

Name: _____ Date: _____ Block: _____

Calculator Lab: Graphing Projectile Motion

Physics

Objective: Graphing calculators are excellent tools to visualize the movement of an object. In this exercise, you'll use a graphing calculator to show vertical motion of a projectile as it changes with time. Through this work, you'll also gain familiarity with the functionality of your calculator.

Materials:

- TI-83 or TI-84 Graphing Calculator

Discussion:

We have learned to make calculations of time and displacement for a projectile using our equations for motion in the x - and y - directions. For this lab, we will use only the vertical displacement and the equation is shown below.

$$y = v_{yi}t + \frac{1}{2}gt^2$$

$$\text{where: } v_{yi} = v \sin \theta \quad \text{and} \quad g = -9.8 \frac{m}{s^2}$$

In this exercise, we want to analyze the relationship between the vertical displacement of the projectile and elapsed time. You'll produce a graph with time on the horizontal (x - axis) and vertical displacement on the y - axis.

The Problem: A baseball is hit at a velocity of 30 m/s at an angle of 60 deg. Use the calculator to produce a graph of the relationship between the ball's vertical displacement (to be shown on the y -axis) and time (to be shown on the x -axis).

Procedure:

1. Calculate v_{yi} and record the result here: _____
2. Substitute this value and the acceleration due to gravity into the equation above for vertical displacement. Simplify if necessary. Write the equation below.

3. Press the $\boxed{=}$ key on your calculator and enter the equation.
(Note: if there are any other functions entered in this list, scroll down to them with the down arrow and press $\boxed{\text{CLEAR}}$.)
4. Hit the $\boxed{\text{GRAPH}}$ button, you should see a section of the parabola.

5. To change the scale of the graph, press the **WINDOW** key and enter the values as shown below. After the scale is changed, press the **GRAPH** button once again.

$$Xmin=0, Xmax=6, Xscl=1, Ymin=0, Ymax=40, Yscl=5$$

Now you should see the full parabola with the vertical displacement on the y -axis and time on the x -axis.

6. Press the **TRACE** button on the calculator. This allows you to move a cursor along the graph (using the left and right arrow buttons) and read the corresponding x - and y - values of that point. Using this capability, approximately how long (in seconds) is the ball in the air?

7. You can also get the y value for any value of x by just typing in the desired x and pressing the **ENTER** button. Answer the following questions.

i.) What is the height of the ball at time $t = 1.75$ seconds?

ii.) What is the height of the ball at time $t = 3.3$ seconds?

8. You can also use the calculator to find the maximum height (and corresponding time) of the ball's path.

a.) Press the **2nd**[CALC] button and select **4: maximum. Left Bound?** will display on the screen. You will now select a left- and right- boundary for the search.

b.) Use the **◀** or **▶** buttons to select a left boundary somewhere to the left of the peak. Press the **ENTER** key.

c.) Use the **◀** or **▶** buttons to select a right boundary to the right of the peak. Press the **ENTER** key.

d.) Now use the **◀** or **▶** keys to make your best guess for the peak. Press the **ENTER** key. The cursor will now be on the peak height and the coordinates will be displayed below.

i.) At what time does the ball reach its peak height?

ii.) What is the peak height of the baseball?

9. Compare your results with other lab groups. If there are significant differences in your answer, discuss the results and determine if any corrections are necessary.

10. Show the calculator and graph to your teacher and be sure to get this lab sheet initialed. Hint: it should look like this:


