LAB 8
Energy and Power

OBJECTIVES

(1) Observe mechanical energy as it transforms between kinetic and potential energy according to the law of conservation of energy:

$$KE_i + U_i = KE_f + U_f .$$

(2) Predict and experimentally measure physical parameters involving a simple pendulum and a spring-loaded launcher using the ideas of conservation of energy.

EQUIPMENT

Pendulum, laser timer, meter sticks, tape measures, calipers, spring-loaded gun, and stopwatches.

PROCEDURE

Part 1: Spring-Loaded Launcher

Use the same spring-loaded gun you used for the projectiles lab (Lab 7) so you know the initial speed of the launched projectile.

(a) Look up the muzzle velocity v_i you measured in Lab 7.

(b) Use the principle of conservation of mechanical energy to predict the max height y_{thy} in terms of the ball's muzzle velocity v_i and g.

(c) Place the launcher on the floor near a wall and measure the initial height of the ball just as it leaves the launcher. Tape a sheet of paper on the wall above the launcher and make a “prediction" mark at your predicted maximum height.

(d) Fire the ball and mark it's maximum height on the paper. Repeat this process 10 times and determine the average maximum height y_{exp} and standard deviation σ_y. Record your data into a table**.**

(e) Setup the confidence interval $y_{exp} \pm \sigma_y$. Is y_{hy} consistent within one standard deviation of the experimental measurements?

Part 2: Simple Pendulum

In this experiment, you will release a pendulum bob from rest and measure the time t it takes to pass through a photogate timer at the bottom of its swing. The bob has diameter d and is released from an initial height y_i above the level of the photogate

(a) Use the principle of conservation of mechanical energy to derive an equation for the speed v_{thy} of the pendulum bob at the bottom of the swing in terms of y_i and g.

(b) Use your equations for v_{thy} to derive an equation (in terms of d, y_i and g) for the time t_{thy} for the pendulum bob to pass through the photogate at the bottom of the swing. Measure the bob diameter d. and calculate t_{thy} for the pendulum released from an initial height of $y_i = 20$ cm.

(c) Release the pendulum from rest from a height $y_i = 20$ cm and measure the time with the photogate. Repeat this process 10 times and determine the average time t_{exp} and standard deviation σ_t. Record your data into a table.

(d) Setup the confidence interval $t_{exp} \pm \sigma_t$. Is t_{thy} consistent within one standard deviation of the experimental measurements?

(e) Use your formula Part (1b) to predict the release height y_{thy} that will give t = 0.0149 s.

(f) Once you have your predicted height, get the instructor to watch as you test out your prediction. The group that gets closest to t = 0.0149 s will receive a prize.

Part 3: Power Output

Find the time you need to run up the stairs; measure their height and your mass. You did work equal to mgh, in time t. The power is the work divided by the time. Convert to horsepower, using (*1 hp = 746 W*). *How many horsepower can you generate?*

NOTE

In all of these experiments, your results are less than perfect. Why???