GSK Science in the Summer™
In partnership with UNC Morehead Planetarium and Science Center

Science in the Summer at Home Level I/II Activity Materials
(for rising 2nd – 5th graders)

Forces of Flight – Thrust	**Quantity**
Balloons	2
Forces of Flight – Lift	1
Straw	2
Index Card	2
Glue Dots	6
Forces of Flight – Drag	
Coffee Filter	2
Pipe Cleaners	2
Magnet Cars	
N/S Magnet (red and blue magnet)	2
Button Magnet (small round magnet)	1
Toy Car	1
Glue Dots	2
Paper	2
Yo-Yo	
Yo-yo	1
Exploding Sticks	
Popsicle Sticks	15
Pom-Pom Shooter	
Cup	1
Balloon	1
Rubber Bands	2
Ping Pong Ball	1
Pom-Poms	10

Materials from home
Scissors
Markers/Crayons

FORCE OF FLIGHT—DRAG

BIG IDEA

Make a parachute to experiment with drag, one of the forces of flight.

READY ...

Gather materials:

- 1 coffee filter
- 2 pipe cleaners
- scissors (from home)
- markers or crayons (from home)

SET ...

Cut one pipe cleaner into three equal pieces. You may need an adult to help with this, because making three equal pieces can be difficult to do.

GO!

1. In this experiment, the coffee filter is going to be a parachute. If you would like to, you can decorate the parachute with crayons or markers. Be careful not to rip your parachute while decorating, or it will not work.

2. Use your three small pieces of pipe cleaner to create a ”person” to test your parachute:

a. Take one piece of pipe cleaner and create a small loop at the top. It should look like a bubble wand. This will be the head and the body.

b. Place the second piece of pipe cleaner in the middle of the body. Wrap one side of this piece around the other, securing the two pieces together. These will be the arms.

c. Place the third piece of pipe cleaner at the bottom of the body. Wrap one side of the pipe cleaner around the other, securing the two pieces together. Angle the two pieces downward into an upside-down V shape. These will be the legs.



3. Drop your pipe-cleaner person and notice if it falls to the floor quickly or slowly.

[continued on back]

[continued from front]

4. Make a parachute with the coffee filter and your full, uncut pipe cleaner. Poke one side of the pipe cleaner through the edge of one side of the coffee filter. Fold the excess pipe cleaner down. Do the same on the other side.

5. Attach the parachute to the pipe-cleaner person by folding each of the pipe-cleaner hands around the pipe cleaner in the middle.

6. Now, drop your pipe-cleaner person with the parachute and see if that changes how long it takes the pipe-cleaner person to reach the ground.

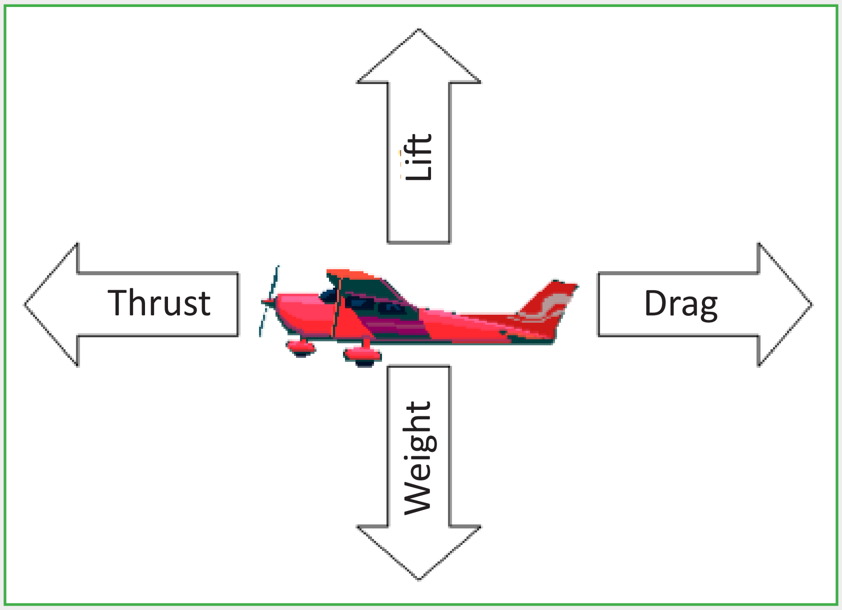
7. Did the pipe-cleaner person fall faster the first time or the second time? Did the parachute make a difference?

