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## Working Wooden Catapult Kit

CAT-300

### Introduction

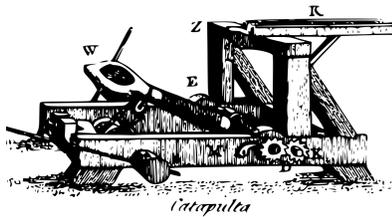
Our Working Wooden Catapult Kit allows you to build your own miniature, fully functional throwing machine. The term “catapult” is generally used to describe all devices that fling objects into the air.

Our Working Wooden Catapult Kit is simple in concept and easy to assemble and operate. It is a perfect way for today’s students to learn more about the fundamentals of projectiles. As your students experiment with the catapult, they are sure to acknowledge the superiority of brain power (and simple machines!) over brawn and muscles.



### Catapults Then and Now

Before gunpowder was invented, ancient military commanders used large, powerful machines to help them lay siege to enemy castles and forts.



In the Middle Ages, what we now call a catapult was known as a mangonel. Catapults were designed so that their lever and potential energy gave them a mechanical advantage for hurling boulders, shrapnel, fireballs, and other damaging materials at enemies. Over time, military engineers created other projectile-launching designs, including the trebuchet. Regardless of what they were named, they were basically all catapults.

You might assume that our modern society has no use for catapults. But in fact, we still use replicas of these medieval weapons—as well as newly engineered designs—to launch pumpkins at harvest festivals! There are dozens of educational YouTube videos that show teams working to build modern “pumpkin chunkin” catapults and trebuchets. Below we have included a few of our favorites.



<https://www.youtube.com/watch?v=dmSyrGsqqmg8>

<https://www.youtube.com/watch?v=sXuQvAPwcoe>

<https://www.youtube.com/watch?v=b0xmTzSXL0E>



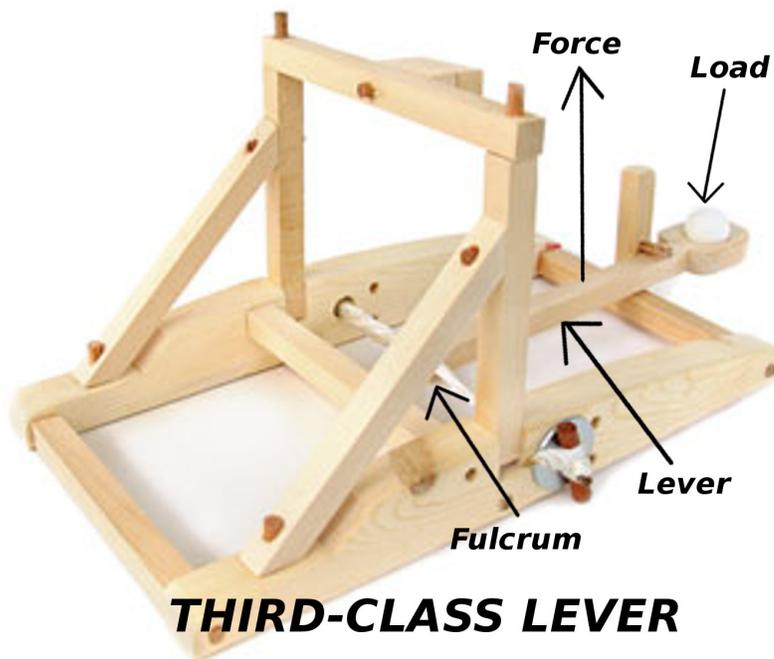
# How Does a Catapult Work?

Our Working Wooden Catapult Kit is easy to assemble in less than an hour (excluding the time it will take for the glue to dry). It is basically a lever with a fixed fulcrum and rope to apply force.

Twisting and coiling the rope many times over creates a “torsion spring.” When the pin holding down the arm is released, soft clay balls become airborne. Catapults powered by coiled ropes are called **torsion catapults**.

When you fire an object from the catapult, it travels in a curved path called a **trajectory**. The distance the object travels is called its **range**. The range of the object and how high it goes depends on its speed and the angle from which it is launched. Changes in the tension, the mass of the clay ball, and the angle of the catapult all have an effect on the projectile’s flight performance.

A mangonel catapult works just like a third-class lever. The base of the catapult acts as the **fulcrum** which the catapult arm pivots on. In this case, the **force** is provided by tension in string. The **load** acts as the projectile in the bucket.



When the arm hits the crossbar, the projectile leaves the bucket and launches forward. This is due to Newton’s First Law of Motion, which states:

## **Objects in motion stay in motion; objects at rest stay at rest.**

The projectile is moving at the same speed as the arm and the bucket. When the arm and bucket stop, the projectile continues to move forward at the same velocity it was before. Gravity brings the projectile back to the ground which gives it its **trajectory**.

# Catapult Activities

## 1. Motion Transfer

Demonstrate how the semi-circular motion of the catapult moves a piece of clay from a standstill to an arching launch and, ultimately, flight.

All three of Newton's Laws of Motion can be identified in the launch and recovery of an object hurled by the catapult.

This is an excellent opportunity to explain how to operate the catapult and diagram the trajectory of the flung objects. Help your students recognize that the catapult is a simple machine. Identify the parts of the catapult and how those parts correspond to the parts of a third-class lever.

### **SAFETY NOTE:**

*It is essential to establish clear safety ground rules to prevent accidents during the activities described here. Students should wear safety glasses while performing these demonstrations.*

## 2. Mass of the Projectile vs. Mass of Potential Energy

This simple activity allows students to test the relationship between the force of the thrower and the mass of the thrown object. Students can vary the number of times they twist the rope to change the force and they can use varying amounts of clay to change the load. Allow students to perform multiple trials until they establish an optimum launching strategy. Setting up multiple catapults with lab groups will transform your classroom into a firing range, so please ensure that all safety precautions are in place.

Ask your students: *What can you do to make the catapult shoot farther?*

## 3. Variables in Launch Angle and Range

Catapults were successful over the centuries because they enabled warriors to calibrate the angle and force required to hit a target in a predictable manner. Adjusting the angle of release is a valuable activity that will enhance your students' understanding of how velocity, air resistance, and gravitational pull can be manipulated.

Students can lean the base of the catapult upon a textbook so that the fulcrum of the catapult is slightly elevated. Use a protractor to measure the angle. Students should launch a constant projectile at a variety of angles to experiment with this concept.



# Catapult Activities

continued

Experimenting with angles, students can take control of the range of the catapult. When students change variables in the amount of stored energy in the weight or the mass of the projectile, new learning opportunities will unfold.

Ask your students:

- *How does the angle of the catapult affect the trajectory of a projectile?*
- *What happens to accuracy of the projectile as the angle is increased?*
- *What happens to the force of the load as the angle is changed?*

## 4. Accuracy of Launching

Catapults were used for centuries because they could hit a target accurately over and over again. This consistent accuracy is what allowed ancient armies to topple castles, knock down ten-foot-thick walls, isolate besieged territories and intimidate their opponents into submission.

Using the Working Wooden Catapult Kit, your students can set up targets for different challenges.

By defining parameters for a variety of tasks, your students will gain a better sense of what this ancient machine was designed to do. For example:

### **SAFETY NOTE:**

***Never allow students to be downrange of the target while these accuracy experiments are being conducted.***

### **Knock over the Wall!**

Challenge your students to develop a tactical plan so they can hit a cardboard target with some clay projectiles, or land them into a bowl or a stack of plastic cups. Taking careful note of their misses should guide their refinement of the trajectory required. Instruct team members to stand alongside the shooting area so they can view the arch motion and speed. This will allow them to gather more evidence to guide their future attempts.

### **Hit the Bull's Eye!**

Draw a bull's eye target on the side of a large cardboard box. To add fun to the competition, small squares of sponge can be soaked with different colors of tempera paint. Teams can make strategic plans and hurl their ammunition towards the target, leaving splats of color on the target. (NOTE: This is best done outside for obvious reasons!)



# Fun Facts about Catapults

- 1.** Did you know that the mangonel is the predecessor to the trebuchet?
- 2.** Did you know that the word “mangonel” derives from the ancient Greek word *manganon*, literally meaning “engine of war”?
- 3.** Did you know that the ancient rope bundles were made from vegetable fibers, hair, or cattle sinews?
- 4.** Did you know that mangonels were used most effectively in sunny places like Greece, Spain, and where modern Turkey, Lebanon, and Israel are now?
- 5.** Did you know that in damp climates—like those of England or northern France—the wet ropes tended to quickly stretch and thus lose most of their throwing power? (This led to engineers designing even better throwing devices.)
- 6.** Did you know that torsion-powered catapults are also known as chiroballista, arcuballista, onager, scorpion, mangonel, stone thrower and lithobolos?
- 7.** Did you know that “catapult” comes from two Greek words: *kata* which means downward and *pultos* which is a small shield. Together, *katapultos* means “shield piercer.”
- 8.** Did you know that all third-class levers have a mechanical advantage less than 1? Its value brings velocity to an object.



# Take Your Lesson Further

As science teachers ourselves, we know how much effort goes into preparing lessons. For us, “*Teachers Serving Teachers*” isn’t just a slogan—it’s our promise to you!

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<http://blog.TeacherSource.com>

To extend your lesson, consider these Educational Innovations products:



## Star Coaster 2.0 (MAR-330)

With so many design variables to explore, your students will have a new learning adventure each time they build this high-speed ball roller coaster! The Star Coaster Level 2 guarantees thrilling action rides that include wild rotations, daring loop-the-loops, hairpin turns, and spectacular swivel motions. After each ride, the steel sphere is hoisted back to its starting position by a battery-powered spiral conveyor elevator.

## Wooden Car Kit (WK-1)

This wooden car is powered by an elastic band. When the potential energy of the stretched elastic is converted into kinetic energy of motion, the car will travel about 3 meters (10 feet). Students can experiment by varying the method of winding the elastic, the number of turns and the type of surface used. Easy to assemble.



## DIY Ferris Wheel STEM Kit (CST-820)

Calling all future architects and structural engineers! This exciting STEM kit for grades 3-6 combines the best of hands-on engineering, problem solving, and DIY creativity. Whether they follow the detailed instructions (included) or opt for their own original design, students will be challenged as they build the wooden Ferris Wheel. Includes a low melt glue gun, 2 glue sticks, 55 wooden craft sticks, cardboard, a ruler, a dowel, and complete instructions. This Educational Innovations exclusive will get students away from their screens and immerse them in the "old-fashioned" pleasure of building an object from scratch.