Name: _____ Section: _____ Date: _____

Worksheet - Exp 4: Projectile Motion Part 2

Objective: The objective of this lab is to measure the initial velocity of a projectile when fired from a spring gun horizontally (part 1) and to predict the landing point when the projectile is fired at a non-zero angle of elevation (part 2).

PROCEDURE

Part 1: Horizontal Launch ***($\theta_0 = 0°$)***

1. Ensure that the back edge of the spring gun is aligned with the back edge of the table.

2. Measure the initial height of the projectile above the ground. (5 points)

   $\Delta y =$ _____

3. As a group, choose the origin of your coordinate system. You will need to decide whether the origin is at the launch position or at the ground, and which direction is positive and which is negative. Record your decision below: (5 points)

4. Read this step and the next step before proceeding. When the spring gun is fired for the first time, you will need to note where the ball lands. This is the location for your target. The target is a sheet of white paper taped to the floor with a sheet of carbon paper placed on top. Do not tape the carbon paper.

5. When the flight path is secure, cock the spring gun to the third (long range) detent, then fire to determine the target location. Place the target.

6. Fire the spring gun four times and measure the distance the ball travels before landing for each trial and record in the table below.

7. Calculate the initial firing velocity for each measurement and record in the table below. **Each group member perform one calculation for initial firing velocity.** You will need to determine time of flight. Perform your calculations on separate paper and attach the the worksheet.

   Horizontal Fire Data (5 points)

Trial	x (m) (landing position)	v_0 (m/s) (initial velocity)
1		
2		
3		
4		

8. Find the mean (average value) and standard deviation of your range measurements. Show your work on your calculation paper. (Refer to the appendix for average and standard deviation calculations if necessary) (5 points)

   x = _____ ± _____ m

9. Find the mean (average value) and standard deviation of your initial velocity measurements. Show your work on your calculation paper. (5 points)

   v_0 = _____ ± _____ m/s

Part 2: Non-Horizontal Launch ($\theta_0 > 0°$)

10. Ask your TA to come adjust the launcher to a non-zero angle. Record the new firing angle below. (5 points)

    Θ = _____

11. Knowing the firing velocity and launch angle, predict the landing position of the projectile, show work on separate page. (15 points)

    x_{final} = _____

12. Repeat steps 4 through 6.

    Non-Horizontal Fire Data (5 points)

Trial	x (m) (landing position)
1	
2	
3	
4	

    x = _____ ± _____ m (5 points)

13. Compare the predicted landing position to the measured landing position. (5 points)

Predicted x_{final}(m)	Measured x_{final}(m)	Percent difference

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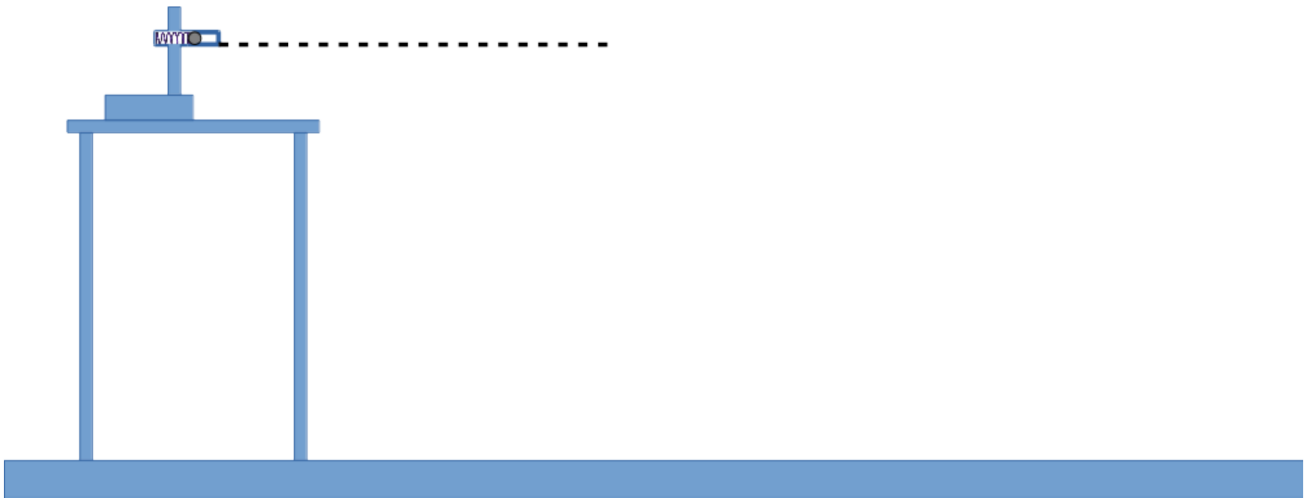
Extended Worksheet:
Projectile Motion Part 2

14. If we increased the angle of the projectile's initial velocity by a small amount ($< 5°$) from the angle you used in this lab:

    a) Would the range of the projectile increase or decrease? Explain. (5 points)

    b) Would the time interval between launch and landing increase or decrease? Explain. (5 points)

15. Does the range continue changing how you described in question 1(a) if we increase the angle of the projectile's initial velocity by a lot? Explain your answer by drawing trajectories for a projectile launched at 0°, 10°, 45°, 80°, and 90° above horizontal. (10 points)



16. A projectile is launched from a nonzero height H above the ground with an initial velocity of v_0 at an angle above the horizontal. (Write your answers in terms of H, v_0, θ, and g.)

    a) At what point in the trajectory is the projectile's speed minimum? What will be the projectile's speed at that point? (10 points)

    b) At what point in the trajectory is the projectile's speed maximum? What will be the projectile's speed at that point? (10 points)