

Girl Scout Genius

Volume 3



Dear Girl Scout,

You like to help people and solve problems to make the world a better place. Did you know that makes you like an engineer? What does an engineer do, you ask? They use science and math to help solve problems. If you look around, there are examples of engineering everywhere in the world around you. Technologies designed by engineers help us talk to each other, take trips, stay healthy, and have fun. Their work is the link

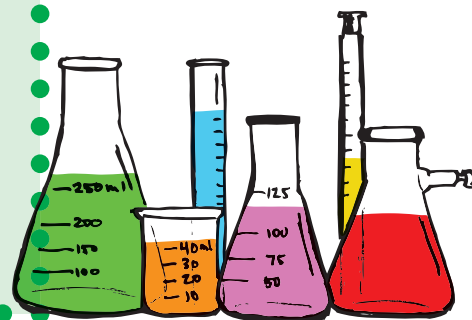
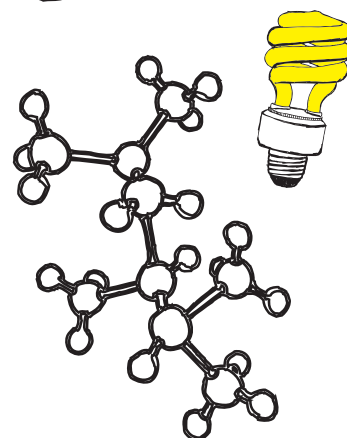
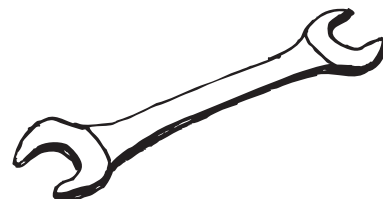
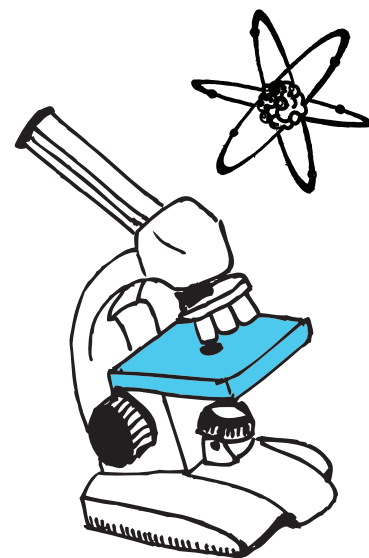
between scientific discoveries and the ways people can use those in everyday life. Activities in this final packet will give you a taste of what it is like to be an engineer.

Girl Scouts is also about spending time with people who can help you learn and grow, so find an adult or older friend to help you read the instructions and do the activities. You'll have a great time together.

Let's start solving problems!

Join the Fun this Fall!

Girl Scouts lets girls have fun with their troop, family, and friends all year round! As she learns essential life skills her confidence soars, and the leader within begins to step up in powerful, everyday ways. Girls are invited to attend events if they belong to a troop or are individually registered. All Girl Scouts of Greater Atlanta sponsored events are fun, interactive, held to the highest safety standards, and developed to meet the needs of all girls. You can always look at our event calendar at www.GirlScoutsATL.org!



BRING AN EGG IN FOR A SAFE LANDING

*Do this activity outside and be prepared to clean up a bit after—it can get messy.

Get egg-cited about this experiment! Can you build a something that will keep an egg from cracking when you drop it?

What you'll need:

- 1 Box
- Padding (not liquid)
- Eggs

Instructions:

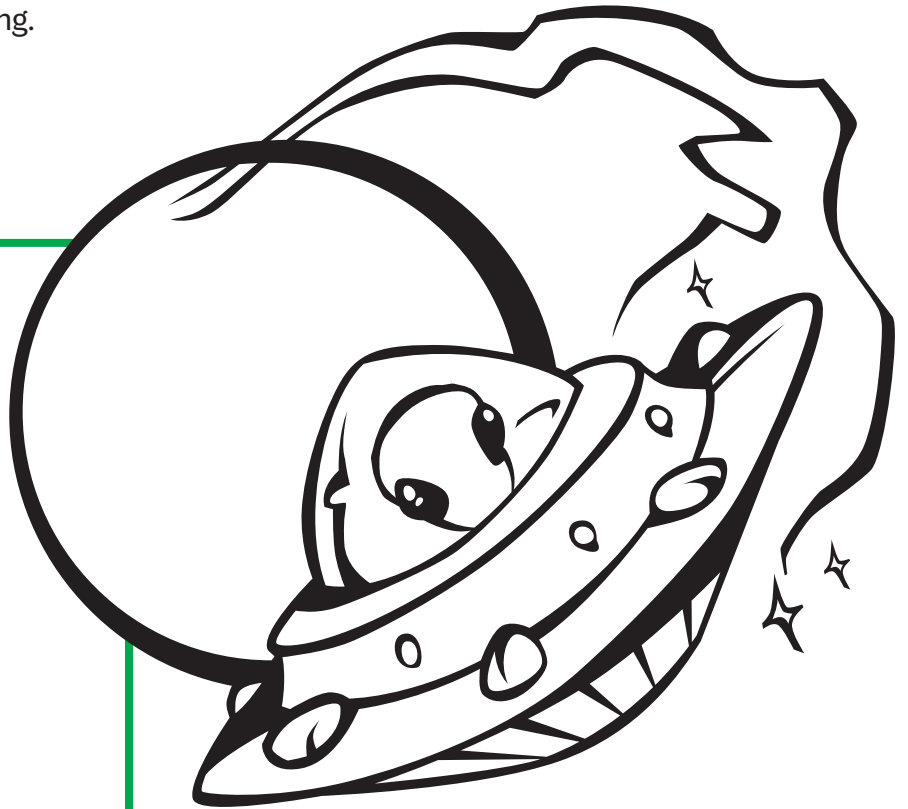
1. Build an egg capsule using one box, any shape, and whatever materials you'd like to use for padding (but don't use liquids).
2. Hold the capsule in front of your body and drop it (don't throw it, let gravity do the work!).
3. Open your capsule to see if your egg made the journey safely.
4. Repeat until the egg makes a safe landing.



What's happening?

You are learning about impact and absorption. What happens when two or more bodies collide is called **impact**. The padding you used to cover your egg absorbed some of the force from the impact of the capsule's fall hopefully leaving your egg in perfect shape.

Write down what materials you used and draw your final design below.



Egg Bungee Jump?

*Do this activity outside and be prepared to clean up a bit after—it can get messy.

Dare-deviled eggs! Design an egg bungee jump and save the egg from cracking.

What you'll need:

- Eggs
- Pennies
- Nylons
- Tape
- Ruler
- Scissors
- Newspaper

Instructions:

Design a bungee jump ride for your egg. The egg cannot break or hit the ground and your bungee must come within two inches of the floor, without touching the floor.

1. Choose a launch site, such as a table, stair rail or ladder.
2. Spread newspaper underneath the launch site.
3. Make a bungee cord using the nylons.
 - Test the nylons to see how stretchy they are.
 - Estimate how long the bungee cord needs to be so the egg falls but doesn't hit the ground.
 - Use tape to attach the estimated length of nylons to the launch site.
 - Make sure to leave an opening to slip the egg in to.
4. Make a test egg. Put some pennies in one hand and an egg in the other hand. Add or subtract pennies until the weight in each hand feels the same.
5. Test your bungee jump. Hold a ruler on the ground close to where you think the test egg will land. Pour the pennies into the opening in the nylons. Measure how close the test egg comes to the ground.
6. Change anything to improve your design, until the bungee jump is ready for the real egg.
7. Try your bungee jump with a real egg.



What's happening?

You are discovering how weight and gravity affect the elasticity of nylon. That is the ability of a material to return to its original shape after being stretched.

Now try this!

What would happen if you used a larger or smaller egg? Would you need to change the nylons in some way? Be sure to predict what you think is going to happen before you test it.

KEEP TRYING!

Engineers put their ideas to the test over and over again until they get it right.



Build a Hovercraft

*This project requires adult help with a glue gun.

In the 1950's a British inventor and engineer noticed how hard boat engines had to work to push through the water. This is because of something called **friction**—the resistance that an object (like a boat) encounters when moving over another object (like water). He wondered if he could invent a vehicle that could eliminate the friction by using air to skim along the surface of water. And so the hovercraft was born. Large scale hovercrafts are still used today and can travel over land, snow, and water.

