Catapults in History

Overview:
Students will compare and contrast the three main types of catapults using primary source images. Students will then investigate how the three types function and will design a catapult in a small group using specific supplies. The lesson is designed for students who are familiar with primary sources and have conducted some primary source analysis in the past.

Question:
What were the similarities/differences between the three types of catapults? How has the technology used in these ancient machines affected our technology today?

Objectives:
Students will analyze one primary source using the Library of Congress online tool, and then conduct and a comparison and contrast diagram of 3 similar primary sources.

Time Required: 3 to 5 blocks (90 minutes each)

Recommended Grade Range: 5-10

Subject/ sub-subject: Algebra

Virginia Standards of Learning

The student will solve multistep linear and quadratic equations in two variables, including

A.4 a) solving literal equations (formulas) for a given variable;
- b) justifying steps used in simplifying expressions and solving equations, using field properties and axioms of equality that are valid for the set of real numbers and its subsets;
- c) solving quadratic equations algebraically and graphically;
- d) solving multistep linear equations algebraically and graphically;
- e) solving systems of two linear equations in two variables algebraically and graphically; and
- f) solving real-world problems involving equations and systems of equations.

Graphing calculators will be used both as a primary tool in solving problems and to verify algebraic solutions.

A.5 The student will solve multistep linear inequalities in two variables, including
- a) solving multistep linear inequalities algebraically and graphically;
- b) justifying steps used in solving inequalities, using axioms of inequality and properties of order that are valid for the set of real numbers and its subsets;
- c) solving real-world problems involving inequalities; and
- d) solving systems of inequalities.

Credits:
Heather Balsley, Teacher-librarian, William Byrd Middle School
Laura Lea Harris, 7th grade math teacher, William Byrd Middle School

PREPARATION

Materials:

- One computer per collaborative group for online Library of Congress analyzing tool
- One set of catapult pictures for each group – printed in color if possible, 1 magnifying glass
- 1 copy of compare/contrast chart for each group
- STEM lesson- marshmallows, Popsicle sticks, paper clips, plastic spoons, rubber bands, tape, glue guns/hot glue sticks/…. Additional supplies as needed by students for creativity part of lesson

Resources:

16th century mechanized warfare

Circa 1501-1600

https://www.loc.gov/item/2011645368/

The Power of Ancient Catapults

Dr. Christopher Jones. Aug. 25, 2011
https://gatesofnineveh.wordpress.com/2011/08/25/the-power-of-the-catapult/

Ballastia Catapult

Dr. Christopher Jones. August 25, 2011 https://gatesofnineveh.wordpress.com/2011/08/25/the-power-of-the-catapult/

Trebuchet Capapult

Emily Glanfield. April 11, 2015
http://www.dailymail.co.uk/news/article-3034632/Ever-wanted-REAL-effect-medieval-flaming-catapult-Demonstration-Warwick-Castle-goes-badly-wrong-siege-weapon-torches-building-forcing-hundreds-evacuated.html

Procedure:

1. Give students a quick review of primary and secondary sources. Ask a question regarding their prior knowledge. As students raise their hands, choose a student to catch the ball, stuffed animal, etc. to signify that they are to answer the question. Change the students per question. Examples: What is a primary source? Secondary source? What is bias in a source? Ask students to name items that fall into each group. 5-10 minutes

2. Re-familiarize the students with the online Library of Congress analysis tool. Share the following resource with the students: http://www.loc.gov/teachers/primary-source-analysis-tool/. Remind students to choose the type of source so that they see the appropriate questions. Give students instructions to either print or email the lesson to the teacher. Teacher should rotate through the students pointing out specific questions and asking students to share what they see and infer about the catapult. Remind students of the control+ to enlarge and the control- to shrink the image.

3. Groups members should now compare/contrast the three types of catapults and look for features to assist them in building their own catapult. A brief discussion of the catapults' designs can be conducted after every group is finished with the compare/contrast sheet.

