EXPLORATIONS

Activity 13

Do You Have a Temperature?

Objectives

- To graphically represent and analyze climate data
- To use linear regressions to understand the relationship between temperatures as measured in the Fahrenheit and Celsius scale
- To use linear regressions to understand conversion factors
- To use technology to find a linear regression

Materials

- TI-83 Plus
- Climate data for different ecosystems
- Cold cup with ice water
- Hot cup with boiling water
- Rubber band
- Watch with a second hand
- Celsius thermometer and Fahrenheit thermometer

Introduction

A man was recently listening to the radio in his New York apartment. The radio announcer was giving the temperatures of cities in other countries. The announcer said, "The temperature in London is 68 degrees." At that same moment, another man was sitting in his London apartment listening to the weather report. The radio announcer said, "The temperature in London is 20 degrees." Both announcers were right! How could this happen?

Problem

There are different units of temperature: Celsius and Fahrenheit. How can you mathematically show the relationship between these two units of temperature?

Collecting the data — Part I

You will need twelve temperature readings using both Celsius and Fahrenheit thermometers. These readings will be obtained in one of two ways.

1. Collect the readings during class.

  a. Take a Celsius and a Fahrenheit thermometer and rubber band them together such that the bulbs are next to each other.

  b. Place the thermometers in the hot cup with boiling water and allow the temperature to stabilize. You and your student partner will each read one of the two thermometers. Record the temperature on the **Data Collection and Analysis** page.

- **c.** Place the thermometers in the cold cup with ice water and start timing. Take a reading every ten seconds, recording the values on the **Data Collection and Analysis** page. You and your student partner will each read one of the two thermometers.

2. Use the 12 average monthly Celsius and Fahrenheit temperatures provided by your teacher for the city of Las Vegas, Nevada.

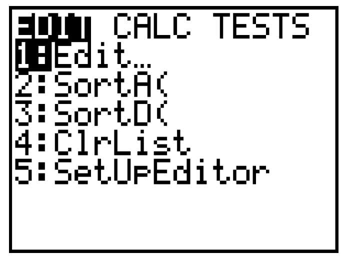
Setting up the TI-83 Plus

Before starting your data collection, make sure that the TI-83 Plus has the STAT PLOTS turned OFF, Y= functions turned OFF or cleared, the MODE and FORMAT set to their defaults, and the lists cleared. See the Appendix for a detailed description of the general setup steps.

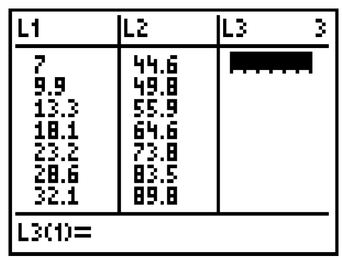
Entering the data in the TI-83 Plus

1. Press [STAT] and select **1:Edit** by pressing [ENTER].

   The list is displayed.

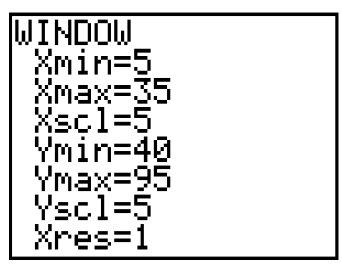


2. Enter the Celsius temperatures in **L1**.
3. Move the cursor to **L2** and enter the Fahrenheit temperatures. (Make sure that the pairs of Celsius and Fahrenheit temperatures match in each column.)



Setting up the window

1. Press [WINDOW] to set up the proper scale for the axes.
2. Set the **Xmin** value by identifying the minimum value in **L1**. Choose a number that is less than the minimum.

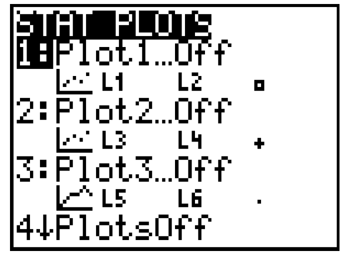


3. Set the **Xmax** value by identifying the maximum value in each list. Choose a number which is greater than the maximum. Set the **Xscl** to **5**.
4. Set the **Ymin** value by identifying the minimum value in **L2**. Choose a number that is less than the minimum.
5. Set the **Ymax** value by identifying the maximum value in **L2**. Choose a number which is greater than the maximum. Set the **Yscl** to **5**.

Graphing the data: Setting up a scatter plot

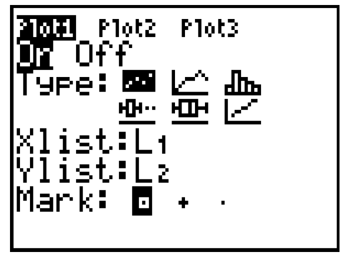
In order to analyze the data, you will need to set up a scatter plot and model the data by graphing a line of best fit (linear regression).

1. Press [2nd] [STAT PLOT] and select **1:Plot1** by pressing [ENTER].

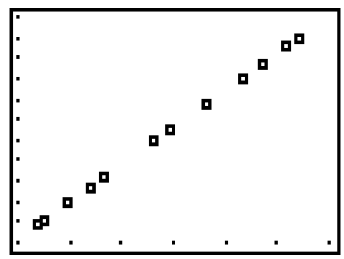


2. Set up the plot as shown by pressing [ENTER] [▼] [ENTER] [▼] [2nd] [L1] [ENTER] [2nd] [L2] [ENTER] [ENTER].

   Note: *Press [▼] [▼] if* **L1** *and* **L2** *are already displayed.*



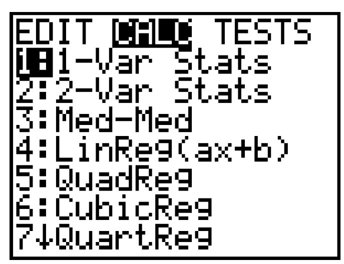
3. Press [GRAPH] to see the plot.



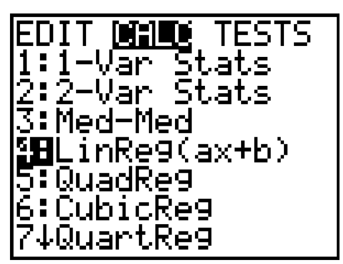
What is the appropriate regression for the plot? Does the slope appear to change?

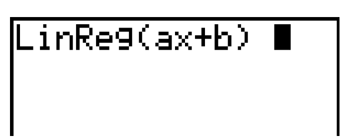
Analyzing the data: Finding a linear regression

1. Press [STAT] and move the cursor to the **CALC** menu.

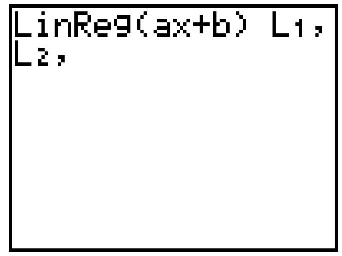


2. Select **4:LinReg(ax+b)** and press [ENTER].

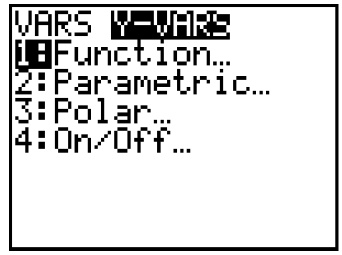




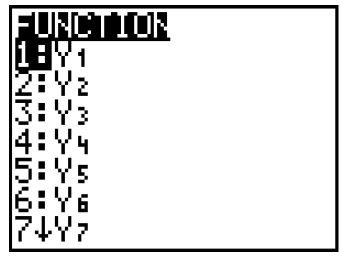
3. Press [2nd] [L1] [,] [2nd] [L2] [,].



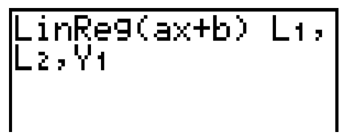
4. Press [VARS] and move the cursor to the **Y-VARS** menu.



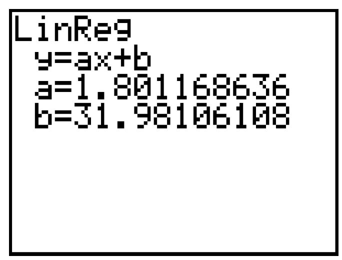
5. Select **1:Function** by pressing [ENTER].



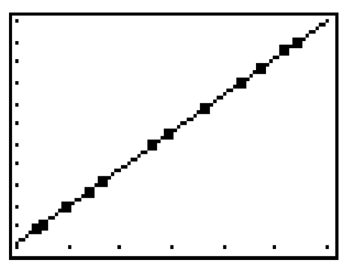
6. Select **1:Y1** by pressing [ENTER].



7. Press [ENTER] to calculate the linear regression and paste the function in **Y1**.



8. Press [GRAPH] to see the linear regression.



Answer Part I questions 1 through 6 on the **Data Collection and Analysis** page.

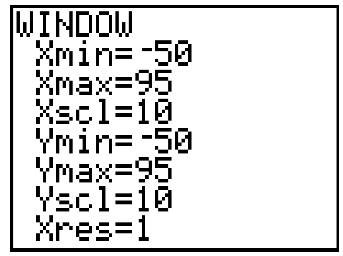
Collecting the data — Part II

Thus far, you have used the data to verify an equation for converting degrees Celsius to degrees Fahrenheit. What if you needed an equation for the opposite conversion, degrees Fahrenheit to degrees Celsius? Simply reversing the data in a STAT PLOT and then determining the linear regression for the data could obtain this equation.

Setting up the window

1. Press [WINDOW] to set up the proper scale for the axes.

   Note: *Make both the* **Xmin** *and* **Ymin** *values –50.*

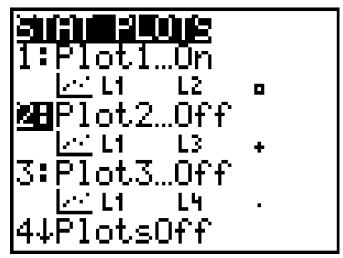


2. Set the **Xmax** value by identifying the maximum value in each list. Choose a number which is greater than the maximum. Set the **Xscl** to **10**.

3. Set the **Ymax** value by identifying the maximum value in **L2**. Choose a number which is greater than the maximum. Set the **Yscl** to **10**.

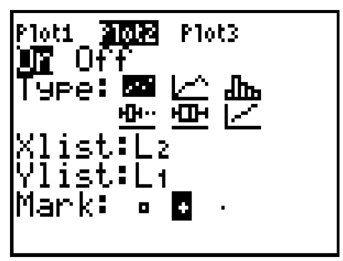
Graphing the data: Setting up a scatter plot

1. Press [2nd] [STAT PLOT] and select **2:Plot2**. Press [ENTER].



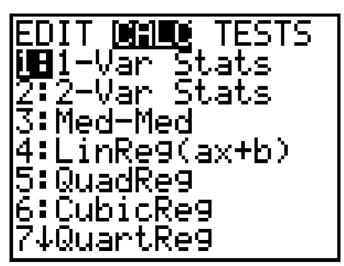
2. Set up the plot as shown by pressing [ENTER] [▼] [ENTER] [▼] [2nd] [L2] [ENTER] [2nd] [L1] [ENTER] [▶] [ENTER].

   Note: *This is similar to* **Plot1***, except that* **L2** *is now the* **Xlist** *(instead of the* **Ylist***) and* **L1** *is now the* **Ylist** *(instead of the* **Xlist***).*

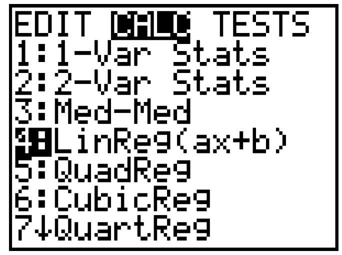


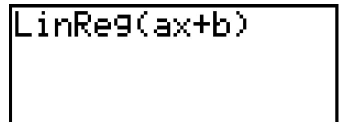
Analyzing the data: Finding a linear regression

1. Press [STAT] and move the cursor to the **CALC** menu.

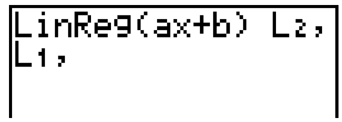


2. Select **4:LinReg(ax+b)** and press [ENTER].

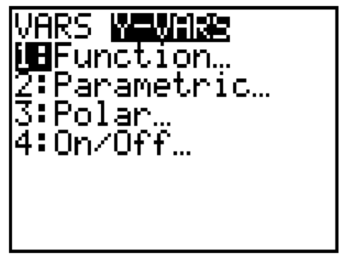




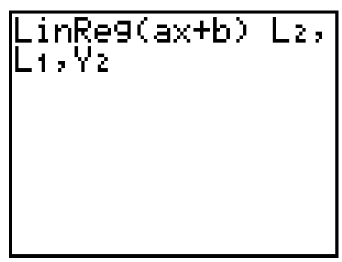
3. Press [2nd] [L2] [,] [2nd] [L1] [,].