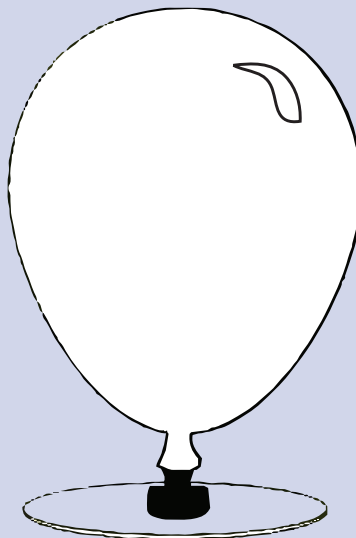
Make your own hovercraft to learn more about friction.

What you'll need:

- An old CD or DVD disc
- A 9" balloon
- A pop-top cap from a liquid soap bottle or a water bottle
- A hot glue gun
- Tape
- Push pin or small nail

Instructions:

1. Cover the center hole of the CD with a piece of tape and poke about 6 holes in the tape with a push-pin or small nail. This will slow down the flow of air and allow your hovercraft to hover longer.
2. Use the hot glue gun to glue the cap to the center of the CD or DVD disc. Create a good seal to keep air from escaping.
3. Blow up the balloon and pinch the neck of it to keep the air from escaping. Don't tie it.
4. Make sure the pop-top is closed.
5. Fit the neck of the balloon over the pop-up portion of the cap. (This is usually easier with 2 people.)
6. Put the hovercraft on a smooth surface and pop the top open.



As the air flows out of the balloon it creates a cushion of moving air between the disc and the surface. This lifts the CD and reduces the **friction** between the smooth surface and the CD which allows the disc to hover freely.

Now try this!

- See if the size of the balloon affects the CD's ability to hover.
- Find out if a helium balloon works better than an air filled balloon.
- See if larger discs make better hovercrafts (plastic picnic plates, old record albums, etc.).

Write or draw a picture of what happened below.

Make a Magnetic Maze

Have you noticed how magnets seem to stick together when you put them together one way, but when you try to put them together the opposite way they seem to push each other apart? You're going to use those properties to help get from the start to the finish of a maze.

Supplies:

Paper plate (coated or Chinet works best)
2 one half inch button magnets
2 pencils or dowels about 8 inches long
1 eraser
Compass or several circular objects to trace
Colored pencils, markers, or crayons
Glue gun and glue sticks

Directions:

Build the maze

1. Lay the pencils or dowels flat on a table and glue one magnet to the top of each near the end. Set the other magnet aside.
2. Make the maze by using the compass or tracing the circular objects. (Diagram A)
3. Erase a small section of each circle. This will create your maze. (Diagram B)
4. Write "Start" at the opening to the largest circle.
5. Write "Finish" in the middle of the smallest circle.
6. Trace the lines with a marker.

Run the maze

1. Place the plate with the maze facing up on your lap.
2. Put the magnet that you set aside on the word "Start".
3. Lift the plate enough to place the pencil with the other magnet directly underneath the magnet that is on the word "Start". If the magnets won't stick together, flip the one on top over.
4. Use the pencil to move the top magnet through the maze. (Don't go too fast or the magnets might not stick.)

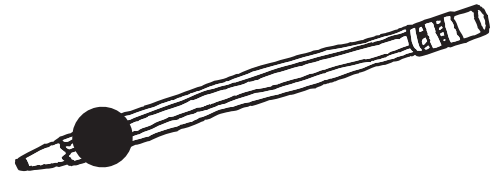


Diagram A
Pencil with magnet

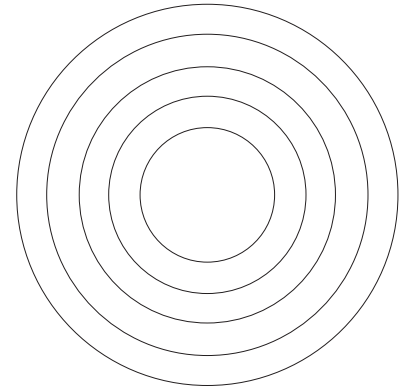


Diagram B
Draw circles

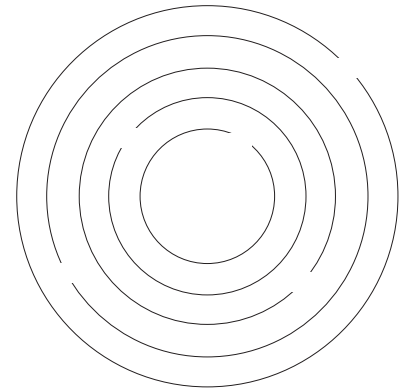


Diagram C
Erase a small section
in each circle



What's happening?

