girl scouts of eastern pennsylvania

Engineering Sampler

Grades K-5

Program Overview

The focus of this program is for girls to explore and learn more about the field of engineering through fun, hands-on activities and experiments.

There are 9 45-minute activities in this program that are age appropriate for girls in grades K-5. Some of the activities involve more complex concepts and will require hands-on assistance from adults especially for younger girls. Depending on the length of your program, you can choose as few or as many activities as you would like. There is no order in which the activities need to be done. All of the supplies needed for each activity are listed with the directions on how to complete the activity. It is recommended that you practice each activity before facilitating with a group of girls so you are aware of any issues/problems the girls might encounter.

Each activity fulfills national leadership outcomes from the Girl Scout Leadership Experience, where girls Discover, Connect, and Take Action. Girls achieve these outcomes through the three Girl Scout processes: Girl Led, Learning by Doing, and Cooperative Learning. An important piece of the activities is the reflection that you do with the girls at the end. Doing the reflection in an enjoyable way helps girls process and retain what they have learned through their Girl Scout experience. One easy way to do reflection is to ask the girl: What?, So What?, and Now What?

When choosing the activities, use the information below as a guide:

- One day program- 5 activities
- 4 week program- 6-8 activities
- Incorporate into troop meetings- 1 activity per meeting

1. Pin Wheel
2. Windsock
3. Kites
4. Rocket Launcher and Rocket
5. Fizzy Flyer
6. Screaming String Thing
7. Target Practice
8. What Gives?
9. Thrill Ride

Through these activities, girls will…..

Discover

1. Seek challenges in the world
2. Develop critical thinking

Connect

1. Promote cooperation and team building.
2. Resolve conflicts

Take Action

1. Feel empowered to make a difference in the world.

Activity 1: Pin Wheel

This activity is most appropriate for K-5th graders.

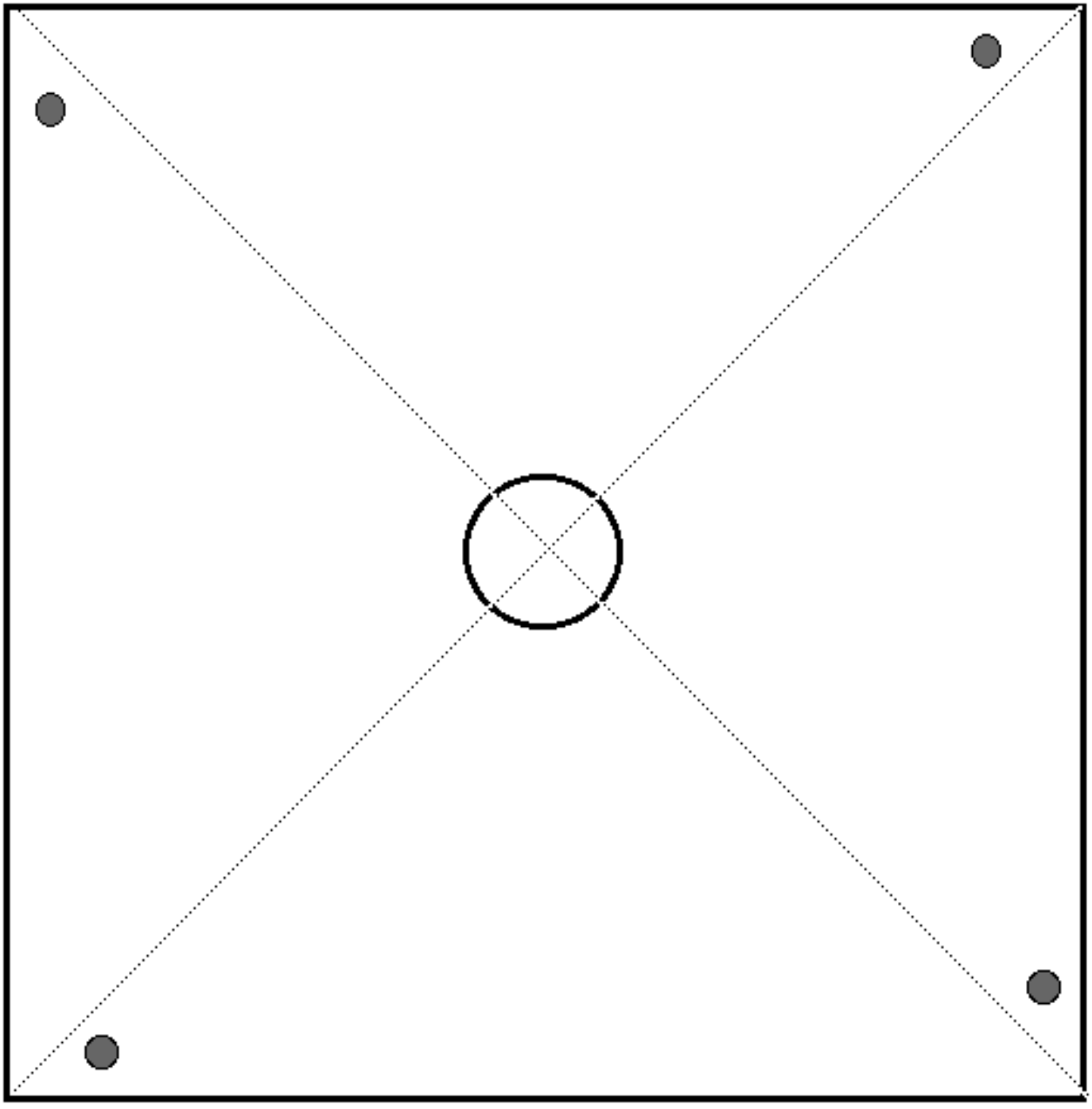
During this activity, the girls are going to be cutting with scissors and using thumbtacks. Please have them be careful and provide the appropriate adult supervision.

