

## CATAPULTS

Have you ever read books about or seen movies set in the Middle Ages? If so, then you've seen pictures of castles and walled cities. These were very important defensive spaces during earlier periods of history because they could keep those within its walls safe from enemy attacks. **Siege weapons**, like battering rams and **catapults**, were designed to break castle walls and damage the defending armies.

A **catapult** is a type of **simple machine**, which is a device with few or no moving parts used to modify **force** (push or pull upon an object) and motion to perform work. There are six different simple machines: an inclined plane, lever, wedge, wheel and axle, pulley, and screw. A catapult uses a **lever**, which is a plank or ridged beam that can rotate freely on a pivot. It is perfect for lifting or moving heavy things.

Catapults were used as weapons to launch things like stones and spears without the use of explosives. It was a very effective tool. There are historical records indicating that catapults were used by pirates in the 1600s, and they were even used by the ancient Greeks and Romans over 2000 years ago! Here are some pictures of ancient catapults:



The laws of **physics** can help explain how a catapult works. **Physics** is the branch of science that studies how objects, forces, and energy relate to each other. Physics helps us to understand forces such as gravity and other forms of energy, like heat, light and electricity.

**Newton's Three Laws of Motion** explain how things move:

1. An object at rest will stay at rest, and an object in motion stays in motion unless another **force** acts on it. **Force** is a push or a pull upon an object
2. The greater the force on an object, the greater the **acceleration** (the rate of change in velocity of an object, a fancy word for speeding up). The greater the **mass** (amount of matter) of an object, the more force is needed to move the object.
3. For every action, there is an equal and opposite reaction.

Building a simple catapult from craft, or popsicle, sticks can help you see how energy is stored, transferred, and converted. A catapult works because energy is converted from one type of energy to another and is transferred from one object to another.

When you are getting ready to launch your catapult, you add energy to it. This is stored in the catapult as **potential**, or **stored energy** (energy that is stored in an object due to its position, arrangement, or state). In



your homemade catapult, elastic potential energy is stored in the wooden stick as you bend it. The stored energy is released when you let go and is converted into **energy of motion** and transferred to the launched object as it flies through the air. The energy an object has due to its motion is called **kinetic energy**.

How to make a homemade catapult:

- Craft or popsicle sticks (9)
- Rubber bands
- Plastic spoon
- Objects to launch (**projectiles** - in physics, a projectile is an object thrown when acted on by a force): examples that will work include marshmallows, cotton balls, or Styrofoam balls



1. Stack 7 sticks and tie them together at both ends with rubber bands.
2. With rubber bands, secure a plastic spoon to one of the two remaining sticks.
3. Stack the stick with the spoon attached to the remaining stick, then secure the ends of those two sticks with a rubber band.
4. Pull the two sticks apart and wedge the first stack of seven sticks between them.
5. **Two extra rubber bands will be needed to hold these two pieces together (see blue arrow in photo of Steps 4 & 5 below).**
6. Place your choice of "projectile" on the spoon.
7. Place one hand on the bottom of the catapult to hold it in place
8. Use your other hand to push the spoon down.
9. Release the spoon and let your projectile fly!



Steps 2 & 3

Step 1





Steps 4 & 5



Step 6

***What happened?***

*Did your projectile fly high or low?*

*How far did it go?*

*What happens if you push the spoon further down? Does it make the projectile fly higher or just farther?*

*Maybe both? Does it seem to go faster?*

*Did you notice that you have to do more work to press the spoon down farther?*

*Try objects with different weights. Do you see a difference in the way they fly?*

**Explanation:**

As you bend the stick, you load it up with energy. When you let go, the energy is released and converted into the energy of motion. Most of this energy is transferred to your projectile that shoots through the air.

You probably noticed that the projectile flew higher and farther when you pushed the stick farther down. This took more effort from you. As the stick bent farther, more elastic potential energy was stored in the stick.

**ADDITIONAL RESOURCES**

Websites

American Museum of Natural History, What is Physics? <https://www.amnh.org/explore/ology/physics>

National Aeronautics and Space Administration (NASA), Newton's Laws of Motion  
<https://www.grc.nasa.gov/www/k-12/airplane/newton.html>

Institute of Physics, Explore Physics <https://www.iop.org/explore-physics>

Videos

National Science Foundation, Newton's First Law of Motion: Science of NFL Football  
<https://www.youtube.com/watch?v=08BFCZJDn9w>



National Aeronautics and Space Administration (NASA), STEMonstrations: Newtons 2nd Law of Motion  
[https://www.youtube.com/watch?time\\_continue=22&v=sPZ2bjW53c8&feature=emb\\_logo](https://www.youtube.com/watch?time_continue=22&v=sPZ2bjW53c8&feature=emb_logo)

National Aeronautics and Space Administration (NASA), STEMonstrations: Newtons 3rd Law of Motion  
<https://www.youtube.com/watch?v=dCF--YOjiOw>

National Geographic, Pumpkin Catapult <https://video.nationalgeographic.com/video/00000144-0a40-d3cb-a96c-7b4d462a0000>

SciShow Kids, Swings, Slides, and Science: Physics for Kids  
<https://www.youtube.com/watch?v=JvSCIZ3vHOI>

### Books available from the Washoe County Library System

*Build a Catapult in Your Backyard* by Bill Wilson

*Physics: Investigate the Mechanics of Nature* by Jane P. Gardner and Samuel Carbaugh

*The Art of the Catapult: Build Greek Ballistae, Roman Onagers, English Trebuchets, and More Ancient Artillery*  
by William Gurstelle

*What are Newton's Laws of Motion?* by Denyse O'Leary

[\*Why Doesn't the Earth Fall Up?: and Other Not Such Dumb Questions about Motion\*](#) by Vicki Cobb and Ted Enik

