

# Storming the Castle

4<sup>th</sup> Grade

Unit 6 – Literary Heroes

Text Connections: *The Middle Ages: An Interactive History Adventure* by Allison Lassieur  
*Magic Tree House: Knights and Castles – Fact Tracker* by Will and Mary Pope Osborne

**\*\*\*This challenge and its associated activities will take multiple days to complete\*\*\***

## Design Challenge Summary

**Challenge:** What will the students be required to do?

In the last battle, the royal catapult was destroyed. The king is looking for engineers that will build a new catapult. Your challenge is to design and build a catapult, within an allotted budget, that will hurl a cotton ball “boulder” the farthest.

(see additional information section for more details)

**Standards:** What standards are addressed?

### Science:

NS.1.4.1 Communicate observations orally, in writing, and in graphic organizers  
NS.1.4.2 Refine questions that guide scientific inquiry  
NS.1.4.3 Conduct scientific investigations individually and in teams  
NS.1.4.5 Communicate the designs, procedures, and results of scientific investigations  
NS.1.4.6 Estimate and measure length, mass, temperature, capacity/volume, and elapsed time...  
NS.1.4.7 Collect and interpret measurable empirical evidence in teams and as individuals  
NS.1.4.9 Identify variables that affect investigations  
NS.1.4.11 Generate conclusions based on evidence  
NS.1.4.12 Evaluate the quality and feasibility of an idea or project  
NS.1.4.13 Use simple equipment, age appropriate tools, technology, and mathematics in scientific investigations  
PS.6.4.1 Investigate the relationship between force and direction  
PS.6.4.2 Investigate the relationship between force and mass

### Math:

Mathematical Practice Standards

4.NBT.4 Fluently add and subtract multi-digit whole numbers...  
4.NBT.5 Multiply a whole number of up to four digits by a one-digit whole number, and multiply two two-digit numbers, using strategies based on place value and the properties of operations. Illustrate and explain the calculation by using equations, rectangular arrays, and/or area models.  
4.MD.2. Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving simple fractions or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit. Represent measurement quantities using diagrams such as number line diagrams that feature a measurement scale.  
4.MD.4 Make a line plot to display a data set of measurements in fractions of a unit ( $\frac{1}{2}$ ,  $\frac{1}{4}$ ,  $\frac{1}{8}$ ). Solve problems involving addition and subtraction of fractions by using information presented in line plots.

### ELA:

W.4.1 Write opinion pieces on topics or texts, supporting a point of view with reasons and information.  
W.4.3 Write narratives to develop real or imagined experiences or events using effective technique, descriptive details, and clear event sequences.  
W.4.4 Produce clear and coherent writing in which the development and organization are appropriate to task, purpose, and audience.  
W.4.7 Conduct short research projects that build knowledge through investigation of different aspects of a topic.  
W.4.10 Write routinely over extended time frames and shorter time frames for a range of discipline-specific tasks, purposes, and audiences.  
SL.4.1 Engage effectively in a range of collaborative discussions with diverse partners on grade 4 topics and texts, building on other’s ideas and expressing their own clearly.  
SL.4.3 Identify the reasons and evidence a speaker provides to support particular points.  
SL.4.4 Report on a topic or text, tell a story, or recount an experience in an organized manner, using appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace.

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**Result:** What will students know, value, and be able to do as a result of the lesson? What's the big idea?

Know and apply the engineering design loop.

Value collaboration and discussion.

Understand the relationship between force and mass/force and direction.

Estimate and measure length of distance the "boulder" travels.

Utilize budgets in planning projects – keep running totals of expenditures and amount left to spend (+/-/x/÷)

Generate a line plot based on catapult hurls.

Write about observations, process, results, etc.

Conduct simple research to assist in the project.

**Assessment:** What evidence will be used to determine student learning?

Did they follow their plan/budget? Did they stay within their budget?

How did their catapult's distance compare to the other groups?

Did they follow the design loop process?

Did groups work collaboratively together?

**Prior Knowledge/Experiences:** What prior content knowledge and skills will the students need?

Experience with the Engineering Design Loop process

Connections to the Mathematical Practices

Investigations/Inquiry in Science

Experiences with weight, mass, and gravity

Experiences in measurement and estimation

Background knowledge from ELA unit regarding catapults and their use

PS.6.1.2 Relationship between mass and weight

PS.6.K.3 Effects of the force of gravity on objects

2.MD.1 Measure the length of an object by selecting appropriate tools

2.MD.3 Estimate lengths using units of inches, feet, centimeters, and meters

2.MD.8 Solve problems involving dollar bills, quarters, dimes, nickels and pennies, using \$ and ¢ symbols appropriately

**Summary/Connections:** How will this design challenge connect with new/future learning, other content areas, real world experiences, etc.?

