

Lab 3 - Projectile Motion and Linear Motion

Name _____

Partner's Name _____

I. Introduction/Theory

This is a purely kinematic experiment to determine the initial velocity of the sphere. A spring "gun" hurls a sphere in a horizontal trajectory so that it hits the floor some measurable horizontal distance from the initial firing point. This experiment finds the initial velocity of the sphere by making a kinematic measurement of the horizontal distance traveled for a particular vertical height when the sphere acts as a projectile. Since the initial velocity is horizontal in direction, a second observation can be made by measuring and timing the horizontal progression of the sphere to calculate the horizontal (initial) velocity.

II. Equipment

Ballistic Pendulum Set
Meter Stick
Ruler
Scale (100 g capacity)
C-clamp
Stopwatch

III. Procedure/Data

Initial Setup:

1. Position the assembled ballistics pendulum at the edge of a table or lab bench. Adjust the feet up or down on the bottom of the base until the bubble in the level, located near the post, indicates that the pendulum base is perfectly level. Clamp the base to the tabletop to prevent accidental movement.

CAUTION: Use care when operating this device. Do not stand or place hands or body in the path of the projectile.

2. Adjustment of the sphere velocity can be made by turning the sleeve on the horizontal shaft which is located on the end of the trigger assembly furthest from the pendulum post assembly. Rotation of the sleeve changes the tension on the spring inside the trigger assembly and produces a noticeable effect only after several complete turns. It is easier to turn the adjustment sleeve before the trigger assembly is in the "cocked" position. The adjustment sleeve should not be changed until both parts of the experiment are completed.
3. In the "un-cocked" position, rotate the sleeve clockwise to nearly maximize the tension in the spring when "cocked".

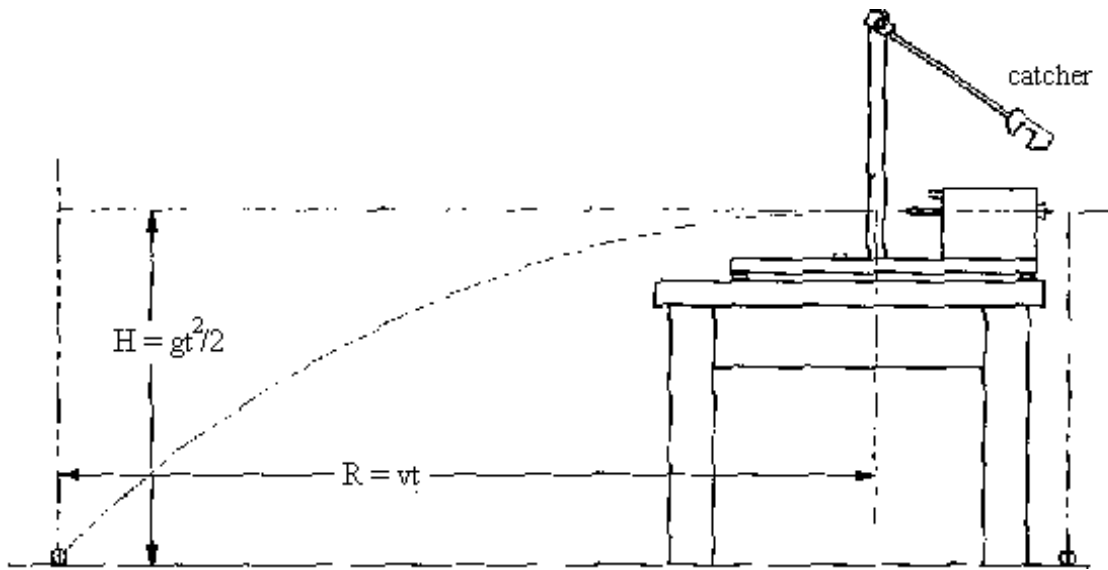


Figure 1

Part 1: Projectile Motion

The sphere will be projected horizontally and the horizontal distance it travels before striking the floor will be measured along with the sphere's initial vertical height above the floor. The sphere travels in a parabolic arc with a constant horizontal velocity and a constant vertical acceleration. The sphere is in the air for a time t during which it travels a horizontal distance R given by

$$R = v_1 t$$

where v_1 is the initial velocity of the sphere. The time the sphere is in the air is determined by the vertical motion governed by the constant acceleration equation

$$H = \frac{1}{2}gt^2$$

where H is the initial distance of the sphere above the floor and g is the gravitational acceleration. The first equation can be solved for t which can be substituted into the second equation and solved for v_1 to give

$$v_1 = \sqrt{\frac{gR^2}{2H}}$$

The values of R and H can be measured by the following procedure.

1. The ballistic pendulum should be set up at the end of a table as described at the beginning of this procedure. The tension adjustment should not be changed between this experiment and the next one.
2. Rotate the catcher away from the trigger assembly until it is resting on the top of the launcher and out of the launcher's line of fire. See Figure 1

3. Fire the sphere out **onto a clear area** on the floor to determine approximately where it will fall. **CAUTION: Use care when operating this device. Do not stand or place hands or body in the path of the projectile once the mechanism is armed.**
4. Fire the sphere onto the clear are and determine where the sphere lands. Measure and record in Table 1 the range R of the sphere. **CAUTION: Use care when operating this device. Do not stand or place hands or body in the path of the projectile once the mechanism is armed.**
5. Repeat the previous step until a total of five measures of horizontal distance are recorded from the end of the firing pin.
6. Measure the vertical distance from the bottom of the sphere when it is on the firing rod (but not when the firing mechanism is cocked) to the floor. Record this vertical distance H.

$$H = \underline{\hspace{2cm}} \pm \underline{\hspace{2cm}}$$

	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
Range R					
XXXXXX	XXXXXX	XXXXXX	XXXXXX	Average	
XXXXXX	XXXXXX	XXXXXX	XXXXXX	Std. Dev.	
XXXXXX	XXXXXX	XXXXXX	XXXXXX	Std. Error	

Table 1

Part 2: Linear Motion

The sphere will be projected horizontally again and the time it takes before striking the floor will be measured. The horizontal distance R is already known from part 1. The sphere travels in a parabolic arc with a constant horizontal velocity and a constant vertical acceleration. The sphere is in the air for a time t during which it travels a horizontal distance R given by

$$R = v_2 t$$

where v_2 is the horizontal/initial velocity of the sphere. The time the sphere is in the air is determined by measuring time it takes for the sphere to reach the floor. R & t and the equation above then determine the initial velocity v_2 .

7. Verify/Rotate the catcher away from the trigger assembly until it is resting on the top of the launcher and out of the launcher's line of fire. See Figure 1
8. Fire the sphere out **onto a clear area** on the floor to determine the time it takes to hit the ground after being fired. Measure and record in Table 2 the time t for the sphere to hit the floor. **CAUTION: Use care when operating this device. Do not stand or place hands or body in the path of the projectile once the mechanism is armed.**
9. Repeat the previous step until a total of five measures of time are recorded.

- c. Compare your results for v_1 and v_2 using your measured uncertainties. Are the two values statistically consistent with the same initial velocity? Comment as necessary.
2. In addition to the measured errors in the parameters H and R, a number of assumptions were also made in the equations. Both experiments neglected air friction. You can think of other assumptions. Make a list and describe how each would effect the calculated values of v.

3. In part 1, the following equation was used: $v_1 = \sqrt{\frac{gR^2}{2H}}$. Show the calculation for this equation.

V. Conclusions (include physical concepts and principles investigated in this lab, independent of your experiments success, and summarize without going into the details of the procedure.)