

Introduction to Motion I

Objectives

In this lab you will learn how to

- collect data using the Vernier LabPro™ computer-based data acquisition system.
- measure the displacement, velocity, and acceleration of a glider along an air track using the Vernier Motion Detector.
- plot your data and analyze it using the Vernier Logger Pro™ software.

Equipment

Air track (with air supply), glider, Vernier Motion Detector (with clamp), Vernier LabPro system (includes computer and Logger Pro), small stand, and a ruler.

Theory

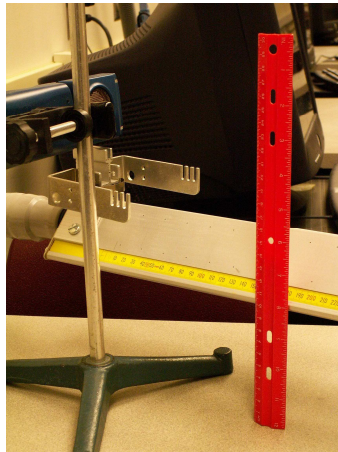
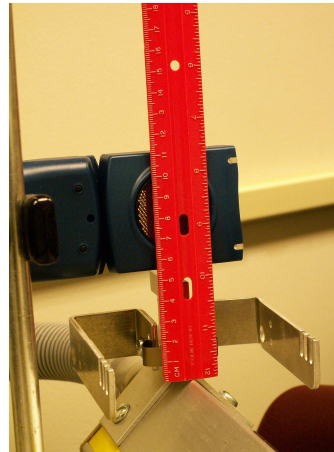
The *displacement* of any particle traveling between two points along the x axis is defined as $\Delta x = x - x_0$ where x_0 is its initial position and x is its final position. Logger Pro refers to displacement as “position” and measures it in meters. The *velocity* v of the particle is defined as the instantaneous rate of change in its displacement. (measured in m/s). The *acceleration* a is defined as the instantaneous rate of change in its velocity (measured in m/s^2).

Procedure

Preliminary Set-Up

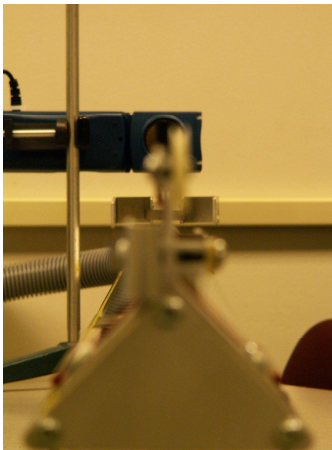
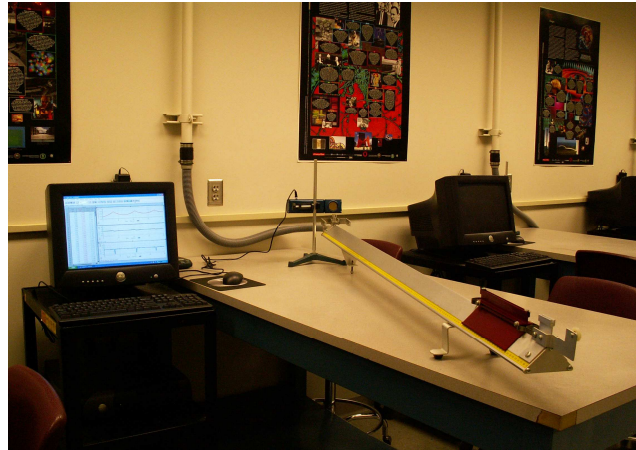
- 1) Use the adjusting knob to lower the end of the air track that is connected to the air supply. The bottom of the track at the 15-cm mark (along the track measuring tape) should be 10 cm above the table top (Photo 1).
- 2) Turn on the air supply then place the glider on the air track. The glider should accelerate smoothly down the sloped track.
- 2) Make sure that LabPro is connected properly to the motion detector (at the DIG/SONIC1 port) and to the computer. Unfold the detector and clamp it horizontally to the ring stand. Move the entire assembly to the end of the track that is closest to the computer. The gold sensor must face the track. Position the center of the sensor between 2 to 6 cm above the air track and in line with its 0-cm mark (Photo 2). Tilt the motion detector so that it is angled slightly away from the air track toward ceiling. Adjust until you get a good reading.