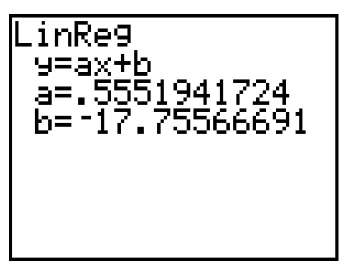
4. Press [VARS] and move the cursor to the **Y-VARS** menu.
5. Select **1:Function** by pressing [ENTER].



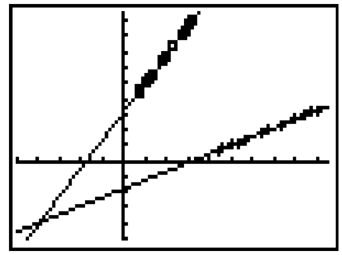
6. Select **2:Y2** and press [ENTER].



7. Press [ENTER] to calculate the linear regression and paste the function in **Y2**.



8. Press [GRAPH] to see the linear regression.



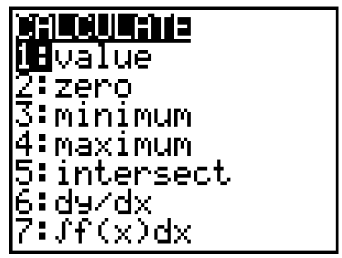
Answer Part II question 1 on the **Data Collection and Analysis** page.

Observe the following statements about the point of intersection of equations **Y1** and **Y2**:

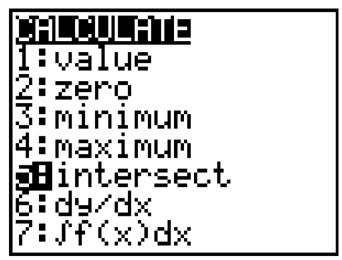
- The *x* and *y* value of the point of intersection is true for *both* equations.
- Since one function (**Y2**) was obtained by switching the *x* and *y* values of the other function (**Y1**), *x* must equal *y* at the point of intersection.

Identify the point of intersection.

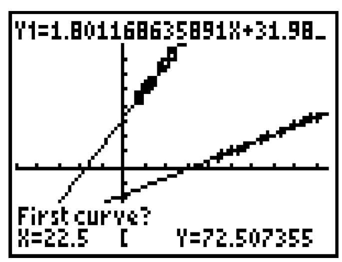
9. Press [2nd] [CALC].



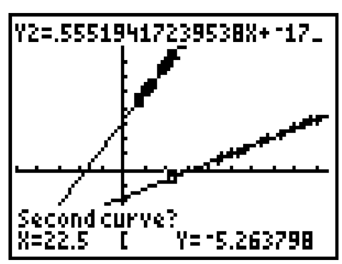
10. Select **5:intersect** and press [ENTER] to find the coordinates of the point of intersection.



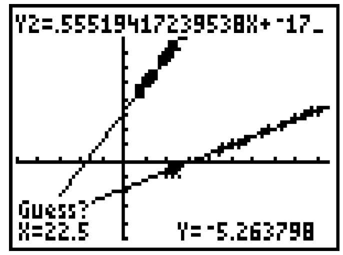
11. The calculator will prompt you for the *First curve*. Make sure the cursor is flashing on the **Y1** regression line and then press [ENTER].



12. The calculator will prompt you for the *Second curve*. Make sure the cursor is flashing on the **Y2** regression line and then press [ENTER].

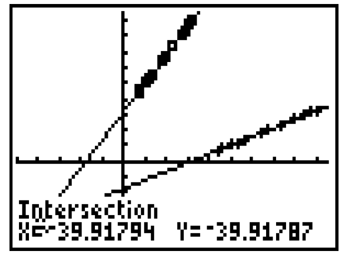


13. The calculator will prompt you to *Guess*. Try to estimate the coordinates of the point of intersection.

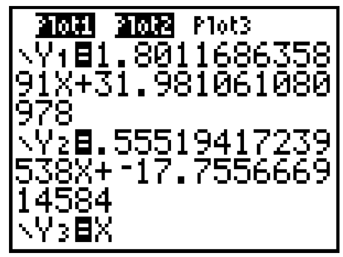


14. Press [ENTER] to find the exact point of intersection.

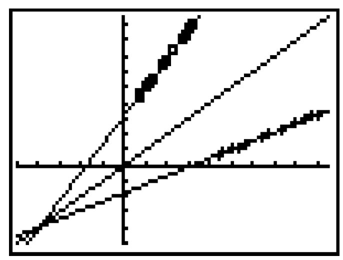
Answer Part II questions 2 through 4 on the **Data Collection and Analysis** page.