This lesson will help students develop problem solving skills and collaboration skills that are essential in succeeding in the 21<sup>st</sup> century. It will allow students the opportunity to transfer and apply skills from various content areas within one task.

Discuss issues and challenges the students encountered during the challenge. Some examples:

- Do any two catapults look exactly alike? What are some of the differences in design?
- What makes one design better than the other? Hurling distance, Cost, Design (aesthetics)
- Did the final design end up anything like what you planned?

Generate line plots with the data from their catapult hurls: Groups could generate a line plot with their test hurls data; class line plot could be generated with all the data from the groups test hurls. 4.MD.4

Writing summaries of/recounting their process W.4.3; W.4.4

Which catapult design do you think the king would select? Why? What factors do you think he would consider in his decision? (Could lead to an opinion writing on which catapult should be selected...) W.4.1

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## Extensions:

- Students conduct research on catapults and their design in order to improve their catapult design. Conduct the task again with their new knowledge. What did they do differently? Was it easier this time? W.4.7
- What might happen if you changed the item being hurled? Marshmallow, ping pong ball, ball of clay, etc.
- Are there other materials that would help you construct a better designed catapult?
- Opinion writing on selection of catapult. W.4.1
- Research project comparing the catapult and the trebuchet. W.4.7 (research documents included)

**Materials/Equipment/Preparation:** What materials and equipment will students need to successfully complete this design challenge?

Popsicle sticks  
Rubber bands  
Plastic spoon  
Cotton balls (or other item to hurl)  
Tools for measurement of distance cotton ball travels

## ADDITIONAL INFORMATION

**\*\*\*This challenge and its associated activities will take multiple days to complete\*\*\***

Since the king is looking to fund this catapult build, he probably will be looking for the most efficient and economical design. This should be something you discuss with your students. (See summary section)

Students should conduct several “test” hurls of their catapult for data collection and decision making. Recommend at least 5 tests with each design. *Before you begin, you will need to discuss which unit of measure will be used for measuring the distance the cotton balls travel.*

Students will need to plan their design and use a budget for the expenditures of their supplies. They will need to keep a record of their budget and expenditures. This is where you should see the mathematics recorded for their design. You can adjust the budget or cost of materials to fit your needs, as well as adding different materials to the challenge.

Two separate task cards and student pages have been included in the lesson – one that uses this budget and one that doesn’t list the supplies or budget, in the case you want to change the materials or cost of items.

Suggested Budget and List of Available Materials:

Budget for Catapult Design: \$30,000

Available Items & Cost

3 Popsicle sticks - \$1500

4 Rubber bands - \$2500

1 Plastic Spoon - \$3550

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## Online Resources:

### **Photos:**

Google image search results:

[https://www.google.com/search?q=catapult+pictures&sa=X&es\\_sm=122&tbm=isch&tbo=u&source=univ&ei=DZBVU4U6yqPxAdBMgJAD&ved=0CCUQsAQ&biw=1280&bih=852](https://www.google.com/search?q=catapult+pictures&sa=X&es_sm=122&tbm=isch&tbo=u&source=univ&ei=DZBVU4U6yqPxAdBMgJAD&ved=0CCUQsAQ&biw=1280&bih=852)

### **Overview, history, how catapults work:**

<https://sites.google.com/site/physicsofcatapults/home/history-of-catapults>

<http://science.howstuffworks.com/transport/engines-equipment/question127.htm>

<http://www.lordsandladies.org/catapults.htm>

<http://www.real-world-physics-problems.com/catapult-physics.html>

<http://www.redstoneprojects.com/trebuchetstore/catapultanimation.html>

(this is a “product” page, but it has animation of how the machines work that would be helpful to see)

### **Examples of student catapult and trebuchet projects/ “how to” plans:**

<https://diy.org/skills/mechanicalengineer/challenges/757/build-a-catapult-or-trebuchet>

<http://pbskids.org/dragonflytv/show/trebuchet.html> student created project and video exploring how a trebuchet works

<http://www.mikesenese.com/DOIT/2010/10/trebuchet-roundup-eight-online-plans-reviewed-for-building-your-own/>

Difference between Catapult and Trebuchet

<http://jarodsforge.blogspot.com/2008/08/whats-difference-between-catapult-and.html>

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In the last battle, the royal catapult was destroyed. The king is looking for engineers that will build a new royal catapult.

