

Forces 6.G.1

Design a Catapult

Grade Level	6
Sessions	2 – approximately 60 minutes
Seasonality	N/A
Instructional Mode(s)	Groups
Team Size	3-4 students
WPS Benchmarks	06.SC.TE.01 06.SC.TE.02 06.SC.TE.03 06.SC.TE.05 06.SC.TE.06 06.SC.TE.07 06.SC.TE.08 06.SC.TE.09 06.SC.TE.10 06.SC.TE.13 06.SC.TE.15 06.SC.TE.16
MA Frameworks	6-8.TE.1.1 6-8.TE.1.2 6-8.TE.1.3 6-8.TE.2.1 6-8.TE.2.2 6-8.TE.2.3 6-8.TE.2.4
Key Words	Catapult, trebuchet, simple machine

Summary

The students will learn about catapults and trebuchets, the type of energy and simple machines they use to propel projectiles. The students will also be given an engineering design task and the opportunity to complete the engineering design process.

Learning Objectives

2002 Worcester Public Schools (WPS) Benchmarks for Grade 6

06.SC.TE.01 Given a design task, identify appropriate materials (e.g., wood, paper, plastic, aggregates, ceramics, metals, solvents, adhesives) based on specific properties and characteristics (e.g., weight, strength, hardness and flexibility).

06.SC.TE.02 Identify and explain appropriate measuring tools, hand tools, and power tools used to hold, lift, carry, fasten, and separate, and explain their safe and proper use.

06.SC.TE.03 Identify and explain the safe and proper use of measuring tools, hand tools, and machines (e.g., band saw, drill press, sanders, hammer, screwdriver, pliers, tape measure, screws, nails, and other mechanical fasteners) needed to construct a prototype of an engineering design.

06.SC.TE.05 Design and build a catapult that will toss a marshmallow the farthest.

06.SC.TE.06 Use a variety of hand tools and machines to change materials into new forms through forming, separating and combining processes that cause internal change to occur.

06.SC.TE.07 Identify and explain the steps of the engineering design process, e.g., identify the need or problem, research the problem, develop possible solutions, select the best possible solution(s), construct a prototype, test and evaluate, communicate the solution(s), and redesign.

06.SC.TE.08 Demonstrate methods of representing solution to a design problem, e.g., sketches, orthographic projections, multiview drawings.

06.SC.TE.09 Describe and explain the purpose of a given prototype.

06.SC.TE.10 Identify appropriate materials, tools, and machines needed to construct a prototype of a given engineering design.

06.SC.TE.13 Given a prototype, design a test to evaluate whether it meets the design specifications.

06.SC.TE.15 Communicate the results of an engineering design through a coherent written, oral or visual presentations.

06.SC.TE.16 Develop plans, including drawings with measurements and details of construction, and construct a model of a solution, exhibiting a degree of craftsmanship.

Additional Learning Objectives

1. **6-8.TE.1.1** Given a design task, identify appropriate materials (e.g., wood, paper, plastic, aggregates, ceramics, metals, solvents, adhesives) based on specific properties and characteristics (e.g., weight, strength, hardness and flexibility).
2. **6-8.TE.1.2** Identify and explain appropriate measuring tools, hand tools, and power tools used to hold, lift, carry, fasten, and separate, and explain their safe and proper use.
3. **6-8.TE.1.3** Identify and explain the safe and proper use of measuring tools, hand tools, and machines (e.g., band saw, drill press, sanders, hammer, screwdriver, pliers, tape measure, screws, nails, and other mechanical fasteners) needed to construct a prototype of an engineering design.
4. **6-8.TE.2.1** Identify and explain the steps of the engineering design process, e.g., identify the need or problem, research the problem, develop possible solutions, select the best possible solution(s), construct a prototype, test and evaluate, communicate the solution(s), and redesign.
5. **6-8.TE.2.2** Demonstrate methods of representing solution to a design problem, e.g., sketches, orthographic projections, multiview drawings.
6. **6-8.TE.2.3** Describe and explain the purpose of a given prototype.
7. **6-8.TE.2.4** Identify appropriate materials, tools, and machines needed to construct a prototype of a given engineering design.
8. Use a variety of hand tools and machines to change materials into new forms through forming, separating and combining processes, and processes that cause internal change to occur.
9. Understand what a simple machine is, and the difference between at least two types (lever and counterweight).
10. Be able to explain the purpose of creating a prototype, and document its creation and purpose.
11. Students should be able to use materials available to create the most accurate prototype possible of the assigned task.

