Horizontal Projectiles Teacher's Notes

Main Topic	Motion
Subtopic	Projectile Motion
Learning Level	High School
Technology Level	Low
Activity Type	Student

Description: Measure the initial velocity of a horizontal projectile, and predict its range. No datalogger required.

Required Equipment	Smooth Track, Steel Marble, Wood Block, Stopwatch, Ditto (carbon) paper, white paper, meter stick.
Optional Equipment	

Educational Objectives

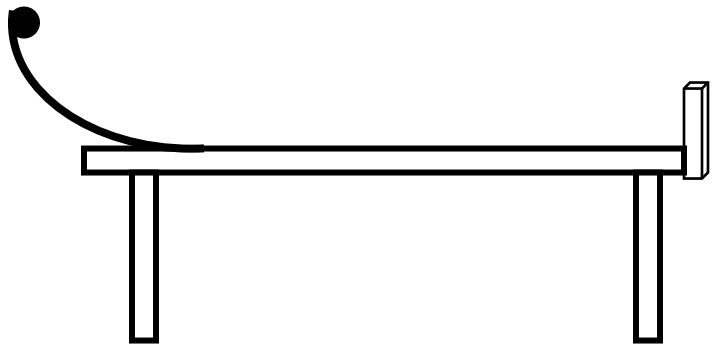
- Predict the range of a horizontal projectile.

Concept Overview

Students will use a simple method, employing just a meter stick and stopwatch, to determine the initial velocity of a horizontal projectile. They will then predict the range of the projectile, precisely measure the actual range by using carbon paper, and calculate the percent difference.

Lab Tips

The track can be constructed of metal, wood, or flexible plastic toy car track. Take care to not let the ball bounce across the table. It should roll smoothly to the edge. If you use plastic track, the track can be extended horizontally all the way to the table edge.



Horizontal Projectiles

Name: _____

Class: _____

Goal:

Predict the range of a horizontal projectile.

Materials:

Smooth Track, Steel Marble, Wood Block, Stopwatch, Ditto (carbon) paper, white paper, meter stick.

Procedure:

Part I – Determining Horizontal Velocity [V_{ih}] of your "Bomb"

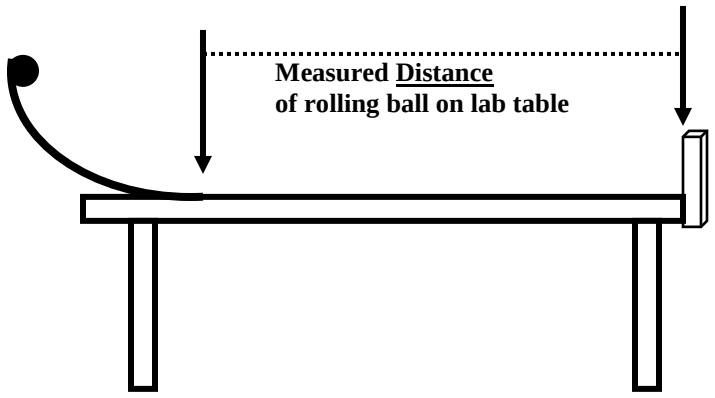
1. Start your "bomb" (steel ball) at the very top of the ramp. Be certain to start your ball at the **same** point for each trial.

2. Release the ball and begin timing the ball when **at the instant it leaves the ramp**.

3. Stop the time the instant the ball ***hits*** the **wood block** at the end of the lab table.

   * **DO NOT ALLOW YOUR BOMB TO HIT THE FLOOR!**

4. Measure the **distance** the ball traveled **from the end of the ramp to the end of the lab table**.



Trial #	1	2	3	4	5	6	7	8	9	10	Ave. Time
Time (seconds)											

5. Using **v=d/t**, the **Average Time** and measured **Distance**, find the **Horizontal Velocity** [V_{ih}] of your "bomb".

