College Physics I

Lab 2: Acceleration

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Setting up the motion detector

Set up the motion detector the same way as last week. Open 03 Cart on a Ramp.cmbl. Experiment with clicking and dragging the boundaries of the three windows to adjust their sizes. When printing a graph out, use the "Print Graph" menu item, and make sure your graph fills the full screen.

Part 1: Accelerated walking motion

Make the distance versus time graph fill the screen, and get rid of the other two windows. Using the motion detector, and watching the distance versus time graph 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 click on the red "Position (m)" label on the vertical axis and select "Velocity" instead. Look at the result, which is 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, click on the vertical axis again and 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.

Important: I don't care whether your predictions are correct or not! I expect some mistakes, and I hope you will learn from those mistakes. So I never penalize getting a prediction wrong. When your predictions don't match what happened, however, I expect you to make note of the mismatch, and give me your best short explanation of what you think happened. Show me that you've learned something.

To hand in for part 1

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

Part 2: Accelerated cart motion

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. Note that you only care about what happens during the time the cart is not in contact with your hand, and is freely going up and down the ramp. (Ignore what happens during the push and the catch.) Discuss your predictions amongst yourselves and don't take data until you all agree on what to expect. Then push "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 and one larger angle. (You need not measure the angles.)

To hand in for part 2

For each angle:

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

Part 3: Throwing a ball up in the air

Suppose you throw a ball straight up into the air (let's say up is positive) with an initial speed of 9.80 m/s, and assume that there is no air resistance. The ball will go up, momentarily come to rest, then fall back down into your 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. To do this correctly, you will need to calculate how many seconds it takes until the ball reaches maximum height, and how many seconds to fall back to your hand. You will also need to calculate the maximum height reached.

To hand in for part 3

Predicted position, velocity and acceleration versus time graphs.

Part 4: A second look at the cart and ramp

Look at your actual acceleration graphs from part 2. Is the acceleration exactly the same going up the ramp as down the ramp? Briefly attempt to explain your observations. (You do not need to get it exactly right; go ahead and speculate. Feel free to talk with me about your ideas.)

To hand in for part 4

Brief explanation.