Name: _____ Unit II
Mr. Willis Motion (Velocity/Acceleration) **II**
Conceptual Physics: _____ Need extra help?
Date: _____ Check out *http://www.bayhicoach.com*

Free Fall Lab

In this experiment you will use the motion sensor to analyze the motion of a bouncing ball. From your graphs, you will study the relationships between the position, velocity, and acceleration of the ball, and you will measure the acceleration due to gravity.

1. Before doing the experiment, let us predict what will happen. First we'll use words. Release your golf ball from a height of about 1 meter above the table, and observe it as it bounces several times. Then describe in words, as completely as you can, the motion of the ball.

2. A graph is a good way to communicate information about motion. Sketch a graph of the position of the ball versus time for the motion you described in part 1.

3. Now we'll compare your prediction to experiment. Mount the motion sensor on a stand a meter or so above the table. Orient the sensor so that the ultrasonic beam will be projected downward. Set the trigger rate to 50 on the GLX Datalogger.

4. Now record the motion of the ball as it is dropped from about 20 cm below the motion sensor onto the table. Try to record the motion of the ball as it bounces at least three times. You may need to attempt this a few times. If the ball drifts out of the ultrasonic beam as it bounces, the sensor will not detect its motion. What differences and similarities do you observe between the measured position and your predicted graph? Can you explain the differences?

5. Now we want to think about the velocity of this ball.

(a) Sketch what you think the velocity versus time graph will look like. Compare your description with your partner's, and try to reach a consensus.

(b) What is the relationship between the position and velocity graphs?

6. Press the F4 key to select two graphs. Then, change the y-axis on the lower graph to Velocity (using the Check button) so that you have simultaneous plots of position and velocity. Click the button on the menu bar to align and match the horizontal axes of the graphs. Does your velocity graph look the way you expected? Explain any differences you see.

7. Now predict, and sketch below, what you think the acceleration graph will look like. As usual, be as complete as you can. Compare with your neighbors, and try to reach a consensus.

8. Use the Check button to change to bottom graph to Acceleration as you did with velocity in part 6, and see if your prediction was correct. Discuss any differences you observe.

Going Further

9. Let us describe these graphs mathematically. Look first at the standard equations for a body in freefall, to see how you might determine the acceleration of the ball from these equations. Select a time

interval *between* bounces; highlight those data points. Fit the position data to a quadratic equation and determine the acceleration of gravity from your fit parameters. Do this by clicking on the small "Fit" button and choosing quadratic. Likewise, fit the velocity data between bounces to a linear equation and determine the acceleration of gravity. Now find the average acceleration of the ball during this time interval from the acceleration graph. *[To find the average of a set of data points, click on the "S" button and choose "mean."]* Record your three results (values for "g") below.

Position graph:

Velocity graph:

Acceleration graph: