



## The Medieval Catapult

**Lesson Objective:** Teach the students about the engineering behind levers and catapults as well as their historical importance.

**Concepts:** Levers, Pivots, Transfer of energy, Tension and The Middle Ages

**The Challenge:** To create a catapult capable of firing an object at least two meters before hitting the ground.

### **Materials:**

- Lego Mindstorms Kit
- Tape measure or meter stick
- Rubber bands

### **Vocabulary:**

- Catapult
- Lever
- Pivot
- Tension
- Energy
- Middle Ages
- Siege

**Procedure:** Begin the lesson with these ideas, questions and demonstrations.

What is a catapult? A catapult is a simple device that uses a swinging arm to throw an object a long distance. How does it work? Catapults use levers that are made from study bars resting on pivots. The pivot is the central point around which a bar turns. It is helpful to have a pre-built model of the catapult to show the students where the lever and the pivot are located and how they work. One of the most effective forms of catapult uses tension to store energy that is then released to move a lever and hurl an object. Rubber bands can be stretched to hold energy through tension, so they can be used to make an effective catapult.

Review the historical importance of catapults. When in history were catapults commonly used? In Europe during the Middle Ages, the catapult was used frequently during sieges of castles. An enemy would use the catapult to hurl large, heavy objects at the walls of the castle in order to break them down. In medieval times, large catapults were made of wood and rope but today they can be made from legos.

**Engineering Challenge:** In small groups, have the students build their own catapults modeled after the pre-built one. Remind the students to first build the frame for the catapult before inserting the lever and the rubber bands. The students should not try to catapult anything during the building stage because the machine might fall apart and hurl



an object in an unexpected direction. Be sure that the students get you to approve their catapults before they begin to launch.

In a designated launch area, have a tape measure or meter sticks set up to measure the distance that the projectile travels. Only single 2 x 6 and 2 x 8 blocks should be catapulted at first because they yield the good travel distances. It is important that they be placed in the projectile holder at a slant so that they do not get stuck during launch. Show the students how to hold the base of the catapult during launch so that it does not move. One student should hold the base and another should release the catapult lever during launch. This will maximize the projectile's distance and minimize the chance that it will go off course.

Have the students estimate where the projectile first touched ground and determine if it traveled farther than the travel distance of two meters. If not, the group should try again and if necessary refine the design of their catapult. Groups can also try to determine the farthest distance that they can get their projectile to travel. After they have met the challenge distance, the groups can try to launch other objects besides the specified blocks.

**Extension:** There is another common type of catapult that uses a counterbalance instead of tension. It works by storing up potential energy from gravity and releasing it to move the lever. Introduce the students to this other type of catapult and consider have them try to construct one. Did they find that the counterbalance catapult was more or less effective than the tension catapult?

**Wrap-Up and Sharing:** Did anyone have problems with their catapults? What were they and how were they corrected?

Where does the energy come from in the catapult? It comes from the work that a person does to push down the lever on the catapult. How is energy stored in the catapult system? It is stored as tension in the rubber bands. Does it matter what size rubber bands are used? For a catapult of a fixed size, the rubber band size does matter because different size bands will hold different amounts of tension.

Is the positioning of the pivot in the lever important? Yes, since it affects the lever's balance, how much tension can be put in the bands and how far the projectile holder travels during launch. To achieve the optimum projectile distance, the pivot should be roughly at the center of the lever beam.

**Troubleshooting:**

- Some students will be more experienced with Legos and others will be new to the experience.
- Some students may have difficulty building a sturdy catapult. Advise them to first build a sturdy frame for the car before trying to add the pivot and lever.



- Be sure to designate a safe launching area for testing. Catapults were designed to launch objects fast and far and to cause damage to the things they hit. Be sure to keep the launch area clear of people and valuables!
- Do not allow students to launch sharp objects of any kind.
- If the projectile hits the ground close to the catapult, try to revise the launching technique or the design. Oftentimes, a greater distance can be achieved if the bricks are position diagonally in the projectile holder. Or, try to move the pivot closer to the center of the lever beam.

**Resources:**

- Lego/Tufts website: [www.ceeo.tufts.edu/curriculum](http://www.ceeo.tufts.edu/curriculum)
- Lego Dracta “Simple and Motorized Machines” Teacher Guide

**Credits:** The design of the catapult is based on one developed by Tufts University Center for Engineering Educational Outreach.



### Catapult Building Pictures

