Name_____

SPEED OF A PROJECTILE

PURPOSE

In this experiment, you will predict the horizontal distance using the measured velocity at launch. Then measure experimentally. As an option, try finding initial velocity using experimental distance.

Equipment Needed

Computer with Logger Pro SW	Vernier Photogate	Plane paper
Vernier Lab Pro	Ringstand, Miniature	Carbon Paper
Ball Ramp Kit	Meter Stick	
Calipers, Digital	Plumb Bob	

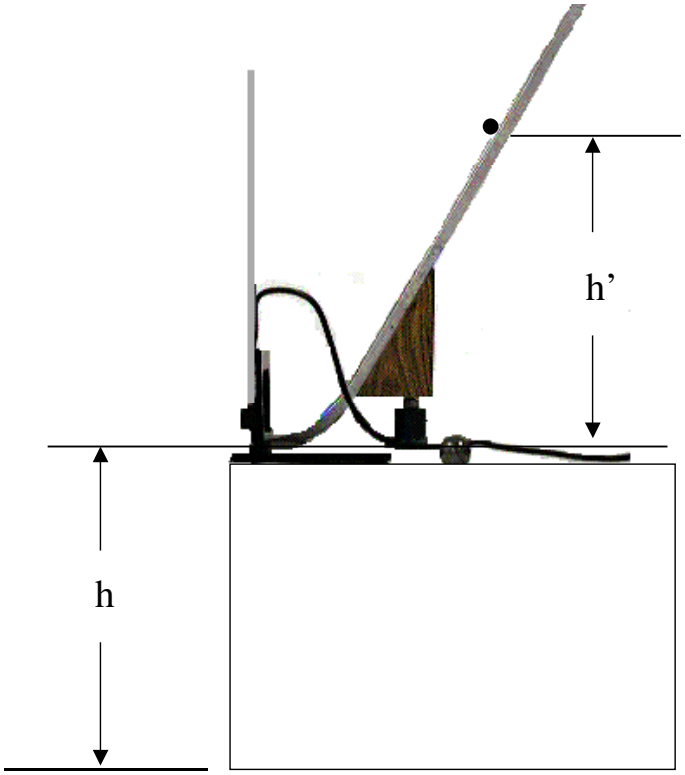

Figure 1

THEORY

This experiment concerns **constant** velocity in the *x* direction and constant acceleration of gravity in the *y* direction. Unless fired straight up or down, projectiles move in the two dimensions, *x* and *y*. Both *x* and *y* share the same time or "time of flight".

Time in flight from the equation:

$$y = gt^2/2$$

is the same time in flight as in the equation:

$$x = vt\ .$$

PROCEDURE

1. Set up the apparatus as shown in figure 1. Turn on Vernier Lab Pro, then the computer. Plug the photogate into Port 1. Choose **One Gate Timing** from **Photogate** folder in the **Probes and Sensors** folder. Support ball at the end of the ramp and adjust the height of the photogate beam to the center of ball.

2. Measure the ball's diameter **d** (in meters) with a vernier caliper and enter the value on your data sheet.

Under the **Experiment** menu select **Set Up Sensors** and then **Show Interfaces**. A dialogue box will appear with the interface box surrounded by the sensors that are presently attached to it. Right click on the Photogate image. A pop up box will appear in which you will select **Set Flag Length**. Enter **d** in as the **Flag Length**.

3. Measure the height of fall **h** from the bottom of the ramp to the floor. Do not confuse this height with the starting height on the ramp " **h'** "**.** Vary **h'** to get different velocities. Associate **h_1', h_2', h_3'** with a different ball release height.

Use a plumb bob to mark a point directly below launch point. Measure the distance x from this point after the ball falls. Measure a time of flight t from the end of the ramp to the floor. This time should be the same for each run. Why?

4. With the gate mounted over the end of the ramp, release the ball once to find where to place a sheet of white paper. Place carbon paper on top of the sheet of white paper with carbon face down.

Press **RETURN** or click the **Collect** button on the screen. Leave the timer running for all of the trials. Release the ball 5 times for each height. Press **RETURN** to stop. Record the velocity

from each run in your data table. Average the velocity and record in the table. Use 1 ball size and 3 heights for each ball times five runs per height - a total of 15 trials.

5. Measure the horizontal distance that the ball traveled. Record as to each point as $\mathbf{x_{meas}}$.

6. Calculate the distance $\mathbf{x_{calc}}$ using $\mathbf{x_{calc} = v_{meas}t}$.

DATA

h end of ramp to floor (meters)_____time of flight t (seconds) _____

Ball Diameter _____ (meters)

Distance above the table h'	Velocity Trials (m/s)					$\mathbf{V_{avg} = V_{meas}}$
	$\mathbf{V_1}$	$\mathbf{V_2}$	$\mathbf{V_3}$	$\mathbf{V_4}$	$\mathbf{V_5}$	
h_1'=						
h_2'=						
h_3'=						

position above the table h'	Elevation h (m)	$\mathbf{v_{meas}}$ (m/s)	$\mathbf{x_{calc}}$ (m)	$\mathbf{x_{meas}}$ (m)	% difference
h_1'=					
h_2'=					
h_3'=					

Note: There are several different balls available in the launcher box.

Percent difference = $(x_{meas} - x_{calc}) *200/ (x_{meas} + x_{calc})$

Lab Report

You will do a formal lab report following the instruction in the handout: Format for Formal Lab Reports, Revised January 15, 2007