EXPLORATIONS

Activity 1

How Many Drivers? Investigating the Slope-Intercept Form of a Line

Any line can be expressed in the form $y = mx + b$. This form is named the *slope-intercept* form.

In this activity, you will study the *slope-intercept* form of the line. When you are finished, you should understand the effect of m and b on the graph of a line. You also will be able to fit a line to data by selecting values for these two parameters by using the guess-and-check method.

### Investigating the Effect of the Values of m and b on the Graph of a Line

1. Begin this investigation by examining one instance of $y = mx + b$, when $m = 3$ and $b = 5$. On your TI-83 Plus, enter the equation **Y1 = 3X + 5**.

    a. Begin in Function (**Func**) Mode and turn off any plots or equations previously turned on. (This screen shows both an unwanted equation and an unwanted plot.)
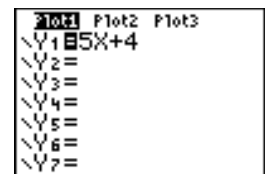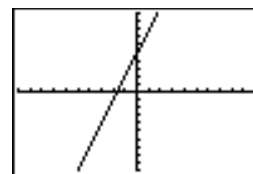
    To turn off a plot, press Y= and use the cursor control keys (▲ and ▼) to move to the highlighted plot and press ENTER. To clear an equation, press ▲ or ▼ to move to the first part of the equation and press CLEAR.
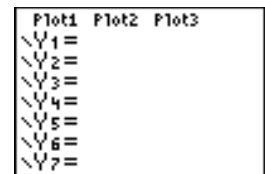
    b. Move the cursor to **Y1=** and enter **3** X,T,Θ,*n* + **5**.
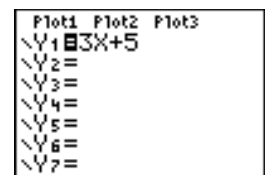
2. Display the graph by pressing ZOOM **6:ZStandard**. Both the x-axis and y-axis will be displayed with a range of -10 to 10.

3. Enter and graph two more examples of $y = mx + b$.

   a. Y2 = 3X + 2

   b. Y3 = 5X + 2

Can you tell the effect of the *m* or the *b* on the graph of the line? Can you guess why they call this form the slope-intercept form of a line?

You probably are not ready to answer these questions because it is difficult with only three examples. You will be ready to answer these after a short investigation. On a piece of paper, write a guess about the effect of *m* and *b* on the graph of a line. You will come back to this sheet later to check your hypothesis.

Using Transformation Graphing to Investigate m and b

To investigate the effects of *m* and *b* you will use a TI-83 Plus with the Transformation Graphing application to graph many examples. You must have Transformation Graphing installed and running on your calculator to complete this activity.

To start Transformation Graphing:

1. Press APPS. Press the number in front of the application **Transfrm**. (This number may vary based on the applications you have loaded.)

2. Press any key (except 2nd or ALPHA) to install the application.

   If the application is already running, press **2:Continue**.

To graph the example:

1. Press Y=, clear the **Y=** editor, and turn off all plots.

2. For **Y1**, enter **AX + B**. Press ALPHA **A** X,T,Θ,*n* + ALPHA **B**.

   Note: You entered Y=AX + B in place of Y=MX + B, which is the form commonly found in textbooks, because Transformation Graphing only uses the coefficients A, B, C, and D.
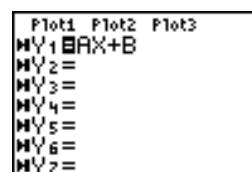
3. Set Transformation Graphing for Play-Pause Mode. Press WINDOW ▲ to display the SETTINGS screen. If necessary, move the cursor until you highlight >|| and press ENTER.

    As a starting place, set the other SETTINGS as pictured. To make these selections, press ▼ 1 ▼ 1 ▼ 1. This defines the starting values for the coefficients and the increment by which you want to observe the change in the coefficients.

4. Press ZOOM **6:ZStandard** to display the graph. If **A=** is not highlighted, press ▼ until the **A=** is highlighted.
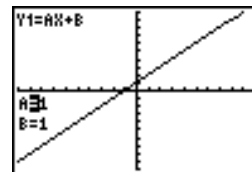
5. Press ▶ to increase the value of **A** or ◀ to decrease the value of **A**. With each new **A** value, notice the change on the graph.

6. Enter values for **A** by hand and notice the effect on the graph. Let **A** take both positive and negative values between -10 and 10, including decimal values. To enter values, press the key for the value you want and then press ENTER.

Questions for Discussion

1. What effect did **A** have on the graph?

    a. As the value gets larger, what happens to the graph?

    b. If the value is decreased what effect will that have on the graph?

    c. If the value is changed to a negative, what will the result be on the graph?

2. Use the same method to investigate the effect of **B** on the graph. Set **A = 1**. To change **B**, press ▼ and then press ▶ to increase the value of **B** or ◀ to decrease the value of **B**. You may also enter values for **B** by hand as you did for **A**.