8. If you would like to, you can take the parachute off and try this experiment again.

WHY IS THIS ENGINEERING?

The parachute in your experiment provided a much bigger area that had to be pulled through the air. This created more drag and slowed down the parachute and pipe-cleaner person as they fell. Drag occurs any time an object tries to pass through a liquid or gas. Air is a gas—and drag is the force of air pushing back on the object.

You can feel drag if you move your hand through water or walk against the wind on a windy day. That feeling of your hand being pushed back by the water, or of your body being pushed back by the air, is drag! A similar thing happens with airplanes. An airplane moving through air is pushing against the air, which creates more drag. That is why it is important for aerospace engineers to design airplanes that have as little drag as possible.



WITH THANKS AND FOR MORE INFORMATION, VISIT:

This activity has been adapted from “Make a Parachute” *Science Buddies* (https://www.sciencebuddies.org/stem-activities/parachutes#instructions).

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FORCE OF FLIGHT—LIFT

BIG IDEA

Make a hoop glider to observe lift, one of the forces of flight.

READY …

Gather materials:

- 1 straw
- 1 index card
- glue dots
- scissors (from home)

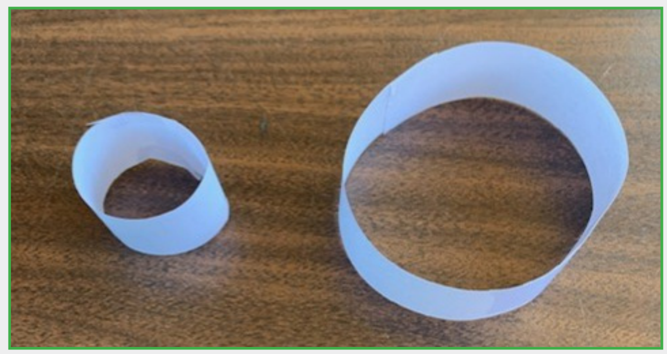
SET …

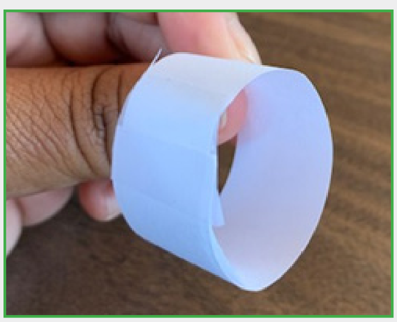
Cut the index card lengthwise into three evenly sized strips. You may need an adult to help with this, because making three equal pieces can be difficult to do.

GO!

1. How to make your hoop glider:

   a. GLUE DOT 1—Use a glue dot to close one strip of the index card, making a hoop. Make sure to overlap the edges before gluing it closed.

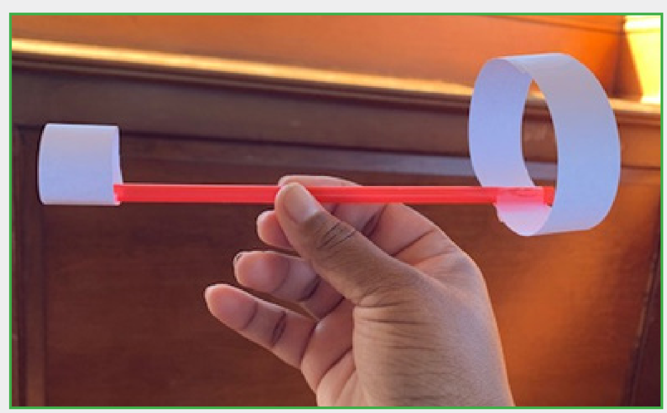




   b. GLUE DOTS 2 AND 3—Glue the other two strips together, then glue them closed to make a much larger hoop. Remember to overlap the edges before closing.

   c. GLUE DOTS 4 AND 5—Glue the straw to the bottom of each hoop.

   d. Your hoop glider is complete!



2. How to throw your hoop glider:

   a. Hold the straw in the middle with the hoops on top. The smaller hoop should be in the front and the larger hoop in the back.

   b. Throw the hoop glider angled slightly up. Remember to throw your glider away from anyone standing nearby.