LIBRARY OF CONGRESS TEACHING with PRIMARY SOURCES

Mini Catapult

Group Members: _____

You and your group members are going to build a catapult that launches mini marshmallows. You may only use the following materials:

~ popsicle sticks ~ rubber bands ~ paper clips ~string
~ hot glue ~ plastic spoon ~ tape

NOTE: your mini catapult can be no larger than a half a sheet of paper.

Day 1: Research your design

Step 1: Today you will be working in small groups to investigate catapults using primary sources. You will complete an analysis using your computer and it will be submitted electronically.
*Click on the following link to see an image from the Library of Congress: https://www.loc.gov/resource/ds.00320/ Use your "ctrl" and "+" keys together to enlarge the image.

*Use the online analysis tool to answer the questions for an image. The form is available here: http://www.loc.gov/teachers/primary-source-analysis-tool/ Email your group's responses to _____ at _____. Include all of your group's first names on the submission form and the block that you have Algebra.

Step 2: You will now receive a packet from your teacher of 3 different types of catapults. Using the compare and contrast form in the packet, compare the three images and answer the questions. Use the magnifying glass to see specific details! Your group is now ready to begin designing the catapult for this project.

See Day 2 for the requirements!

Day 2: Build your catapult.

- Build your catapult. You must exercise maturity and good judgment during construction and throughout the project. Your group will be given a **zero** if you are caught launching anything from your catapult in the classroom. We will launch tomorrow!
- Use the materials given to you in class. All group members must participate during construction. No one is allowed to sit and look pretty!
- Catapult guidelines:
  - Your catapult may not be larger than a half a sheet of paper.
  - Your catapult must launch a mini marshmallow.
  - Your catapult is only made up of materials given
  - You must be able to launch your marshmallow from the same spot every time

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Day 3: Marshmallow Launch

Today, you will be putting your catapult construction to work! You will also be determining the path your marshmallow follows.

- Assign a timer, a recorder, and a launcher amongst your group members.
- Complete a table of data which includes trial number, time in air, and distance traveled.
    - Complete 25 trials (do some practice launches first).
    - Distance traveled does not include if the marshmallow slides or rolls. Record **exactly** where the marshmallow lands.
    - Start the stop watch **as soon as** the marshmallow has **left the catapult's arm**.
- Find the mean hang time (time in air) and record on your sheet.
- We will be using the equation for vertical motion to find the equation of the parabola your marshmallow makes.
    - $h = -16t^2 + vt + h_0$
        - h represents height, in feet, at any given time
        - t represents time in seconds
        - v represents the velocity of your marshmallow when it leaves the catapult
        - h_0 represents the initial height of your marshmallow right before it launches
    - To find h_0 you will need to accurately measure the height of your catapult arm when it is fully extended vertically. Make sure you convert your measurement into feet. Record the value on your worksheet.
    - What is the height of the marshmallows when they land? Record this height on your worksheet.
    - Use your average hang time, your initial height (h_0), and the height when the marshmallow lands values and substitute them into the formula $h = -16t^2 + vt + h_0$ to find the initial velocity. Record your answer on your worksheet.
    - Now you have all the information you need to create your equation! Record your final equation on your worksheet.

Trial	Time in Air (s)	Distance Traveled
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		

Timer: _____

Recorder: _____

Launcher: _____

Mean Hang Time: _____

Starting Height (h_0): (12 in.= 1 ft.)

_____

Height when on ground:

_____

Work to find velocity:

Velocity of marshmallow (v):

_____

Vertical motion formula:

$h = -16t^2 + \_\_\_\_\_t + \_\_\_\_\_$

Grading:
--Complete design/ sketch: **20**
--Build catapult with materials given: **20**
--complete table: **10**
--find h_0: **10**
--find velocity: **10**
--vertical motion formula: **10**
--participation: **20**
Total Possible: 100 points

Extra Challenge:
Find the vertex of your parabola.
Use the vertex to hit a target.