    What effect does **B** have on the graph? As the value gets larger what happens? As it gets smaller? Negative?

3. Go back to the sheet of paper where you wrote your hypothesis about the effect of M and B. How close were you to the actual effect?
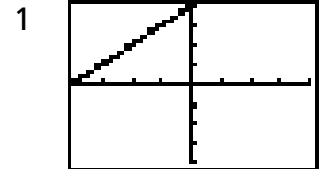
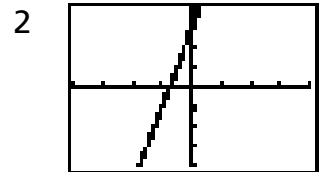   Why do you think they call this the slope-intercept form of the line?

Problems

For the following problems, use your hypothesis to guess the correct answers and then use your calculator to confirm your guess.

1. Match the graph from the second column to its equation in the first. Notice that the window range for both X and Y is from -4 to 4 with a scale of 1.
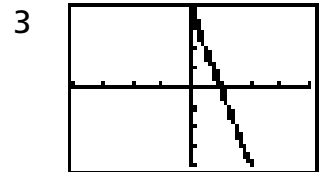
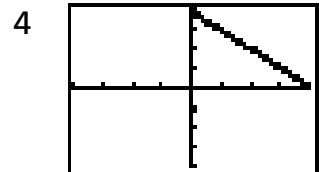a. y = 4x + 3   1
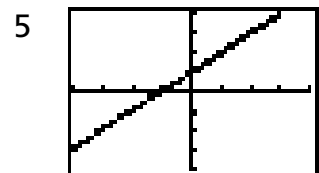
b. y = 4x + 1   2

c. y = 1x + 4   3

d. y = 1x + 1   4
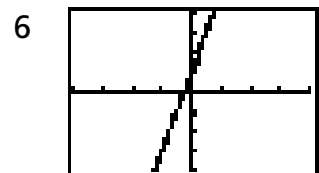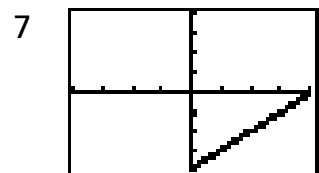
e. y = 1x - 4   5

f. y = - 1x + 4   6

g. y = -4x + 4   7

2. Where does $y = 4x - 1$ cross the y-axis?

3. Where does $y = -3x + 2$ cross the y-axis?

4. Which line is steeper, $y = 3x - 1$ or $y = x + 5$?

5. Which two lines slant the same direction?

      $y = 2x + 5$ $y = 5x - 1$ $y = -x + 3$

Use Your New Skill

Most students turn 16 and start thinking about getting a driver's license. The table shows the population from the 1990 census and number of licensed drivers in a few selected states.

| State	Population (in millions)	Licensed Drivers (in millions)
California	29.8	19.9
Florida	12.9	9.2
Georgia	6.5	4.4
Illinois	11.4	7.3
Michigan	9.3	6.4
Montana	0.8	0.6
New Mexico	1.5	1.1
New York	18.0	10.3
Pennsylvania	11.9	7.8
Texas	17.0	11.1

Source: Used with permission from *World Alamanac and Book of Facts, 1992*.
© 1992, 2001 World Almanac Education Group, Inc.

Create a scatter plot for this data and determine if you think you see a relationship or pattern. Which variable do you think should be the independent variable?

1. Enter the data in two Stat Lists of your TI-83 Plus. Press $\boxed{\text{STAT}}$. Select **1:Edit**. Enter the values from the table into an empty list in the stat editor. Clear two lists if no lists are empty. To clear a list, press $\boxed{\blacktriangle}$ to highlight the list name, press $\boxed{\text{CLEAR}}$, and then press $\boxed{\text{ENTER}}$.

2. Press MODE and verify that you are in **Func** mode. (**Func** is highlighted if you are in Function mode.)

3. Press Y= and deselect any functions that have been turned on. Verify that all plots are off (not highlighted).
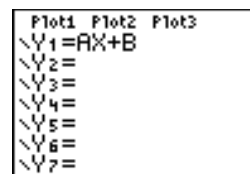
4. To display the plot, press 2nd [Stat Plot]. Select **1:Plot1** and press ENTER. Turn the plot on and set the setup menu as shown at the right.

5. Press ZOOM **9:ZoomStat** to display the plot. Does there appear to be a relationship between a state's population and the number of licensed drivers in that state?

6. There appears to be a linear relationship between the two variables. Estimate values for the slope and the y-intercept of a linear model to represent the data.
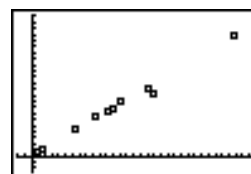
7. Press Y= to display the **Y=** editor. Enter **Y1 = AX + B** for the equation. (Press ALPHA **A** X,T,Θ,n + ALPHA **B**.) Leave Plot1 on.
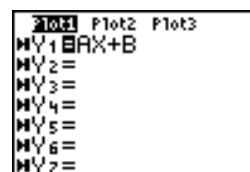
   Press ◄ to move to the left of **Y1=** and continue to press ENTER until Transformation Graphing is in Play-Pause mode (>‖).

8. Since the window was just set to display the plot, you do not need to change the WINDOW settings. Display the plot with Transformation Graphing enabled by pressing GRAPH. The line **Y = AX + B** will be displayed with the most recent values of A and B. This line will have no relationship to your plot.
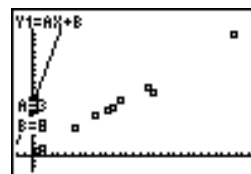
9. In step 6, you estimated values for the slope and y-intercept. Enter these values for A and B. For the purpose of this sample, assume your estimates are A=1 and B=0. To enter these values use the up and down cursor control keys (▲ and ▼) to move the highlight to **A=**. When **A=** is highlighted, press **1** ENTER.

---
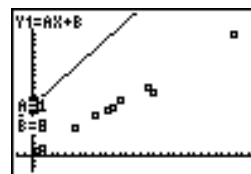
10. Press ⬇ to highlight **B** and press **0** ENTER. This is your starting point as you look for a reasonable model.
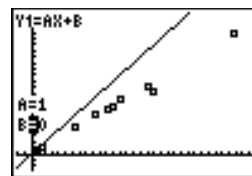
11. Keep selecting and entering new values for **A** and **B** until you feel you have a reasonable model with values for **A** and **B** estimated to the hundredths place.

Homework Page

Name_____

Date _____

How Many Drivers?

Most students turn 16 and start thinking about getting a driver's license. The table shows the population from the 1990 census and number of licensed drivers in a few selected states.

State	Population (in millions)	Licensed Drivers (in millions)
California	29.8	19.9
Florida	12.9	9.2
Georgia	6.5	4.4
Illinois	11.4	7.3
Michigan	9.3	6.4
Montana	0.8	0.6
New Mexico	1.5	1.1
New York	18.0	10.3
Pennsylvania	11.9	7.8
Texas	17.0	11.1

Source: Used with permission from *World Alamanac and Book of Facts, 1992*.
© 1992, 2001 World Almanac Education Group, Inc.

1. About how many licensed drivers does your model predict the state of Maryland, with a population of 4.9 million, should have?

2. Go to the Internet and find the population of your state. Use your model to predict the number of licensed drivers in your state.

3. Population is constantly changing. Do you think the slope of the line you used as a model would change very much if you used newer data, such as the 2000 census? Explain your answer.

4. What do you think is the meaning of the slope of your model? What else could the slope represent?

5. What is the unit of measure of the slope in this example?

Notes for Teachers

This activity is an introduction to the slope-intercept form of the line. Its purpose is to enable the student to recognize the effect of changes in the slope and/or the y-intercept on the graph of a line. At the end the student will use Transformation Graphing to eyeball fit a linear model to actual data.

At this point, no attempt is made to have the students graph a line by hand, just to recognize the effect of the parameters and start modeling.

This activity will help the development of what makes a reasonable model. You should spend time talking about different models that are selected and what makes some better then others—but be careful that you do not look for a best model. As part of the activity, various models should be entered in the overhead calculator, with Transformation Graphing deactivated, to discuss the reasonableness of each model.

The activity will take approximately 50 minutes.

There is one modeling exercise at the end of the activity. Only one was given as the next activity picks up from here and continues with more practice. If you would like to give more practice, any linear data set from your textbook could easily be used.

Be sure students realize that only one equation can be graphed at a time while Transformation Graphing is installed and activated.

To de-activate Transformation Graphing:

1. Press APPS and select the number preceding **Transfrm**.

2. Select **1:Uninstall**.

Answers

Questions for Discussion

1. **A** affects the slope (slant) of the line. The larger **A** is, the steeper the line. When **A** is negative, the line slopes downward from left to right. Both **A** and **-A** have the same steepness; but one slants up from left to right and the other down.

2. **B** affects where the line crosses the y-axis. The larger the value of **B**, the higher the line appears on the graph.

3. **B** gives the y-intercept and **A** is the slope.

Problems

1. a. 2

    b. 6

    c. 1

    d. 5

    e. 7

    f. 4

    g. 3

2. -1

3. 2

4. y = 3x - 1

5. y = 2x + 5 and y = 5x - 1

Use Your New Skill

11. Reasonable values for A and B will be approximately **A** = .65 and **B** = .10.

Homework Page

1. Approximately 3.3 million.

2. Answers will vary.

3. No, the slope of the line probably relates to the percentage of people in the state over 16 and this percent probably wouldn't change over short time spans.

4. The change, in millions, in the number of drivers per every 1 million change in the population. This is the percentage of licensed drivers in the total population. See the answer to Question 3.

5. The unit of measure of the slope would be drivers/population.