## Project Title

# How Does the Length of the Arm of a Trebuchet Affect the Distance an Object Can Be Launched? 

## Objectives/Goals

Abstract
There has been limited research on the relationship between a trebuchet's arm length and the vertical and horizontal distance an object can be launched. Virtually all authors consider the arm length "fixed." However, one research study discussed the results of a computer simulation, indicating (1) decreasing vertical distance associated with increasing arm length and (2) increasing and then decreasing horizontal distance an object would be launched, associated with arm length, suggesting an "optimal" arm length for a trebuchet. Unfortunately, that study did not substantiate the theoretic computer simulation results or provide a reason for the optimal distance.
As a result, the purpose of this research is to empirically investigate the impact of the length of the arm on distance an object can be launched.

## Methods/Materials

My trebuchet was made from wood which had two side holders for support. Then I made five arms with the lengths of $2 \mathrm{ft}, 2.5 \mathrm{ft}, 3 \mathrm{ft}, 3.5 \mathrm{ft}$, and 4 ft and 20 pounds in weight for the counter weight. The object I launched was a tennis ball.

Using each of the five arms, I found the horizontal distance, velocity, angle of the launched object, time in the air, and starting height. I set the cocking angle for each of the arms at 45 degrees. The longest arm touched the ground when set this way, establishing the "touch point."

## Results

Using five different arms, I found that, as the length of the arm increases the vertical distance traveled from the point of release decreases. I also found that, for horizontal distance, the results were like a mountain, with increasing and then decreasing distance associated with arm length. Accordingly, there is an "optimal" arm length, based on what you want to accomplish.
When I compared the arm length that generated the longest horizontal distance, I found it was related to the underlying triangle that the trebuchet defines. It appears that an arm length equal to the distance between the touch point and the base point may provide an \#optimal\# arm length for generating horizontal distance.

## Conclusions/Discussion

My primary findings were
\#Shorter arm lengths result in higher vertical distance
\#Arm length increases and then decreases the distance an object can be launched
Summary Statement
I studied how the length of the arm of a trebuchet affects the distance an object can be launched.

## Help Received

Mother helped me build portions of the trebuchet that required drilling. Friends helped me gather data. Mother and Father proof read paper.