[continued on back]

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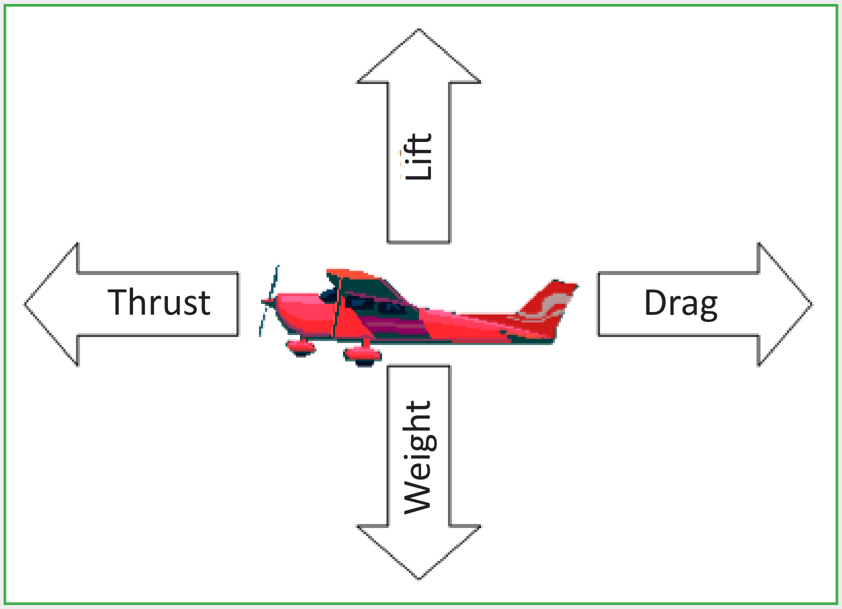
WHY IS THIS ENGINEERING?

Although your hoop glider doesn't look much like an airplane, it can fly! The hoops you added to the straw act like wings, creating lift. Lift—the force that is opposite of weight—is more complicated than the other forces of flight. Lift results from air pressure and Bernoulli's principle.

The air all around us exerts pressure—or is pushing—on us. Daniel Bernoulli, a Dutch scientist during the 1700s, found that fast-moving air has a lower pressure than slow-moving air. When the glider is thrown, the curved shape of the hoops creates different pressure above and below the hoops. The reduced pressure above the hoops "sucks" the object upward, while the higher pressure below the hoops "pushes" the object upward. Together, the "suck" and "push" cause lift.

The same thing happens on an airplane. The wing slices through the air, causing some air to go over the top and some to go underneath it. The air on the top travels faster, producing low pressure, while the air underneath the wing moves slower, producing high pressure. This high pressure under the wing is pushing more than the low pressure on top of the wing, causing the wing to be lifted.



Aerospace engineers design, build, and test machines that fly. These engineers use lift to create wings that will make airplanes fly.

WITH THANKS AND FOR MORE INFORMATION, VISIT:

This activity has been adapted from "The Incredible Hoop Glider!" *Science Bob* (https://sciencebob.com/the-incredible-hoop-glider/).

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FORCE OF FLIGHT—THRUST

BIG IDEA

Do a simple experiment with a balloon to learn about thrust, one of the forces of flight.

READY ...

Gather materials:

- balloon

SET ...

No setup needed!

GO!

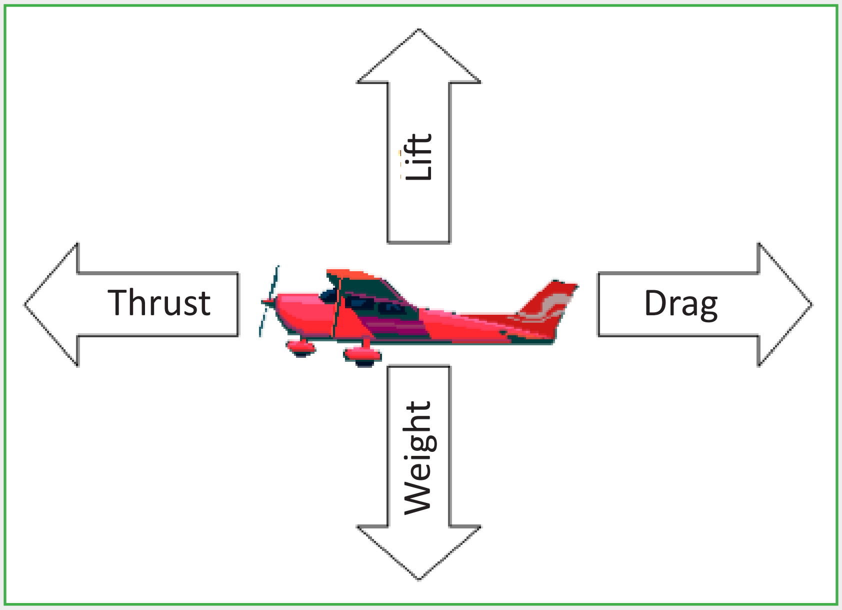
1. Blow up a balloon and pinch it closed with your fingers so the air does not escape.

