Conservation of Energy

Fall 2011

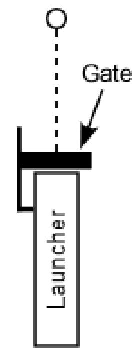
Introduction

In this experiment, you will show that the kinetic energy of a projectile fired vertically is converted into potential energy.

Theory

The total mechanical energy of a projectile is given by the sum of its potential energy, U, and kinetic energy, K. If no external force acts on the system, the total energy is *conserved*. When a projectile is fired vertically, the initial U is zero, and the kinetic energy $K = \frac{1}{2} m v_o^2$, where m is the mass of the projectile. When the projectile reaches its maximum height, h, the final kinetic energy is zero, and $U = mgh$. Conservation of energy tells us that the final potential energy equals the initial kinetic energy.

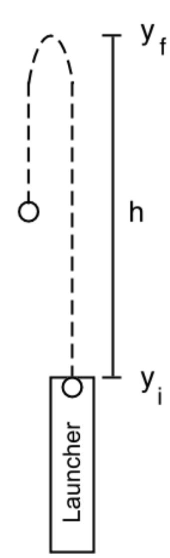
Experiment



I: *Initial kinetic energy:*

1. Measure and record the mass (in *grams* and *kilograms*) and diameter of the projectile. Use vernier calipers for your diameter measurement.
2. Secure the projectile launcher to the bench with a large clamp. Set the launch angle to 90^o (vertical).
3. Attach the photogate bracket to the launcher; keep the gate as close to the end of the launcher as possible (*why is this necessary?*). Set the photogate timer to *gate, 0.1 ms* mode.
4. Put the projectile into the launcher, and use the ramrod to set it to the ***short***-range position (any other setting will hit the ceiling!). Fire the launcher several times; the display shows the amount of time for the projectile to pass through a single photogate. Record the time for several trials (periodically check that the launcher angle does not change).

Observe caution when firing the projectile!!



5. Calculate the initial velocity of the projectile, v_o, from the diameter of the projectile, and the average of your times.
6. Calculate the initial kinetic energy of the projectile.

II: *Final potential energy:*

1. Remove the photogate, and place the launcher on the floor, next to the 2-*m* stick.
2. Adjust the 2-*m* stick so that a convenient mark (say, 10 *cm*), is aligned with the end of the launcher (*don't use the end of the meter stick!*). Call this position y_i.
3. Rest a pair of 2 *kg* masses on the base of the launcher (to help hold it in place). Again set the launcher to the ***short***-range position, and fire the projectile *at least 10 times*, recording the uppermost position of the top of the ball, y_f (do your best to estimate within 0.5 *cm*). Calculate the height of the projectile: $h = y_f - y_i$.
4. From the *average* height the projectile achieves, calculate the final potential energy.

Analysis

1. Calculate the percent difference between the initial and final energies of the projectile.

Discussion

- Summarize your energy results.
- Was energy conserved? What might have affected the results?
- Was energy gained or lost? Which would you expect to occur? Why?