



# High Touch High Tech®

Science Experiences That Come To You

## Pulley Power

Have you ever tried to lift a really heavy object, but it just would not budge? How do engineers construct large buildings and raise heavy blocks of wood and cement? How do scientists lift very fragile (and heavy) equipment? Fortunately, we can utilize *simple machines* to help make difficult tasks much easier!

For this activity, you can make a pulley system that helps you move your favorite snack with a fun twist.

### Supplies:

- favorite bite-size snack (i.e. Cheerios, Skittles, popcorn, crackers)
- 6 paper towel cardboard tubes
- 3 straws
- 3 empty ribbon spools
- baker's twine or thin string
- small plastic cup (3oz.)
- masking tape
- scissors
- pen, screwdriver, or single hole-punch (to poke holes in cup and tubes)

### Instructions:

*For this activity, ask an adult to help you set-up.*

- \* *Punch 2 small holes in your plastic cup directly across from each other. The holes should be close to the opening of the cup.*
- \* *Cut 2 of the paper towel cardboard rolls in half.*
- \* *Punch 2 small holes in each cardboard tube, directly across from each other. The holes should be 1 inch from the opening of the cardboard tube.*
- \* *Cut a 6" piece of twine or string. Insert the twine or string through the 2 holes of the cup. Tie the ends of the twine together. This gives the cup a short handle.*
- \* *Cut a 18" piece of twine*



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First, you will construct the base of your pulley system with the cardboard rolls and masking tape.

Tape one of the long cardboard tubes to the table so that it is standing up. You want the end with 2 holes on top. Tape a second tube (that is the same length) about 4 inches from the 1<sup>st</sup> tube. You want both tubes standing straight up beside each other. Make sure the holes line up.

Insert one straw through the 2 holes in one tube.

Insert the straw through the center of one empty ribbon spool. The spool will be between both cardboard tubes.

Now, insert the same straw through the 2 holes in the second tube. The straw should go straight through one tube, then the ribbon spool, and finally through the second tube.

Test the ribbon spool wheel by spinning it. Do the cardboard tubes support the ribbon spool? Does the wheel spin? (If the wheel does not spin, make sure the holes in the tubes are large enough.)

Next, tape one of the short cardboard tubes to the table. It should be approx. 4 inches away from one of the taller tubes. Tape the second short cardboard tube 4 inches from the other short tube. (The 2 short tubes will form a square on the table with the tall tubes.)



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Insert a straw through the holes of the short tube. Insert the straw through a second empty ribbon spool. Insert the straw through the 2 holes of the second short cardboard tube.

Test the ribbon spool.

Now you have 4 cardboard tubes, 2 straws, and 2 ribbon wheels set up.

Next, tape the last 2 tall cardboard tubes beside the short tubes. This will form a straight line of cardboard tube pairs. (Tall, short, tall).

Following the same steps, be sure to insert the straw and ribbon spool between the final 2 cardboard tubes. Test the ribbon spool wheel.

Now, you have the basic structure for your pulley system. It is ready for the twine or string.

Cut 18" of twine.

Thread the twine over the groove of the first ribbon spool. (Do NOT wrap the twine completely around the spool.)

Now thread the twine under the groove of the second spool.

Finally, thread the twine over the groove of the last spool.

Attach the twine handle of your cup to one end of the twine in your pulley system.

Place a few pieces of your favorite snack in the cup.

Now, carefully pull the end of the twine on the other side of your pulley system. What happens? The pulley lifts up the cup!

Try placing more snack pieces in your cup. How does this change the pulley? Do you need to pull harder on the twine? Does it affect how quickly the cup lifts off the table?

Now that you have created a pulley system, can you think of other ways to use this engineering at your house? Have fun!

The Science Behind It:



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Pulleys are a type of *simple machine* that we use everyday. Pulleys have been extremely important to scientists and engineers for thousands of years. (In fact, Ancient Egyptians used pulleys to build the pyramids!)

A *pulley* consists of a rope (or string) wrapped around a wheel. One end of the rope is attached to the object being lifted and the other end is pulled by a person or motor.

A very simple pulley is on a flagpole. A single rope loops around a wheel at the top of the flagpole. You can attach the flag to the rope, pull down on the rope, and the flag is slowly lifted to the top. Other types of pulleys are made for elevators, bicycles, fishing boats, cranes and large pieces of machinery.

A pulley system is a series of wheels that work together to raise heavier objects. The more pulleys decreases the amount of energy needed to raise the object. However, more pulleys working together require longer rope to engage the simple machine.

## Real World Relevance – Etch a Sketch

One of the most well-known toys, called an Etch a Sketch, uses a fairly complex pulley system to create a captivating drawing device. An Etch a Sketch is made of a red plastic case with a thick, flat piece of glass on top. There is sticky aluminum powder inside the Etch a Sketch, which coats the back of the glass screen.

What we cannot see inside the toy is a complicated pulley system of tightly strung steel wire. This very thin wire connects to bars inside the device. When you turn the knobs, the pulley system is engaged. A stylus (pointed metal object) moves along the bars inside the device. As the stylus moves, it scrapes (etches) the aluminum powder off the glass screen. You see a thin dark line on the screen because the absence of gray powder reveals the inside of a dark, empty box! When you shake the Etch a Sketch, the gray aluminum powder sticks to the glass screen, erasing the dark lines.

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