Introduction:
Moving air is wind. Wind is caused by warm air rising over cool air. You cannot see the wind but you know when it is around. Wind makes things move. Can you name 5 things that the wind can make move? A pinwheel will spin as the wind pushes it around.

Materials Needed:
- 1 pencil per girl
- 1 thumbtack per girl
- Markers
- 1 pin wheel page per girl
- Scissors

Procedure:
1. Break the girls into small groups of 3-4 girls per group.
2. Give each girl one piece of paper with the pin wheel drawing on it, one pencil, and one thumbtack.
3. Have the girls color both sides of the pin wheel. Have them cut out the square.
4. After the girls have cut out the square pin wheel, have each girl then cut up the diagonal lines (do not have them cut all the way up to the inner circles).
5. Next, have each girl fold the corner down with the dot on it until the point is overlapping the inner circle. Have them do this to all four corners.
6. Once the girls have folded all four of the dotted corners down, have them stick the thumbtack through the center of the pinwheel paper and then secure the thumbtack back into the side of the pencil's eraser.
7. The pin wheel should spin freely when the girls blow on it. If the pin wheel does not spin freely, have the girls pull out the thumbtack a little.

Explanation:
Pick up the pinwheel near the pencil point and let it catch the wind. You will notice that the pinwheel only spins when the wind hits its center.



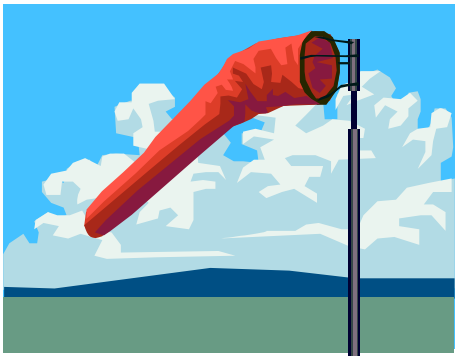
Activity 2: Windsock

This activity is most appropriate for K-5th graders.

Introduction:
What is a windsock? It's a device made of cloth or cloth-like material that is shaped like a cone, perhaps 6 feet long (but can be longer or shorter). Pilots use windsocks so they can tell what direction (and sometimes how strongly) the wind is blowing on the runway, when they land or take off.