LIBRARY OF CONGRESS **TEACHING** *with* PRIMARY **SOURCES**

Name _____ Block _____

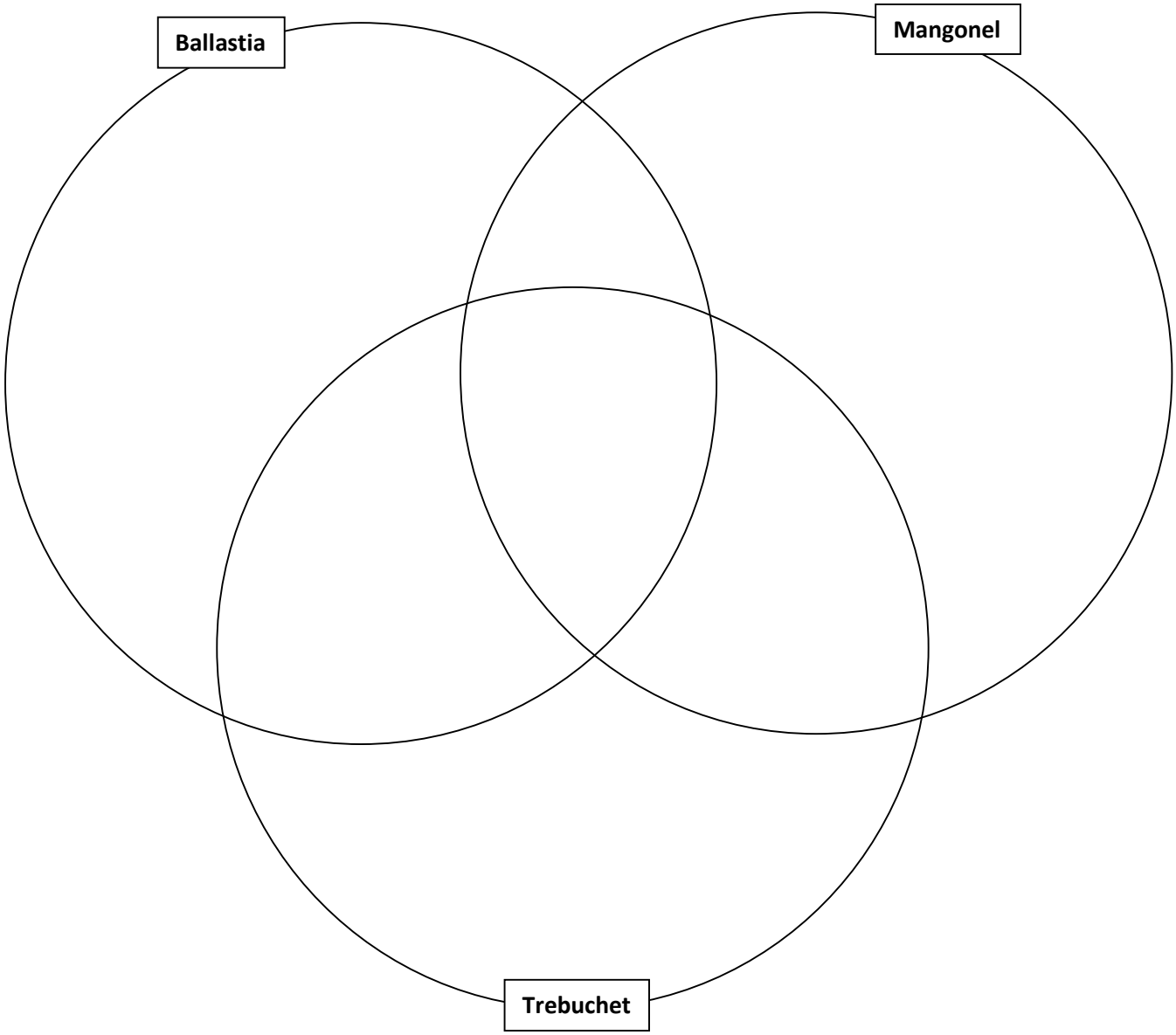
Discuss:

*How were the catapults transported?

*What part of their design is still used today in technology? (Think of science terms!)

*What catapult do you think was the easiest to use? Why?

*What catapult do you think was the hardest to use? Why?



What characteristics do all three types of catapults share that you plan to use in your design?