College Physics – Summer 2014

Lab 4: Force and Motion

Goals: Improve communication and teamwork capacities**;** Improve confidence in hands-on work with equipment; Improve ability to make, describe, and record observations; Learn to use a data logger with a motion detector to measure motion and kinematics data; Learn to use LoggerPro software to analyze kinematics data; Gain more experience with graphical representations of motion; Collect and analyze data for constant velocity and constant (non-zero) acceleration situations; Use Newton's 2nd Law to determine unknown forces and masses.

Equipment: You will be oriented to the set-up and proper use of the equipment for this lab.

Groups & Lab Notebook: Work in groups of 3. Update your Table of Contents. General Lab Notes guidelines apply (see Lab 2 handout).

Part 0: Getting Started

a) You will be oriented to equipment and today's investigation in the opening remarks.
b) One group member should log on to the computer. Make a folder in the program share Workspace named 'Lab 3 Name 1 Name 2 Name 3' as suitable for your group.
c) Set up the motion detector with a protective stop so that the cart doesn't crash into the detector or fall off the other end of the track.
d) By moving the cart along the track by hand, determine the detector's usable range and adjust the position/orientation of the detector as needed to get the most useful range.
e) Draw a sketch of your experimental set-up in your lab notebook.

Part 1: Constant Velocity Measurements (Spring Launcher Rebound)

a) As described in the equipment orientation, obtain several position vs. time graphs for motion where the cart is initially moving away from the motion detector, rebounds via the spring launcher and end-stop, and moves towards the motion detector. Save your best run named as Constant Velocities with Rebound.
b) You should be able to identify three regions on your graph of position vs. time and velocity vs. time: when the cart is rolling freely away from the detector; while the cart is rebounding and changing direction; and when the cart is rolling freely towards the detector. Adjust the display of your graph as described in the orientation to fill the graph with the data for these three regions of motion, making sure to represent the data as individual points.
c) Recall that on a **position vs. time graph**, **linear regions** represent **constant velocity**, with the velocity equal to the **slope** of the line. Determine and record the velocity (include sign and units) for the part of the run when the cart is rolling freely away from the detector. Also determine and record the velocity for the part of the run when the cart is rolling freely towards the detector. Take care not to include the rebounding phase in your highlighted regions.
d) Copy (and label) the graph including the two linear fits to your Word document for later printing and inclusion in your lab notebook. Save this file, named Constant Velocity, to your Workspace folder. Then, start a new LoggerPro file.

Part 2: Constant Force Scenarios

a) As described in the equipment orientation, obtain position vs. time graphs for motion where the cart is initially moving towards the motion detector, turns around, and moves away from the motion detector. As before, your goal is to obtain several position vs. time graphs for each of the following scenarios. For each scenario, name your best run with the scenario name.
   - Fan + Cart
   - Fan + Cart + 0.250 kg
   - Fan + Cart + 0.500 kg
   - Fan (half batterie) + Cart
   - Fan (half batteries) + Cart + 0.500 kg
b) For each scenario, display the **velocity vs. time graph**. Zoom in and display a region approximately centered on the turn-around point and make sure you are displaying the data as individual points.
c) Recall that on a **velocity vs. time graph, linear regions** represent **constant acceleration**, with the acceleration equal to the **slope** of the line. For each scenario, determine and record the acceleration.
d) Copy (and label) each velocity vs. time graph including linear fits to your Word document for later printing and inclusion in your lab notebook. Save this file, named Constant Force, to your Workspace folder.

Analysis

a) Use your data and Newton's 2nd law to determine the force of the fan (with all batteries) and the mass of the cart. Assume the force of the fan is constant for scenarios with the same number of batteries.
b) This cart-track system is designed to be low-friction. Low-friction is not the same as no-friction, however. Look closely at your data from the Part 2 scenarios and see if you can find evidence for the effects of friction. Use your data and Newton's 2nd law to determine the force of friction.