2. Think about will happen when you let go of the balloon. Where will it go? Will it fall straight down to the floor?

3. Now, let go of the balloon—and watch what happens!

WHY IS THIS ENGINEERING?

Isaac Newton, a scientist born in England in 1643, made many discoveries about mechanics and motion. You just used a balloon to demonstrate Newton's Third Law of Motion: "For every action, there is an opposite and equal reaction." When the air was released from the open end of the balloon, the balloon was thrust in the opposite direction. The action was the balloon's air blowing backward; and the opposite reaction was the balloon moving forward.



This is also how thrust works on an airplane. Thrust is the driving force that moves the airplane forward in flight. Aerospace engineers use the plane's engine to create enough thrust for the plane.

Thrust is one of the four forces of flight. The other three forces are lift, weight, and drag. Drag is the opposite of thrust.

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FORCE OF FLIGHT—WEIGHT

BIG IDEA

Do a simple experiment to learn about weight, one of the forces of flight.

READY …

No materials needed!

SET …

Find a spot where you can stand up with plenty of space around you.

GO!

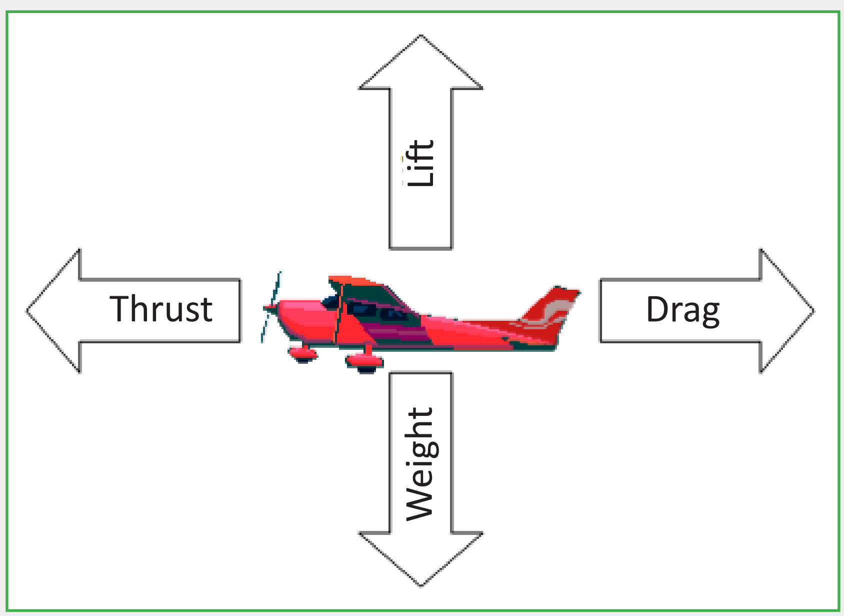
1. Jump up in the air and try to stay there!
2. What happened when you jumped? Could you stay up in the air?
3. Why did you come back to the ground? The invisible force of gravity pulled you back down.

WHY IS THIS ENGINEERING?

If the invisible force of gravity hadn't pulled you back down, you would have stayed up in the air when you jumped! This force is important for aerospace engineers to know about because, just like a person's body, an airplane is pulled downward toward Earth by gravity.

When we measure gravity's pull on an object, we call the measurement "weight." Weight is one of the forces of flight. The opposite force of flight is called "lift."

An aerospace engineer who is designing an airplane must make sure the wings can create enough lift to keep the craft up in the air. The airplane's weight will control how much lift there needs to be. This is how airplanes, some of which weigh more than a million pounds, are able to get off the ground … and then fly for hours!



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AIRPLANE CHALLENGE

BIG IDEA

Step into the role of an aerospace engineer as you design an airplane that flies a long distance.

READY ...

Gather materials:

- paper
- pencil
- paper clips (optional)
- tape (optional)

SET ...

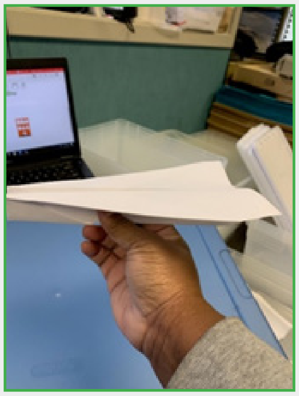
Ask an adult to help you decide on an open area (outdoors, if possible) where you can test your paper airplanes.

Remember, we must never throw our paper airplanes toward or near someone's face.

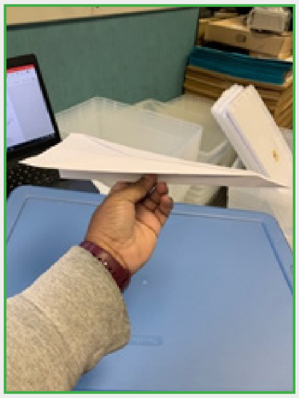
GO!

1. For this activity, you have been hired by a toy company to create a paper airplane that will travel a long distance:
    - It will be up to you to decide what type of paper airplane you will be creating.
    - These pictures of paper airplanes may give you some ideas for your design.
    - Or perhaps you already know a way to make a paper airplane that you would like to try today.
2. Folding is extremely important when making a paper airplane. Here are some folding tips:
    - Make each fold as carefully and accurately as possible.
    - Folding should have several steps. First, gently bend the paper to align the fold. Then, firmly press with fingertips to make the fold. Finally, firmly press with a fingernail to finish and crease the fold.

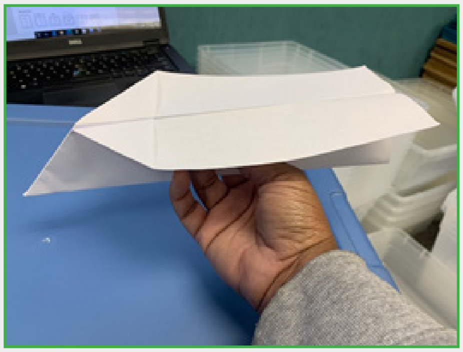
Hornet (expert)



Snub nose (advanced)



Dart (intermediate)



Bumblebee (easy)

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3. Decide on a name for your design and write the name on the airplane. (In 1947, when pilot Chuck Yeager became the first person to fly faster than the speed of sound, he was flying an aircraft called Bell X-1. The Bell Aircraft company helped the U.S. government design and build the plane.)

4. Try out your design by throwing it in the testing area! Here are some hints for throwing a paper airplane:

- If a paper airplane is thrown at a very high angle or straight up in the air, it will “stall” and quickly fall to the ground. Throwing the airplane like this causes a great increase in drag and very little lift.
- If a paper airplane is thrown at a zero-degree angle, or completely flat, the plane’s underside will get very little air. Very little drag will be generated—but, also, very little lift will be generated.
- The best way to throw the airplane is to point its nose up slightly.
- Remember, we never throw our planes at or near another person.

5. Once you throw your airplane, watch it fly and see where it lands. What you do notice about your aircraft’s flight? Does it go straight, nosedive into the ground, just go in circles, or something else? Did your airplane travel a long distance?

6. Now that you have tested your airplane design, you can use what you learned to improve your design and increase the distance your airplane travels. You can make changes to your first plane or use a new piece of paper to make another plane.

7. Aerospace engineers test their designs to see what works well and what needs to be improved. Here are some ideas to help you solve problems and create a new airplane design:

Problem	Solution
The plane doesn’t fly far.	Increase the wing size. (Big wings increase lift.) Reduce drag. (A narrow front on the plane will create less drag.)
The nose drops and the plane dives into the ground.	Bend up the back of the wings (only a little bend).
The nose rises first and then drops.	Bend down the back of the wings (only a little bend).
The plane floats and goes in circles.	Narrow the nose. Add weight (using things like tape or paper clips).

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8. Test your new design in the testing area. Did the changes help your airplane fly farther?

9. If you would like to, you can set up a target on the ground. You could make a target by drawing a circle on a piece of paper or making a circle from a piece of string. Throw your paper airplane and see if it can reach the target! (Remember, if the airplane doesn't reach the target on your first try, this is an opportunity to improve the design or try a new way to throw it.)

WHY IS THIS ENGINEERING?

Aerospace engineers design, build, and test machines that fly. There are two main types of aerospace engineering:

- Aeronautical engineering involves machines that fly inside Earth's atmosphere (such as airplanes, jets, helicopters, etc.).
- Astronautical engineering involves machines that travel outside Earth's atmosphere (such as spacecraft and rocket ships that travel to other planets).