Materials Needed:

- Colored construction paper-1 sheet per girl
- Crayons
- Stickers (optional)
- Rulers
- Tissue paper- 1 2-foot sheet per girl
- String
- Masking tape
- Hole puncher



Procedure:

1. Have the girls decorate the construction paper any way they want with the crayons and stickers.
2. Once the girls have decorated the construction paper, assist them in making a tube with the paper by taping the ends of the construction paper together with their decorated side facing out.
3. Next, have the girls cut streamers 2 feet long and tape them to the inside of the bottom of the ring.
4. Hole punch a hole in the top end of the windsock. Have the girls cut a piece of string about 3-4 feet long and insert it into the hole.
5. Tie the string into a knot so one end is very long. This long end becomes the handle for the girls.
6. Take the windsock outside and see how it works!

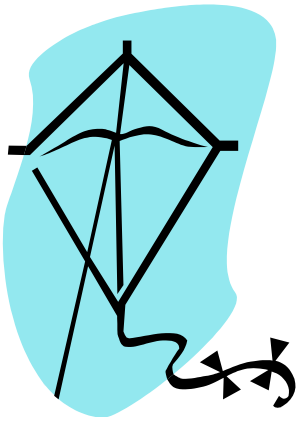
Explanation:
When the wind blows, it inflates the sock and the windsock turns so that the wide, open end faces the wind, and the short end extends behind the wide end, so that the whole windsock points in the direction the wind is blowing.

Activity 3: Kites

This activity is most appropriate for 2nd -5th graders.

Introduction:
How does a kite fly? Make your own kite and learn all about how it takes flight. Then think about what can you modify to make your kite lighter, make it spin, or give it more control?

Materials Needed:
- Large piece of thin paper or a black plastic garbage bag per girl (for the actual kite skin)
- 2 pieces of thin wood per girl (they can be round dowel or square, it doesn't matter)
- Ball of string
- Duct Tape
- Glue
- Scissors
- Crayons
- Markers
- Tissue paper
- Colored ribbons or thin strips of old fabric for decorating the tail



Procedure:
1. Trace a kite pattern onto the garbage bag and cut it out.
2. Place the wooden dowel onto the plastic. Trim if they do not fit.
3. Then tape the dowels to the plastic to hold them in place.
4. Attach the string to the middle of the kite near where the dowels intersect.
5. Cut tissue paper strips for the tail. Attach the tail to the bottom of the kite with duct tape.

Explanation:
A kite is heavier than the air, yet the air supports it, just as water supports a boat. Not only does the air support the kite, the air also lifts the kite, just like it lifts the wings of an airplane, and so the kite climbs upwards. The more wind there is, the kite will climb higher and higher.

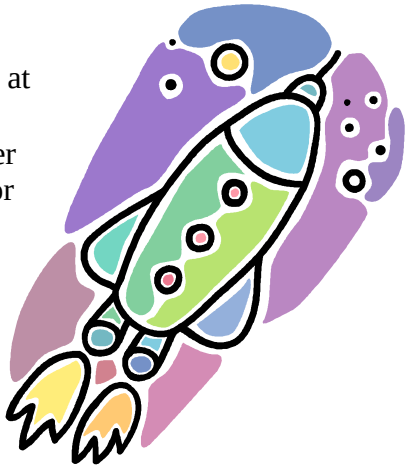
Activity 4: Rocket Launcher and Rocket

This activity is most appropriate for 4th-5th graders.

Introduction:
According to historians, rockets were first used in China in 1200 B.C. According to the Chinese, they were called "arrows of fire." The first modern rocket was invented by an American by the name of Robert Goddard. His first rocket climbed only 41 feet into the air, which is about the equivalent of a 4 story building.

Materials Needed: (per group of 3-4)
Rocket Launcher

- Empty two liter soda bottle
- 1 foot of PVC pipe with ½ inch inner diameter (available at Home Depot or similar store)
- 3 feet of clear flexible tubing with a ½ inch inner diameter and a 5/8 inch outer diameter (available at Home Depot or similar store)
- Duct tape



Rocket

- Sheet of colored paper
- Clear tape
- Index card
- Scissors
- Markers

Procedure:

1. Have the girls remove the cap from their bottle and stick about 1 inch of the flexible tubing into the bottle opening.
2. Have one girl hold the plastic bottle and the tubing while another girl duct tapes the tubing in place at the opening of the bottle so that the connection between the tubing and the bottle is air tight. Make sure that no air can escape.
3. Next, have one girl push the PVC pipe up against the other end of the flexible tubing and tape the tubing and pipe together. Don't have the girls get the tubing to go into the pipe. Just have them put them together and then use the tape to make an airtight seal.
4. The launcher is complete. Now it's time to make the rocket!
5. Have each girl roll their paper around the PVC pipe and tape it together along the seam. Have the girls make sure that the rolled paper is just wide enough to slide easily off the pipe.
6. Have the girls fold the top of their tube inwards to create a cone or nose of the rocket.
7. Once the girls have made the cone or nose of their rocket, have them tape the rocket cone so when they blow into the rocket no air escapes from the cone end.
8. Next, have each girl fold her index card in half to make a short rectangle.

9. Cut the card in half along the folded line and lay the two pieces on top of one another. Have each girl cut their index card in half from one corner to another corner to make four triangular fins.
10. After each girl has cut out their triangles, have them tape the triangles along one of the short sides around the base of their rocket. The four fins should be spaced equally apart from one another.
11. Finally have the girls use the markers to write their name on the rocket and decorate it however they would like to.

Launching the Rocket:

1. Place the rocket onto the PVC pipe on the rocket launcher. The rocket should fit loosely over the PVC piping.
2. Next, place the launcher onto the ground and have a friend hold the PVC pipe pointed upwards and away from everyone.
3. To launch the rocket, have one girl stomp down on the plastic bottle with one foot. This should cause air to travel from the 2 liter bottle, through the flexible tubing and into the PVC piping causing the rocket to blast off the PVC pipe.
4. To inflate the 2 liter bottle again, blow into the open end of the PVC pipe until the bottle is inflated again.

Explanation:

Rocket engines work on Newton's Principle that for every reaction, there is an equal and opposite reaction. When the rocket burns fuel, it's "throwing" the fuel downward, which causes the rocket to rise upward. Think of a firefighter holding a hose with a lot of water coming out of it. If he wouldn't hold it tightly, it would jump around and maybe fly out of his hands. Burning fuel increases the speed at which the fuel is thrown out of the rocket. The faster the fuel comes out of the rocket, the more force there is to push the rocket upward.

Activity 5: Fizzy Flyers

This activity is most appropriate for 2nd-5th graders.

This activity gets messy so be sure to take this experiment outside. Make sure the girls have clearly labeled their Fizzy Flyers to avoid any confusion.

Introduction:
Ask the girls to make a hypothesis as to what they think will happen to the rocket when you mix the water and Alka Seltzer into the film canister.

Materials Needed:

- Cardstock paper- 1 sheet per girl
- Scissors
- Film canister (1 per girl or pair) or small plastic water bottle- 1 per girl
- Masking Tape
- Alka-Seltzer tablets-1/2 tablet per girl
- Teaspoon measuring spoon
- Water- 1 teaspoon per girl
- Markers or crayons (optional)

Procedure:

1. Have each girl cut cardstock paper into a 4" x 6" square. The girls may want to color and draw on the cardstock paper prior to building.
2. Have the girls wrap the 4" side of the paper square around the bottom of the film canister, taping it in place. Make sure that the opening to the film canister is available and that the rocket is 6 inches tall.
3. Have the girls cut a cone shape into the top of the rocket and tape it closed.
4. After the rocket is taped, have the girls cut 3 fins from the remaining cardstock and tape them onto the rocket.
5. Have the girls take the rocket outside. Add 1 teaspoon of water to the film canister.
6. Once the water has been poured into the film canister, have the girls drop half of an Alka Seltzer tablet into the water, replacing the cap quickly.
7. Place the rocket on the ground with the cone facing upwards and stand back to watch as the rocket explodes.

Explanation:
The rocket exploded because the water and the Alka Seltzer create a chemical reaction in the film canister and the rocket blasts into the air from the pressure.

