Mini Trebuchet Kit

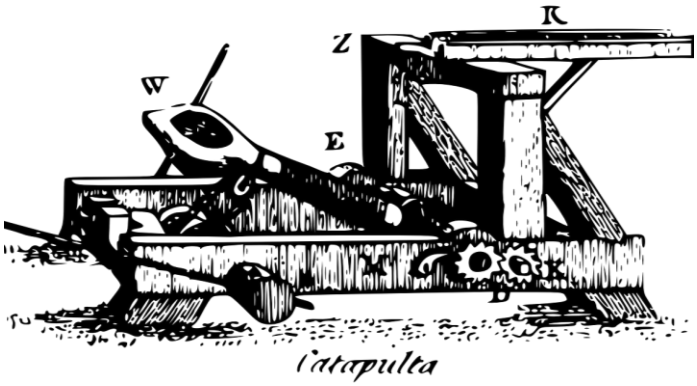
CAT-350

Introduction

The term “catapult” is generally used to describe all devices that fling objects into the air. The trebuchet is one of the final catapult designs created for ancient warfare. It is also a perfect way for today’s students to learn more about the fundamentals of projectiles.

Our Mini Trebuchet Kit consists of a working model that can be easily assembled and operated. As your students experiment with the trebuchet, they are sure to acknowledge the superiority of brain power (and simple machines!) over brawn and muscles.

Some Historical Background



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

The status of engineers was greatly increased as catapult and trebuchet designs evolved. Engineers possessed the advanced mathematical skills and formulas required for building and properly aiming these giant missile launchers. Projectiles traveled away from the trebuchet in a high, arcing trajectory that traced out a parabola in the sky.

With its consistent counterweight force, the trebuchet became one of the most reliable weapons in the arsenals of ancient warfare.

5 Francis J. Clarke Circle
Bethel, CT 06801

Phone (203) 74-TEACH (83224)
Fax (203) 229-0740
www.TeacherSource.com

Trebuchets Today

You might assume that our modern society has no use for trebuchets. 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" trebuchets. Below we have included a few of our favorites.

Middle School Punkin Chunkin Series

This series of brief YouTube videos follows the efforts of two brothers, ages 9 and 14, who designed and built an authentic trebuchet as part of their participation in the Youth Division of a "Punkin Chunkin" competition. Great for showing in the classroom!

Friday, Part 1:
www.youtube.com/watch?v=iG2c9e7UAXY

Saturday, Part 2:
www.youtube.com/watch?v=oG7nNedoQNI

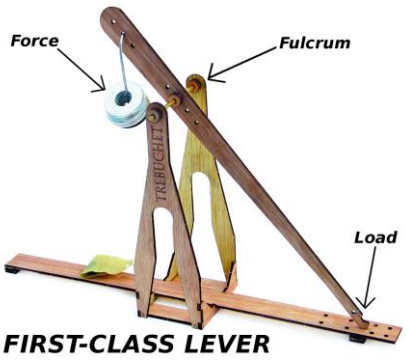
Sunday, Part 3:
www.youtube.com/watch?v=QakELGNnotQ

How Does a Trebuchet Work?

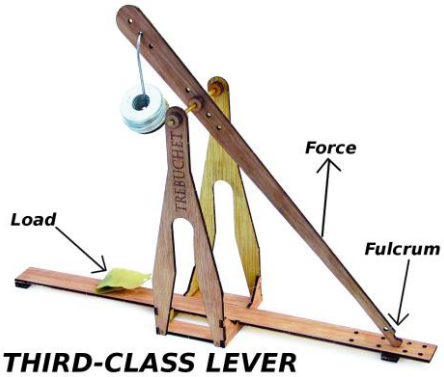
This Mini Trebuchet Kit is easy to assemble in less than an hour (excluding the time it will take for the glue to dry). It is a complex machine based primarily on a simple machine—a lever. The trebuchet's lever has a fixed fulcrum and a weight to apply the force that moves the load (projectile) with enough speed to make it fly through the air.

Here's the sequence: A sling loaded with ammunition is attached to the longer end of the lever. When the pin holding down the arm is released, the counterweight on the opposite end of the lever drops with a thump, the long arm rises, pulling the sling quickly with it.

The sling joint actually creates a second fulcrum (a third-class lever) at which the cord pivots around and whips the sling into the air, carrying its load (i.e., a ball of soft clay). This second lever amplifies the force, giving it a better mechanical advantage and therefore increasing the speed and distance the load will travel.



FIRST-CLASS LEVER



THIRD-CLASS LEVER

When you fire an object from the trebuchet, 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 force (weight of the downward motion), the mass of the clay and angle of the catapult will determine the flight performance.

The trebuchet works just like a first class lever AND a third class lever. The quick chain reaction of events can be explained by Newton's first law of motion, which states:

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

When the trebuchet's arm is released the weight drops, lifting the arm and pulling the sling. Next, the motion of the arm stops—but the sling and the projectile both stay in motion. When the cord finally stops the sling, the projectile continues and is hurled. Finally, gravity brings the projectile back to the ground which gives it its trajectory.