   * Since the **Velocity** on the level surface is **Constant**, your answer will be the calculated **Horizontal Velocity [V_{ih}] for your ball**

Measured Distance → _____ **Average Time of rolling ball** → _____

Horizontal Velocity [V_{ih}] of your ball → _____

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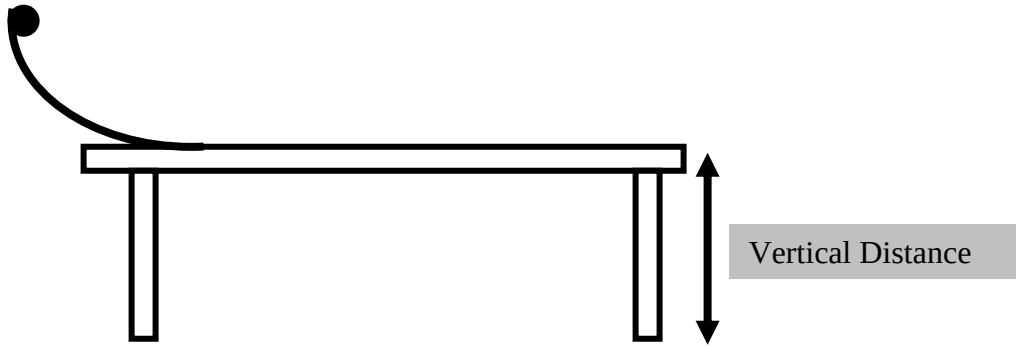
Part II – Determining Horizontal Time [t_h] of your "Bomb"

1. Since the **Horizontal Time** [t_h] for your "bomb" **is = to the Vertical Time [t_v]**, you need to determine the **Vertical Time [t_v].**

2. Measure the **Vertical Distance** [d_v] from the end of the ramp to the floor.

3. Using $\mathbf{d = v_i t + 1/2at^2}$, determine the **Vertical Time** [t_v] it will take the ball to drop to the floor. Remember to use ONLY vertical values!



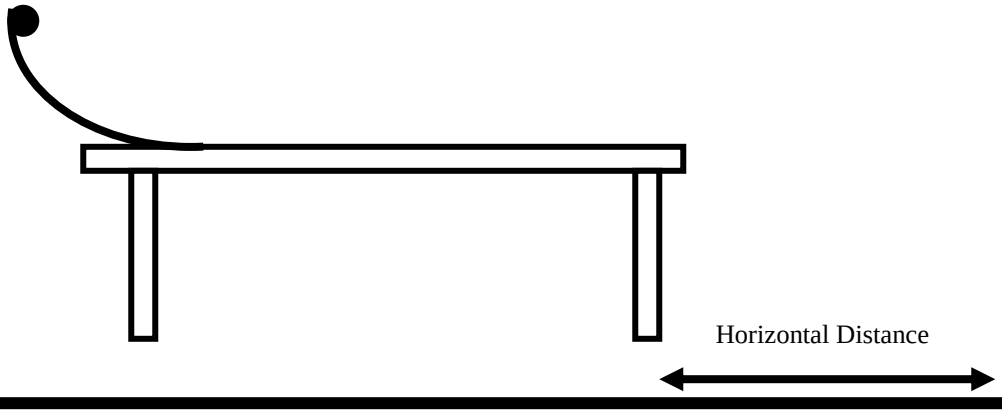
Vertical Distance [d_v]	**Vertical Time** [t_v]	**Horizontal Time** [t_h]

Part III – Determining Horizontal Distance [d_h] of your Bomb

1. Using $\mathbf{d = v_i t + 1/2at^2}$, determine **mathematically** where your "bomb" (**Horizontal Distance [d_h]**) will hit the floor. Remember to use **ONLY** horizontal values!

2. When you are ready to launch your "bomb", you must call your teacher to **verify** your **landing area calculation**.

3. Place a piece of ditto paper over the predicted landing area. Roll the ball and indicate where it hits by the **ditto dot** on the floor.



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Calculations for determining Horizontal Distance

Your Calculated Horizontal Distance → _____

Your Experimental Horizontal Distance → _____

Conclusions

1. Find the **Percent Error** between your **Theoretical (Calculated) Horizontal Distance** and your **Actual Measured Horizontal Distance.**

$$\frac{\text{Actual-Theoretical}}{\text{Theoretical}} \times 100 = \%\ \text{Error}$$

2. If the ball were rolled **faster** off the ramp, the **time** it would take to hit the floor would…
   a. increase
   b. decrease
   c. remain the same

3. If the ball were rolled off the end of a ramp which was **2 meters in height** from the floor, the **time** it would take to hit the floor would…
   a. increase
   b. decrease
   c. remain the same

4. If a **golf ball** and a **billiard ball** were rolled off two **identical** ramps from the same height, the…
   a. …golf ball would hit the floor first.
   b. …billiard ball would hit the floor first.
   c. …they both would hit the floor at the same time.

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5. A B-52 World War II bomber plane needs to drop a bomb to destroy the German gear factory. If the plane's altitude is **3000m** and it is moving at **200m/s**, how **far** from the target must the pilot release the bomb?