Physics 231: General Physics I **Names:**________________________
Lab 2 – Jan. 29, 2004 ________________________

Projectile Motion

In this lab, we will analyze the motion of a projectile. In an attempt to have a consistent initial velocity, we use a firing device (a dart gun). This initial velocity is found experimentally and used to calculate the range of the projectile. For a given range, we calculate the firing angle needed and test this calculation by firing the dart gun.

1. Prepare gun. Since later we will need to know the angle with which we are firing, we must find a way to measure that angle. We use a protractor taped to the side of the gun, with a plumb bob to measure the angle. First, construct a plumb bob attached to the protractor. Cut a piece of fishing line and run it through the hole in the straight part of the protractor. Make a knot to attach it, and be certain it lies straight. Tape a weight (like a penny) to the end of the wire and be certain this plumb bob is measuring the angle correctly as the protractor is tilted. Now, tape the protractor to the gun. If the person to fire the gun is right-handed, tape the protractor to the left side of the gun; for left-handers, tape to the right. Make sure the protractor is lined up with the direction the gun fires and that it does not block the trigger.

2. Find initial velocity. Set up a situation in which 3 quantities are known so we can take a measurement and use it to calculate the initial velocity. The acceleration due to gravity is known. If we then fire the gun straight up ($\theta=90°$), the final velocity is known ($v=0$ m/s) and we can measure the height the projectile reaches (Δy).

    a. **Pre-lab** Derive an equation for the initial velocity of the projectile as a function of the maximum height and acceleration due to gravity with the final velocity set to zero.

b. Take the gun outside and fire it straight up. Describe your method of measuring Δy and note your measurement. Be sure to repeat the measurement and take the average.

c. Plug your measurement from b into your formula from a to find the initial velocity.

3. Find the firing angle. You now want your projectile to land a certain horizontal distance from where you fire (Δx). At what angle do you fire it?

    a. **Pre-lab** Derive an equation for the firing angle as a function of the initial velocity and horizontal distance. Do you have to make any simplifying assumptions?

b. Ask your instructor for your value of Δx and note it in the blank: $\Delta x=$ ________

c. Calculate the firing angle.

d. Test your calculation by firing your dart gun at that angle. Place a target at the location you want the projectile to land. Do this several times. How close can you get to the target (don't count the bouncing of the dart)? Why can't you get any closer?

Pre-Lab #2 Name:______________________

a. **Pre-lab** Derive an equation for the initial velocity of the projectile as a function of the maximum height and acceleration due to gravity with the final velocity set to zero.

b. **Pre-lab** Derive an equation for the firing angle as a function of the initial velocity and horizontal distance. Do you have to make any simplifying assumptions?