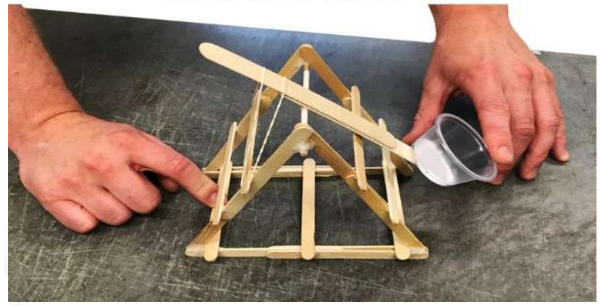
KIDDER CREATE

CATAPULT 25 Student Class Pack
Cat# 83-54CPLTG



Design and Build

This is a good entry level activity. There are some basic structural components to the design i.e; triangles and levers.
Students need to have some kind of working knowledge of framing and supporting structures before they try to design something for any extension for this project, but this gives a great set of basics. Otherwise they will just follow the model on the instructions.

Design Suggestions

You want the students to follow the design here. They need to have the same base structure so that they all have the chance of creating a functional launch lever. It is important for them to follow these plans. The basic overlap of the Popsicle sticks is key to having a solid base.

All about the base...

Make sure that students design a simple, stable, solid structure. There are several ways to do that using trusses, triangles and gussets, and these triangles are a great example of the solid base. These supporting structures are part of the structures unit and can come in handy.

Build Issues

Cutting Popsicle sticks

Popsicle sticks can be great building material, but not all of them are ideal all of the time. Splitting and cracking can occur when using either the saws or the Kidder Cutters. A couple of quick tips to help with cuts.

1. Tape the Popsicle sticks together. If you are cutting multiple sticks the same length it is a great way to get them cut identically. But it also gives support. If you are cutting near an end, the other stick(s) will support and/or hold the stick from flexing and potentially cracking.
2. Soak the sticks. Most of the wood and Popsicle sticks we work with are kiln-dried so all the moisture is out of them, which means that they are susceptible to cracking or fracturing. By soaking the wood, you get moisture back into the wood which softens the cell structures of the wood, but also relaxes the fibers and they are less likely to break.

Working in 3 Dimensions

One of the issues that students sometimes encounter is dealing with how they transition to the third axis when dealing with a Popsicle stick. That edge is pretty thin, and does not give you a lot of material to attach. Especially if you are using the white glue. One way is lamination. If you build off-set laminated sticks it will give you a width to use. The other is to create half lap joints. Where you cut a grove in overlapping sticks so that they sit into each other. This creates a stable frame and even construction to build a platform on.

Leveling the structure.

This is an aspect that goes unchecked all the time. Level the structure as often as possible. Most phones now have the level app on it if you do not have a level in the tool box. This will make a difference in how stable it is on the table, and reduces friction of the axle when the turbine is spinning.

Some Questions for Discussion

What is the science behind rubber band catapults?

Catapult science basically involves some physics and engineering skills to hurl a projectile without the use of an explosive. It works mainly by using potential and kinetic energy stored in the rubber bands. Potential energy is the store energy whereas the kinetic energy is the energy in motion. Also, the three primary energy storage mechanisms that help the catapult to work are torsion, tension and gravity. A catapult stores energy every time you stretch the rubber band and until you hit the trigger. When you let go of this rubber band, the potential energy is released creating a force. The force of this energy is responsible for the flung of any object (upwards or forwards) attached to the rubber band.

How does a catapult get its energy?

A catapult gets energy either from the twisted ropes or the rubber bands. When you stretch a rubber band the potential energy stored is converted into kinetic energy. These are the two main energies used for the catapult's action. As you increase the number of rubber bands at the base of the lever, you increase the tension, and therefore increase the potential energy release of the projectile.

How high can a catapult shoot?

In the medieval period, the largest trebuchets (with throwing arms 50 feet in length and ~20,000 lbs counterweight) could throw stones 200-300 lbs to a distance of about 1000 feet. While the modern torsion catapults can fire 400 m to 500 m and any that can't shoot 300 m [i.e.. bow range] are useless. To achieve maximum accuracy and effect rocks must be spherical.

