

**Experiment #1**  
**PHYS 121L**  
**“Fire in the Hole!”**

**Goal:**

Cannon balls are expensive. Furthermore, their effectiveness directly depends upon the ability of the cannon master to accurately hit the target. In this lab you will learn how to accurately determine where a cannon ball will impact. In other words: the goal of this lab is to better understand how to apply the fundamental kinematic equations (A.K.A. “The Fantastic 4”) to two dimensions; particularly to the situation of a projectile motion.

**Equipment:**

Marble Cannon	Masking Tape
Packing Rod	“C” Clamp
Steel Marble	Spool of High Visibility String
Plastic Marble	Plenty of Scratch Paper
Meter Stick	Pencil and Calculator
Blank Paper x7	

**Procedure:**

**Part 1. Attack from above:**

1. Find the launch velocity:
  - a. Clamp the marble cannon to the edge of the table.
  - b. Set the cannon to launch at  $\theta=30^\circ$ .
  - c. Launch the steel marble off the table so that it lands on the floor at each of the three settings.
  - d. Carefully measure (using the paper (and the resulting dent), and a meter stick) the landing location.
    - i. Note the line of projection with the string and tape.
    - ii. Record the three landing locations
  - e. Using your knowledge of kinematics and planet earth, along with the measuring tools provided, find the launch velocities at each of the three settings.
    - i. Record you final simplified equation.
    - ii. Record your three resulting velocities.
2. Analytically (without launching any marbles) determine where on the floor the marble will hit the ground at each of the three settings when the launch angle is set to  $45^\circ$ .
  - a. Record your master equation that determines the landing location.
  - b. Record your three answers.
3. Using a target test your launching skills.
  - a. Draw a 5” circle with an ‘x’ in the middle on 3 pieces of paper.
  - b. Place the center of each circle at each of the three locations where you think the marble will land at each of the three cannon settings.
  - c. Prove your cannon expertise (show me your launches!)

- d. Your grade will directly reflect your ability to hit the target (the first time), so double-check each other's math!!

**Part 2. Attack on a level playing field:**

1. Choose a launch setting that will do the most damage to that target.
2. Determine the launch velocity of a plastic marble (it will be different than that of a steel marble).
  - a. Record that information.
3. Aim for the target.
4. Affix your cannon to the table.
5. You are allowed one shot "over the bows" to check your line of projection
6. Set the angle and launch velocity so that you utterly destroy the target!
  - a. Prove your cannon capabilities with two different launch angles at the same speed.
  - b. Again your grade is based on your accuracy.

**Part 3. (Bonus) Attack from below:**

1. This is the same as part 2 only your target must be higher than the cannon.
2. Again, find both angles of attack.
3. Prove your mastery of the cannon!

# Fire in the Hole!

## Data Sheet

Name: \_\_\_\_\_

### Part 1. Attack from above

Steel marble test launches ( $\theta=30^\circ$ )

Setting	$\Delta x$ (m)
1	
2	
3	

Simplified equation that solves for launch velocity:

Steel Marble Launch velocities:

Setting	Speed (m/s)
1	
2	
3	

Simplified equation that solves for landing location at  $45^\circ$ :

Three landing locations ( $\Delta x$ ) for steel marble launched at  $45^\circ$

Setting	$\Delta x$ (m)	Hit?
1		
2		
3		

### Part 2. Attack from a level playing field

Launch setting: \_\_\_\_\_

Launch speed: \_\_\_\_\_

Simplified equation that determines  $\theta$ :

How did you find the two angles that will hit the target, and list those two angles:

Was the target utterly destroyed? \_\_\_\_\_