15. Press [Y=] and move the cursor to **Y3**. Type X so that the equation is Y3 = X.



16. Press [GRAPH] to see the plot.



Answer Part II question 5 on the **Data Collection and Analysis** page.

Collecting the data — Part III

You have examined climate data for Las Vegas, Nevada, which included temperatures measured in degrees Celsius and Fahrenheit over a twelve-month period. You learned about the relationship between the two units of temperature measurement. You will now explore how graphical analysis of climate data can be used to compare different ecosystems. You will compare rainfall and temperature in three locations, the tundra (Fairbanks, Alaska), the desert (Las Vegas, Nevada), and the tropical rain forest (San Jose, Costa Rica). Climate data for the three ecosystems is provided.

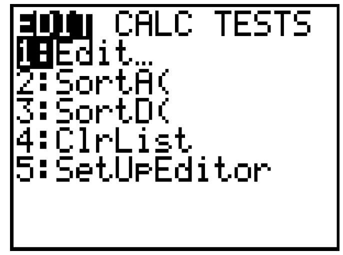
Setting up the TI-83 Plus

Before starting your data collection, make sure that the TI-83 Plus has the STAT PLOTS turned OFF, Y= functions turned OFF or cleared, the MODE and FORMAT set to their defaults, and the lists cleared. See the Appendix for a detailed description of the general setup steps.

Entering the data in the TI-83 Plus

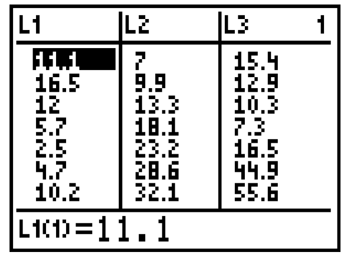
1. Press STAT and select **1:Edit** by pressing ENTER.

   The list is displayed.



2. Enter the climate data in lists **L1** through **L6** according to the chart below.

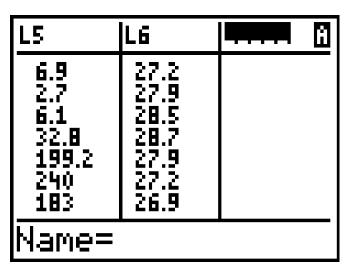
   Note: *The data for January is repeated as a 13th point. This allows the plot to show a full cycle. Leave the 13th data point off* **L1** *through* **L6** *for now. You will need to add it later in the activity.*



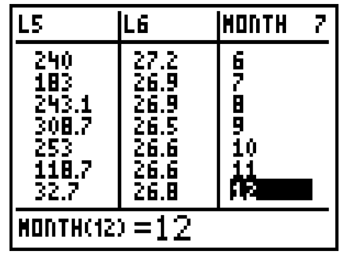
	Desert		**Tundra**		**Tropical Rain Forest**	
Month	**Rainfall (mm)**	**Temperature (°C)**	**Rainfall (mm)**	**Temperature (°C)**	**Rainfall (mm)**	**Temperature (°C)**
	L1	**L2**	**L3**	**L4**	**L5**	**L6**
Jan	11.1	7.0	15.4	-21.1	6.9	27.2
Feb	16.5	9.9	12.9	-18.1	2.7	27.9
Mar	12.0	13.3	10.3	-10.4	6.1	28.5
Apr	5.7	18.1	7.3	-1.0	32.8	28.7
May	2.5	23.2	16.5	8.5	199.2	27.9
Jun	4.7	28.6	44.9	14.6	240.0	27.2
Jul	10.2	32.1	55.6	16.1	183.0	26.9
Aug	13.3	30.9	52.9	13.2	243.1	26.9
Sep	10.6	26.6	32.3	7.0	308.7	26.5
Oct	6.3	19.6	21.8	-4.0	253.0	26.6
Nov	6.2	11.9	18.7	-15.3	118.7	26.6
Dec	14.2	7.5	21.1	-19.7	32.7	26.8
Jan	11.1	7.0	15.4	-21.1	6.9	27.2

Source: Reprinted with permission from WorldClimate (http://www.worldclimate.com).