A magnet has two ends called poles, one is called the north pole and the other is called the south pole. The north pole of one magnet **attracts** the south pole of another magnet. But it doesn't work the other way around. In fact, if a north pole meets another north pole it will push away or **repel** the other magnet. Same thing happens with south poles. When your magnets stuck together, even with the plate in between, that meant that the north pole of one magnet met the south pole of the other.



Do-It-Yourself Coin Sorter

Sort your change in a different way! You could use your hands to sort through the coins in your piggy bank, but it would be faster if you built a coin sorter to do the work for you. Be a true engineer and figure this one out on your own.



What you'll need:

- A jar of coins
- Shoe boxes or other cardboard boxes
- Construction paper
- Cardboard tubes
- String
- Masking tape
- Scissors
- Sharpened pencils
- Paper



Instructions:

1. Think about the problem you are trying to solve. Consider the different ways you could sort coins like by weight, size, sliding ability or shape.
2. Sketch your design ideas below before you begin building.
3. Build your coin sorter using your sketch as a guide.
4. Test out your design with your spare coins.
5. Modify your design until it works.
6. Draw your final design below.



Sketch your design ideas here.

Did you have to change your design as you built the coin sorter? Write or draw some of the changes you made and how they helped improve your design.

Change	How did it help?



Draw your final design here.

BUBBLE BLOWING MACHINE

One of the main goals of engineering is to design machines that make our lives easier by doing the work for us. This machine saves you the work of dipping the wand each time you want to blow a bubble. It's a double-dipping machine that blows billions of bubbles!

What you'll need:

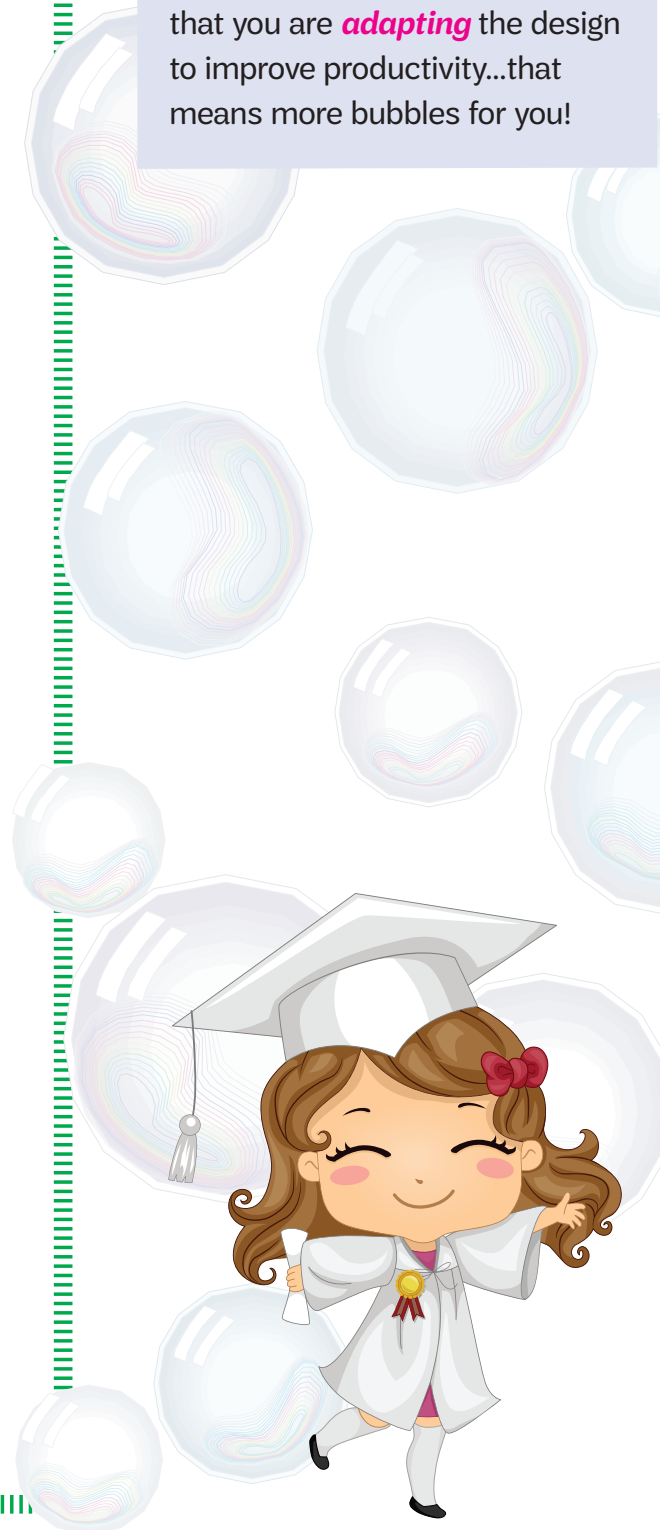
- 1 quart empty milk carton
- Drinking straw
- Clay or play dough
- 4 bubble blowing wands
- Scissors
- Clothespin
- Bubble solution