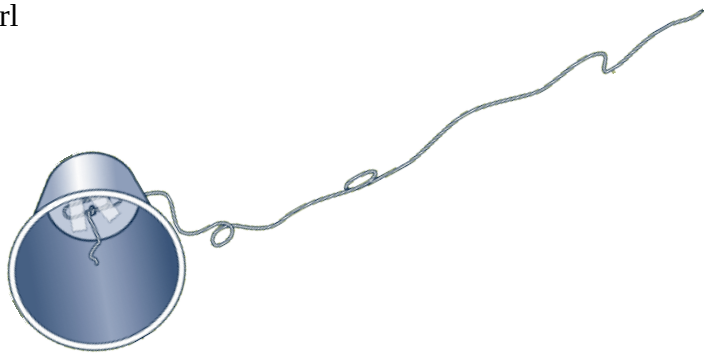
Activity 6: Screaming String Thing

This activity is most appropriate for K-5th graders.

Introduction:
Turn an ordinary cup and string into a screeching, squawking, sound machine. Sound vibrations can travel through liquids, gases, and solids as we'll see in this activity.

Materials Needed:

- Paper or plastic cups- 1 per girl
- Large paper clips- 1 per girl
- Cotton string- 2 feet per girl
- Scissors
- Sharpened pencil- 1 per girl
- Masking Tape
- Water
- Dishwashing liquid



Procedure:

1. Poke a small hole in the bottom of a cup with a pencil.
2. Pull a string (about 2 feet long) through the bottom of the cup.
3. Tie a paper clip to the end that's inside the cup.
4. Pull the string tight, so that the paper clip rests against the bottom of the cup.
5. Tape the paper clip flat.
6. Hold the cup in one hand and the string in the other, near the bottom of the cup. Squeeze the string tightly between your fingers and thumb and slide them down the string as fast as you can. What happens?
7. Predict what would happen if you put dishwashing liquid on the string. Then test it. Which makes the loudest sound-the dry, wet, or soapy string? Why might one work better than the others?

Explanation:
Sliding your fingers along the string creates friction. This causes the string to vibrate. The vibrations travel up the string to the cup, which acts like a speaker and amplifies them. But why does the wet string work better than the dry string? The wet string made your fingers stick and rub more, causing more vibrations and more sound. Why didn't the soapy string work? The soap is a lubricant. It reduces friction and makes your fingers glide smoothly, causing fewer vibrations and less sound.

Activity 7: Target Practice

This activity is most appropriate for 2nd-5th graders.

Introduction:
Build a catapult using a lever, and power it with a rubber band. Then, use what you've learned to build your own design, and send a marshmallow flying through the air!

Materials Needed (per group of 3-4):

- Plastic spoons
- Rubber bands
- Duct tape
- Craft sticks
- Brass fasteners
- Scissors
- Mini marshmallows
- Pen
- Toilet paper or paper towel tubes
- Cardboard base (shoebox, tissue box, cereal box, milk carton, etc.)
- Target (trash bin, for example)

Procedure:

1. Attach a toilet paper or paper towel tube to a cardboard base.
2. Tape the handle of a plastic spoon to the end of a craft stick.
3. Use a pen to make a hole in the top of the tube and insert the lever. Secure with tape.
4. Punch a hole in the base in front of the tube (using a pen), and attach a brass fastener.
5. Wrap a rubber band around the brass fastener, then around the middle of the lever. Tape in place.
6. Pull back on the lever and put a marshmallow on the spoon. Then, let go! What happened?
7. Can your marshmallow hit a target? How can you make it go farther? Or higher?

Explanation:
A catapult is a device used to hurl an object. It uses a simple machine called a lever, which is attached to a stationary point called a fulcrum (the cardboard tube), to help move a load (the marshmallow).

Your catapult is powered by the rubber band. When you pull back on the lever, potential energy is stored in the rubber band. When you let go, the potential energy is transferred to the lever and turned into the energy of motion, and the marshmallow is flying forward.

Activity 8: What Gives?

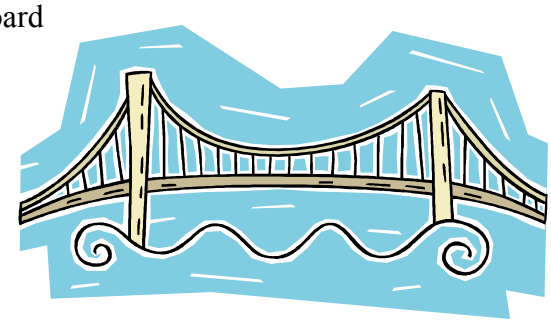
This activity is most appropriate for 4th-5th graders.