Trebuchet Activities

1. Motion Transfer

Demonstrate how the semi-circular motion of the trebuchet 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 trebuchet and diagram the trajectory of the flung objects. Help your students recognize that the trebuchet is a simple machine. Identify the parts of the trebuchet and how those parts correspond to the parts of a first- and 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 use various weights 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 trebuchets 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 trebuchet 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 trebuchet upon a textbook so that the long end of the trebuchet 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.

Experimenting with angles, students can take control of the range of the trebuchet. 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 trebuchet 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

Trebuchets were used for centuries because they could hit a target accurately over and over again. The counterweight provided a consistent force that engineers could then factor into their calculations for range. 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 Mini Trebuchet 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!

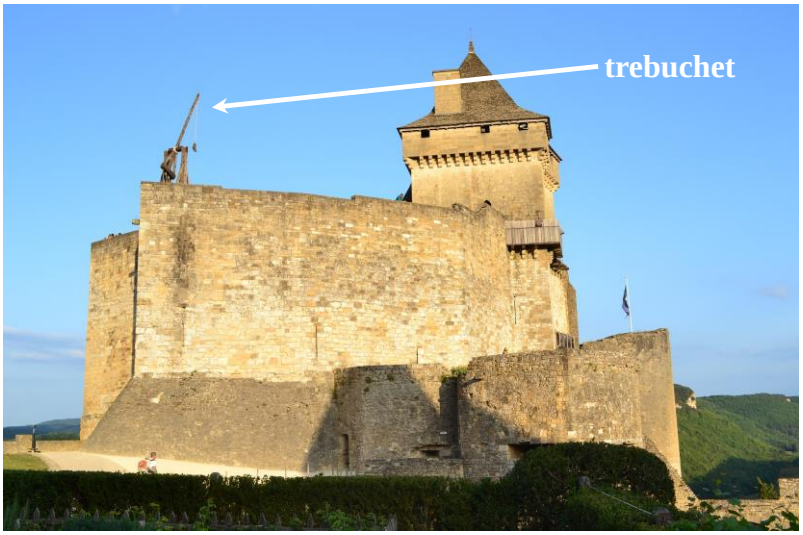
Draw a bull's eye target on the side of a large cardboard box. To add fun to the competition, small squares of sponge can be soaked with different colors of tempera paint. Teams can make strategic plans and hurl their ammunition towards the target, leaving splats of color on the target. (NOTE: This is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

Fun Facts about Trebuchets

1. Did you know that the trebuchet's lever allows you to substitute force for speed and vice versa?

2. Did you know that the trebuchet is the largest and most powerful of all the catapults types?

3. Did you know that the word "trebuchet" is derived from the old French word "trebucher," which means to throw over?



The Château de Castelnaud is a medieval fortress in Southern France.

4. Did you know that circa 1300, a group of catapult carpenters founded their own labor union, the Carpenter's Guild? That guild still exists today!

Assorted trebuchet projectiles

5. Did you know that the famous Greek scholar Archimedes served as a military engineer for Syracuse in 215 BC?

6. Did you know that Newton's first law of motion is also known as "The Law of Inertia"?

7. Did you know that trebuchets could be built on a very large scale and were able to throw heavy, round stones well beyond the range of defensive archers and spear throwers in ancient times?

8. Did you know that in England, war engines like the trebuchet were collectively known as "The Ingenium"—from the Latin *ingenium* meaning "ingenious device?"

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!

Please visit our website for more lesson ideas:
www.TeacherSource.com/Lessons

Check our blog for classroom-tested teaching plans on dozens of topics:
http://blog.TeacherSource.com

To extend your lesson, consider these Educational Innovations products:

Working Wood Catapult Kit (CAT-300)

Build your own miniature fully functional mangonel! What's a mangonel, you ask? You probably know it as a catapult. It's the predecessor to the trebuchet, and was one of the earliest throwing devices in the Middle Ages. Perfect for side-by-side comparisons and competitions with the trebuchet for distance and accuracy!

Dancing Robots and Sliders (ROB-320 / ROB-325)

These simple wind-up machines include levers and rotating cams, and show the change from elastic potential into kinetic energy. The Dancing Robot has a visible cam in its belly that moves the hips and arms while bobbing the head. The Slider uses a remarkable timing gear to switch between two different dance moves, including a split. Unique motors cannot be overwound.

Sparklz Wind-Up Toy (KLW-310)

This 'sparky' little wind-up critter may seem aimless, but take a closer look. The axle on this simple machine is bent to produce a complex pattern of motion. Can you predict where it will go? Also take a look at the wheel on the top of the machine. Two pieces of flint circle around a strike plate, producing brilliant sparks as Sparklz makes its way across a flat surface. Perfect for the study of simple machines, friction, and for prediction activities!

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.