Instructions:

1. Take a straw and wrap some clay or play dough around the middle.
2. Snip off a ring from one end of the bubble-blowing wands so that each wand has just one ring.
3. Poke the ends of the bubble-blowing wands into the clay so that the rings stick out around the straw.
4. Lay the milk carton on its side and cut a big window out of the side that's facing up.
5. Cut two "V"s across from each other on the long edges of this big window.
6. Place your straw in the milk carton so that the ends of the straw are resting in the "V"s and the bubble-blowing wands are in the center of the milk carton.
7. Put a clothespin on one side of the straw to make a handle for turning the straw easily.
8. Fill the milk carton halfway with bubble solution.
9. Turn the clothespin and blow into the rings as they come up out of the bubble solution.
10. If your bubble-blowing machine isn't working well, you may need to modify your design by making the wands shorter or longer.

Now try this!

Now that you have the basic bubble-blowing machine down, can you improve upon the design? Would you use different materials? Engineers would say that you are **adapting** the design to improve productivity...that means more bubbles for you!



You Can't Get There from Here—Can You?

All engineers are good at solving problems. Can you find a way to get a super ball or marble to go from one table to another and then back to the first table? How do you control the back and forth motion of the ball? Figure it out and solve the problem.

What you'll need:

- Super ball or marble
- 10 sheets of paper
- 10 paper clips
- 10 rubber bands
- 20 feet of string
- Masking tape
- Ruler
- 2 tables

Instructions:

1. You can only use 10 sheets of paper, 10 paper clips, 10 rubber bands, 20 feet of string, some masking tape, and a ruler. You can't use your hands to move the super ball or marble.
2. Set the two tables so they are about 10 feet apart.
3. Think about what makes things move forward and what makes them move backward.

Write or draw a picture of what happened below.

Rock No Roll

Be a true engineer and figure this one out on your own.

What you'll need:

- Straws
- Tape

Instructions:

1. Using straws and tape, build a structure that's not attached to a table or flat surface that will rock back and forth without rolling away when you blow on it through a straw.

Draw your final design below.



MAKE A SEISMOMETER

*You will need an adult to help with this project.

Do you know what a seismometer is? It's a machine that measures movement. It helps scientists predict earthquakes and map the ground underneath us. Follow the directions to make a really simple seismometer that can measure the movements you make in your house.

What you'll need:

- Cardboard box
- Plastic cup
- Felt tip marker
- String
- Cup of small rocks, marbles or bolts
- Clay or play dough
- Paper
- Scissors
- Ruler



What's happening?

The vibrations created from the movement of the box are transferred through the string to the cup. When the cup moves the marker moves with it making lines on the paper.

Instructions:

1. Take a box and open the top. Cut off the flaps and turn the box so the open side faces you.
2. Using scissors poke two holes next to each other in the center of the top of the box. (*Diagram A*)
3. Poke one hole in the center of the bottom of the plastic cup large enough to hold the marker. Poke two holes along the rim of the cup exactly opposite of each other. (*Diagram B*)
4. Put the marker through the hole in the center of the bottom of the cup. The writing end should be sticking out of the bottom of the cup.
5. Put some clay or play dough around the hole to keep the marker in place.
6. Cut an 18 inch piece of string and thread it through the two holes along the rim of the cup. (If you have a bigger box, you may need a longer piece.)
7. Hold the cup inside the box right under the two holes so the marker touches the bottom of the box. (Keep the cap on.)
8. Thread the string up and through the holes in the top of the box. Pull them through until the ends are equal. Tie the ends on top of the box.
9. Fill the cup about 3/4 full with something heavy that will weigh the cup down like marbles or rocks.
10. Cut strips of paper as deep as the box and about 5 inches wide.
11. Put one end of the paper under the marker. Take the cap off the marker and make sure that it sticks out of the cup far enough so it touches the paper. Adjust the length of the string if necessary.
12. Now shake the box right and left while someone else pulls the paper forward. If your seismometer was made properly, lines should appear on the paper. (*Diagram C*)