3. Move the cursor to the top of **L6** to highlight it. Move the cursor once to the right. The cursor is in an unnamed data list as shown.

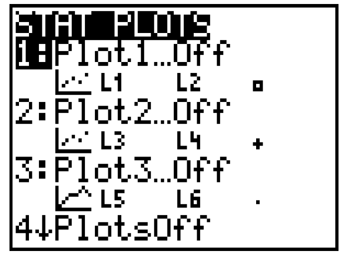


4. Press [ALPHA] **M**-**O**-**N**-**T**-**H** and press [ENTER]. Observe that this data list is now a named list.

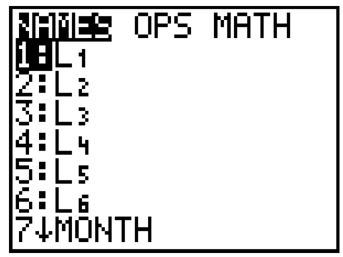


5. Move the cursor down in the data cell and type the numbers 1 through 12 for each of the 12 months.

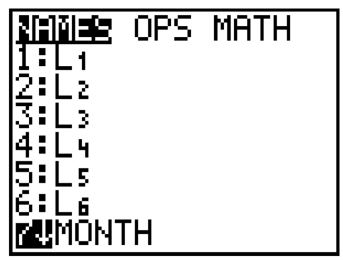
6. Press [2nd] [STAT PLOT] and select **1:Plot1** by pressing [ENTER].



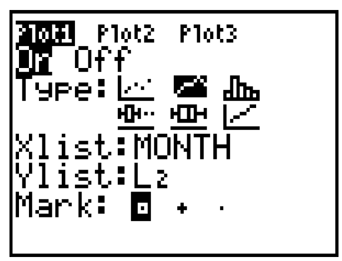
7. Set up the plot as shown by pressing [ENTER] [▼] [▶] [ENTER] [▼] [2nd] [LIST].



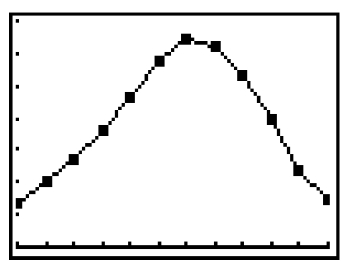
8. Move the cursor to **MONTH** and press [ENTER]. The list called **MONTH** is pasted in the **Xlist**.



9. Press [ENTER] [ENTER].



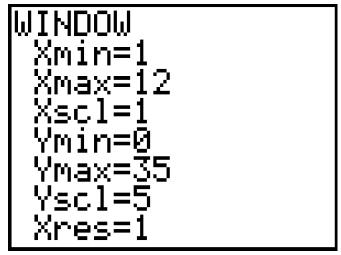
10. Press [GRAPH] to view the pattern of desert temperature changes over the twelve-month period.



Answer Part III questions 1 and 2 on the **Data Collection and Analysis** page.

Setting up the window

1. Press [WINDOW] to set up the proper scale for the axes.

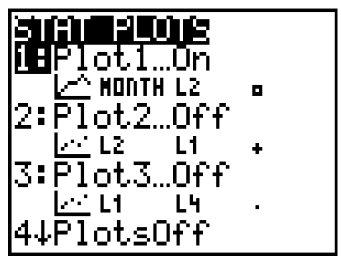


2. Set the **Xmin** value by identifying the minimum value in **L1**. Choose a number that is less than the minimum.
3. Set the **Xmax** value by identifying the maximum value in each list. Choose a number that is greater than the maximum. Set the **Xscl** to **1**.
4. Set the **Ymin** value by identifying the minimum value in **L2**. Choose a number that is less than the minimum.
5. Set the **Ymax** value by identifying the maximum value in **L2**. Choose a number that is greater than the maximum. Set the **Yscl** to **5**.

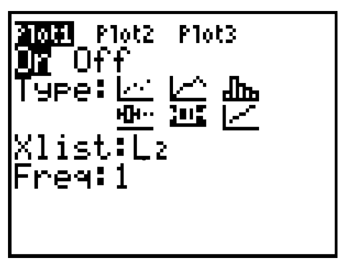
Graphing the data: Setting up a box-and-whisker plot

The type of analysis that you did with the desert temperature data could also be done with the other data from the table. Another way to analyze the data is by examining a box-and-whisker plot.

