail for your animal.
- Step 5:** Try to balance your animal on your finger. Poke your animal. Does it stay balanced?



What's going on:

You've found the center of gravity! The center of gravity is the point at which an object balances. Your animal balances when its center of gravity is below its pivot or support point. The washer lowers the center of gravity and allows your animal to balance. Your animal should rock but not tip over if you poke it. Many tightrope walkers carry a sagging bar or pole to help lower the center of gravity as they balance on the narrow rope.

Now try this:

Would your animal balance easier if its tail was heavier? Add another washer to find out!

Cone Car

What you need:

- Round-bottom drinking cup
- Cardboard
- Jumbo Straws
- Regular Straws
- Paper (2 sheets)
- Paper plate
- Pencil
- Scissors
- Ruler
- Tape



What you do:

Step 1: Use the cup bottom as a template to draw four circles on the cardboard. These are your wheels. Draw one more circle on the piece of paper, and cut it out.

Step 2: Fold the paper circle in half twice, and unfold it. Use a pencil to poke a hole at the middle point where the fold lines cross.

Step 3: Cut out the wheels. Use the paper circle to mark the centers, and use a pencil to poke a hole in the center of each wheel.

Step 4: Cut the jumbo straws so they are about 2cm (3/4") shorter than the regular straws. Tape a jumbo straw to each end of the plate. Use a ruler to make sure they are parallel.

Step 5: Push a wheel onto the end of a regular straw. Repeat for the second regular straw. Slide each regular straw into a jumbo straw, and then put the other two wheels on. Flip the plate onto its wheels to make sure it rolls easily.

Step 6: Make a paper cone, and tape it on top of the plate. You made a cone car!

Step 7: Blow into the cone to propel your car.



What's going on:

You made a wind-powered car! The cardboard wheels spin around the straw axles, and the cone acts like a sail. The pointed end of the cone reduces drag by parting the air as the car moves forward. The open end of the cone catches the air that you exhale and pushes the car forward.

Now try this:

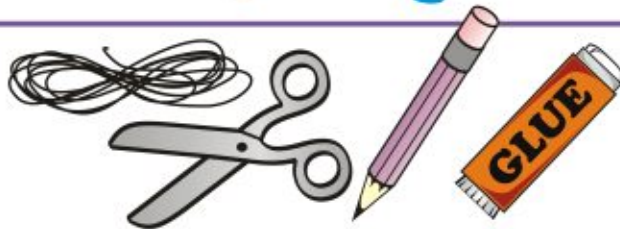
What happens if you attach the cone at an angle, or change its size? Try changing your cone car to see if you can make it go faster!



Thaumatrope

What you need:

- String
- Scissors
- Sharp pencil
- Glue stick
- Printed Thaumatrope images – bird and cage, fish and bowl



What you do:

- Step 1:** Cut out one set of two circles – either the bird and cage or the fish and bowl. Keep the two circles attached to each other.
- Step 2:** Use the pencil to punch holes through the two small circles marked at the edges on each of the two paper circles.
- Step 3:** Spread glue on the blank side of one paper circle. Fold the other paper circle down to glue the two blank sides together. Make sure to line up the holes.
- Step 4:** Cut two short lengths of string, each about 30cm (12") long.
- Step 5:** Tie one string to each hole. This is your thaumatrope!
- Step 6:** To use your thaumatrope, hold one string in each hand, and spin the thaumatrope like a skipping rope to wind it up. Gently pull the strings to unwind them and look at the center of the spinning thaumatrope. What do you see?



What's going on:

The name thaumatrope ("THAW-ma-trope") has Greek roots. In English, it means, "wonder turner". If you spin the thaumatrope quickly, you see the bird inside the cage, or the fish inside the fishbowl. If you spin it more slowly, you will see more flickering between the two pictures. Your eyes see two images as one image if they move fast enough. You see the same thing happen when you watch a movie – this is due to a phenomenon called "persistence of vision".



