

<b>Main Topic</b>	Motion
<b>Subtopic</b>	Projectile motion
<b>Learning Level</b>	High
<b>Technology Level</b>	Low
<b>Activity Type</b>	Student

Description: Verify the results of the classic "Monkey and Hunter" problem, empirically and experimentally.
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Required Equipment	Monkey and Hunter apparatus, Ring Stand, C-Clamp, D battery, S-Clamp
Optional Equipment	

## Educational Objectives

- Verify the results of the classic "Monkey and Hunter" problem, empirically and experimentally.

## Concept Overview

A monkey is hanging in a tree, 15m high. A hunter approaches, sees the monkey, and stops 20m away from the tree. The hunter aims his blowgun directly at the monkey. The monkey then sees the hunter, and drops out of the tree at the instant that the dart is shot. The dart's initial velocity is 17 m/s. Does the dart strike the monkey?

To solve the problem empirically, first define the hunter's position as 0, both horizontally and vertically. The monkey's horizontal position is 20m.

Find the time that the dart reaches the monkey's horizontal position. Start by defining the horizontal position of the dart.

$$x = v_x t$$

$$x = 17 \cos \theta t$$

The angle can be found using the inverse tangent of 15/20, the legs of the triangle.

It is  $37^\circ$ .

$$x = 17 \cos 37t$$

Now define the horizontal distance as 20 meters, and solve for t.

$$t = \frac{20}{17 \cos 37} = 1.4731s$$

Keep a lot of significant digits, since this time will be used to compute two separate results next. Now, find the vertical position of both the monkey and dart at this time, and compare. For the monkey, the vertical position is:

$$y = y_i + \frac{1}{2} at^2$$

$$y = 15 - 4.9t^2$$

$$y = 15 - 4.9(1.4731)^2 = 4.4m$$

For the dart, the vertical position is:

$$y = v_{yi} + \frac{1}{2} at^2$$

$$y = 17 \sin 37 - 4.9t^2$$

$$y = 17(\sin 37)(1.4731) - 4.9(1.4731)^2 = 4.4m$$

Since both monkey and dart are at the same position at the same time, the dart hits its target!

To test this problem experimentally, follow the directions on the datasheet included with the Monkey and Hunter demonstration. Careful aim is crucial!

## **Lab Tips**

This activity works well as a demonstration, working through the calculations as a class, or as a station through which student groups rotate. Setting up the apparatus is not trivial, and will almost certainly require teacher assistance in any pre-college class.

# Monkey and Hunter

Name: \_\_\_\_\_

Class: \_\_\_\_\_

## Pre-Lab Questions:

A monkey is hanging in a tree, 15m high. A hunter approaches, sees the monkey, and stops 20m away from the tree. The hunter aims his blowgun directly at the monkey. The monkey then sees the hunter, and drops out of the tree at the instant that the dart is shot. Does the dart strike the monkey? To answer this question, calculate three values:

1. How much time does it take the dart to reach the monkey's tree? (Use at least four decimal places in your answer, as you will use this number to calculate the next result.)
2. What vertical position will the monkey reach in that time?
3. What vertical position will the dart reach in that time?
4. Does the dart hit the monkey?

## Goal:

Verify the results of the classic "Monkey and Hunter" problem, empirically and experimentally.

## Materials:

Monkey and Hunter apparatus, Ring Stand, C-Clamp, D battery, S-Clamp

## Procedure:

1. Set up the Monkey and Hunter apparatus as directed. Careful aim is crucial. Aim the projectile directly at the hanging "monkey."
2. When you fire the projectile, the electromagnet holding the "monkey" will release, dropping it.
3. Describe the results of your experiment, repeating as needed to perfect your aim.