CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)

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Project Number

J0312

Project Title

The Effect of Trebuchet Arm Length on the Distance an Object Is Thrown

Abstract

Objectives/Goals

In medieval times, the trebuchet was preferred over the catapult because its design allowed for longer and more accurate throws. This simple mechanical machine uses a hinged counterweight attached to a rotating lever arm to throw heavy objects long distances. My hypothesis was that an object could be thrown farther using the mechanical advantage generated by using a longer trebuchet arm. To test this, I built a trebuchet and varied the lever arm length to determine the effect it had on the distance an object was thrown.

Methods/Materials

Three trebuchet arm lengths were tested as part of my project: 120 cm, 90 cm, and 60 cm. The trebuchet I used was constructed out of 3/4 in. and 1 in. PVC pipe and fittings and was based on a design I found online. A plastic bucket filled with 6.8 kg of gravel was used as the counterweight and a standard tennis ball attached to a string was used as the object being thrown. To measure the distance the ball was thrown, a 30 m measuring tape was attached to the base of the trebuchet and pulled to the object where it first landed. To keep the angle of the trebuchet arm the same, the base on which the ball and string were laid, as well as the firing pin, were raised with each change of arm length to keep all distances and angles proportional. The trebuchet was fired ten times for each of the three arm lengths and the data was averaged.

Results

The 120 cm arm threw the farthest with an average distance of 21.20 m. The 90 cm arm was only a few meters less with an average distance of 19.96 m. The 60 cm arm had a drastically shorter distance of throw, averaging only 9.36 m. This showed a 6% reduction in distance thrown between the 120 and 90 cm arms and a 56% reduction between the 120 and 60 cm arms. It was also noted that the 60 cm arm had a more vertical throw than the other two arm lengths.

Conclusions/Discussion

The data collected supported my original hypothesis that a longer arm length would throw an object farther. While this relationship is not linear, to achieve maximum throw distance a longer arm would have to be used. Even though testing showed arm length to be an important aspect of distance thrown, there are other potential factors of the design that could also have affected my results including the angle of the throw (tennis ball string length) and the weight of the counterweight (too heavy or too light, affecting the velocity of the arm).

Summary Statement

The purpose of my project was to determine the affects of trebuchet arm length on the distance an object is thrown.

Help Received

Father helped construct trebuchet, Mother helped measure distances.