College Physics – Summer 2014

Lab 5: Exploring Energy

Goals: Gain more experience using a data logger with a motion detector to measure motion and kinematics data; Gain more practice using LoggerPro software; Gain more experience with graphical representations of motion; Calculate kinetic energy, potential energy, and mechanical energy for a bouncing ball and a vertical mass-spring system.

Equipment: Data collection will occur as a group using a motion detector, and then you will work at your own computer station.

Groups & Lab Notebook: Individual work. Update your Table of Contents. General Lab Notes guidelines apply (see Lab 2 handout).

Part 1: Data Collection

a) As a group, we will collect data using a motion detector for a bouncing ball and for a vertical spring-mass system.
b) Take notes on procedures and record any data collected separately from the LoggerPro files.

Part 2: Bouncing Ball Energy Analysis

a) Save the bouncing ball data file from the Handouts folder to your Cubbie.
b) Using Data: New Calculated Column, calculate a column for kinetic energy as follows:
   - for Name: Kinetic Energy
   - for Short Name: E_K
   - for Units: J
   - for Expression (or Equation), type in the formula for kinetic energy as follows, using the numerical value for the ball mass that we measured, and finding "Velocity" under Variable(Columns)>. Type the formula using this form: 0.5*mass*"Velocity"^2
   - Click Done when done
   - If you have a data table displayed, this may be added automatically; otherwise you might need to Display the column on the table
c) Similarly, calculate a column for Gravitational Potential Energy, with Name: Gravitational Potential Energy, Short Name: E_G, Units: J. You should be able to figure out the expression to enter (note that you will need to type in 9.8 and that the height of the ball is given by "Position").
d) Now, calculate a column for Total Mechanical Energy, with Name: Total Mechanical Energy, Short Name: E_tot, Units: J. You should find your previous calculated columns for Kinetic Energy and Gravitational Potential Energy in the Variable(Columns)> drop down menu.
e) Make three graphs: 1) Kinetic Energy vs. Time, 2) Gravitational Potential Energy vs. Time, and 3) Total Mechanical Energy vs. Time. Zoom your graph horizontally to show at least 3 good bounces and vertically to fill the white space.
f) Make a graph that shows each of Kinetic Energy, Gravitational Potential Energy, and Total Mechanical Energy (vs. Time) on the same graph. Zoom your graph horizontally as before (showing 3 good bounces). Also, make a version that shows just one region of time while the ball is clearly in the air (and away from the bounce events).
g) Copy (and label as needed) each of the 5 graphs to your Word document for later printing and inclusion in your lab notebook. Save this file to your Cubbie with a useful name.
h) Discuss with your instructor.

Part 3: Vertical Spring-Mass Energy Analysis

a) Save the vertical spring-mass data file from the Handouts folder to your Cubbie.
b) You will repeat the analysis exactly as you did for the bouncing ball.
c) What do you notice about Total Mechanical Energy, specifically contrasted with the case while the bouncing ball was in the air (away from any bounce events)?
d) See if you can account for Spring Potential Energy by calculating it and adjusting your Total Mechanical Energy to include it. This will be challenging.
e) Copy graphs, etc. Save file, etc.

Extension

From the ball bouncing data, plot E_tot vs. bounce number. Does the ball lose the same amount of mechanical energy after each bounce? Does it lose the same fraction of mechanical energy after each bounce? Can you find an equation that models the mechanical energy loss?