Module 3: Motion In Two Dimensions

Topic 1 Application: Projectile Motion Scientific Investigation

Before you begin this scientific investigation, make sure to download the Projectile Motion Scientific Investigation Report. As you complete this scientific investigation, fill in any needed information on the report template. If you need more information about each section of the report, please visit the Developmental Module.

Introduction

Projectile motion involves the moving of an object in both a vertical and horizontal direction. As the object moves, the vertical and horizontal motion are independent of each other. Objects in projectile motion are often thrown, shot, or launched with varying speeds. A number of variables like the angle at which the projectile is thrown, the initial speed of the projectile, the mass of the object being thrown, and the diameter of the object being thrown can have an effect on the distance that the projectile travels.

Objectives

In this scientific investigation, you will:

- examine the independence of vertical and horizontal motion.
- observe the effect of changing conditions on the motion of a projectile.

Hypothesis

Using the **Procedure and Data Collection** section, read through the procedural information for this scientific investigation. Based on your understanding of the procedure, develop your own hypotheses which describe your expected results. You should consider the following questions:

- When a projectile is launched into the air, what is the relationship between vertical and horizontal motion?
- How will the initial speed of the projectile affect the range (or distance traveled)?

Record these hypotheses in the **Hypothesis** section of your Projectile Motion Scientific Investigation Report.

Required Simulation

Projectile Motion Simulation

Provided by:
PhET Interactive Simulations
University of Colorado
http://phet.colorado.edu

Procedure and Data Collection

Simulation Set-Up

1. Open the Projectile Motion simulation.
2. On the right side of the simulation window, you should see a green box with several fields in which you can enter variable quantities. Enter a zero into the angle (degrees) field.
3. In the list of projectiles, select the option for baseball.
4. You should also see two magnifying glass icons. Zoom out by clicking two times on the magnifying glass with the "-" symbol.
5. Uncheck the option for Air Resistance.

6. On the bottom of the simulation window, you should see a cannon. Lift the cannon to its highest point by clicking on it and dragging it towards the top of the screen.
7. Note that the following items in the simulation have the following meanings:
   - Range = horizontal distance traveled
   - Height = vertical distance traveled
   - Time = duration of the projectile's flight

Effect of Initial Speed on Range

1. Consult the first row of the data table in the **Data** section of your Projectile Motion Scientific Investigation Report or shown in the Data section. Using the simulation, enter a zero into the initial speed (m/s) field.
2. Click Fire.
3. Observe the path of the projectile as it is fired. After the projectile has landed, enter the specified range, height, and time into the data table.
4. Repeat steps 1 through 3 ten more times, replacing the amount of initial speed with the amount provided to you in the data table.

Data

Use the data table provided on your Projectile Motion Scientific Investigation Report to record your data from this scientific investigation. The data table is also shown below:

Initial Horizontal Speed (m/s)	Range (m)	Height (m)	Time (s)
0			
2			
4			
6			
8			
10			
12			
14			
16			
18			
20			

Data Analysis

In the **Data Analysis** section of your Projectile Motion Scientific Investigation Report, create two graphs based on the data you collected in your data table. On one graph, plot the time versus initial speed. On the second graph, plot the range versus initial speed. In addition, provide responses to the following questions:

1. What is the relationship between initial horizontal speed and the time of flight?
2. How does a change in the initial speed affect the time that the projectile is in the air?
3. Does the data that you collected through this simulation support or refute the idea that the horizontal motion and the vertical motion are independent?
4. What is the relationship between initial horizontal speed and the range of the projectile?
5. How does a change in the initial speed affect how far an object moves vertically?

Conclusion

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Using the **Conclusion** section of your Projectile Motion Scientific Investigation Report, compose three to four sentences describing an overall conclusion about the relationship between horizontal and vertical motion, and the effect that the initial speed had on the range of the projectile. Were your hypotheses true or false, and how do you know? Use the data and notes that you collected from your simulation experience to form your conclusion. Make sure that you include information that you gained from data analysis to support your conclusion.

Experimental Sources of Error

On your Projectile Motion Scientific Investigation Report, provide responses to the following questions:
Are there any sources of error? If so, what are they, and what could be done to minimize error?

Once you have completed the Projectile Motion Scientific Investigation Report, please submit your work to the dropbox.