Required Background Knowledge

None

Essential Questions

1. What is a catapult?
2. What design features are important to the performance of a catapult?

Introduction / Motivation

Ask the students what they know about catapults. Use the attached transparencies to explain what they are and to show examples. Explain that these tools were used as weapons in the medieval time period (about 1000 years ago !). The trebuchet is thought to have originated in China in 300 BC (more than 2300 years ago!). They were used to launch things such as large stones over city walls during battles.

Procedure

1. Divide the students into design groups of three or four.
2. Pass out the Engineering Design Process Handouts (two pages), and then put the list of materials on the projection so the students are aware what their design should incorporate.
3. Have the students fill out steps 1-4 in their groups before receiving their materials. Step one can be done together as a class. Be sure to remind students that step number three is one of the most important steps, and to make sure everyone in the group is open-minded to all ideas. Each student in the group should provide one design idea. The brainstorming session of designs can include sketches and notes. Students may use the reverse side of the paper if there is not enough room on the front.
4. Once each group of students comes up with an appropriate number of designs and has then completed step four (picking the best design from the brainstorming session), pass out the materials to each group.
5. Have the students build their prototypes according to the design that was chosen as the best. This concludes the first session of the lesson.

6. To begin the next session, have the students complete step five. Once their detailed picture is complete, they may begin testing their catapults by launching the marshmallows. Have them measure the distance it is launched with their ruler. Once they have recorded the results of their testing in step six, begin to organize a list that puts an order of presentation.
7. Tell the students they will be presenting their designs to the rest of the classroom for about 1-2 minutes. The presentation should focus on how they went about the design process (brainstorming, etc.). Tell the students in the class to pay close attention to what other groups did for their design so they can think of ways they may have been able to improve their own.
8. Once all of the groups have presented their ideas, have them return to their seats, and individually (rather than in groups) complete the final step of their worksheets.

Materials List

Materials per group	Amount	Location
Masking tape	1 roll	Office Supply Store
Plastic cups	4-5	Supermarket
Copy of <i>Engineering Design Process</i>	1/student	N/A
Rubber bands	4-5	Supermarket, office supply store
Plastic spoons	2-3	Supermarket
Paper clips	4-5	Office Supply Store
Scrap pieces of cardboard	availability	Free at supermarket
Marshmallows	1	Supermarket
Ruler	1	Office supply store

Vocabulary with Definitions (in alphabetical order)

1. ***Catapult*** – A catapult is a simple machine, a lever that uses a material to store potential energy required to throw a projectile.

2. *Kinetic energy* – The energy possessed by an object because of its motion, equal to one half the mass of the body times the square of its speed.
3. *Potential energy* – The energy derived from position, or condition, rather than motion. A raised weight, coiled spring, or charged battery has potential energy.
4. *Simple machine* – A simple device, such as a lever, pulley or inclined plane; a machine without moving parts that usually makes a task easier.
5. *Trebuchet* – A trebuchet is the successor of the catapult. It works by using a counterweight and a long lever arm to propel a projectile.

Assessment / Evaluation of Students

Completion of ***Engineering Design Process*** and participation in activity.

Lesson Extensions

None

Attachments

1. **What is a Catapult**
2. **Design Task**
3. **Engineering Design Process**

Troubleshooting Tips

None

Safety Issues

None

Additional Resources

None

Key Words

Catapult, trebuchet, simple machine

What is a catapult?

A catapult is a simple machine. There is an arm, called a lever that is able to hurl a projectile a great distance due to the amount of potential energy it stores.



<http://www.itl.nist.gov/div898/handbook/pri/section4/pri472.htm>

What is a trebuchet?

A trebuchet is the successor of the catapult. It works by using a counterweight and a long lever-arm to propel a projectile.



<http://www.trebuchet.com/kit/tabletop/>

Design Task

Each group is to design and build a catapult using the following materials:

Masking tape

4 Plastic cups

4 Rubber bands

2 Plastic spoons

4 Paperclips

Cardboard

Marshmallows to launch

Name _____

Date _____

Engineering Design Process

Step 1: Identify the need or problem

Step 2: Research the need or problem

Write what you find in your science notebook, or simply record what you learned in class.

Step 3: Brainstorm

Draw three different possible solutions below (you can use the back of the paper too):

Step 4: Select the best possible solution

Circle the solution in Step 3 that your team selected. Why did you select that solution?

Name _____

Date _____

Engineering Design Process (page 2)

Step 5: Construct a prototype

Draw and label a detailed picture of what your prototype looks like.

Step 6: Test and evaluate the solution

What would happen if you would try to launch a brick with your catapult?

How far does your catapult launch the marshmallow? This test may be performed up to five times. Record the distance each time.

Test #	Test 1	Test 2	Test 3	Test 4	Test 5
Distance					

Step 7: Communicate the solution

Present your prototype to the class.

Step 8: Redesign

Draw pictures of your new and improved design ideas (you can use the back of the paper too).