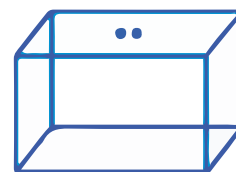


Diagram A

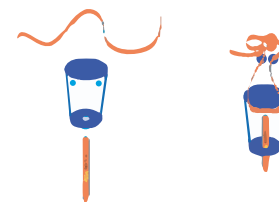


Diagram B



Diagram C

Now try this!

- What happens when you shake the box really hard? Do the lines get wider or closer together?
- Can the seismometer detect small movements like tapping on the table or talking? Are those lines wider or closer together?

Test Paper Airplanes

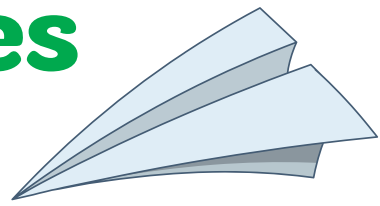


Illustration A

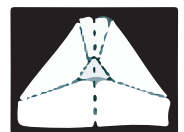
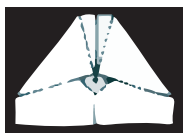
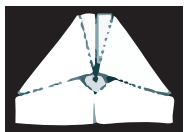
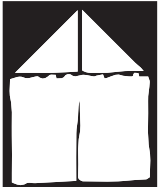
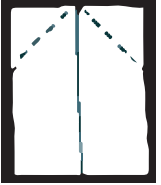
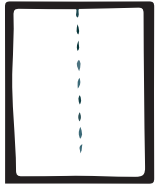
What you'll need:

- Paper

Instructions:

1. Make a classic dart paper airplane. (Illustration A.) Ask your parents how to make one or check out a book from the library or YouTube video for instructions.
2. Use the illustrations to the right to make a Nakamura lock paper airplane. (Illustration B.)
 - a. Fold a sheet of paper in half lengthwise. Unfold so that the crease is 'valley' side up.
 - b. Open the paper and fold the top corners down to the center fold.
 - c. Fold the tip down.
 - d. Fold about one inch of the tip up and then unfold.
 - e. Fold the top corners down to the center fold so that the corners meet above the fold in the tip. (Note that the top—the nose of the plane—should be blunt.)
 - f. Fold the tip up. This is the Nakamura lock.
 - g. Fold the entire plane in half so that the tip is on the outside.
 - h. Fold the wings down.
3. Test your paper airplanes and then trim if necessary (instructions on the next page).

Illustration B



The most amazing thing about a paper airplane is that all you need to make one is a sheet of paper—nothing more. You don't need scissors, glue, tape or paper clips. A few folds, a couple of adjustments, and you have a superb paper flyer. The properties of paper give the airplane all it needs to fly.

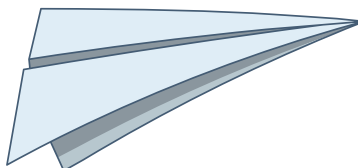
In the last two decades, paper airplane designers have imported techniques from **origami**, the *art of paper folding*. Perhaps the best innovation was the addition of one fold to the classic dart paper airplane design to create a plane called the "Nakamura lock" which was named after the origami artist who designed it.

Make this paper airplane and see how well it flies. If you need help making your airplane, there are lots of videos on YouTube that your parents can share with you.



What's happening?

The blunt tip of the Nakamura lock airplane helped make it sturdier so it should fly better and not take the classic "nose dive" that classic paper airplanes usually take.



Trim Your Plane

Once you've made all of your folds, it's time to adjust the design for the best flight. Scientists call that trimming.

1. Give the plane a gentle toss forward. Your goal is to have it glide smoothly and gently to the ground while flying as straight as possible.
2. Make these adjustments, if necessary. Keep your adjustments small, a little bending goes a long way.
 - **If the nose drops** and the plane dives into the ground, bend up the back of the wings.
 - **If the nose rises first and then drops**, the plane is stalling. Bend down the back of the wing.
3. When you get the plane to balance on the air and float down gently, then you can give it faster tosses. The Nakamura lock is a sturdy plane and should be able to take several flights.