Now try this:

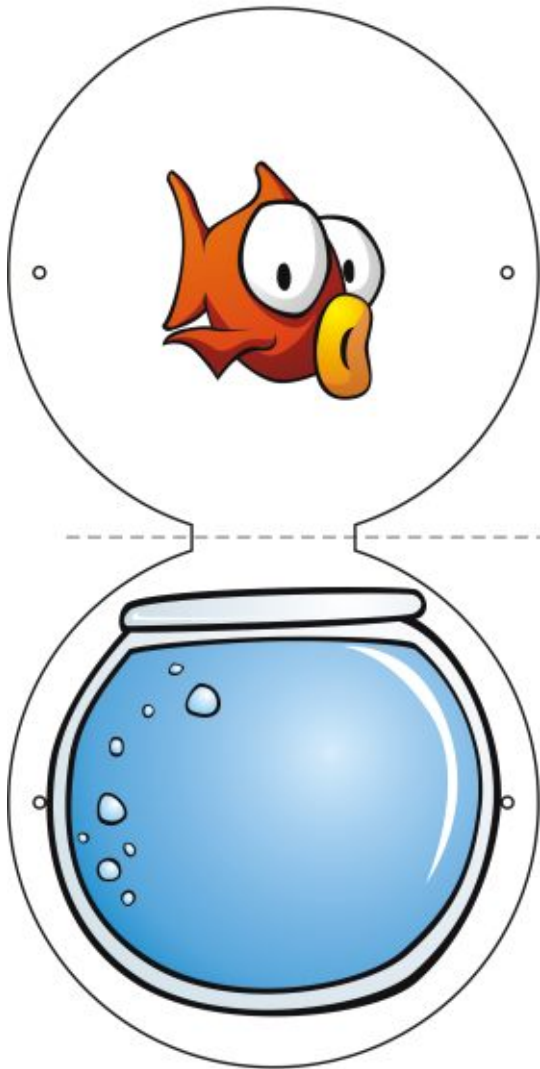
You can draw your own images to create a new thaumatrope! Draw two images that will overlap, or draw two halves of a picture that will make a whole. Make sure that one image is upside-down relative to the other image.

Put the two images back-to-back and look at them against a light. They should line up! Here are some examples of pictures you can try out:

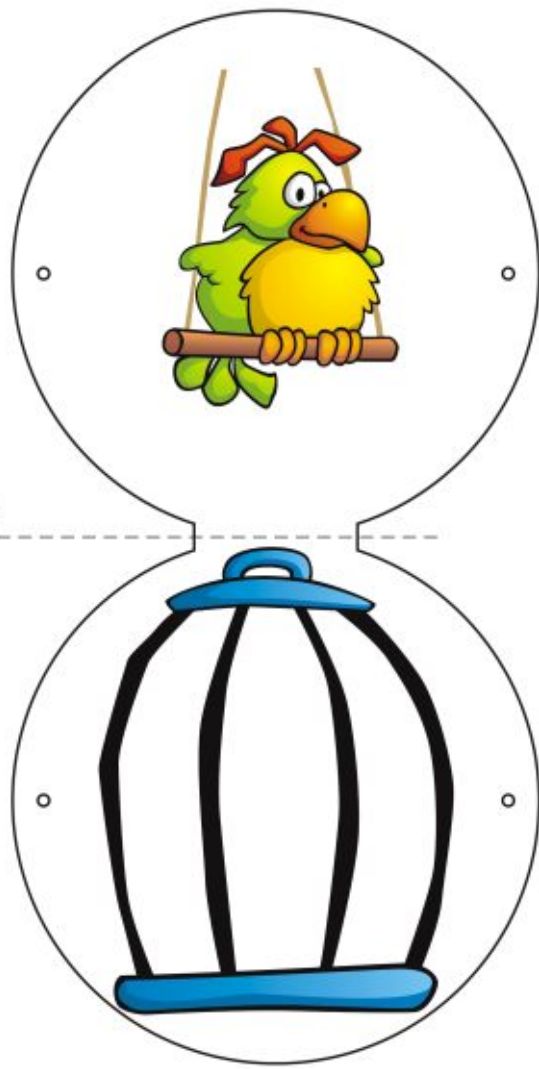
- Flowers in a flower pot
- Head with a face
- Bug in a jar
- Car on a racetrack
- Leaves on a tree
- Spider on a web



Thaumatrope 1



Thaumatrope 2



Milk-O-Rama!