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YO-YO MOTION

BIG IDEA

Kinetic energy is energy in motion.

READY ...

Gather materials:

- yo-yo

SET ...

Find a spot where you can stand up with plenty of space around you.

GO!

1. If not already done, wind the string around the yo-yo.
2. Find the loop at the top of the string. Place this loop on your middle finger.
3. Holding the yo-yo in your hand, palm down, let go of the yo-yo.
4. Watch as gravity pulls the yo-yo down the string, toward the ground.
5. Notice what happens when the yo-yo gets to the bottom of the string. Does it stay there? No, the yo-yo starts to travel back up the string toward your hand, but it doesn't get all the way back to your hand.
6. Re-wind your yo-yo once again.
7. Hold the yo-yo in your hand, this time palm up. Make sure the string is coming over the top of the yo-yo. (The photograph shows this step.)
8. Now, throw the yo-yo off the end of your hand and watch the yo-yo fall toward the ground.
9. See if you can get the yo-yo to return to your hand. To do this, after you throw the yo-yo, turn your hand over, palm down, and give your hand a slight jerk upward. The yo-yo should return to your hand. This may take some practice, so keep at it!

Holding the yo-yo in Step 7

WHY IS THIS ENGINEERING?

Gravity is the force pulling the yo-yo down.

As soon as the yo-yo leaves your hand, it has kinetic energy. Kinetic energy is energy that something has when it moves. You may have noticed that when the yo-yo reached the bottom of the string, it started to come back up but didn't come all the way to your hand. That is because the yo-yo didn't have enough kinetic energy to travel

[continued on back]

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all the way back up the string. This is why you had to throw the yo-yo downward AND give your hand a little jerk upward. These two things helped give the yo-yo the additional kinetic energy it needed.

Like the yo-yo, a roller coaster must also have enough kinetic energy. Once the roller coaster goes over the top of the first hill, gravity pulls it down and causes it to accelerate (go faster). The cart must have enough kinetic energy to make it over all the rest of the hills and turns in the track. This is why it is important that civil engineers create roller coasters that have enough kinetic energy to last until the end of the ride.

WITH THANKS AND FOR MORE INFORMATION, VISIT:

This activity has been adapted from *Teachers Guide: Teaching Science with the Yo-Yo* by Dr. James Watson and Nancy Watson, Duncan Toys (https://jojoabc.files.wordpress.com/2016/02/yoyo_teachers_guide_duncan.pdf).

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POM-POM SHOOTER

BIG IDEA

Build a pom-pom shooter to learn about potential energy and kinetic energy.

READY ...

Gather materials:

- 1 paper cup
- 1 balloon
- 10 pom-poms
- rubber bands
- scissors (from home)

SET ...

No setup needed!

GO!

1. Follow these steps to make a pom-pom shooter:

   a. Cut the bottom off the paper cup.

   b. Tie a knot at the open end of the balloon. (Note: Do not blow the balloon up.)

   c. Cut the bottom 1/3 off the balloon.

   d. Stretch the cut end of the balloon over the bottom cut end of the cup, making sure to pull it down the sides of the cup and ensuring the knot is in the center.

   e. Place a rubber band around the balloon and cup to hold the balloon in place.

[continued on back]

[continued from front]

   f. The pom-pom shooter is complete!

2. Here's how to use your pom-pom shooter:

   a. Place one pom-pom inside the cup, ensuring it falls into the center or knot of the balloon.

   b. Hold the cup in one hand.

   c. Pull back on the knotted end.

   d. Let go to launch the pom-pom!

3. See how far you can get a pom-pom to travel. (Hint: Pulling the knotted end farther back will increase how far the pom-pom travels.)

WHY IS THIS ENGINEERING?

The pom-pom shooter helps us see both kinetic energy and potential energy at work. When the pom-pom is in the cup and the knotted end is pulled back, this is when it has the most potential energy—stored energy. When you release the knotted end of the balloon and the pom-pom goes flying out, this is when the pom-pom has the most kinetic energy—energy of motion.

Civil engineers have used the concepts of potential energy and kinetic energy to design everything from rockets to roller coasters. A roller coaster cart, for example, needs to have a lot of potential energy at the beginning of the ride. This is why almost all roller coasters start by going up a very big hill. This tall hill gives the cart a lot of potential energy. Once the cart goes over the hill, all that potential energy is then changed into kinetic energy as the cart begins speeding along the track.