This activity is more challenging and will require some hands-on assistance from adults working with each group of girls.

Introduction:
Can you build a bridge out of cardboard that won't collapse under the weight of a pile of books? Suspension bridges have a number of parts. The deck is suspended from hangers. The hangers are attached to the cables. The cables are draped over the towers then secured to the ground on either end of the bridge by solid rock or huge concrete blocks called anchors.

Materials Needed (per group of 4):

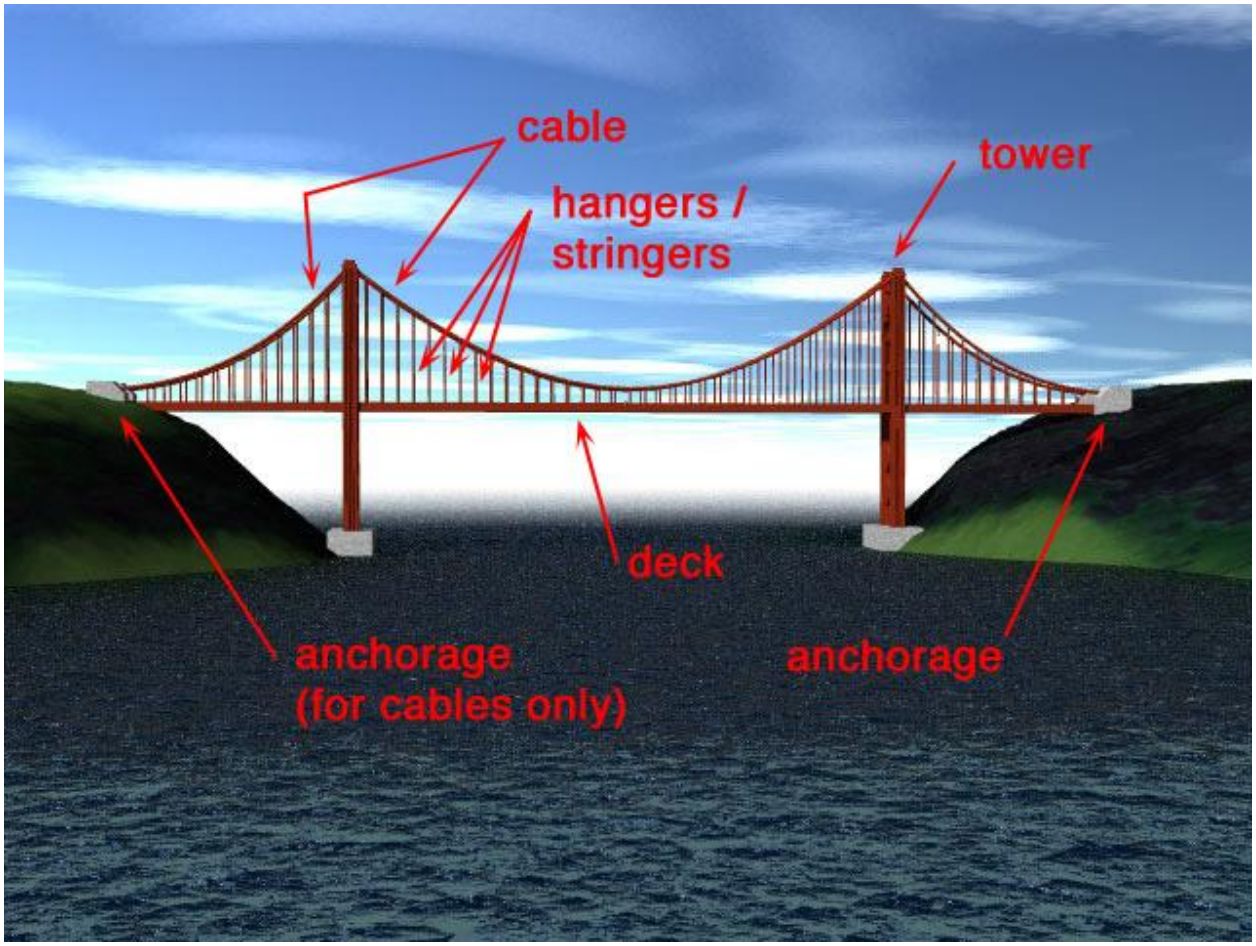
- 2 chairs with backs
- 3 11" x 17" sheets of corrugated cardboard
- Duct tape
- String
- Hole puncher
- Scissors
- Yard or meter stick
- Paper and pencil
- Books



