

**Trebuchet**

**Activity #1**

**9-12**

# **Objective**

The purpose is to build a trebuchet that demonstrates the concepts of potential energy, kinetic energy, and a lever arm to throw small projectiles.

# **Materials**

* 12” x 12” pieces of cardboard
* Pencil
* Milkshake straw
* Paper clip
* Rubber bands
* Eraser caps
* Popsicle sticks
* Film canister
* Ruler and/or straight edge ***(not provided)***
* Tape ***(not provided)***
* Scissors ***(not provided)***
* Elmer’s glue ***(not provided, optional)***
* Battery (AA, C, or D) ***(not provided, optional)***

# **Instructions**

* Take one 12” x 12” cardboard square and draw a line diagonally from one corner to the other using your ruler or straight edge. Cut along this line to make two triangles. Match up the edges of the triangles and tape them together. Note: you will be removing this tape later so try and use as little as possible.
* On the long side of the triangle measure 3 ½” in from the corner and use a writing utensil to draw 1½” line perpendicular to the edge. Do this on both triangles from both corners on the long side.
* Roughly ½” below the corner opposite the longest side of the triangle, mark a dot and then carefully use scissors to poke a hole in both triangles. Once you have the hole started, use the pencil to widen the hole – it should fit snugly in it.
* Untape the triangles and carefully cut vertical notches along your 1 ½” lines. These notches should be wide enough to slip another piece of cardboard into them snugly.

***Caution****:* Do not cut these notches too wide or it will make it more difficult for your trebuchet to stand.

* Take the other 12” x 12” cardboard square and measure 6” up one side of the square. Mark this spot with a witting utensil. Do the same on the opposite side of the square. Use your ruler or another straight edge to draw a line and connect them.
* Repeat step 5 on the same sides of the square, measuring only 3” up instead of 6”.
* On the 3” line, measure in from the edge of the cardboard 3 ½”. Draw a 3” line perpendicular to the 3” line at this point such that it is there is a 1 ½” line on each rectangle. Do this from the opposite side of the board as well so that you have two 1 ½” marks on each rectangle.



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* Cut along the 6” line and 3” line to create two separate 3” x 12” rectangles. Carefully cut vertical notches along your 1 ½” lines. These notches should be wide enough to slip another piece of cardboard into them snugly.

***Caution:*** Do not cut these notches too wide or it will make it difficult for your trebuchet to stand.

* Using the notches, assemble the base on the trebuchet such that both triangles are parallel to each other and both rectangles are parallel to each other. You can use Elmer’s glue in the notches to reinforce the base if you wish.
* Tape together two popsicle sticks.
* Unbend one end of the paper clip such that it is almost but not quite straight. Attach the remaining flat part of the paper clip to the end of one of the popsicle sticks.
* Cut a 1” portion of the milk shake straw and attached it to the middle of the popsicle stick are using rubber bands or tape. Be careful not to deform the straw – it needs to be able to rotate freely around the pencil later on.
* Use tape and/or rubber bands to attach your film canister to the end of the popsicle stick arm opposite of the end with the paper clip. Place something heavy inside and close the cap on the canister. OPTIONAL: If you are unable to find something heavy to put inside the film canister, consider using a battery instead.
* Place the milkshake straw on the pencil, and then place the pencil into the holes you poked on the triangles.
* Use the eraser caps, a small amount of tape, and any remaining rubber bands to create the payload for your trebuchet (see picture).
* Place on paper clip, tilt backward, and release to fire trebuchet.

# **The Science**

A trebuchet uses several physics concepts to launch objects long distances. The first of these is the conversion of potential energy (the energy stored in an object due to its position) to kinetic energy (the energy of motion). When the counterweight (in the case of these mini trebuchets the film canister or battery) is raised it gains gravitational potential energy – when the trebuchet is released the counterweight swings down and this potential energy is converted to kinetic energy which launches the payload. The second concept is a lever arm – by adjusting the distance of the payload and the counterweight from the fulcrum (pivot point – which in this case is the pencil) you can change how much force is exerted on the payload, and thus change how much kinetic energy it gains when the trebuchet arm is released making it go longer or shorter distances.

# **Questions to Think About**

* What happens when you move the counterweight closer to the fulcrum? What happens when you move it farther away? (Hint: Additional popsicle sticks are provided that can help you investigate this question and the next one)
* What happens when you move the paperclip/payload closer to the fulcrum? What happens when you move it farther away?
* Can you optimize your trebuchet so that it can throw the furthest distance possible?

