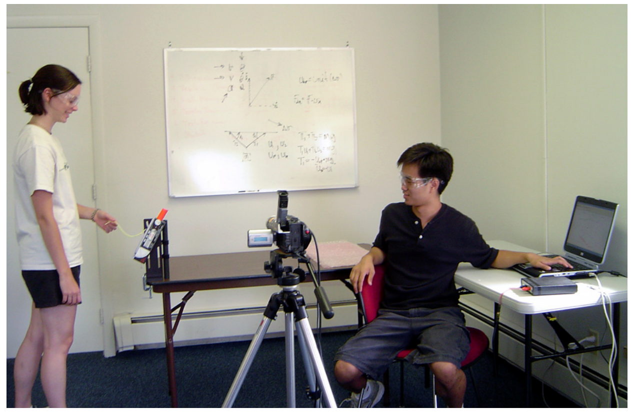
Projectile Motion Activity
Using Motion Visualizer™ 2D

Materials



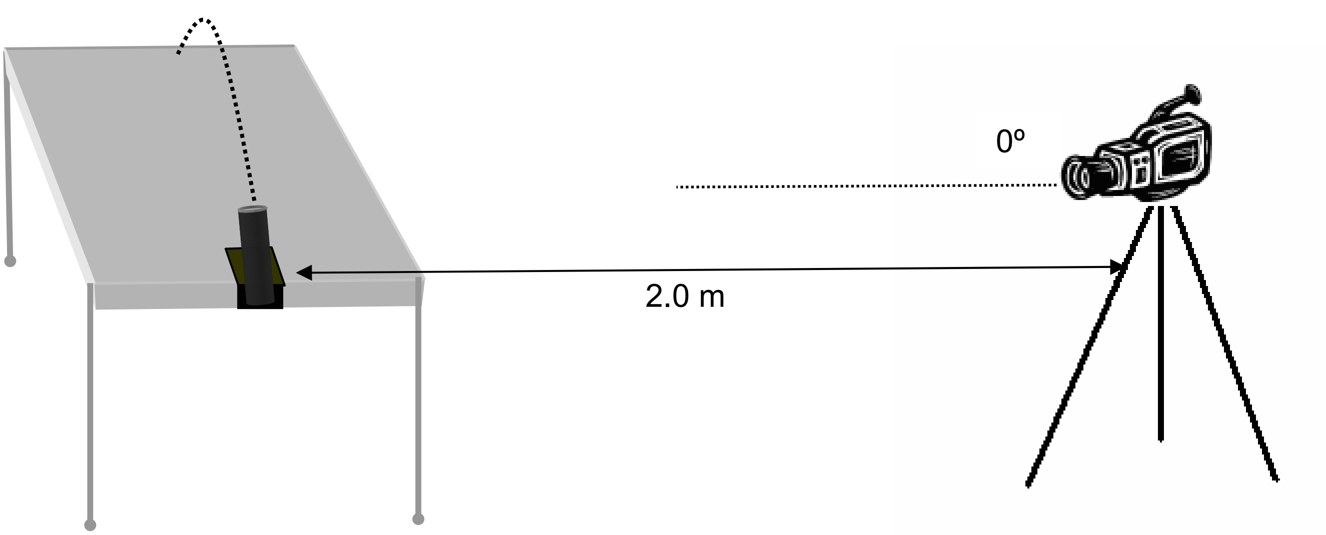
- Angle measuring device*
- Tape measure
- PASCO Projectile Launcher
- 1 in dowel (painted bright orange)

*Included with Motion Visualizer.

Setup

1. Place orange dowel in projectile launcher.
2. Use rod to set spring at smallest velocity setting.
3. Release trigger and capture motion with Motion Visualizer.

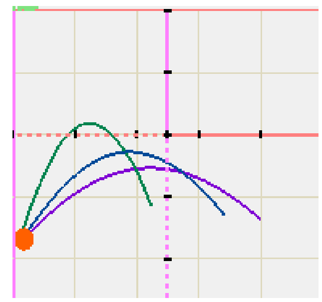
Experiment Type	1 Object
Motion	Vertical
Camera Angle	0°
Camera Distance	2 m
Smoothing Points	9



Written by Heather Hausladen. Heather is a Wellesley College sophomore who spent the summer of 2004 working with Alberti's Window under the NSF's Research Experiences for Undergraduates program.

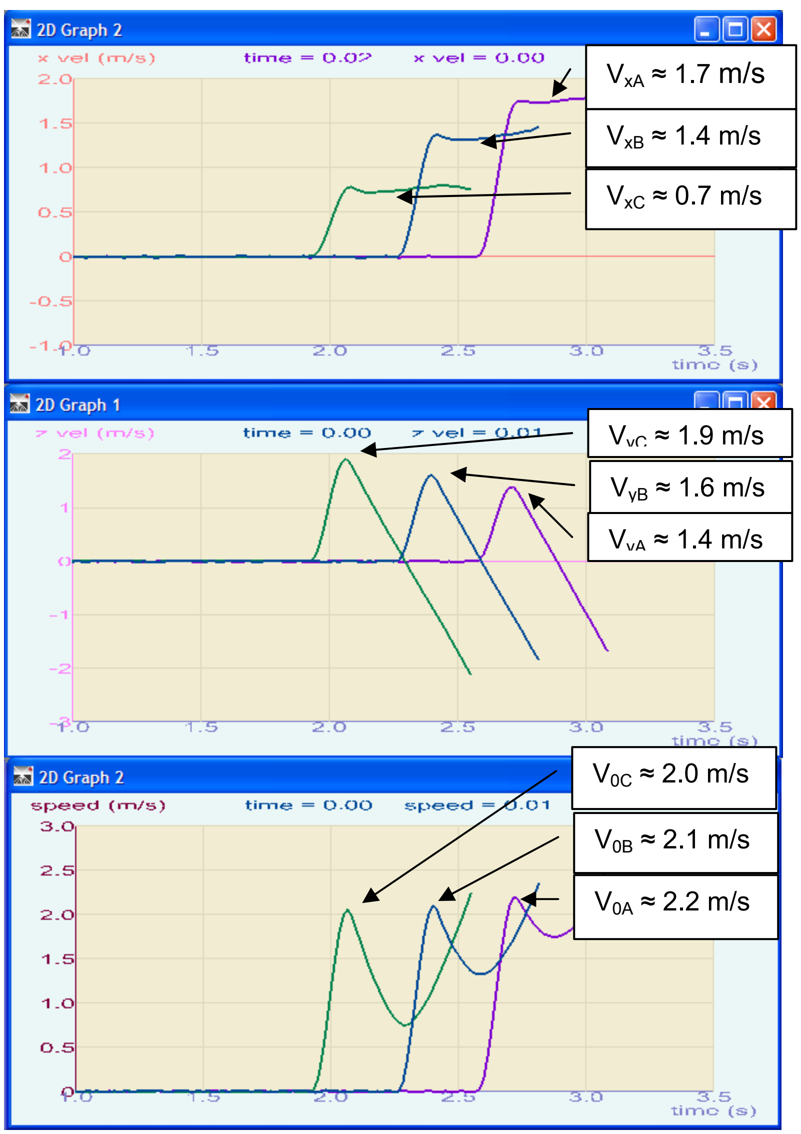
Data Analysis

The following X Position v. Y Position graph shows the path taken by projectiles launched using the same speed setting at different angles.



Finding Angles and Adding Components

The independence of motion between the vertical and horizontal direction is easily depicted with Motion Visualizer graphs. By looking at the following graphs of velocity in the x (horizontal) and z (vertical) direction, simple calculations can be performed to find the launch angle, such as



$$\tan^{-1}\left(\frac{v_y}{v_x}\right) = \theta$$

From this it follows that

$$\theta_A = \tan^{-1}(1.4/1.7) = 39.5°$$
$$\Theta_B = \tan^{-1}(1.6/1.4) = 48.8°$$
$$\Theta_C = \tan^{-1}(1.9/0.7) = 69.8°$$

Another simple calculation using estimations of the initial velocity in the x and z direction gives students practice in vector addition.

By taking the square root of the sum of the horizontal and vertical components squared it is found that

$$V_{0A} = \sqrt{(1.7)^2 + (1.4)^2} = 2.2 \text{ m/s}$$
$$V_{0B} = \sqrt{(1.4)^2 + (1.6)^2} = 2.1 \text{ m/s}$$
$$V_{0C} = \sqrt{(0.7)^2 + (1.9)^2} = 2.0 \text{ m/s}$$

which is confirmed by Motion Visulaizer's Speed v. Time graph.

Written by Heather Hausladen. Heather is a Wellesley College sophomore who spent the summer of 2004 working with Alberti's Window under the NSF's Research Experiences for Undergraduates program.

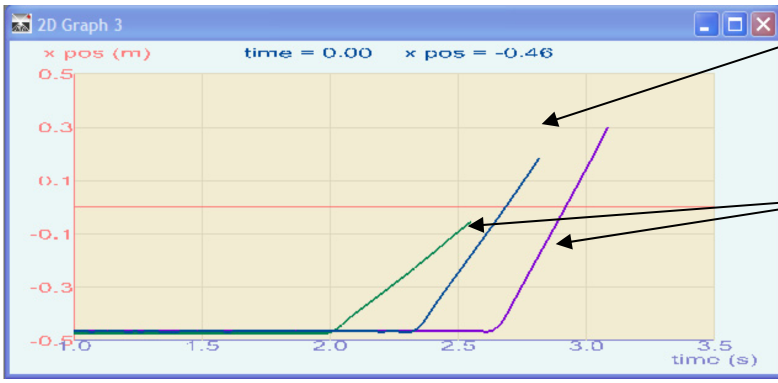
Breaking it Down

Understanding the Horizontal and Vertical Components of Displacement, Velocity, and Acceleration

The Horizontal Component

The following graphs depict three projectile launched at 40º (purple), 50º (blue), and 70º (green).

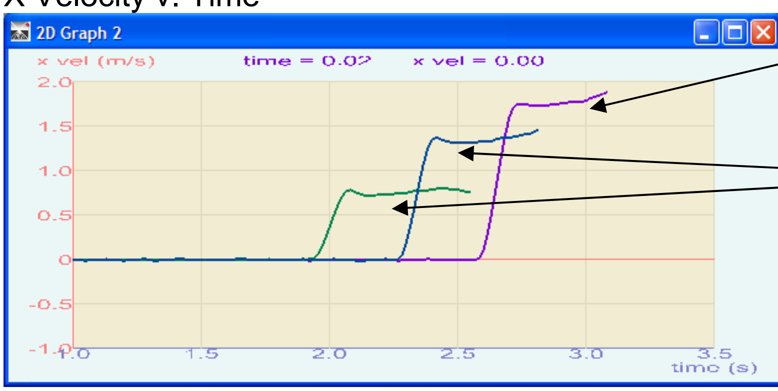
X Position v. Time



The X Position v. Time graphs can be represented as straight lines indicating constant

The slope of the X Position v. Time graph is smaller for the projectile launched at a larger angle.

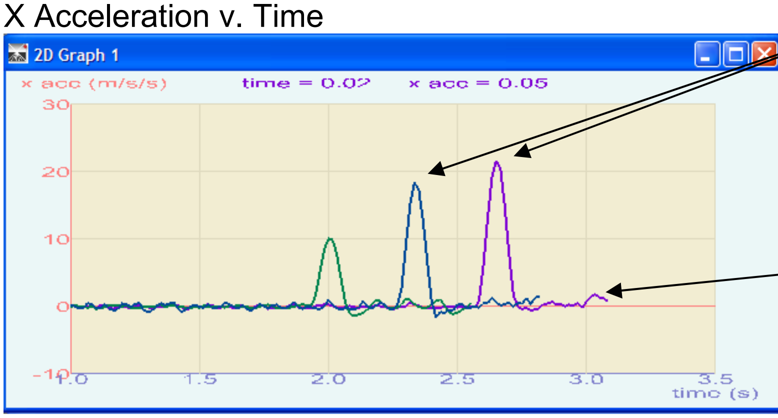
X Velocity v. Time



Graph shows that x velocity remains constant.

The larger angle has a smaller horizontal velocity component.

X Acceleration v. Time

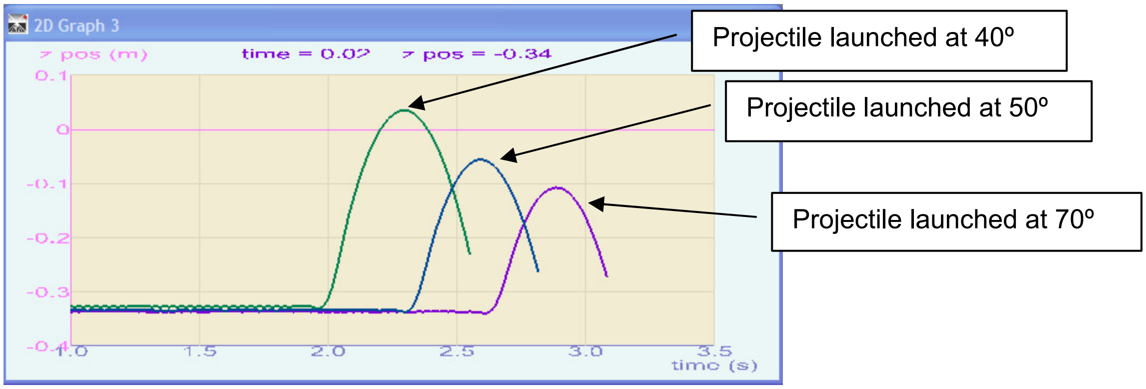


Initial acceleration of object in the horizontal direction before projectile leaves launcher.

