Name _____

Lab: Horizontally Launched Projectile

Objective

The objective of this lab is to use the physics of projectile motion to predict the distance a horizontally launched projectile will travel before hitting the ground.

We'll roll a steel ball down a ramp on a lab table and measure its velocity across the table. We'll assume the ball will not slow down much as it makes its way across the table top, and use this velocity as the horizontal launch velocity.

Using the launch velocity and the height of the lab table above the floor, we'll use the physics of projectile motion we've been learning to predict how far away from the table edge the ball will hit the ground.

Procedure (Part 1): Calculate the horizontal velocity of the ball across the table.

1. Position the ramp so that its end is about 1 meter from the edge of the table. Carefully measure the distance from the end of the ramp to the table edge. Record your measurement below:

$x_{table} =$ _____

2. Now measure the time it takes for the ball to travel the distance from the bottom of the ramp to the edge of the lab table.

   a) Make a mark on the ramp so you release the ball from the same spot each time.

   b) Roll the ball down the ramp and across the table top, but catch it before it hits the ground.

   c) Use the stopwatch to measure the time it takes for the ball to roll from the bottom of the ramp to the edge of the table.

   d) Repeat this 10 times and record the results in the table below.

Trial	Time (s)		Trial	Time (s)
1			6	
2			7	
3			8	
4			9	
5			10	

   e) Calculate the average time for your 10 trials and record the result below:

$t_{average} =$ _____

3. Use $v_x = \frac{x_{table}}{t_{average}}$ to determine the horizontal speed of the ball and record it below.

$v_x =$ _____

Procedure (Part 2): Calculate the time for the ball to drop to the floor.

1. Measure the distance from the top of the table to the floor and record it below:

$d_y =$ _____

2. Calculate the time it takes for the ball to drop to the floor using the formula below. Show all of your work. (Assume $v_i = 0$ and $a = -9.8\ m/s^2$)

$$d_y = v_i t + \frac{1}{2} a t^2$$

$t =$ _____

Procedure (Part 3): Calculate the distance the ball will travel horizontally.

1. Using $d_x = v_x t$, calculate the horizontal distance across the floor the ball will fly before hitting the ground. Use v_x from Part 1 and t from Part 2. Show all of your work.

$d_x =$ _____

Procedure (Part 4): Test your prediction.

1. Set up a target by placing a piece of masking tape on the floor at a distance d_x from the base of the table.

2. Place 2 more pieces of tape, one 2 cm closer to the table and one 2 cm farther from the table (as compared to your target line).

3. Roll the ball off the ramp to see if it lands in between the lines you've marked.

4. Measure the distance to the actual landing spot and record it below:

$$d_{actual} = \_\_\_\_\_$$

5. Calculate the difference (Δd) between your predicted distance and the actual distance and record it below:

$$\Delta d = \_\_\_\_\_$$

Lab Questions

1. People who have not studied physics sometimes question whether the horizontal and vertical motion of a projectile are really independent. Does this lab give you evidence to support this concept? Justify your answer.

2. Imagine that we increased the height of the ramp to 20 cm, making the ramp a much steeper slope.

   a) How would this affect the horizontal velocity of the ball off the end of the table?

   b) How would it affect the drop time of the ball?

c) How would it affect the distance the ball flies?

3. Imagine that we increased the height of the table from the floor.

   a) How would this affect the horizontal velocity of the ball off the end of the table?

   b) How would it affect the drop time of the ball?

   c) How would it affect the distance the ball flies?

4. Could you use the distance a horizontally launched projectile flies to find the initial velocity of the projectile? Describe how.