The motion detector emits ultrasound waves from the gold sensor in a 30° - 40° cone. Any object within this cone is detected when the waves “echo” back to the detector. The detector is tilted in order to avoid picking up any extraneous motions from you or your partners – a potential source of systematic error!

**Photo 1****Photo 2**

3) Click the Logger Pro icon on the desktop of your computer. Click the **Collect** button in the upper right corner of the screen. A clicking sound indicates that the motion detector is active. Wave your hand in front of it as you watch Logger Pro plot its position and velocity graphs. If you do not hear the clicking, check whether your LabPro is connected properly and try again. If this fails, ask your lab instructor for help.

4) Create a small “flag” to attach to the end of glider closest to the detector. Adjust the orientation of the detector so that the flag completely covers the gold sensor as you look through the groove at the end of the air track (Photo 3).

**Photo 3****Photo 4**

4) When you open Logger Pro, only two graphs (position and velocity) will be shown. Pull down the **Insert** menu and select **Graph**. A third graph (acceleration) will pop out. Resize all three graphs so that your display resembles that of Figure 1. Click on the title of the y axis in each graph and change it to *position*, *velocity*, and *acceleration*. Change the title of all x axes to *time*. Click the **A** button to automatically rescale the axes.

5) Finally, click the clock button (collection parameters) and enter 20 sec in the **Length** box. You are now ready to begin the experiment (Photo 4)!

