BioEd℠

Think like an Engineer

TEACHER'S GUIDE

Catapults

 ISBN: 978-1-888997-64-4

Baylor College of Medicine

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Printed in the United States of America.
ISBN: 978-1-888997-64-4

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Teacher Resources from the Center for Educational Outreach at Baylor College of Medicine

Development of Think Like an Engineer educational materials was supported, in part, by National Science Foundation (NSF) grant number DRL-1028771. Activities described in this book are intended for middle school students under direct supervision of adults. The authors, Baylor College of Medicine and NSF cannot be held responsible for any accidents or injures that may result from conduct of the activities, from not specifically following directions, or from ignoring cautions contained in the text. The opinions, findings and conclusions expressed in this publication are solely those of the authors and do not necessarily reflect the views of BCM or the sponsoring agency.

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Acknowledgments

This project at Baylor College of Medicine has benefited from the vision and expertise of scientists and educators in a wide range of specialties. Our heartfelt appreciation goes William A. Thomson, PhD, Professor and Director of the Center for Educational Outreach, and C. Michael Fordis, MD, Senior Associate Dean and Director of the Center for Collaborative and Interactive Technologies at Baylor College of Medicine, who have lent their support and expertise to the project.

We are especially grateful to the many classroom teachers in the Houston area who participated in the field tests of these materials and provided invaluable feedback.

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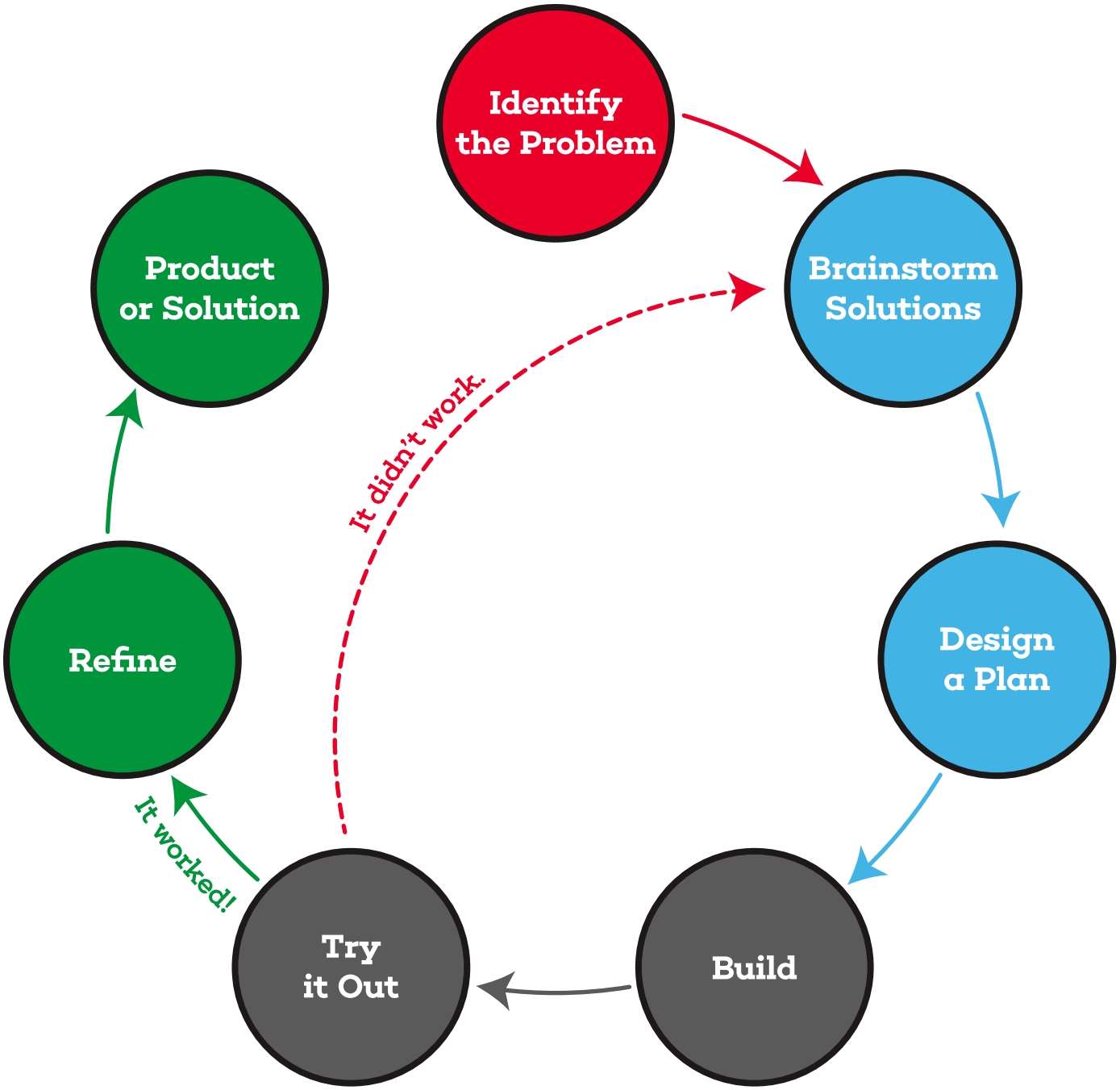
An Engineer's Approach



