Lab A3alt: *ACCELERATION of a BASKETBALL* 8/29/2001

Goal: To investigate the position, velocity and acceleration of a basketball tossed into the air, to test Galileo's theory of gravity, and to measure the local gravitational field of the earth.

Pre-lab: In this lab, you will toss a basketball in the air above a motion detector and measure the height and velocity of the ball as a function of time. Find the following:

- The functional form relating the height of the ball as a function of time.
- Draw a graph of your prediction of the height as a function of time.
- The functional form relating the velocity of the ball as a function of time.
- Draw a graph of your prediction of the velocity as a function of time.

Prepare the pre-lab individually as you would a homework assignment. Show your work.

ISet-up: (Note: A lab assistant may have already done this for you.)
Plug in the motion detector to the LabPro, and start LoggerPro
Go to the following pull-down menus:

- Setup --> Data Collection --> Sampling
    - o Time of experiment should be changed to slightly more than you found in the pre-lab.
    - o Sampling should be about 20 samples/second
- View --> Graph Layout
    - o One Pane
- View --> Graph Options
    - o Turn ON Point Protectors
    - o Turn OFF Connecting Lines (why?)
    - o Give it a good title like "The Height of a Basketball as a Function of Time"

Verify now that you have one distance vs. time graph of the appropriate range in time and no other graphs on the screen.

II Data Collection: Place the motion detector on the floor or a lab bench. Take data, and verify that it is measuring the height of the ceiling, and that the data are represented as points without connecting lines.

Now, hold the ball above the motion detector, toss it into the air, and catch it while taking data. Make sure you catch the ball, or you will be buy yourself a broken motion detector! Are the data as expected? Compare with your predictions. Make sure that you explain the following from this graph:

- When was the ball tossed?
- When was the ball caught?
- When was the ball in the air?

** CHECK POINT #1: Make sure you can discuss this with each other, call over the instructor or TA.

III Analysis of the Position data:

Go to "Analyze-->Curve Fit" or push the "f(x)" button.

- Select those data that you believe to represent when the ball was in the air, without your touching it. Think carefully.
- Select the appropriate function (remember the pre-lab), and try the fit. Assuming it all works out, push "OK" and place the box somewhere nice on your graph. Print out your graph.

Now write down your physics and math equations, including a translation table. Which fit parameters do you expect to change with a different toss, and which do you expect to remain the same? Why?

Now toss the ball and fit the "theory curve" again. Were you correct? Did the parameters you thought would stay the same with a second toss do so? Why, why not?

Report the acceleration of the ball while it was in the air? Does this value agree with the accepted value of 9.8 m/s^2 downward? Find the percent different between your value and the accepted value.

** CHECK POINT #2

IV Analysis of the Velocity Data

Review your prediction of velocity as a function of time. Do you still agree with yourself? Do you and your lab partner agree? What do you predict the acceleration will be at the top?

Click on the vertical axis label to change the graph from "distance" to "velocity"

Click on the vertical axis to manually scale the graph so your good data use the whole space.

Consider changing the title of the graph to something relevant.

Now investigate the acceleration of the ball using the tangent line button.

What is the ball's acceleration when:

- You are throwing it
- It is going up
- It is at the top
- It is going down
- You are catching it

How do these data compare with Galileo's theory? Which are relevant?

** Check Point #3: Make sure you all agree, and call over your instructor or TA.

Now it is time to fit a "theory curve" to the velocity data. Fit the appropriate function to only those data what Galileo's theory is applicable. Print out your graph when you are happy with it.

Make another clear translation table between your math and physics equations.

Are the data consistent with Galileo's theory? Why, why not, and to what degree?

What is the acceleration of the ball while it is in the air?

- Is this consistent with your prior results in part III?
- Is this consistent with the book value of 9.8 m/s^2 for the *Gravitational Field of the Earth*.

What was the velocity of the ball just after leaving your hand?

What was the velocity of the ball just before catching it?

What is the theoretical relationship between these two values? Show your work to derive this, showing your math equations.

Find the % difference between the two speeds. (note: use the average for the denominator, why?)

**Check Point #4: Have your TA check your lab before you go.

Summary:

Include a concise summary/conclusion to your lab, as always. Remember this is much like an abstract.