What you need:

- 250mL (1 cup) milk (whole milk, if possible)
- 3-4 different bottles of food coloring
- Pie plate
- Liquid soap



What you do:

Step 1: Fill a pie plate with room temperature milk.

Step 2: Add a few drops of food coloring to the milk. Make sure to use different colors!

Step 3: Put a single drop of liquid soap in the middle of your plate, and watch your milk colors explode!



What's going on:

Milk contains fats and proteins in solution. Any change in the solution (for example, adding soap) affects these fats and proteins. By adding food coloring, we can observe the effect the soap is having on the molecules, which are twisting, bending and swirling into all kinds of different shapes. The soap has weakened the surface tension, which is the watery skin that holds the liquid's molecules together. This creates the explosion of different colors!

Now try this:

Try using cold milk... does the temperature of the milk have any effect? What happens when you use different kinds of milk, like skim or 2%? Be daring, and try half-and-half, or even cream!



Ketchup Diver

What you need:

- Small ketchup packet (like those found at “fast food” restaurants)
- Large clear plastic soda bottle with cap, cleaned and rinsed, (with label removed)
- Water



What you do:

Step 1: Choose a ketchup packet that floats in water.

Step 2: Fill the soda bottle with water and place the unopened ketchup packet inside. Screw the cap on tightly.

Step 3: Squeeze the bottle to make your ketchup packet dive.

Step 4: Release the bottle to make the packet head back to the top!

Step 1:



Step 2:



Step 3:



Step 4:



What's going on:

If you examine a ketchup package, you will notice that it is kind of squishy. This “squishiness” shows that the package is not completely filled, but contains some air as well. This air allows the packet to dive and surface! Squeezing the bottle pushes the water against the packet. Air can be squeezed easier than liquids, so the air in the packet gets squished instead of the ketchup. Squishing air makes it smaller. The bubble inside the packet shrinks when you squeeze the bottle. As the bubble in the packet shrinks, the packet becomes heavier relative to the water around it, and the packet sinks. When you release the pressure on the bottle, the air in the packet expands again. As the bubble in the packet expands the packet becomes lighter relative to the water around it, and the packet floats, right back up to the top!

Now try this:

Get some other condiment packets such as relish, soy sauce or vinegar. Can you make these packets sink and float as well?



Petal Pressure

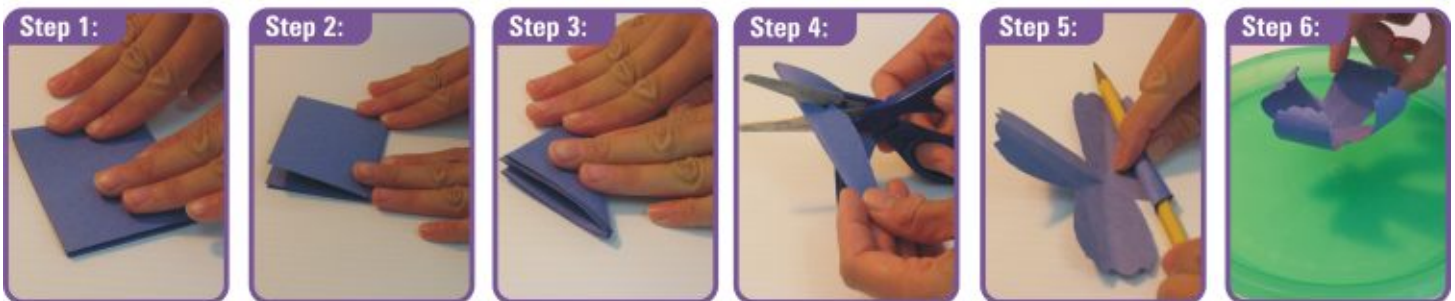
What you need:

- Wide bowl filled with water
- Construction paper (standard paper will not work)
- Scissors
- Pencil



What you do:

- Step 1:** Cut the construction paper into a square that fits inside the bowl. Fold it in half. Mark the center of the fold with the pencil.
- Step 2:** Fold the paper in half again to make a square. Make sure that you can still see the pencil mark.
- Step 3:** Fold it in half again to make a triangle.
- Step 4:** The corner of the triangle that has been marked with the pencil is the middle of your flower. Do not cut this corner! Start 1 cm (3/8") from this corner and cut a petal shape out of the rest of the triangle. Unfold the paper, and you will have made a flower!
- Step 5:** Use a pencil to curl the petals of the flower so that it looks as if the flower is closed.
- Step 6:** Drop the flower into the water and watch the petals. What happens?



What's going on:

You used capillary action to make your flower bloom! Water has many important properties and functions. In plants, water acts like a part of a skeleton, allowing the leaf to hold itself up. This pressure that keeps leaves up is called turgor pressure. When leaves on a plant wilt and become droopy it is because there is not enough water to maintain this pressure. The plant is not dead when this happens, but it is a sign that it is time to water your plants - and soon! The stem of a plant is a transportation system filled with tiny tubes called capillaries. The attractive force between molecules of water and the sides of capillaries is strong enough to draw water up the plant, just as water was drawn up the paper to make your flower bloom!

Now try this:

Try this experiment with other flower designs. You can get different results using different shapes and numbers of petals. What happens if you use different kinds of paper, such as newspaper or tissue paper?




MINDS-ON - More in-depth, facilitated STEM Investigations

Lead these activities with groups of older children to delve into STEM at a higher level.

Audio Engineers - Constructing a Sound Booth

In this Engineering activity, children will have an opportunity to engage in the engineering design process and create their own insulated (not sound) booth based on the properties of sound waves and insulating materials.



Materials

- Cardboard boxes (one for each group)
- Scissors
- White glue
- Duct tape
- A variety of the following materials: jumbo cotton balls, craft sticks, paper towels, tissues, construction paper, newspaper, foam or clay
- A small device to play your music (portable radio, computer, iPod, MP3 player, etc.)
- Small speaker, connected to your device to play music (preferably wirelessly)
- Optional: decibel meter

Procedure

1. Explain to the children that they are going to have the opportunity to work like audio engineers and design their own sound booth. Review the concept of sound waves.
2. Divide the class into small groups and give them a few minutes to think about what types of materials they might like to use to build their sound booth. It may be helpful to provide each group with their cardboard box as inspiration. Explain that they will live the inside of the box with materials they think will best block sounds. To test their designs, the box will be placed over a speaker playing music to determine how successful they were at creating an insulated sound booth.
3. Once the children have decided on their materials, give them time to select their materials and adhere them to the inside of their boxes. Remind them to only take the items they need out of the box.
4. When they are finished, send their sound booths. Make each group describe how they designed their booth before you test it so all children are aware of the materials they used.
5. To test each sound booth, place the booth upside down over the speaker. Prepare your decibel meter if you have one. Play some music on the speaker and see how much you can hear, or how many decibels the meter detects. Be sure to play the same song at the same volume level for each booth so your results are consistent.
6. Give children the opportunity to adjust and re-test their designs based on what they observed during the initial test.

Tip: For increased accuracy, you can create a base for the booths to prevent sound from escaping out the bottom of the box.


Explanation

This experiment is designed to demonstrate that some materials are better at absorbing sound vibrations than others. Sound engineers who create soundproof music studios need to know the best kinds of insulating materials so they can produce high-quality recordings without any background noise from outside. Some materials insulate sound waves by absorbing them. Others simply them by reflecting them.

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Trophic Math - Ecosystem Energy Flow

This Math activity will provide children with an opportunity to use their measuring skills, and to learn about the energy system and about fractions and percentages, all while understanding how energy flows through an ecosystem.



