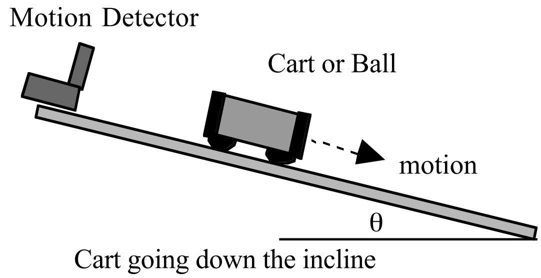
Going Downhill – Comp.

Introduction:



This lab will serve as an introduction to some of the processes and features you will use in the next few weeks of your physics class as you study how the world works in more detail.

In the diagram, a dynamics cart or a ball is released to roll down an inclined plane. Ultrasonic chirps from the Motion Detector are used to track the resulting motion and the graphs that follow provide a picture of the motion.

In this version of the lab, you will employ a computer to acquire the data, to display the graphs and to analyze the graphs.

Purposes:

- Study the motion of an object rolling down an incline.
- Learn how to use the data collection hardware and software.

Equipment:

Macintosh or PC computer, inclined plane (ramp or dynamics track), laboratory cart or ball, protractor, Go! Motion or Motion Detector and LabPro.

Setup:

1. Set up the inclined plane or dynamics track as shown above with an angle of approximately 2^o.
2. **LabPro:** Connect the Motion Detector to one of the Dig/Sonic ports on the LabPro, power up the LabPro either with batteries or with the external power supply, then connect the LabPro to your computer using a USB cable.
   -OR-
   Go! Motion: Connect the Go! Motion directly to your computer using a USB cable.
3. Launch *Logger Lite* or *Logger Pro* as directed by your instructor. Note that Logger Lite must be version 1.4 or higher to utilize the curve fitting feature.
4. The default data collection scheme is 20 samples/s for 5 seconds. You should also see both a position vs. time and velocity vs. time graph on the screen. To change this setup:
   a. *Logger Pro*: click on the "stopwatch" icon; *Logger Lite*: click on **Experiment > Data Collection**
   b. On the screen that appears, replace the 5 for length with 3
   c. Press [Done]

Procedure:

1. Set the cart or ball on the incline so it is at least 15 cm away from the Motion Detector or Go! Motion. [This distance must be at least 50 cm if your Motion Detector has an older blue case.]

2. Initiate data collection by clicking the green Collect button. When clicks are heard coming from the Motion Detector or Go! Motion, release the cart or ball to roll smoothly down the incline. Go to the **Analysis** section.
3. When you have completed your analysis with one angle, repeat for a different angle if asked by your instructor.

Analysis:

1. Examine the position vs. time graph. You should have one section that is smoothly curved beginning at your starting distance and going to the end of the incline. Focus your attention on this section.

    In ***Logger Pro***, you can click and drag the cursor so the shaded area encompasses just the section you wish to work with. Then click on the magnifying glass icon to zoom to just that portion of the graph. In ***Logger Lite***, you can click and drag the cursor so the shaded area encompasses just the section you wish to work with. Then go to **View** > **Zoom Graph In** to zoom to just that portion of the graph.
2. Describe the shape of the graph line. Is the curvature uniform, or does it curve more rapidly either at the beginning or at the end? Which? What does this tell you about the motion of your cart or ball?
3. ***Logger Pro:*** Click and drag your cursor across the smoothly curved section of your graph. Click on the Curve Fit icon (two to the left of the green Collect button. On the screen that appears, go down the column of options and click on the button next to "Linear". Click the [Try Fit] button. Notice how *Logger Pro* makes the best fit straight line it can through the data, but the fit isn't particularly good. You can check your curve fits quickly and easily with this visual tool.

    Logger Lite: Click and drag your cursor across the smoothly curved section of your graph. Go to **Analyze** > **Linear Fit**. Notice how *Logger Lite* makes the best fit straight line it can through the data, but the fit isn't particularly good. You can check your linear fits quickly and easily with this visual tool
4. ***Logger Pro:*** Now click on the button to the left of "Quadratic" then click the [Try Fit] button. The black line is the best fit the computer can make with your data. How well does it fit? Now click on [OK] to return to the main graph. Note that you are given the coefficients **A**, **B** and **C** in $\mathbf{At^2 + Bt + C}$. Record these values in the data table in these instructions.

    Logger Lite: This analysis is not available in *Logger Lite*.
5. Examine the velocity vs. time graph. You should have one section that is smoothly changing beginning from nearly 0 m/s to some maximum. Describe the shape of the graph line. Is the value constant, or does it change over the course of the run? Which portion has the larger value, the beginning or end of the run? What does this tell you about the motion of your cart or ball?
6. For your velocity vs. time graph, repeat step 3 above. How well does a straight line fit with the data you collected? If it fits well, click [OK] to return to the main graph. Note that you are given **m** and **b** in $\mathbf{mt + b}$. Record these values in the data table in these instructions.
7. According to theory, your coefficient A is 1/2 of the acceleration. Based on this, what is the acceleration, $\mathbf{a_1}$, of your cart or ball?
8. The slope of a velocity vs. time graph is the acceleration. Based on the velocity graph, what is the acceleration, $\mathbf{a_2}$, of your cart or ball?

9. Compare the two values you obtained for acceleration by calculating the percentage difference:

   % difference = |difference| / average = $|a_1 - a_2| / (1/2\,(a_1 + a_2))$

Data Table:

Quantity	Units	Run 1	Run 2
Angle, θ			
Position Graph **A**			
B			
C			
a_1			
Velocity Graph **m**			
b			
a_2			
% Difference	**---**		

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