LAB 9
Conservation of Energy

OBJECTIVES

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

$$K_i + (U_g)_i = K_f + (U_g)_f \,.$$

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

EQUIPMENT

Pendulum, laser timer, meter sticks, tape measures, spring-loaded gun, lab jack, track, and carts.

PROCEDURE

Part 1: 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 h_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 $h_i = 20$ cm.

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

(d) *Is your theoretical time consistent with your experimental results? Explain.*

(e) Use your formula Part (1b) to predict the release height h_{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 2: Spring-Loaded Launcher

(a) Use the photogate timer to measure the launch speed of your launcher when it shoots the ball straight upwards. Shoot the ball at least 10 times (record each time) and get an average time. From your average time, calculate the launch speed of your launcher.

(b) Use the principle of conservation of mechanical energy to predict the max height y_f in terms of the ball's launch speed 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 its maximum height on the paper. Repeat this process 10 times and determine the average maximum height $y_{f,exp}$ and standard deviation. Record your data into a table.

(e) *Are your experimental and predicted heights consistent? Explain.*

Part 3: Frictionless Inclined Plane

(a) Design a simple experiment to see if the potential energy a cart has at the top of a "frictionless" inclined plane is equal to the kinetic energy it has at the bottom on the plane. Write down a step-by-step procedure for your experiment.

(b) Use the principle of conservation of mechanical energy to predict the speed v_{thy} the cart has at the bottom of the inclined plane in terms of the cart's initial height y_i and g.

(c) Run the experiment at least 10 times and get an average speed and a standard deviation.

(d) *Are your experimental and predicted speeds consistent? Explain.*

NOTE

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