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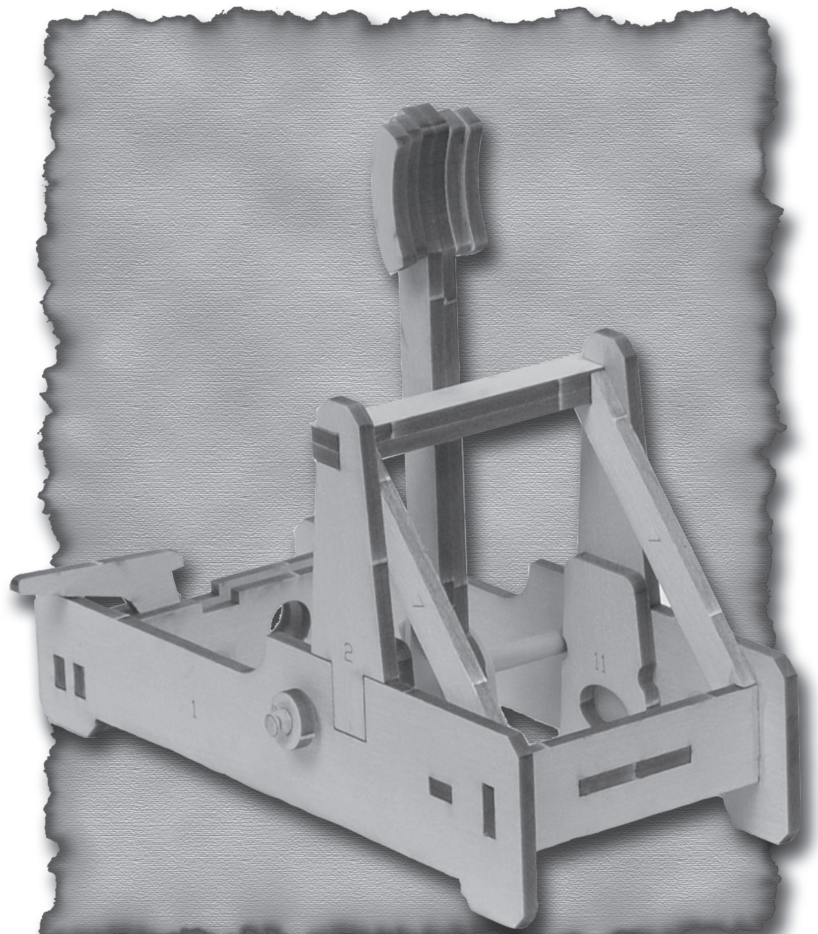
The Catapult

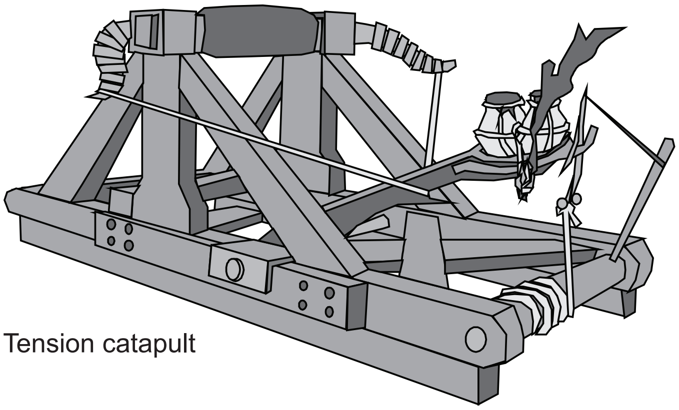


Launching into Science: Tension and Torsion

An interesting thing about a catapult is there are two forces from which to choose to make it work: tension and torsion.

Tension

The original catapults – as well as the Pitsco Catapult – were operated with tension. Tension was created by using a device much like a large crossbow mounted on a frame. The bow part of the device would be made of wood or animal horns. These materials could both be bent back to create tension in the materials' fibers. When the bow was released, the fibers would quickly spring back into place, flinging the attached object as a result.
The Pitsco Catapult uses tension created by



Tension catapult

pulling back the arm attached to a rubber band. This stretches the rubber band. The fibers in the rubber band react just as the fibers in the wooden or animal horn bows. Releasing the tension makes the attached arm fling forward and release the ammunition.

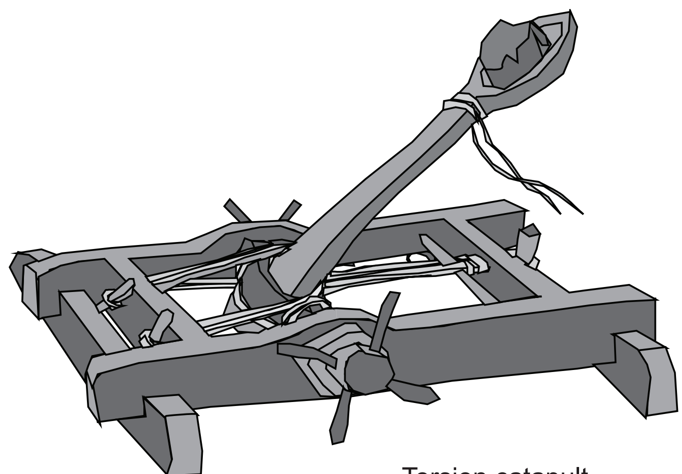
Other styles of catapults used a strong yet flexible piece of wood as the catapult arm. The arm could be pulled back to the bottom of the frame and then released to fling the ammunition.

Torsion

While using tension was a simpler and more obvious answer to powering a catapult, tension didn't offer tremendous power. The development of torsion as the driving force increased the catapult's power significantly. Increasing the power allowed larger ammunition to be used or increased the distance the standard ammunition could be hurled.

Torsion is the strain that develops in a material as it is twisted. We can create torsion by twisting ropes tightly around the catapult arm. At this point, the twisted material acts as a spring. Releasing the material allows the material to react to the strain by quickly unwinding – allowing the catapult arm to fly up and release the ammunition.

The torsion force built up in the twisted material actually has the energy to return the material to its original state.

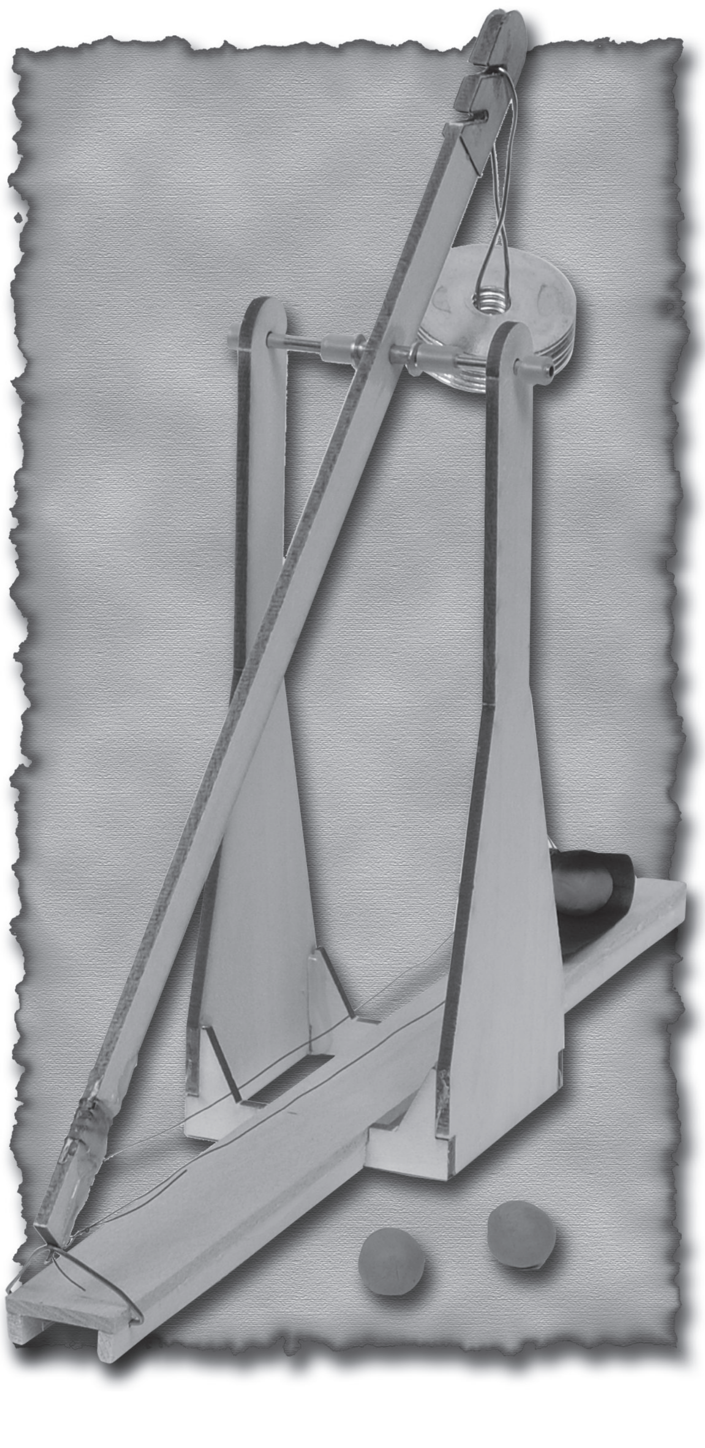


Torsion catapult

Uncommon Ropes

The ropes twisted to create torsion were made from a variety of materials. It was very common to use animal sinew, which is a tendon stretched to use as a cord, instead of the plant fiber rope or nylon rope we have today. Sometimes, the rope was even made from women's hair!

The Trebuchet



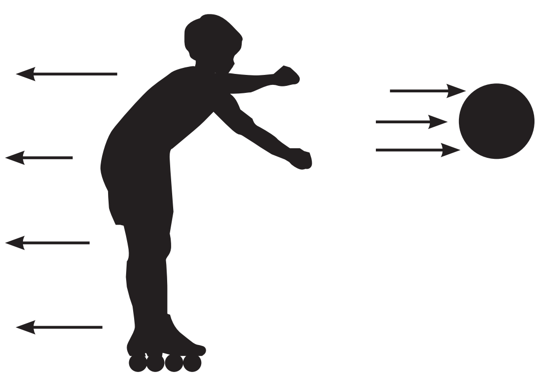
Launching into Science: Force and Motion

Pitsco's Trebuchet uses a swinging weight – have you wondered why it swings?

Trebuchets put a lot of force behind the ammunition it throws, but the device itself has to be able to take a lot of force too.

This concept goes back to Newton's third law of motion: For every action there is an equal and opposite reaction. It's easy to see the result of this when two things collide – given the two things have fairly equal mass and force, they will usually bounce off each other. But how does this work for a device or person throwing something? After all, baseball pitchers don't fall every time they throw a ball, right? Well, if you don't think the third law of motion applies in this situation, try this experiment:

Find a ball to throw – a baseball or softball will work fine. Put on some skates. Standing on the skates, throw the ball forward. As you throw the ball forward, you and the skates will be moved back a bit.



This happens on skates because there is less friction to hold you still than when you simply stand on the ground. If you tried this experiment on ice skates, you would probably move backward even more. This is because there is even less friction between the ice skate blades and the ice than there is between the skate wheels and the ground.

If we are able to absorb the force of throwing a ball because of the friction we have with the ground (and our mass), how does a trebuchet absorb the force? With the Pitsco Trebuchet, the swinging weight helps accomplish that task.

When the mass plates swing down, they swing down in an arc so the energy generated is both horizontal and vertical energy. The horizontal energy goes into the trebuchet body while the vertical energy is transferred to the ammunition sling.

A Pitsco Trebuchet – the swinging weight absorbs much of the excess force.

Notice after firing the trebuchet that the weight is swinging? That is how some of the horizontal energy is absorbed.

A trebuchet with a fixed weight and no wheels – the machine absorbs much of the force.

If the wooden body of the trebuchet had to absorb all the force, the stress of that could actually destroy the trebuchet's body.

What happens if a trebuchet can't be built with a swinging weight? What if a builder only has the means to attach the weight directly on the firing arm? In that situation, the builder can help the trebuchet absorb the stress by putting it on wheels. When the trebuchet is fired, the force is transmitted to the wheels, which will roll back and forth to deal with that energy.

A trebuchet with a fixed weight with wheels – much of the force is absorbed by the motion of the wheels.