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Catapults
Powering a Projectile

Time
1–2 sessions

Before You Start
Prepare bags of materials for each team of students.

You Need This Stuff
Teacher Materials
- Bag of marshmallows or gummy bears (to use as projectiles)
- Foam building blocks
- Masking tape

Per Student Group
- 2 survey flags or plastic orange cones
- Bulls-eye target, or paper to create a target
- Manual tennis ball thrower with tennis ball (available at pet stores)
- Tape measures or metersticks

Per Student
- At least 20 craft sticks, notched craft sticks, chopsticks, or wooden skewers with sharp ends removed
- Plastic spoon
- Rubber bands
- Safety goggles
- Copy of "Catapults," and "Build a Spoonapult" pages

What It's About
Throughout history, warriors and hunters have developed weapons to aid in their battles and pursuit of food. War machines, in particular, have been a focus of technological innovation. As warfare grew more complex, so did weapons. Javelins and boomerangs were tools for both hunting and war. Another device, the atlatl, extended the throwing arm and greatly increased throwing force. Eventually, catapults were invented. Catapults harness physical and/or mechanical energy to launch projectiles. Examples of catapults include slingshots, hurling devices used in castle sieges, and even steam-powered machines that launch airplanes off aircraft carriers.

NOAA uses a pneumatic catapult to launch the ScanEagle, an unmanned monitoring aircraft.

Catapult technology, first thought to have been developed in Greece as early as 50 BCE, was initially used to increase the range and penetration of arrows. When released, a catapult would shoot a large arrow toward the enemy.

ScanEagle courtesy of NOAA\Erin Moreland. (http://www.afsc.noaa.gov/nmml/polar/research/images/UAStestflight.jpg)

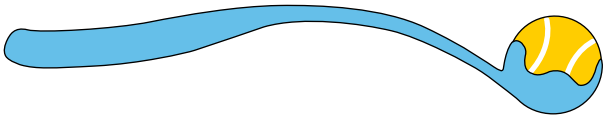
Later, more powerful catapults were able to launch large stones, biological weapons (e.g., a hornets' nest), incendiary bombs, and even terror projectiles like the heads of the captured! The history of catapults includes a large variety of designs, each with a different purpose.

What's the Question?

Can you design and construct a catapult that meets specific goals, such as being most accurate, firing the greatest distance, or launching the heaviest projectile?

What To Do: Launching Projectiles

1. Ask students, *How far do you think you can throw a tennis ball?* Take them outside and give all students a chance to throw the ball as far as they can. Use masking tape to indicate the distance achieved by each student.



A tennis ball thrower for dogs is a modernized variant of an atlatl. You can find one at most pet stores.

2. Next, ask *Is there any way you could throw the ball further?* Introduce the atlatl, a stick that extends from the arm of the thrower. The atlatl has been used by ancient Egyptians, Inuits of the Arctic Circle, and Aztecs of Mexico, among others.

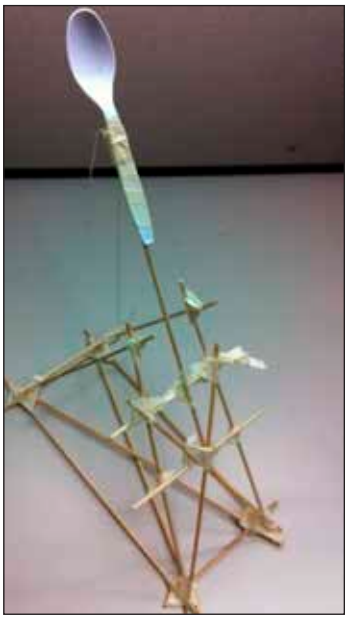
   A spear would be affixed to the end of the atlatl, which provided extra arm length that enabled the thrower to produce greater acceleration of the spear than would be possible without this tool. Modern day ball throwers for dog owners employ the same principle.

   Have students use a ball thrower to throw the tennis ball again. Mark the new distances and compare them to the original measurements.
3. Return to the classroom and lead a discussion of students' observations. Ask, *How far could you throw the tennis ball using just your arm? How far did you throw it with atlatl? Do you think there is a limit to how long an atlatl can be and still work?*

   Is there a limit to how heavy a projectile can be thrown with an atlatl?

What To Do: Spoonapults

1. Review students' experiences with the atlatl and remind them of their answers to the questions above. Tell them that a catapult can launch a boulder hundreds of meters. In fact, the Greeks were engineering war machines as early as 400 BCE. They had perfected the bow and arrow, but for mass warfare, they sought more powerful weapons. Initially, the catapult was designed to launch several arrows at once, but over time, it was refined into a mighty machine that also could hurl large rocks, biological weapons and even the heads of enemies.



Student catapult

2. Show pictures of catapults and discuss key design characteristics. Have students use craft sticks to build an equilateral triangle and square base, and then test the stability of each design. Be sure they understand that

Student catapults

a catapult requires a stable base to launch projectiles.

3. Explain that students will investigate catapults by building and testing a "spoonapult," which uses a plastic spoon to launch projectiles. Have each student team construct a spoonapult, following the illustrations on the student sheet. Then, direct teams to test their spoonapults by launching marshmallows toward a bullseye placed on the floor.
4. Discuss the results of students' first spoonapult construction challenge. Ask, *How well did your spoonapult work? How far did it fling the marshmallows? Was your spoonapult accurate?*
5. Have student teams follow the engineering model to build a better spoonapult. Remind teams that their development process should include sharing ideas (brainstorming solutions), designing a plan, building the new spoonapult, and then testing, evaluating and refining their designs.
6. Build a small castle out of foam blocks. Challenge teams to "destroy" the castle with their newly created spoonapults by launching projectiles from a distance of three meters.

Extra

Have students bring in materials to make a larger catapult, capable of launching a tennis ball or small water-filled balloon at least 10 meters. ■

Catapults

Catapults harness physical and/or mechanical energy to launch projectiles. Examples of catapults include slingshots, hurling devices used in castle sieges, and even steam-powered machines that launch airplanes off aircraft carriers.

Can you design and construct a catapult that meets specific goals, such as being most accurate, firing the greatest distance, or launching the heaviest projectile?

The ballista, said to have been created by the Greeks, acted as a giant crossbow. It shot javelins, fire arrows and other sharp objects at opponents. Shown above is a replica of a Roman ballista near the ancient ruins of Gamla in Israel.

Twisted ropes (torsion) provided power to onager catapults, which threw heavy boulders against city or castle walls. Shown above is an onager catapult at Neurathen Castle in Germany.

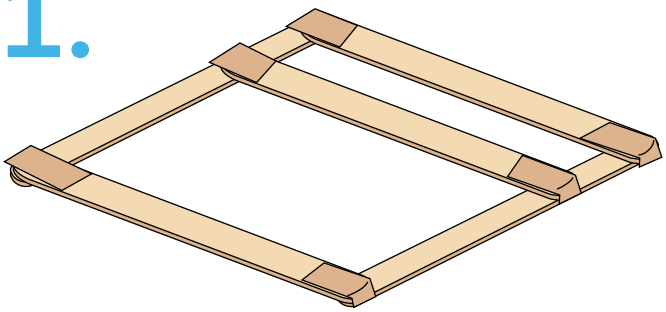
A trebuchet catapult used a raised counterweight and a sling to send huge stones or incendiary ammunition over or through walls. Shown above is a Medieval trebuchet in Château des Baux, France.

