Physics 100

Lab 2: Acceleration

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Using the motion detector and computer as before, plus a cart and a ramp, you will study *change* in motion, or *acceleration*.

Activity 1: Set up the motion detector

Set up the motion detector the same way you did last week. Open the file Motion Detector.MBL.

To hand in for activity 1

Nothing.

Activity 2: Using the motion detector to analyze accelerated motion of a walking person

Using the motion detector, and watching the distance versus time graph (do not look at any other graphs yet) as you do it, have a member of your group make a distance versus time graph for the following motion:

- Move away from the detector, slowing down as you go,
- Come to a stop,
- Walk back toward the detector, speeding up as you go.

Make a printout of this distance versus time graph, and mark on it regions where you think the velocity was zero, negative, or positive. Then, with a different color ink, mark on it regions where you think the acceleration was zero, negative, or positive.

Now look at the velocity versus time graph for the same motion, and make a printout. How did your velocity estimates from the position versus time graph compare with what you see on the velocity versus time graph? Now mark on this graph where you think the acceleration was zero, negative, or positive. How do these compare with your acceleration estimates from the position versus time graph?

Lastly, look at the acceleration versus time graph for the same motion. Make a printout, and compare what you see with your predictions from the velocity versus time graph and the position versus time graph.

To hand in for activity 2

Position, velocity, and acceleration versus time graphs, marked as noted.

Activity 3: Using the motion detector to analyze accelerated motion of a cart on an incline

Set up a straight track and a cart, tilting the track so that it is at an angle, thus making a ramp. Put the motion detector at the bottom of the ramp, and give the cart a brief push at the bottom so that it rolls up the ramp away from the detector, and then rolls back down the ramp towards the detector. *At no point should the cart be closer than 0.5 m from the detector.* You will need to practice this a bit until you can dependably repeat it. (Don't let the cart smash into the detector!) Now, before pushing "Collect," draw, qualitatively, what you think the distance, velocity, and acceleration versus time graphs will look like for this motion. Discuss this amongst yourselves and don't continue until you all agree on what to expect. Do an "official take" of the motion by pushing "Collect," and compare the resulting position, velocity and acceleration versus time graphs with those you predicted. Resolve any discrepancies!

Do this for *at least* two angles, one very small angle (around 5°) and one larger angle (about 30°).

To hand in for activity 3

For each angle:

- Predicted position, velocity and acceleration versus time graphs,
- Actual position, velocity and acceleration versus time graphs.

Activity 4: Throwing a ball up in the air

Suppose I throw a ball straight up into the air (let's say up is positive) with an initial speed of 10 m/s, and assume that there is no air resistance. The ball will go up, momentarily come to rest, then fall back down into my hand. (Note that this motion is similar in many ways to that of the cart rolling up and then back down the ramp). Draw position, velocity, and acceleration versus time graphs for this motion. Note that, to do this correctly, you will need to calculate how many seconds until the ball reaches maximum height, and how many seconds to fall back to my hand. You will also need to calculate the maximum height reached. (Consult section 3.6 and Figure 3.12 in your textbook.)

To hand in for activity 4

Predicted position, velocity and acceleration versus time graphs.

Activity 5: A second look at the cart and ramp

Look at your actual acceleration graphs from activity 3. Is the acceleration exactly the same going up the ramp as down the ramp? If you see a difference, is it most apparent in the small angle graph or the large angle graph? Briefly explain your observations.

To hand in for activity 5

Brief explanation.