Modelling Projectile Motion

Background

In this unit you have studied projectiles launched in a number of different scenarios. In this experiment you will launch projectiles horizontally from various heights to see how well projectile motion theory and calculations predict your results.

Testable Question

How does changing the vertical displacement of a projectile affect its range and time of flight?

Hypothesis/Prediction (to be completed before beginning the lab)

Read through the experiment and predict an answer to the Testable Question. Use reasoning to justify your prediction.

Hypothesis:___________________________________________________________________________________
________________________________________________________________________________________________
________________________________________________________________________________________________
________________________________________________________________________________________________

Experimental Design

Equipment

- Ramp
- Textbooks (to lift the ramp)
- Marble
- Metre stick
- Chart paper
- Tray
- Marker
- Tape

Important Note: Adjusting the height of the ramp will be done using the textbooks. Also note that this is an investigation of horizontal projectile motion, and thus changing the height of the ramp will change the initial horizontal velocity.
PROCEDURE

1. Consider assigning roles to different people: (i.e. one person can be the recorder, one person can be the marker, one person can be the ball roller, etc.)

2. Set up your ramp by laying it perfectly horizontal on the lab bench so that the end of the ramp is ‘flush’ with the edge of the bench.

3. Use a half sheet of chart paper and place it on the floor in the tray. Use a small amount of tape to secure it (note that you may need to move it shortly)

4. Roll the marble across the ramp by giving it a ‘small’ push. Use this to gage how the marble will travel down the ramp. Note where it hits the floor.

5. Place the ramp under one textbook so that the marble will be accelerating down the ramp. Be sure to set up your ramp so that the marble can roll off the bench briefly before falling. This is to ensure that you are modelling horizontal projectile motion.

6. Place a mark on the ramp to indicate your consistent start location. Place the marble at the starting point of the ramp and release (without introducing any force). Record the point at which the marble strikes the ground. This will take some very good ball-eye coordination and requires you to pay very close attention. Where the ball falls should be marked with a dot by the marker.

7. Repeat Step 5 more times so that you have produced a cluster of points. The cluster should be very close together (precision); otherwise you should adjust how you are releasing the marble so that you are consistent. Record your horizontal and vertical displacements in the chart below

8. The following table will be used to record vertical and horizontal displacement.

9. Measure the horizontal and vertical displacement. Using this information calculate the time of flight. Using the above information, you will then be able to calculate the initial vertical velocity.

10. Repeat the above experiment using two textbooks. You may want to use a different coloured marker in order to distinguish between the data sets. Record your horizontal and vertical displacements in the table below.

11. Once you have completed the above, your teacher will then place a mark on your chart paper. Your goal will be to achieve the correct horizontal velocity (using a number of books/pages) in order to hit the target consistently. Therefore, your horizontal displacement will be fixed, as well as your vertical displacement. However, your horizontal velocity will be the unknown. Once you have achieved hitting the target consistently, record the vertical height of the ramp above the table top.
DATA TABLE FOR PROJECTILE MOTION INVESTIGATION

<table>
<thead>
<tr>
<th>Trial #</th>
<th>Vertical Displacement (measured from floor to table top) ((d_y))</th>
<th>Calculated Time of flight ((t))</th>
<th>Experimental Range (measured) ((d_x))</th>
<th>Calculated Horizontal Velocity (v_{ix})</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Data using ONE Textbook**
1. 
2. 
3. 
4. 
5. 

**Data using TWO Textbooks**
1. 
2. 
3. 
4. 
5. 

**Data using ????? Textbooks**
Vertical height of Ramp (above table): ____________
1. 
2. 
3. 
4. 
5.
ANALYZE AND EVALUATE

1) Complete all calculations and include them in a table similar to the one above. You only need to include one sample calculation for each type, and the remaining values can be summarized in the table.

2) Write a statement that answers the testable question.

3) Describe the step-by-step process/procedure that you used in order to hit the target indicated by the teacher.

4) Describe any sources of error that occurred during the experiment. If the experiment were repeated what would your recommendations be in order to improve the results.

5) Using the same equipment, how could this experiment be modified in order to study other forms of projectile motion.

A formal lab report must be typed with all equations properly formatted (submit this package with your rough notes). As well it should follow closely to the format below:

   a. Title Page
   b. Introduction
   c. Purpose
   d. Materials
   e. Procedure
   f. Observations and Data Tables
      i. Complete all calculations required throughout this experiment
      ii. Submit a copy of your rough notes as well
   g. Analysis Questions (1-5)
   h. Conclusion

<table>
<thead>
<tr>
<th>Thinking and Inquiry</th>
<th>Communication</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task</td>
<td>Mark Out Of</td>
<td>Task</td>
</tr>
<tr>
<td>Using initiating</td>
<td>5</td>
<td>Expression and organization of ideas &amp; information. Following lab report template and overall presentation</td>
</tr>
<tr>
<td>&amp; planning skills</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>&amp; strategies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data Table</td>
<td>2</td>
<td>Introduction, Purpose, Materials, Procedure, Conclusion</td>
</tr>
<tr>
<td>Rough Notes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>22</td>
<td>TOTAL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>18</td>
</tr>
</tbody>
</table>