Medieval mobile onager catapults, each with a fixed bowl on an arm, were capable of hurling several projectiles at one time. The onagers shown above are in front of fortress Cuknštejn in South Bohemia, Czech Republic.

Build a Spoonapult

Use the illustrations below as a guide to build and test a spoonapult.

1.



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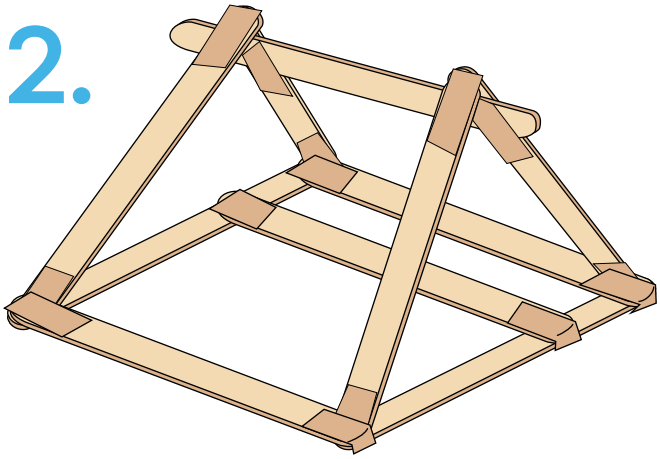

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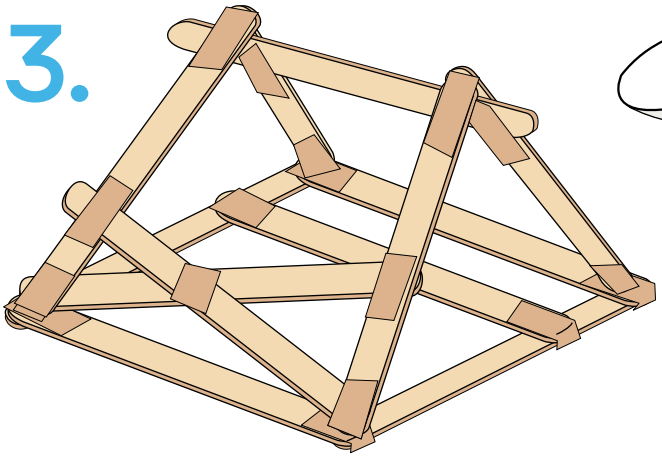

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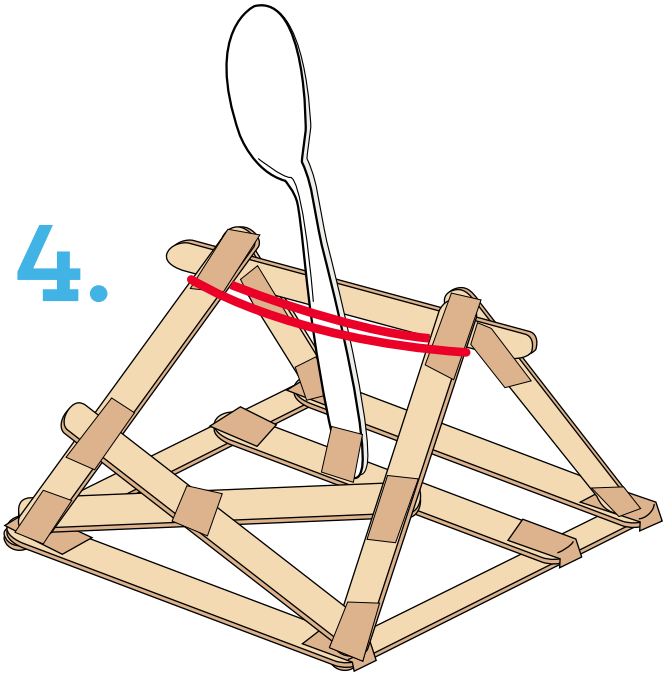

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