When you throw the paper plane, the energy used to throw it is transferred into the plane which makes it fly. That energy is called **kinetic energy**. Once the kinetic energy wears off, the paper plane becomes a glider powered by gravity.

As the plane falls, its wings deflect the air backward and down, providing thrust and lift which helps keep it in the air longer and make a soft landing.

Paper makes good airplanes because it's lightweight and impermeable to air. That means that air cannot pass through it. This is because a single sheet of paper is made of multiple layers of interlocked fibers that make it solid.

Now try this!

- Grab a friend, make your favorite type of paper airplane, and see which plane can fly the farthest.
- Make a paper pilot for your Nakamura lock airplane. Is it sturdy enough to give the pilot a good ride?
- Imagine if you made a plane out of the materials listed below and then answer the questions.

Would an airplane made out of paper towel fly?

☐ Yes ☐ No

Why or why not?

Would an airplane made out of plastic wrap fly?

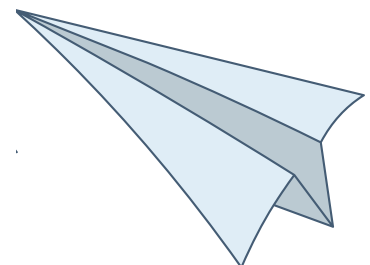
☐ Yes ☐ No

Why or why not?

Would an airplane made out of foil fly?

☐ Yes ☐ No

Why or why not?



Build a Suspension Bridge



Engineers are always looking for better ways to build things. They are constantly challenged with creating designs that are strong but not expensive to build. This challenge led to the design of the suspension bridge—a structure made of tall beams with cables attached that hold a road or walkway. The Golden Gate Bridge in San Francisco is a great example of a suspension bridge.

Build a suspension bridge and test its strength. How many books can your bridge hold?

What you'll need:

- 2 chairs with backs
- 2- 9 foot pieces of rope
- Heavy string
- Duct tape
- Cardboard measuring 3 feet long by 1.5 feet wide
- Scissors
- Stack of books

Instructions:

1. Put two pieces of rope, each about nine feet long, over the back of two chairs so that the ropes are above the cardboard and run between the chairs.
2. Now pull the ropes tight.
3. Bring six equal lengths of string from each rope to the cardboard.
4. Attach them to the bottom of the cardboard with duct tape.
5. Attach the other end of the string to each rope with duct tape or by tying knots.

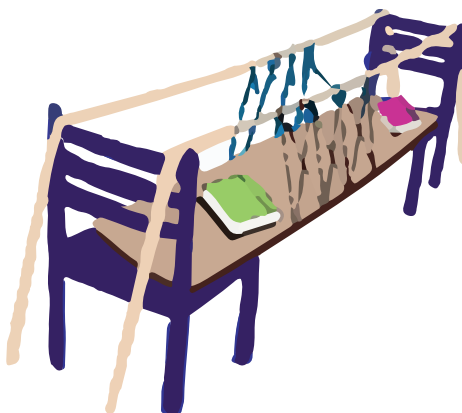
Make Your Prediction

How many books do you think your suspension bridge can hold? _____

Test Your Bridge

Put a stack of books on the cardboard. How many books can it hold? _____

(We found this idea and the image at pbskids.org/zoom/activities/suspensionbridge.html. There are lots of other great ideas online, grab a parent and see what you can find!)



What's happening?

Even though very few materials were used to make the bridge, it is able to support a lot of weight by transferring it. The weight of the cardboard and the stack of books pull on the strings. The strings pull on the ropes. The ropes push down on the chairs. So, all the weight is transferred to the chairs. The rope is also pulling the person holding it. All of the pulling is called **tension**. And all of the pushing is called **compression**.

Now try this!

- What happens if you don't pull as hard on the ropes?
- Try making the bridge with a 6 foot by 1.5 foot piece of cardboard instead. How will your design be different? Can it hold more or less weight?
- Look for suspension bridges the next time you are traveling.

Send us your photos!

We'd love to see what you did with your Girl Genius projects over the summer! Tag Girl Scouts of Greater Atlanta on your social media pages!

