CALIFORNIA STATE SCIENCE FAIR
2008 PROJECT SUMMARY

Name(s)
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Project Number
J0224

Project Title
Ready, Aim, Fire! Maximizing the Trebuchet's Range

Abstract

Objectives/Goals
The objective was to determine the best design for a trebuchet to maximize the distance a projectile is thrown. My hypothesis was that a heavier counterweight will launch the projectile the farthest, using elastics will work better than the counterweight, using a sling will launch the projectile farther than using a cup and using a lighter projectile will go farther than using a heavier one.

Methods/Materials
Extensive research occurred throughout the project from topic selection to conclusion. Materials were: trebuchet, projectiles, elastics, measuring tape, counterweights, stopwatch, distance markers, and the collection form. 20 tests each were completed varying Counterweight, Elastics with Crash Bar, Projectile Mass, and Cup Instead of Sling for a grand total of 120 tests. Tests included launching the projectile, timing the flight time, and then measuring the distance from the end of the trebuchet to the landing spot. Distance/second (horizontal velocity), average, standard deviation, range and median for all test variations were calculated and graphed. Analysis was completed to arrive at a summary and conclusion. Afterwards, I applied the findings to what happened in history and how the findings impact toy, playground, fair and other mechanical designs.

Results
The data showed that an effective trebuchet would use a projectile to counterweight ratio of 1:95. The greatest range will result from using the lightest projectile (with a forward motion) using a sling, with the heaviest counterweight available that does not break the throwing arm.

Conclusions/Discussion
This study explained why the trebuchet was prominent in medieval warfare. The attackers tested and revised their machine in order to achieve an effective range slightly greater than that of the defending archers. They applied Science and Math concepts outlined in Newton's Laws of Motion, Momentum Theory, Mechanical Advantage of a Lever and Potential and Kinetic Energy and determined heavy counterweight, light projectile, and a sling work best. Toys, play gear and machinery employ these concepts on every design today. We can continue to employ these concepts to designs to maximize effectiveness and to increase safety.

Summary Statement
Using mathematic and scientific principles, this project studied the optimal counterweight mass, projectile mass, energy transfer design and fling method to maximize the distance a projectile is thrown from a trebuchet.

Help Received
In the testing phase, 3 people were required to assist me (time observer, distance observer, and date/time controller) while I was managing the tests as Launch Controller. My mother taught me Excel for graphing and data analysis. All input, analysis and presentation was completed entirely on my own.