Physics 100 Names: ______________________________

Projectile Launcher Efficiency

**Pretend for this assignment that there is no air resistance! And pretend that $g=10m/s^2$

Question: Which will launch more efficiently from a rubber band-powered projectile launcher -- an oak projectile or a steel spherical projectile? [assuming that we stretch the rubber band an equal amount for each projectile]

Hypothesis [what do you think? Why?]:

Directions for the <u>Oak</u> Projectile:

1. Experiment with the launcher until you can launch the <u>oak projectile</u> vertically to a point that almost reaches the ceiling. Then collect (or determine) the following data:
2. Find the work done in cocking the launcher before firing (should be the same for both projectiles). To find this, you will need to measure the average force applied to the string as you cock the launcher.   You will also need to measure the stretch distance.
   a. Write down the "power setting" on the launcher – it measures how far you are stretching the string)
      Power setting = _________
   b. Use a spring scale to pull the string back to the launching point. Read the force, in Newtons. This is the maximum force.

      Maximum (ending) force = __________N
   c. What is the force at the very beginning of the stretching process?

      Minimum (starting) force = ________N

   d. Find the average force launcher force by averaging the starting and ending forces.

      Average force = ________ N

   e. Measure the distance that the string gets stretched (along the launch tube).

      Stretch distance = ________ m

   f. Calculate the work that went into stretching the band (W=Fd -- average force x stretch distance). This is the input energy.

      Work = _________ J = Input Energy

3. Prepare to shoot the projectile straight up. But first, measure its starting height in cm and convert that height to meters.

   Projectile starting height = _______ cm = _______ m

4. Shoot the projectile and measure the height it reaches.

   Projectile maximum height = _______ cm = _______ m

5. Use the starting and ending heights to calculate the change in height (Δh) of the projectile.
   Δh = ________ m

6. Measure the projectile mass, in grams, and convert it to kg.

   Mass = _______ g = ________ kg

7. Now calculate the potential energy gained by the projectile. You can use a version of the potential energy formula: PE = mgΔh. This is also the output energy.

   Potential Energy Gained = _______ J = Output Energy.

8. Now calculate the overall efficiency of the launcher, using the oak projectile. You can find input and output energies in #1f and #7.

   % Efficiency with Oak Projectile: __________

Now repeat all of those steps (except for #1) with the steel ball. Use the same power setting that you used for the oak projectile!

1. Skip
2.
   a. Power setting = _________

   b. Maximum (ending) force = __________N

   c. Minimum (starting) force = ________N

   d. Average force = ________ N

   e. Stretch distance = ________ m

   f. Work = _________ J = Input Energy

3. Projectile starting height = _______ cm = _______ m

4. Projectile maximum height = _______ cm = _______ m

5. Δh = ________ m

6. Mass = _______ g = ________ kg

7. Potential Energy Gained = _______ J = Output Energy.

8. % Efficiency with Oak Projectile: __________

Conclusion: