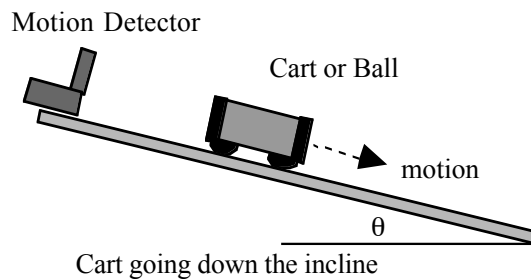


Going Downhill – LQ

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 LabQuest 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:

Inclined plane (ramp or dynamics track), laboratory cart or ball, protractor, Vernier Motion Detector and LabQuest.

Setup:

1. Set up the inclined plane or dynamics track as shown above with an angle of approximately 2° .
2. Connect the Motion Detector to your LabQuest, plugging it into one of the DIG ports.
3. Launch *LabQuest app* by pressing the silver button at the top of LabQuest to power up the LabQuest unit.
4. The default data collection scheme is 20 samples/s for 5 seconds as shown in the data collection rectangle on the right side of the **Sensor** screen. To change this:
 - a. Tap on the data collection rectangle; a new screen will pop up
 - b. Tap and drag across the 5 to change the collection time
 - c. A keyboard will pop up; tap 3 then [OK]

Procedure:

1. Set the cart or ball on the incline so it is at least 15 cm away from the Motion Detector. [This distance must be at least 50 cm if your Motion Detector has an older blue case.]
2. Initiate data collection either by tapping the Collect button on the screen or pressing the Collect button on the front of the LabQuest. When clicks are heard coming from the Motion Detector, 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.

On the graph, tap and drag so the shaded area encompasses just the section you wish to work with. Then use the menu: **Graph > Zoom In** to zoom in 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. **Linear Fit:** Tap on **Analyze > Curve Fit > Position**. On the screen that appears, tap on **Choose Fit > Linear**. Notice how LabQuest draws 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.
4. **Quadratic Fit:** Tap on the drop-down arrow where you previously tapped on Choose Fit. Choose **Quadratic** from the menu. The black line is the best fit LabQuest can make with your data. How well does it fit? Note that you are given the coefficients **A**, **B** and **C** in $Ax^2 + Bx + C$. Record these values in the data table included with these instructions. Tap on [OK] to return to the main graph.
5. Examine the velocity vs. time graph. 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 only choosing **Analyze > Curve Fit > Velocity**. How well does a straight line fit with the data you collected? If it fits well, note that you are given **m** and **b** in $mx + b$. Record these values in your data table. Tap on [OK] to return to the main graph.
7. On the position graph, according to theory, the coefficient **A** is 1/2 of the acceleration. Based on this, what is the acceleration, **a₁**, 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, **a₂**, of your cart or ball?
9. Compare the two values you obtained for acceleration by calculating the percentage difference:

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

Saving Data:

Save to LabQuest

- Tap on **File > Save**.
- Tap and drag across "untitled" in the Name space.
- Type in a name for your data file then press [Save].
- Only do this if your instructor tells you to save your data in this way.

Save to USB drive

- Insert your USB drive in the USB port on LabQuest.
- Give LabQuest a few seconds to recognize the drive, then tap on **File > Save**.
- Tap on the icon identified as USB to direct saving to the thumb drive.
- Tap and drag across "untitled" in the Name space.
- Type in a name for your data file then press [Save].
- Only do this if your instructor tells you to save your data in this way.

Data Table:

Quantity	Units	Run 1	Run 2
Angle, θ			
<u>Position Graph</u>			
A			
B			
C			
a₁			
<u>Velocity Graph</u>			
m			
b			
a₂			
% Difference	---		

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June 2007