Who invented the catapult?

Catapults were invented by the ancient Greeks. The Greek Dionysius (the Elder of Syracuse), who was looking to develop a new type of weapon, invented the catapult about 400 BCE. Thereafter, it became a key weapon in warfare and remained so up through medieval times. In ancient India, they were used by the Magadhan Emperor Ajatshatru around (the early to mid) 5th century BC.

How does a catapult relate to physics?

A catapult actually works on the three main terms of physics i.e. tension, torsion and gravity. Also it works on energy storage mechanisms (nothing but the stored potential energy and energy in motion kinetic energy) says that a catapult works on physics. Newton's second law relates an acceleration, object's mass, and force with which it is moving. We can also observe this law when the projectile hits the ground. All these moments remind us of physics.

What are the 3 types of catapults?

The three main types of catapults are:

1) Ballista: The ballista is a missile weapon, very similar to a crossbow that launches a large projectile at a distant target.

2) Mangonel: The mangonel is the most iconic catapult which comes first in our mind when we think of catapults. It is basically made of wooden arms and a bucket to launch projectiles.

3) Trebuchet: The trebuchet is a bit different in model when compared to the above two catapults. It is made with a long arm (balanced on a fulcrum) and short arm (to counterbalance). The Trebuchet was designed for max power and distance.

What kind of energy is used in a catapult?

When you use your catapult to launch a cube you are transforming Potential into Kinetic Energy. Potential Energy is the stored energy and the kinetic energy is the energy of motion. When you twist the rubber band, tension is created and stored in the twisted band. When you let go of the rubber band the released kinetic energy helps to throw off the launched projectile.

What came first, the catapult or trebuchet?

Catapults were invented first during ancient times. Though they are good at accuracy, trebuchets are invented by Chinese to attain greater range of accuracy and maximum force and power. The main difference between both is that trebuchet uses a swinging arm to throw a projectile. Without such a sling (swinging arm), the machine would be a catapult. (https://gosciencegirls.com/catapult-stem-project/)

Frequently Asked Questions about the design.

Is wood glue better than hot glue?

It depends on how you're going to be building. Hot glue is faster and will help you get the construction done in a shorter time span. Wood glue or white glue will bond the wood together much stronger, but takes longer to set. Once it sets however, the wood will shatter before the glue lets go.

Which design is best? (How do I assess the build?)

That is just it. There is no correct answer to this question. And that is what will make for such a rich exercise. There is no one design, but it is the quality of the designs. How closely does the build match the design? Are the glue joints clean? How well does the team understand the function of their design? These are the factors that give us an understanding of how well they have done.

There is a lot of flex in the dowel and I worry about it snapping.

The original design image has the triangular uprights as being perfectly vertical, but if they are put on a slight taper to the middle it reduces the gap between the uprights at the top, which reduces the flex. It also gives more room to wrap multiple elastics around for more tension.

Does the drawing really matter that much?

Yes! Absolutely! Having the students go through the design process is important. Having them think about the placement, the use of the wood. How to align the gears are all major ideas, and many students think they can just start building. Then when they get to an issue they have to rethink their process. These types of problems can get solved during design. Even if the final product does not look like the design, because they saw flaws as they built. They should still go back and adjust their design. Also keep all the drawings from first concept to final product. That shows their learning throughout the activity.

What about counterweights?

The design is light and simple, but if you want to really pull back on the catapult, it will lift the front of the catapult up. So it might be a good idea to have a counterweight or something to hold it in place. This could be a clamp or even tape.

How do we keep things in place?

Tape is one of the easiest things to use to hold the Popsicle sticks in place while you are trying to glue. A clamp might be too drastic. This should be something that teachers can have on hand while the build are going on, not a necessity for the build kit.

Challenge Data Sheet

Order	Student Name	Launch 1 Distance	Launch 2 Distance	Launch 3 Distance	Average Distance
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