WITH THANKS AND FOR MORE INFORMATION, VISIT:

This activity has been adapted from "Easy Pom Pom Shooter Craft for a Fantastic Indoor Kids Activity!" *Little Bins Little Hands* (https://littlebinsforlittlehands.com/pom-pom-shooter/).

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MAGNET CAR

BIG IDEA

Use an invisible force—magnetism—to move a car!

READY ...

Gather materials:

- 1 button magnet (round magnet)
- 1 N/S magnet (red-and-blue magnet)
- 2 glue dots
- 1 toy car
- paper
- markers or crayons (from home)

SET ...

Remember, magnets must never be placed in the mouth. If swallowed, magnets can cause serious internal injuries. Call for medical assistance immediately.

GO!

1. It is easy for us to push or pull objects with our hands, but there are some invisible forces that can move toy cars and other objects, too! You are going to use an invisible force that can push AND pull a toy car.

2. Use the glue dots to stick the button magnet onto the roof of the toy car. The button magnet is the round magnet.

3. Hold your other magnet. Notice that it is red and blue. Try to find out why this magnet has two colors by experimenting with your toy car and both sides of the magnet to see what each does.

4. Did you notice the difference between the red and blue sides of the magnet?

- The blue side pulls, and the red pushes.
- Scientists and engineers have words to describe the invisible push and invisible pull of a magnet. When a magnet pulls something to it, we say it “attracts.” When a magnet pushes something away, we say the magnet “repels.”
- The magnet makers paint different colors on each end so that we know which one attracts and which repels.

5. Use your paper and markers or crayons to draw a road for your car to travel on.

6. Practice using the N/S (red-and-blue) magnet to push and pull your car along the road you have drawn.

[continued on back]

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WHY IS THIS ENGINEERING?

Because magnetism can be very useful, engineers often include magnets in their product designs. As a result, there are magnets doing many kinds of work—here on Earth and in outer space! Magnets help refrigerator doors to stay shut. Cranes with special magnets pick up and move large pieces of metal. NASA's Mars Exploration Rovers use magnets to collect magnetic dust that can help scientists learn about the planet. Some special high-speed trains even move by using the push and pull of magnetism instead of normal engines! They are called maglev trains—short for "magnetic-levitation trains."

One invisible force—magnetism—you are using when you play with your Magnet Car is created by the magnet. But there's another one that is all around us that is different, and it affects us every day. Gravity! Gravity is an invisible force that keeps your toy car from floating off your table and up into the air!

If you have ever ridden a roller coaster before, you may have noticed the cart didn't have an engine like a plane or car does. Without an engine to power the roller coaster, how does it go so fast? There's an invisible force pulling it along the track: gravity. Just by harnessing the power of gravity, civil engineers can create roller coasters that are able to go over 100 mph.

WITH THANKS AND FOR MORE INFORMATION, VISIT:

"Magnet Array," NASA (https://mars.nasa.gov/mer/mission/instruments/magnet-array/)

"How Maglev Trains Work," Kevin Bonsor and Nathan Chandler, *How Stuff Works* (https://science.howstuffworks.com/transport/engines-equipment/maglev-train.htm)

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EXPLODING STICKS

BIG IDEA

Use Popsicle sticks to change potential energy into kinetic energy.

READY ...

Gather materials:

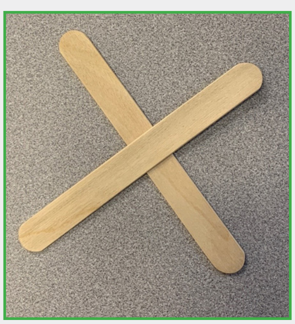
- 15 large Popsicle sticks

SET ...

This activity may require an adult helper.

GO!

1. Be careful and remember throughout this activity that the Popsicle sticks will fly up when they are released.
2. Sticks 1 & 2—Start off with two Popsicle sticks. Lay them in an X-shape on a table. (Picture A.)
3. Stick 3—Take a third Popsicle stick and place it under the end of the stick on the bottom of the X. This third Popsicle stick should go over the stick on top of the X. (Picture B.) Note: It helps to keep pressure on the center of the X as you build the reaction.
4. Stick 4—Place a fourth Popsicle stick under the open end of the bottom of the X and over the third stick. Remember to keep pressure on the new stick you add—in this case, Stick 4. (Picture C.)



