

Introduction

This is the outline of a standard research paper introduction:

- **Background information** - Creates a setting for your research. **Explain the physics behind the investigation.** Give sufficient background into the problem you are solving so that the reader is drawn logically to the question you are investigating. Your background should make the reader say "of course!!" when you state what your problem is.
- **Statement of the Problem** - Outline specifically what problem you are investigating. Clearly define what your dependent and independent variables are.
- **Statement of the Hypothesis** - Your hypothesis going into the study, and specifically define how you will measure your variables. Say why you have this hypothesis.
- **A bibliography for any references you make. (Choose any format you like)**

If you were researching the **relationship between wave velocity on water, and the depth of the water**, your Introduction would be laid out like this:

Background:

Describe how water waves move along the surface of the water. Talk about how the water moves really in a circle, and that as you go deeper and deeper, the motion gets less and less. If there is motion where the bottom is, then that motion is constrained to be horizontal only. Talk about possible variables like wavelength, amplitude, viscosity, and depth that could be manipulated.

The background provides enough information that we are never surprised by the statement of the problem.

Statement of the problem:

"The purpose of this investigation is to find out the relationship, if any, between the depth of water, and the speed of small disturbances on the surface of it."

Hypothesis:

"I believe that the wave speed is going to gradually increase with water depth in my experiment. This will happen because the water will be able to move more freely given the space. Depth is defined as the distance between the surface and the bottom of the container, and wave speed is defined as the linear speed of the leading edge of the ripple. The controlled variables include, but are not limited to the size of the wave, the frequency of the wave, and the temperature and purity of the water."

Bibliography:

All sources you cited, and every source you list in your bibliography is cited. Use the style of your choice. Note that you can use any citation style you use – footnotes, parenthetical or whatever, as long as it is within the text, and links any idea that is not yours unambiguously to one of your sources. Things that are general knowledge don't need to be cited. (i.e. don't cite your textbook if you are referring to Newton's second law $F = ma$)

Tips:

1. Leave out **how** you are going to do this in the introduction. Save that for the method.
2. Don't forget to define the variables of your hypothesis. Also define the controlled variables.
3. Don't forget to cite all the sources in your Bibliography.

Background

The first recorded historical reference to siege weapons occurred “in A.D. 339 when a biographer states that Dionysus I, Tyrant of Syracuse, brought together engineers from all over the Mediterranean for the purpose of developing an engine of war powered by a large bow – requiring more power than one man could muster” (Hansen). Of the common siege engines - the ballista, the catapult, and the Trebuchet, by far the most powerful is the Trebuchet. The most common use for a trebuchet today is for entertainment, from pumpkin throwing contests to human projection. The main purpose of a trebuchet was to hurl missiles over or into the walls of cities or castles. Along with the traditional stones being tossed, they also used “beehives, small stones burned into clay balls which would explode on impact like grapeshot bullets, casks of tar and oil on fire, dead animals introducing plagues and diseases, and finally prisoners of war and spies” (Hansen, 1998). The effectiveness is evident as, “the first weapons using gunpowder were introduced to the theaters of war in Europe during the 14th century but it took another 200 years before they replaced the old engines of war completely” (Hansen).

Trebuchets employ a strong yet lightweight arm with a sling full of ammunition, with a heavy counterweight. The trebuchet operates changing potential energy of a falling counterweight into the kinetic energy of a projectile. It is a bit like a seesaw, with the heavy counterweight on one end of the throwing arm, and a sling on the opposite end containing the projectile. As the counterweight falls, the throwing arm pivots upward, and whips the sling around until the projectile is released.

Radlinski (1996) lists the mass of the counterweight, the length of the counterweight arm, the length of the projectile arm, the starting angle, the angular acceleration, and the angular speed as variables that affect the performance of trebuchets. Since there are so many different variables involved with trebuchets, we limited our research to those topics that pertain directly to the effect the projectile mass has on the range of the missile. This, however, encompasses a wide range of issues. A light projectile, while it is more easily accelerated due to its small inertia, may lack the momentum to push the air out of the way. Furthermore, projectiles below a certain mass may cause the release point to be either too soon or too late. (Motz and Weaver, 1989). Projectiles that are too massive once launched would be able to overcome air friction, but due to their increased inertia, may prove too massive to accelerate to a sufficiently high velocity before launch.

Statement of the Problem

The purpose of this investigation is to determine the effect that projectile mass has on the range of a trebuchet.

Hypothesis

We believe that graphically (with mass as the independent variable and range as the dependent variable) our results will resemble a bell curve, with the extremely heavy and the extremely light missiles having the least range. We will strive to find a medium in which the missile will have the greatest range. Projectile mass is defined as the measure of the missile’s inertia. Range is defined as the horizontal distance the projectile travels before hitting the level ground.

Bibliography:

Gardner, Robert. Famous Experiments You Can Do. New York: Franklin Watts, 1990.

Hansen, Peter V. “War Engines of the Middle Ages.” Middelaldercentret 1998.

Miners, Russell. “How Do Trebuchets Work?.” The Grey Company Trebuchet Page. 2004

<<http://members.iinet.net.au/~rmine/gctrebs.html>>

Motz, Lloyd and Jefferson Hane Weaver. The Story of Physics. New York: Plenum Press, 1989.

Radlinski, Filip. “The Physics of the Trebuchet.” 1996.

<<http://www.geocities.com/SiliconValley/Park/6461/>>