

# Experiment 2: Motion: Uniform and Non-Uniform



Figure 2.1: Experimental Setup

## *EQUIPMENT*

Lab Pro Interface and USB Chord  
Motion Detector  
Power Supply  
Basketball

**Advance Reading**

*Text:* Uniform motion, non-uniform motion, graphical representation of motion, position, displacement, distance, velocity, speed, acceleration, kinematic equations, slope of a line.

*Lab Manual:*

*Appendix B: COMPUTERS and SOFTWARE*

**Objective**

To qualitatively analyze the kinematic equations by graphing a student, then objects, in motion; to enhance graph analysis and graphing skills.

**Theory**

*Kinematics* is the description of how objects move. An effective method of describing motion is to plot graphs of distance, velocity, and acceleration *vs.* time. Using a motion detector and computer software, your motion as you move around the room will be graphed. Qualitative analysis of these graphs will help your develop a better understanding of the concepts of kinematics and enhance your graph analysis skills.

Definition of terms:

**Distance** is the length of the path traveled.

**Displacement** is the change in position.

*Example:*

Your friend lives on the north side of Memphis, 100 miles from Ole Miss. You visit your friend and return to Ole Miss. Let's assume towards Memphis is the positive direction of our coordinate system.

Your traveled a *distance* of 200 miles.

Your *displacement* from Ole Miss to Memphis was +100 miles.

Your *displacement* from Memphis to Ole Miss was -100 miles.

Your total *displacement* was 0 miles.

**Speed** is the distance traveled/total time traveled

**Velocity** is displacement/time

*Example:*

You drove for 2 hours to visit your friend and 2 hours on the return trip to Ole Miss.

Your *average speed* was 50 mph.

Your *average velocity* from Ole Miss to Memphis was +50 mph.

Your *average velocity* from Memphis to Ole Miss was -50 mph.

Your *average velocity* for the entire trip was 0 mph.

**Acceleration** is the change in velocity/change in time. It can be either positive or negative.

*Note* that linear graphs (straight lines) are analyzed with the *slope-intercept* equation of a line:

$$y = mx + b \quad (2.1)$$



**PROCEDURE****PART 1: Position vs. Time**

1. Turn on your computer; connect the Lab Pro and motion detector device.
2. Open the Logger Pro software.
3. Find and open the file title “01a Graph matching.” Applications  $\Rightarrow$  Logger Pro 3  $\Rightarrow$  Experiments  $\Rightarrow$  Physics with Vernier  $\Rightarrow$  01a Graph Matching
4. Stand in front of the motion detector, with plenty of room to walk in front of it. Push “Collect” to begin collecting data and move towards/away from the detector however you like. Watch your measured distance as it is recorded onscreen; try to adjust it with your motion. Remain at least 0.5 meters from the motion detector at all times.
5. Print this graph with your name on it; select File  $\Rightarrow$  Printing Options and enter your own name.
6. Have your partner create his or her own graph and print it.

**PART 2: Position vs. Time Graph Matching**

7. Open 01b and choose one partner to reproduce it. Begin collecting data and match the position graph as closely as possible with your own motion.
8. Print the graph with your name on it once you have achieved a satisfactory graph.
9. Have your lab partner match 01c similarly and print the result.

**PART 3: Velocity vs. Time Graph Matching**

10. Open the file 01d. Push “Collect” and match the graph with your own velocity as closely as possible. Print the resulting graph.
11. Similarly, have your lab partner attempt to match 01e and print it.

**PART 4: Bouncing Ball**

12. Open the file titled “02 Ball.”
13. Hold the motion detector at shoulder height, pointing down to capture the motion of the ball.
14. Drop the ball beneath it and record its motion through four full bounces.
15. Adjust the scale to show exactly four bounces on the screen.

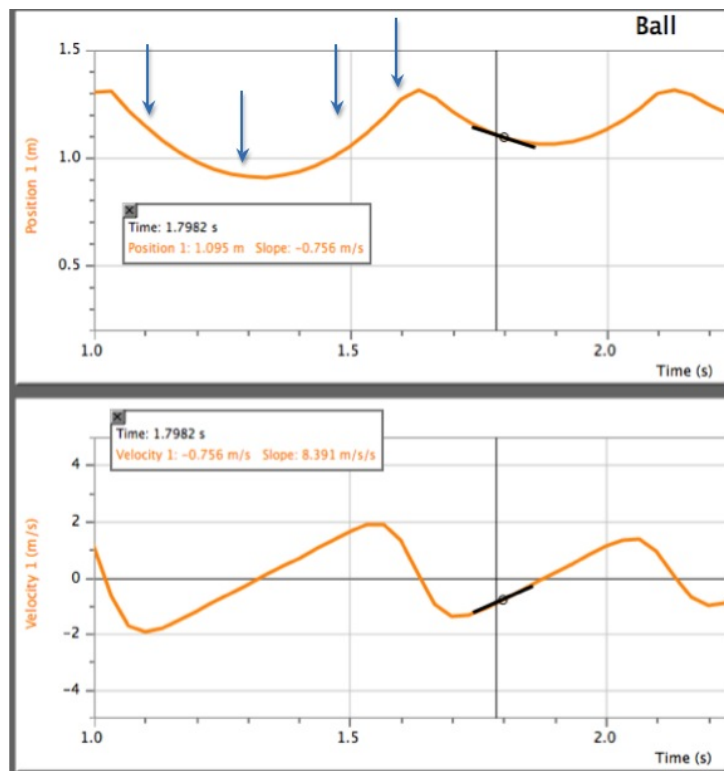


Figure 2.2: Position and velocity graphs of a bouncing ball. Note that the shape of the bounce appears to be inverted.

16. On the velocity graph, click and drag to select a section that appears to be a straight line with a positive slope (*i.e.* the ball is in the air). Use the *Linear Fit* button to obtain a linear fit for this segment of the graph. Repeat for each bounce, for a total of four segments. Print a copy for each lab partner, labeled with both of your names.



17. Use the *Examine* and *Tangent* buttons to determine position, slope, and time on both the position and velocity graphs. Take these measurements at four locations: traveling upwards, near the top, traveling downwards, and near the bottom (indicated in Fig. 2.2).