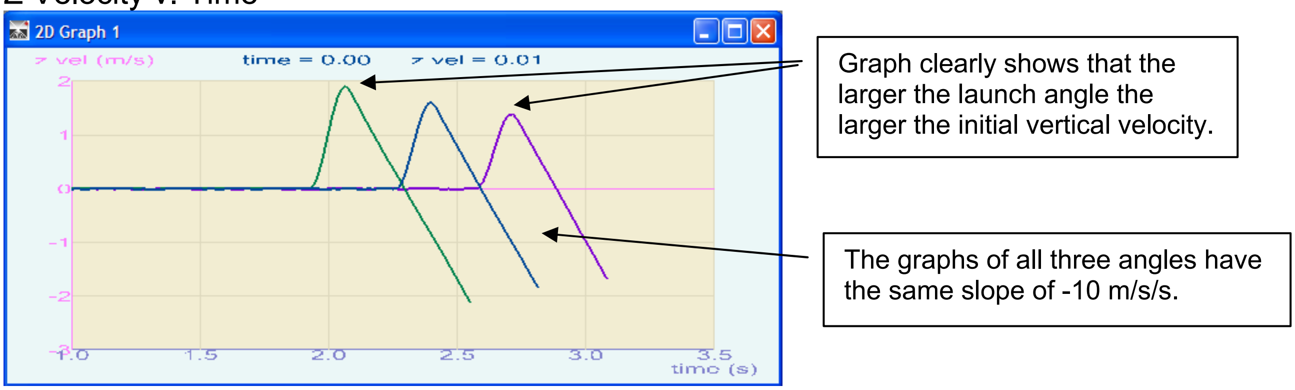
After the projectile has been launched there is no horizontal acceleration.

The Vertical Component

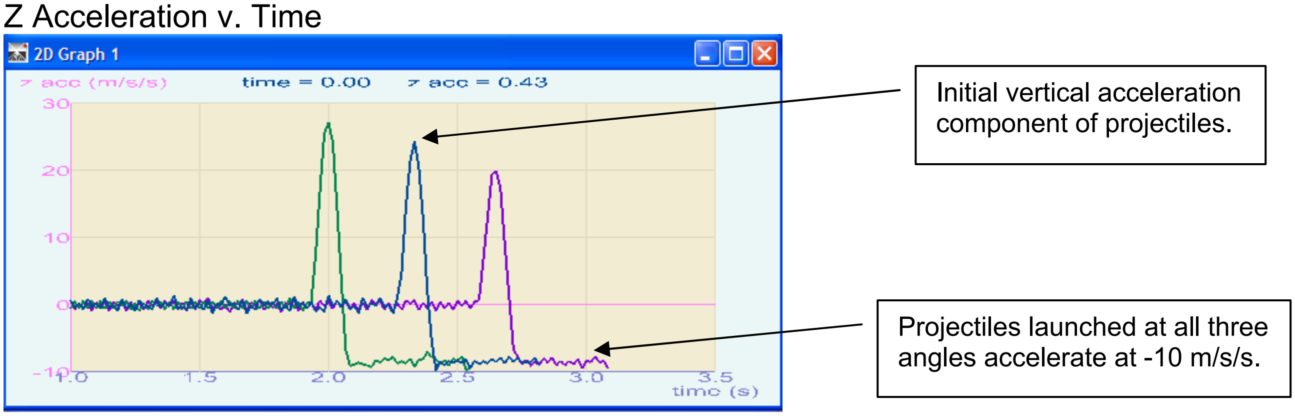
Z Position v. Time



Z Velocity v. Time



Z Acceleration v. Time



Written by Heather Hausladen. Heather is a Wellesley College sophomore who spent the summer of 2004 working with Alberti's Window under the NSF's Research Experiences for Undergraduates program.