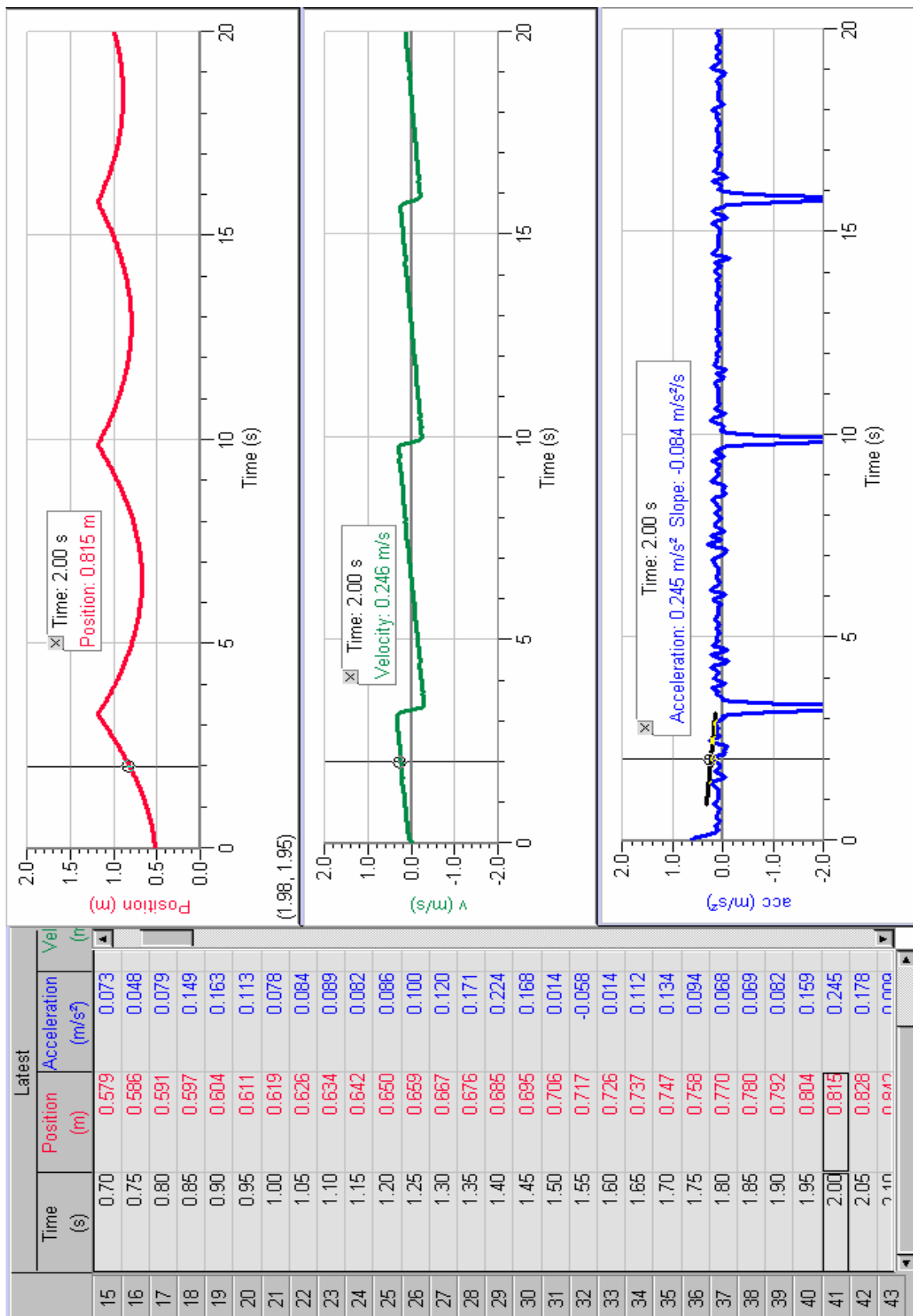



Figure 1 – Vernier Logger Pro data table and motion graphs

Data Collection and Display

1) Hold the glider 40 cm from the detector and release it one second after clicking the **Collect**  button. If your graphs are jittery, adjust the detector and/or the air track until your position graph shows at least 3 peaks and 3 valleys as in Figure 1. Answer the questions in Part I of your data sheet.

2) Click the **X=** button to display the coordinates of a specific point on a graph. Answer the questions in Part II of your data sheet.

3) Go to the **File** menu and select **Print Graph** for each of your graphs. Do not click the printer button – you will be printing whatever is currently displayed on screen! Choose a unique group name for the header of your print-outs so that you can easily identify them in the pile at the printer. Be sure to select the correct printer (such as HP 3500N) using the **Printer Option** folder before you click **OK**.

Data Storage and Retrieval

Save your best data under your group name in a file on the desktop of your computer. You can retrieve and replay your stored data when you pull down the **Analyze** menu and select **Replay**.

Each student is required to submit a completed data sheet in order to receive full credit. Your lab group needs to submit only one set of motion graphs (one position, one velocity, one acceleration). These three graphs are to be stapled to the data sheet of one of your lab partners – each lab partner does not need to submit his/her own set of graphs.

Data Sheet - Introduction to Motion I

Name _____

Date _____

Partners' Names _____

Part I – Qualitative Questions

- 1) What is the velocity of your glider at the peaks in your position graph? What is the position of your glider on the track at these instants?

- 2) What is the velocity of your glider at the valleys in your position graph? What is the position of your glider on the track at these instants?

- 3) Describe the motion of your glider on the track as it travels from a peak to a valley in your position graph.

- 4) Describe the motion of your glider on the track as it travels from a valley to a peak in your position graph.

- 5) At which points in its motion does the glider achieve maximum velocity *toward* the sensor? Why?

- 6) At which points in its motion does the glider achieve maximum velocity *away from* the sensor? Why?

- 7) At which points in its motion does the glider achieve exactly zero velocity? Why?
- 8) At which points in its motion does the glider achieve maximum negative acceleration? Why?
- 9) Does the glider ever achieve constant velocity (Yes/No)? Explain your answer.
- 10) Does the glider ever achieve constant acceleration (Yes/No)? Explain your answer.

Part II – Quantitative Questions

Measure the following values from your graphs.

Position Graph	Time (sec)	Position (m)	Velocity (m/s)	Accel (m/s^2)
Peak 1				
Valley 1				
Peak 2				
Valley 2				
Peak 3				
Valley 3				
Peak 1 to Peak 2	XXXXXXXX	XXXXXXXX	XXXXXXXX	
Peak 2 to Peak 3	XXXXXXXX	XXXXXXXX	XXXXXXXX	

- 1) As you inspect your velocity data (column 4 above), can you conclude that the velocity is constant? Explain your answer.
- 2) As you inspect your acceleration data (column 5 above), can you conclude that the acceleration is constant? Explain your answer.