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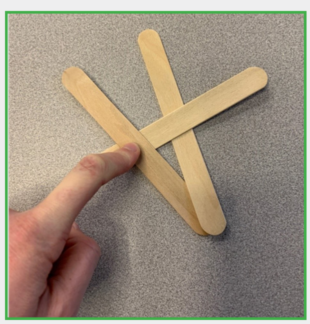

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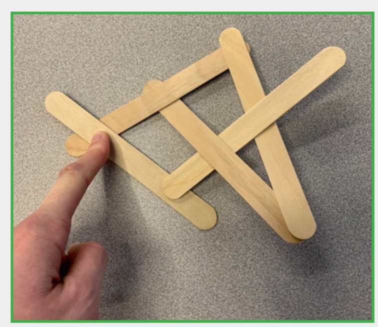

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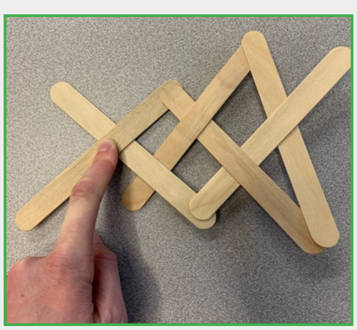

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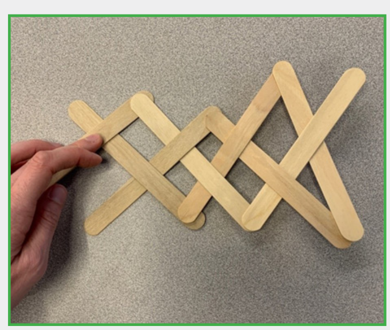

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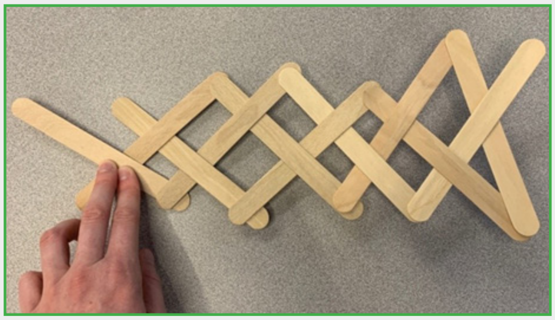

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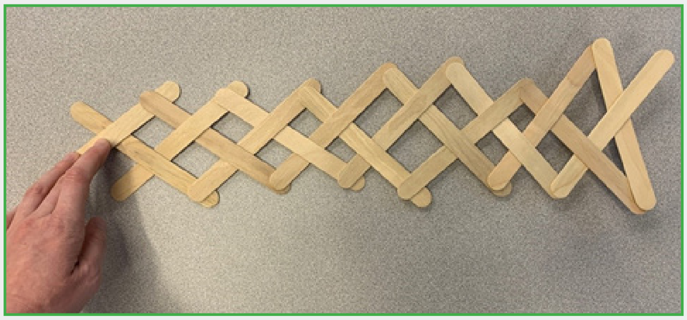

H

5. Sticks 5–15—Continue this pattern, adding a total of about 15 Popsicle sticks. Remember, each time you add a Popsicle stick, it goes over one stick and under the other. (Pictures D–H.)

6. Once you have finished adding the last stick, stand back. Then let go of the pressure you are putting on the last stick and watch out! The sticks will begin to explode down the line!

WHY IS THIS ENGINEERING?

As you weave the Popsicle sticks over and under, you are continually building up potential energy—stored energy—because the Popsicle sticks are sitting and waiting to move. Each stick is bent just a little over one stick, and then held under another stick. Each stick wants to lie flat, but it can not. With each stick you add, you are building up more and more potential, or stored, energy. Once you release the last stick, the potential energy changes into kinetic energy. Kinetic energy is energy of motion—or, the Popsicle sticks exploding all over the place!

Just like the exploding Popsicle sticks, a roller coaster cart needs to have a lot of potential energy at the beginning of the ride. This is why almost all roller coasters start by going up a very big hill. Civil engineers know that this tall hill will give the cart a lot of potential energy. Once the cart goes over the hill, all that potential energy is then changed into kinetic energy as the cart begins speeding along the track.

WITH THANKS AND FOR MORE INFORMATION, VISIT:

This activity has been adapted from from “Popsicle Stick Chain Reaction” *Steve Spangler Science* (https://www.stevespanglerscience.com/lab/experiments/popsicle-stick-chain-reaction/).

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