Materials

- Juice: 1L (1 qt.)
- An Eyedropper
- 4 Graduated Cylinders (each: 200 mL)

Procedure

1. Set up four graduated cylinders side by side. Explain to the children that you are going to create a model ecosystem using these cylinders and a bottle of juice to help explain how energy flows through an ecosystem. Scientists use models to help them to learn more about things that are difficult to study because of their size or state.
2. Describe a food chain that includes a plant, an insect, a sparrow, and a hawk. Ask the class how much energy they think each level in a food chain will use. Explain that these are their hypotheses, or best guesses, and that you are going to conduct an experiment to see if they are accurate.
3. Ask for five volunteers to represent the following components of the ecosystem: the sun, a plant, an insect, a sparrow, and a hawk.

Explanation

The juice will represent energy. The sun has one liter or (1000 mL, 0.48 qt.) worth of energy to give to the first cylinder which has to give a fraction (Answer: 1/100) of that energy to the second cylinder. Explain that the first cylinder represents an insect, which gets only 10% of the energy from the plant. Have children calculate the amount of energy that the insect gets (Answer: 100 mL, 0.48 qt.).

Then ask your "sparrow" volunteer to use an eyedropper to measure the amount of energy that the insect gets, and then ask your "hawk" volunteer to measure the amount of energy that the sparrow gets. Have children calculate the amount of energy that the hawk gets (Answer: 10 mL, 0.48 qt.).

Explain that the hawk gets only one tenth of the energy from the insect. Have children calculate the amount of energy that the hawk gets (Answer: 10 mL, 0.48 qt.).

Finally, ask your "hawk" volunteer to use an eyedropper to measure the amount of energy that the hawk gets. Have children calculate the amount of energy that the hawk gets (Answer: 1 mL, 0.48 qt.).

Discuss the following questions to discuss the results: Which organism was the most efficient at getting energy? Which organism was the least efficient? How much energy did each organism get? How much energy was lost at each level? How much energy was gained at each level? How much energy was lost in the form of heat? The total energy passed from one organism to another. At each level of the food chain, there is less energy available. Animals located at the top of the food chain are called top predators. It takes a lot of producers to support a few top predators. Ask students to predict ecosystem levels and positions.

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Audio Engineers - Constructing a Sound Booth

In this Engineering activity, children will have an opportunity to engage in the engineering design process and create their own insulated mini sound booth based on the properties of sound waves and insulating materials.

Materials

- Cardboard boxes (one for each group)
- Scissors
- White glue
- Duct tape
- Electrical tape
- A variety of the following materials: jumbo cotton balls, craft sticks, paper towels, tissues, construction paper, newspaper, foam or cloth
- A small device to play your music (portable radio, computer, iPod®, MP3 player, etc.)
- Small speaker, connected to your device to play music (preferably wirelessly)
- Optional: decibel meter



Procedure

1. Explain to the children that they are going to have the opportunity to work like audio engineers and design their own sound booths. Review the concept of sound insulation, and discuss what types of materials they think might work for dulling or blocking sound waves.
2. Divide the class into small groups and give them a few minutes to think about what types of materials they might like to add to their sound booth. It may be helpful to provide each group with their cardboard box as inspiration. Explain that they will line the inside of the box with materials they think will best block sounds. To test their designs, the box will be placed over a speaker playing music to determine how successful they were at creating an insulated sound booth.
3. Once the children have decided on their materials, give them time to select their materials and adhere them to the insides of their boxes. Remind them to only take the items they agreed upon as a group.
4. When they are finished, test their sound booths. Have each group describe how they designed their box before you test it so all children are aware of the materials they used.
5. To test each sound booth, place the booth upside down over the speaker. Prepare your decibel meter if you have one. Play some music on the speaker and see how much you can hear, or how many decibels the meter detects. Be sure to play the same song at the same volume level for each booth so your results are consistent.
6. Give children the opportunity to adjust and re-test their designs based on what they observed during the initial test.

Tip: For increased accuracy, you can create a base for the booths to prevent sound from escaping out the bottom of the box.

