

Estimate Solutions with Graphs

Materials

HP39gs

Graph paper

In this investigation, you will work with graph paper and a graphing calculator to estimate solutions to equations. You know that linear relationships can be expressed symbolically, using an equation in the form $y = mx + b$.

In the first part of this investigation, you will graph two linear equations in the decimal view, which is the window $[-6.5, 6.5]$ by $[-3.1, 3.2]$.

Graph $y = 3x + 1$ and $y = 3x - 2$. Then describe how the graphs are related.

Graph the equation $y = 3x + 1$.

- On your calculator, start the Function Aplet by choosing **Function** from the Aplet Menu and pressing the ENTER key.
- Clear any existing equations by pressing the SHIFT CLEAR keys.
- Highlight F1(X) and enter $3x + 1$. (Figure 1)
- Press the VIEWS key and choose **Decimal** from the options. (Figure 2) This will graph the equation. (Figure 3)

FIGURE 1

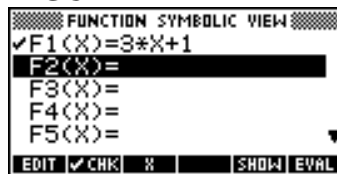
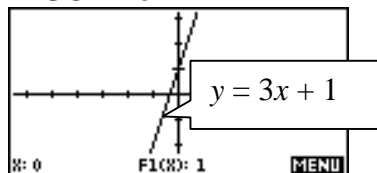


FIGURE 2



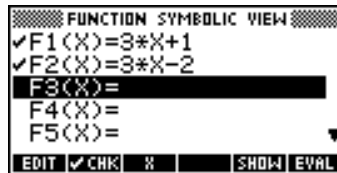
FIGURE 3



Graph the equation $y = 3x - 2$.

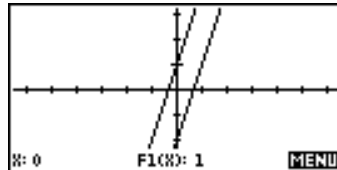
- Press the SYMB key.
- Notice that the equation $y = 3x + 1$ is already defined as F1(X). Enter $3x - 2$ in F2(X). (Figure 4)

FIGURE 4



- Press the PLOT key to graph the two equations. (Figure 5)

FIGURE 5



Move along each graph by pressing the left or right arrow key. Move from one equation to the other using the up or down arrow keys.

- 1) What is the slope of the two graphs?
- 2) What are the y -intercepts?
- 3) Will the graphs ever intersect? Explain your answer.

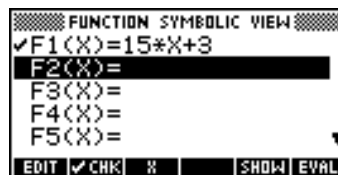
Set It Up

Although it is true that you cannot rely on a graph for an exact solution to an equation, you can get reliable approximations.

The formula $t = 15s + 3$ where t is temperature in $^{\circ}\text{C}$ and s is an ants' speed in centimeters per second allows you to estimate the air temperature by measuring the speed that ants crawl.

You will now look at numeric and graphic views of the equation by making a table of values and plotting ordered pairs.

Press the SYMB key and then press the SHIFT and CLEAR keys to clear all the expressions. Enter $15X + 3$ for $F1(X)$. Note that you must use X for the name of the independent variable instead of s .



Press the SHIFT NUM keys to get to the Numeric Setup menu, and highlight NUMTYPE by pressing the down arrow key twice. Press the CHOOSE menu key, select **Build Your Own** table, then press the OK menu key.



- 4) Press the NUM key to look at the numeric view of the equation. Enter 5 values for X (which represents the ants' speed, s) between 0.5 and 4.0, and record your results in a table. Notice that when you enter a value for X, the speed of the ant, the corresponding value for the temperature, t , is shown in the F1(X) column of the table. One value is shown below:

X	F1		
5	10.5		

EDIT INS SORT BIG DEFN

- 5) Look at the values in your table, and use them to make reasonable choices for a viewing window to look at the graph of the equation. Press the SHIFT and PLOT keys and enter your choices for the minimum and maximum horizontal and vertical values, as well as the tick spacing for X and Y. Record your graph on graph paper.
- 6) What is the slope of the graph?

Make a Prediction

- 7) Suppose an ant crawls at a rate of 1.5 centimeters per second. Use the formula to predict what the temperature.

Try It Out

- 8) Andrea timed some ants and estimated their speeds to be about 2.5 centimeters per second. Use your graph to estimate the temperature.
- 9) Compare your answer to number 4 with the value predicted by the formula. To do this with the HP39gs, on the PLOT screen, press the GOTO menu key and enter 2.5 for X. The value for F1(X) is the predicted temperature.
- 10) Early in the morning, Andrea measured the ants' speed to be 1.2 centimeters per second. By late afternoon, it was 2.0 centimeters per second. What is the change in temperature during that time?
- 11) Write an equation you could solve to find the ants' speed when the temperature is 25°C. Use your graph to estimate the solution.
- 12) Use your graph to estimate how much the speed of the ants would change if the temperature increased from 10°C to 20°C.
- 13) What equation would you solve if you were trying to figure out how fast an ant would crawl at a temperature of 24.9°C? How fast would it crawl?

Make a Connection

Press the SHIFT NUM keys, enter 1 for NUMSTART, enter 1 for NUMSTEP, and select **Automatic** for NUMTYPE. Press the NUM key to look at the table. Notice that the table starts at 1 cm/s for the speed of the ants and goes up by 1 cm/s each time.

FUNCTION NUMERIC SETUP	
NUMSTART:	1
NUMSTEP:	1
NUMTYPE:	Automatic
NUMZOOM:	10
CHOOSE TABLE FORMAT	
CHOOS	PLT

X	F1		
1	18		
2	33		
3	48		
4	63		
5	78		
6	93		

1	ZOOM	BIG	DEFN
---	------	-----	------

- 14) How much does the temperature increase for each increase of 1 centimeter per second in the ants' speed?

What Did You Learn

- 15) The currency in much of Europe is the euro. One day, the formula to convert euros to U.S. dollars was $D = 1.42E$, where D was the amount in U.S. dollars and E was the amount in euros.
- Use your HP39gs calculator to define an equation to convert euros, X , to dollars, $F1(X)$.
 - Set up a "Build Your Own" table so that you can enter an amount, X , in euros, and determine the corresponding amount in U.S. dollars.
 - That day, a French collector advertised a toy train for sale for 125 euros, including postage. Write an equation you could solve to find out how much this was in U.S. dollars. Use your table to solve your equation.
 - Set up a Plot to graph the equation for an amount in euros between 0 and 150.
 - Use your graph to approximate an answer to part c.
 - On that same day in June, Megan exchanged the \$120 she had saved towards a vacation in Germany. Write and solve an equation to find how many euros she received. Use your graph to check your solution.
 - Which is more expensive, an ice cream cone that costs \$1.50 or an ice cream cone that costs 1 euro?
 - What are the advantages of using the graph to solve the equation you wrote?
 - What are the advantages of using the rule to solve the equation you wrote?