ENERGY TRANSFER IN A TREBUCHET

Video Summary

www.teachersdomain.org/resources/hew06/sci/phys/maf/trebuchet

In this video segment adapted from *NOVA*, a team of historians, engineers, and trade experts recreate a medieval throwing machine called a trebuchet. To launch a projectile, a trebuchet utilizes the transfer of gravitational potential energy into kinetic energy. A massive counterweight at one end of a lever falls because of gravity, causing the other end of the lever to rise and release a projectile from a sling. As part of their design process, the engineers use models to help evaluate how well their designs will work.

Topics Covered:

- Physical Science: Motions and Forces

Recommended for Grades 6-12
Media Type: QuickTime Video
Video Length: 4m 17s
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Discussion Questions

- Where does the potential energy in the lever arm come from?
- Where is there potential energy throughout the loading, cocking, and releasing of the trebuchet? Where is there kinetic energy?
- What evidence is there that energy is conserved?

Background Essay

In medieval times, one of the most fearsome weapons was a trebuchet—a powerful machine used to hurl projectiles. Combining the launching capabilities of a catapult and a sling, trebuchets were able to throw massive objects at high speeds and over great distances. Trebuchets were also more accurate than a basic catapult and more powerful than a simple sling; they could throw objects hundreds of pounds in weight to targets hundreds of yards away. During a siege, a trebuchet could be used to crumble castle walls by launching large rocks or to spread disease to the people inside the castle walls by tossing over dead animals.

Imagine what would happen on a seesaw (a simple lever) if a book were placed on one end and you were to jump on the other end—the book would go flying into the air. A trebuchet functions similarly, except that the pivot point of the lever is placed off-center (in this case, farther away from the load) to amplify the force that launches the projectile. The load, or object to be moved, is placed in a sling (composed of a pouch and two cords) attached to the long arm of the lever. A very heavy counterweight is attached to the short arm of the lever. When the counterweight falls, the long arm of the lever is raised very quickly into the air, pulling the sling up with it. As the sling swings into a vertical position, one end of the sling is unleashed, opening up the sling and releasing the load at a high velocity.

To put a trebuchet into its "cocked" position, a team of people use their energy to hoist the counterweight. When the counterweight is raised, it gains this energy as potential energy. In this case, the potential energy is gravitational potential energy—energy that results from the position of an object in a gravitational field. The amount of gravitational potential energy is dependent on both the weight of the object and its position, or height, above the ground. Since the counterweight in a trebuchet is very heavy, it has a great deal of potential energy.

While energy cannot be created or destroyed, it can change forms. The potential energy from the raised counterweight is transformed into kinetic energy—the energy of motion—as the counterweight is released and begins to fall. The downward motion of the counterweight then causes the sling to swing and the projectile to be released. The potential energy that was stored in the raised counterweight is transferred, in the form of kinetic energy, to the projectile, which is released at a high velocity.

To learn more about potential and kinetic energy, check out Potential and Kinetic Energy: Spool Racer and Energy in a Roller Coaster Ride.

To learn more about the conservation of energy, check out Masses and Springs.

To learn more about levers, check out Lever an Obelisk.

To learn more about projectile motion, check out Projectile Motion and Galileo: His Experiments.

Lesson Plans Using This Resource:

Investigating Kinetic and Potential Energy

Curricular Standards Correlations:

NSES, Project 2061, MCREL, and state standards correlations available at www.teachersdomain.org. (Free registration required for your specific state standards correlated to this resource.)

Source: *NOVA*: "Secrets of Lost Empires II: Medieval Siege"
This resource was adapted from *NOVA*: "Secrets of Lost Empires II: Medieval Siege"

Materials used courtesy of:

Hew Kennedy pulling rope	WGBH
Still: Leonardo Da Vinci trebuchet with dead horse	Public Domain
Still: Leonardo Da Vinci trebuchet with dead horse	Public Domain
Wide shot of piano flinging trebuchet, then view of piano landing	WGBH
Wide shot of trebuchet coming back to rest	WGBH
Medium shot of trebuchet arms	WGBH
Hew Kennedy and friend attaching piano to trebuchet	WGBH
Wide shot of piano flinging trebuchet, then view of piano landing	WGBH
Hew Kennedy and Wayne Neel in library	WGBH
Still: CantigasTrebuchet image from 13th century manuscript	Patrimonio Nacional, Spain
Interview: Hew Kennedy "how it can be done"	WGBH
Still: Leonardo Da Vinci trebuchet with dead horse	public domain
Interview: Hew Kennedy ctnued	WGBH
Wayne Neel flipping through notes at construction site	WGBH
Wayne Neel flipping through notes at construction site	WGBH
Wide shot construction site	WGBH
Marcus Brandt working / Interview: Marcus Brandt	WGBH
Close up carpentry	WGBH
Close up axe chopping	WGBH
Forging / Interview: Marcus Brandt	WGBH
Wide shot pulling up site of trebuchet	WGBH
Wide shot profile trebuchet under construction	WGBH
Medium shot of workers pushing cart with lead	WGBH
Medium shot placing lead weights onto arm	WGBH
Medium shot weighted arm at rest	WGBH
Looking up at throwing arm at rest	WGBH
Wide shot of forty men cocking the trebuchet	WGBH
Extreme wide shot forty men cocking the trebuchet	WGBH
Medium shot weighted arm pulled upward	WGBH
Close up weighted arm pulled upward	WGBH
Medium shot two men inserting firing pin	WGBH
Medium shot throwing arm of cocked trebuchet, firing pin is clear	WGBH
Static wide shot of cocked trebuchet, profile view	WGBH
Static wide shot of cocked trebuchet, 3/4 view	WGBH
Close up firing pin straining	WGBH
Close up removing firing pin / WS trebuchet firing	WGBH
Slow motion trebuchet firing	WGBH
Wide shot trebuchet coming back to rest after firing	WGBH
Marcus Brandt and Wayne Neel firing trebuchet model that rocks / model rocking	WGBH
Interview: Wayne Neel / fire model trebuchet that rocks	WGBH
Fire model trebuchet with wheels (animated on top)	WGBH
Fire full scale trebuchet	WGBH

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