Explanation

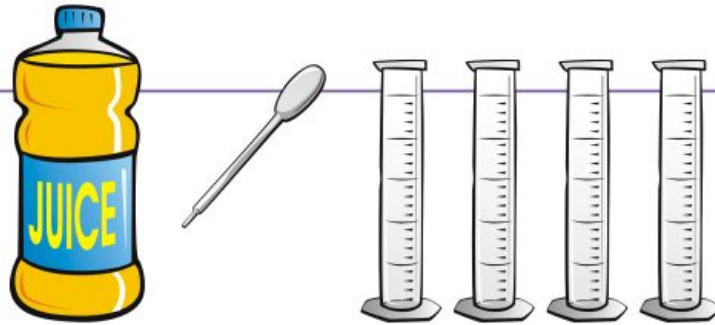
This experiment is designed to demonstrate that some materials are better at absorbing sound vibrations than others. Sound engineers who create soundproof music studios need to know the best kinds of insulation materials so they can produce high-quality recordings without any background noise from outside. Some materials insulate sound waves by absorbing them. Others amplify them by reflecting them.

Trophic Math - Ecosystem Energy Flow

This Math activity will provide children with an opportunity to use their measuring skills, and to learn about the metric system, and about fractions and percentages, all while understanding how energy flows through an ecosystem.

Materials

- Juice, 1L (1 qt.)
- An Eyedropper
- 4 Graduated Cylinders (each 100 mL)



Procedure

1. Set up four graduated cylinders side by side. Explain to the children that you are going to create a model ecosystem using these cylinders and a bottle of juice to help explain how energy flows through an ecosystem. Scientists use models to help them to learn more about things that are difficult to study because of their size or state.
2. Describe a food chain that includes a plant, an insect, a sparrow, and a hawk. Ask the class how much energy they think each level in a food chain will use. Explain that these are their hypotheses, or best guesses, and that you are going to conduct an experiment to see if they are accurate.
3. Ask for five volunteers to represent the following components of the ecosystem: the sun, a plant, an insect, a sparrow and a hawk.
4. Explain that the juice will represent energy. The sun has one liter, or 1000mL (34fl.oz.) worth of energy to give to the system. Your volunteer "sun" should measure and pour 100mL (3.4fl.oz.) into the first graduated cylinder. Explain that of that one liter of energy that the sun has to give, the plant gets 100mL (3.4fl.oz.) of it. Have children determine what this is as a fraction [Answer: $1/10$], and what it is as a percentage [Answer: 10%].
5. The second cylinder represents an insect, which gets only 10% of the energy from the plant. Have children calculate this volume, and then ask your "plant" volunteer to measure and pour out this amount of the juice from the first cylinder into the second [Answer: 10mL (0.34fl.oz.)].
6. The third cylinder represents a sparrow, which gets only one tenth of the energy from the insect. Have children calculate this volume, and then ask your "sparrow" volunteer to use an eyedropper to measure this amount of the juice from the second cylinder, and transfer it into the third cylinder [Answer: 1.0mL (0.034fl.oz.)]. Finally, the fourth cylinder represents a hawk, which gets only 10% of the energy from the sparrow. Have children calculate this volume, and then ask your "hawk" volunteer to use an eyedropper to measure this amount of the juice from the third cylinder, and transfer it into the fourth. This represents the hawk's portion of energy as it only gets one tenth of the sparrow's energy [Answer: 0.1mL (0.0034fl.oz.)].
7. Have the class observe the results. Use the following sample questions to discuss the results: Which organism was most satisfied by the amount of "energy" (in the form of juice) that they received? Which organism was the least satisfied? What do you think happened to the 900mL (30fl.oz.) of energy from the sun that the plant did not use? What organism in the food chain will have to eat the most food to meet their energy needs?

Explanation

In ecosystems, there is a transfer of energy in the form of food from one organism to another. At each level of the food chain, about 90% of the energy is lost in the form of heat. The total energy passed from one level to the next is only about 10%. Therefore, as you move up the food chain, there is less energy available. Animals located at the top of the food chain need a lot more food to meet their energy needs. It takes a lot of producers to support a few top consumers. Math is an important tool that ecologists use to predict ecosystem trends and patterns.



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