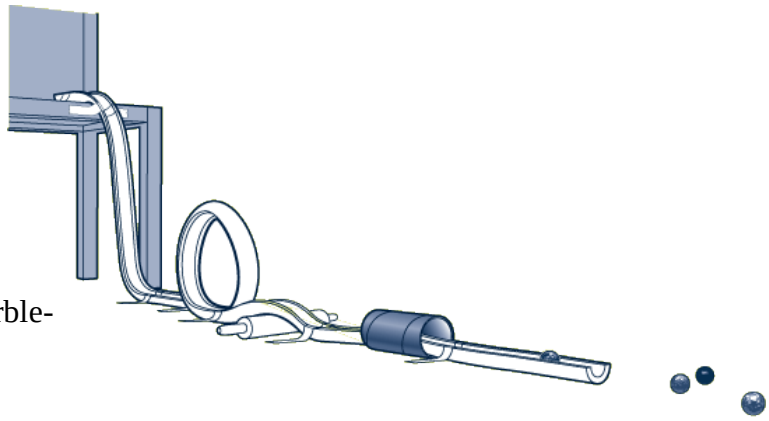
Procedure:

1. Get into groups of 4. Tape 3 pieces of cardboard together to make the deck, and place across 2 chairs.
2. Make two cables out of string, each 3 yards long. Drape the cables over the towers so they hang above the deck.
3. Think about the best way to attach the cables to the deck. The goal is to make a sturdy, strong bridge.
4. Talk ideas over with your group and sketch out designs with paper and pencil.
5. Follow these rules:
    a. Don't tape the deck to the chairs.
    b. Don't tape the cables to the chairs or floor.
    c. Don't tie the cables to the chairs.
6. Now have two group members serve as the anchors. They hold the cables at each end, pulling them over the chair backs and down to the ground.
7. Then the other two group members use the hole punchers, string, scissors, and duct tape to make hangers to attach the deck to the cables, while the anchors pull the cables tight.
8. Is your bridge working the way you want it to? Try putting an object on the deck. If it's not holding up, brainstorm ideas and redesign.
9. Pile books on the deck, one at a time, while the anchors pull the cables. How many books can your bridge hold?

Explanation:
Suspension bridges are among the strongest and longest of bridges. How do they work? The deck is suspended from vertical hangers that are attached to two heavy cables. The cables are pulled over the towers and secured by heavy anchors at each end. Weight pushes down on the deck, but the cables and hangers holding it up transfer the weight to the strong towers, which support the weight of the bridge.



Activity 9: Thrill Ride



This activity is most appropriate for 2nd-5th graders.

Introduction:
Design a crazy roller coaster ride for a marble- but make sure it doesn't fly off the track!

Materials Needed:

- Marbles- 1 per girl
- 6' foam pipe insulation tubing, ¾" or 1" in diameter, cut in half lengthwise- 2 halves per girl
- Masking tape
- Scissors
- Various props: boxes, books, chairs, cups
- Toilet paper or paper towel tubes (optional)

Procedure:

1. Start your track at the top of a high place: tape one end of the tubing to the top of a ledge, table, or other high spot.
2. Use props to design different kinds of roller coaster courses. Steady your track with tape where needed. Use toilet paper or paper towel rolls as tunnels.
3. You can try:
    a. Two hills
    b. A hill and a sharp turn
    c. A loop-de-loop
4. Send your marble on a wild ride and see what happens! If your marble jumps the track or runs out of energy before the end, it's time to redesign.
5. Are your hills too steep or wobbly? Test out different solutions until your coaster is as cool as you want it to be!

Explanation:
Did you notice that your starting point had to be the highest point on the course? The higher the starting point, the more potential energy your marble has stored up to use for later. When the marble started rolling downward, its potential energy began to change into kinetic energy. If it has enough energy, your marble will make it up the next hill or even around the loop-de-loop.