Your challenge is to design and build a catapult, within an allotted budget, that will hurl a cotton ball “boulder” the farthest.

Group Supplies:

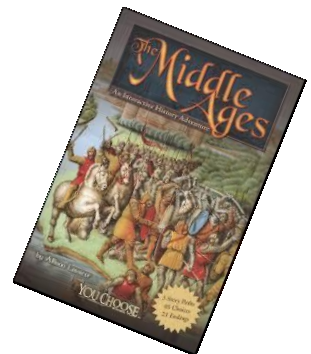
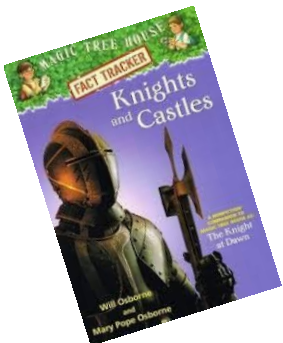
Popsicle sticks, rubber bands, plastic spoon, cotton balls

Other supplies: tools for length measurement

Design Budget: \$30,000

## Available Materials


3 Popsicle sticks	\$1500
4 Rubber Bands	\$2500
1 Plastic Spoon	\$3550



# STORMING THE CASTLE

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Generate Ideas:



Select a Solution - Plan Your Budget:

Allotted Budget: \$ 30,000.00

Materials	Unit Price	Quantity	Cost
3 Popsicle Sticks	\$1500.00		
4 Rubber Bands	\$2500.00		
1 Plastic Spoon	\$3550.00		

Total Cost: \$ \_\_\_\_\_

# STORMING THE CASTLE

Build the Item - create and test your catapult:

*Record observations from the building process, testing, evaluation, and redesign of the catapult*

Test your design. Be sure to measure and record the distance the cotton ball travels.

Test #	Distance cotton ball travels
1	
2	
3	
4	
5	

# ***STORMING THE CASTLE***

Evaluate:

1. As you were building and testing the catapult, what were some changes your group made to improve your design? Explain your reasoning for these changes.

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2. If you were to do this process again, what would you do differently? Why?

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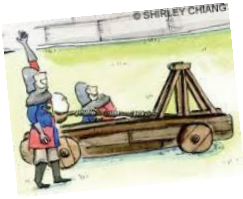
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# Researching Catapults

Research the history of catapults and their construction.

What is a catapult?

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Sketch some pictures of the catapults you found:

How does a catapult get its energy to launch items?

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# Researching Trebuchets

Research the history of trebuchets and their construction.



What is a trebuchet?

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Sketch some pictures of the trebuchets you found:

How does a trebuchet work?

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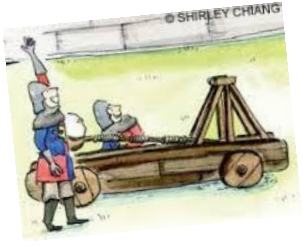
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# Comparing Catapults & Trebuchets



Complete the Compare/Contrast Matrix.

	Catapult	Trebuchet
What is it?		
Purpose		
How it works (source of energy/force)		

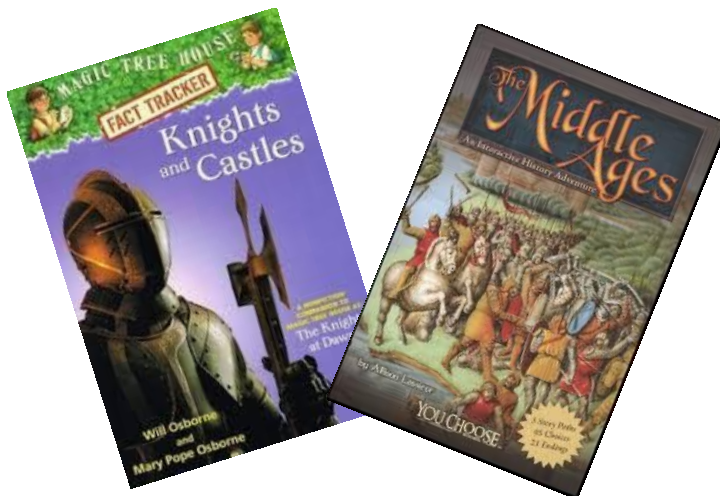
Using the information learned and your matrix, write a paragraph comparing these two devices.

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Generate Ideas:



Select a Solution - Plan Your Budget:

Allotted Budget: \$ \_\_\_\_\_

Materials	Unit Price	Quantity	Cost

Total Cost: \$ \_\_\_\_\_