**Dart and Pennies Lab**

**Purpose:**

Determine the relationship between mass and the velocity of a projectile when energy is conserved.

**Materials:**

dart, tape, dart gun, 6 pennies, meter stick, protractor, photo gate and labquest.

**Procedures:**

1. Determine the potential spring energy of a dart gun by calculating the muzzle velocity of the dart gun and measuring the dart’s mass. Apply the skills you learned from projectile motion to calculate muzzle velocity. Check your theoretical prediction using the photo gate.
2. Modify the dart by taping a penny to the front of the dart. Make a theoretical prediction regarding the new muzzle velocity. You will need to measure the mass of a penny for this step.
3. Make six theoretical predictions for muzzle velocity if an additional penny were added after each dart modification. Create tables to display your predictions and calculations.
4. After making a theoretical prediction for each new muzzle velocity, measure the actual velocities. To achieve this end, modify the dart an additional five times, adding a penny during each modification. Perform multiple trials for each modification. Create tables to display your collected data.
5. Calculate the percent difference between the actual and predicted muzzle velocities.

Percent Difference = ((predicted – observed)/predicted)\*100

1. Plot the actual velocities with respective masses on graph paper.

**Questions:**

1. What is the muzzle velocity of the dart gun?
2. What is the combined mass of the dart and piece of tape?
3. What is the potential spring energy of the dart gun in joules?
4. What is the kinetic energy of the dart just after it is launched?
5. According to the mass vs. actual velocity plot, what mathematical relationship exists between the two variables?
6. What are the potential sources of error in this experiment?

Bonus

1. Measure the depth at which the dart is embedded within the barrel. Given the spring energy calculated previously and depth embedded, what is the dart gun’s spring constant?