# Work Sheet

Student Name: _____

Team members:
1.- _____ 2.- _____

3.- _____ 4.- _____

Instructor: _____

**Note:** *Please attach your plots for the analysis of each experiment.*

## Introduction

# Analysis

**Muzzle Velocity:**

1. From your measurements, calculate the average muzzle speed, $v_0$ for each of your range settings. Show your work.

2. Determine the components of the muzzle speed for each experiment.

3. For each experiment, Write the muzzle velocity as a vector.

**Launch Experiments:**

4. From the lab manual, solve equation (3.8) for time. **You will need to use the quadratic formula.** Show your work.

5. Use equation (3.7) from the lab manual and the expression for the time found in the previous question to obtain the theoretical range of the projectiles, $x - x_0$. Show your work.

6. Use your data and the previous result to determine the theoretical range for the first launch experiment. Show your work.

7. Compare by Relative difference the theoretical and measured range for the first experiment.

8. Were the effects of air friction noticeable? Explain.

9. For the parameters of your second launch experiment, determine the theoretical range $(x - x_0)$. Show your work.

10. Compare by relative difference your theoretical and measured range.

11. Were the effects of air friction noticeable for this experiment? Explain.

**Angle of Maximum Range**

12. Show that when launching and landing heights are the same, the theoretical range is given by

$$R = \frac{V^2}{g} \sin(2\theta), \tag{1}$$

where $V$ is the initial speed of the projectile, $g$ is the acceleration of gravity, and $\theta$ is the launching angle. *Hint:* use the identity $\sin(2\theta) = 2\sin(\theta)\cos(\theta)$.

13. Use the value of the muzzle speed for this experiment to make a plot of the theoretical range $R$ as a function of the launching angle $\theta$. Use a continuous black line for this plot.

14. Using square symbols, add your observed range values to your plot.

15. Does your data support the prediction that the maximum range is attained at 45°?

## Conclusion

(Write a short paragraph to explain what you have learned from the experiments. In particular, tell us if the theoretical predictions give you at least ballpark estimates for your observations? Refer to your plots and analysis as needed.)