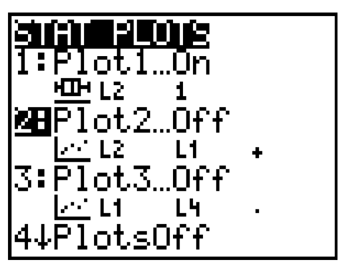
1. Press [2nd] [STAT PLOT] and select **1:Plot1** by pressing [ENTER].



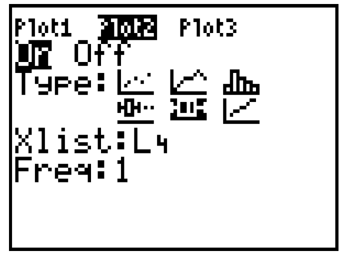
2. Set up the plot as shown by pressing [ENTER] [▼] [▶] [▶] [▶] [▶] [ENTER] [▼] [2nd] [L2] [ENTER] [ENTER].



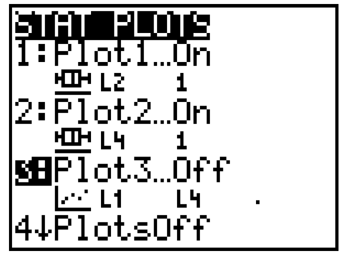
3. Press [2nd] [STAT PLOT] and select **2:Plot2**. Press [ENTER].



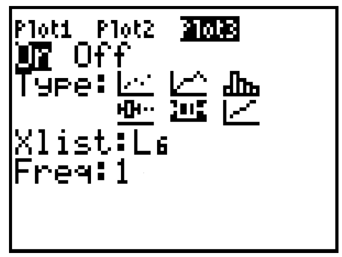
4. Set up the plot as shown by pressing [ENTER] [▼] [▶] [▶] [▶] [▶] [ENTER] [▼] [2nd] [L4] [ENTER] [ENTER].



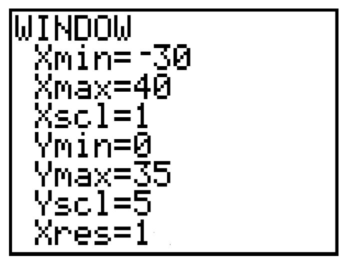
5. Press [2nd] [STAT PLOT] and select **3:Plot3**. Press [ENTER].



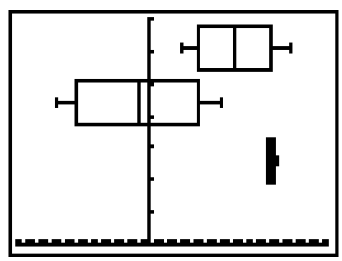
6. Set up the plot as shown by pressing [ENTER] [▼] [▶] [▶] [▶] [▶] [ENTER] [▼] [2nd] [L6] [ENTER] [ENTER].



7. Press [WINDOW] and set the window values as shown.



8. Press [GRAPH] to compare the three box-and-whisker plots.

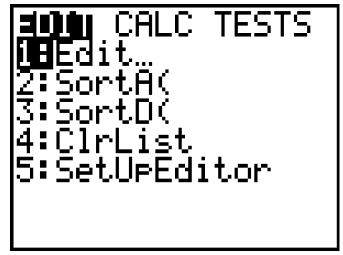


Answer Part III questions 3 through 5 on the **Data Collection and Analysis** page.

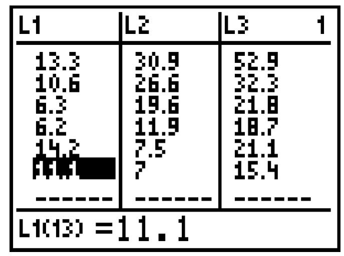
Analyzing the data: Finding a linear regression

Construct climagraphs of the data. Climagraphs are plots of rainfall (on the *x*-axis) versus temperature (on the *y*-axis). Each point on the plot represents the average rainfall and temperature for a given month. Rainfall and temperature are the two most important climatic factors that affect an ecosystem. A climagraph gives the trained eye a true picture of the climate of an ecosystem.

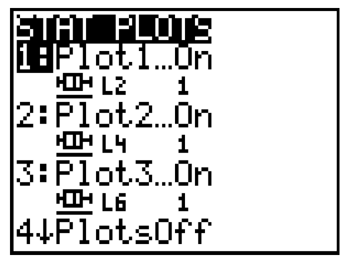
1. Press [STAT] and select **1:Edit** by pressing [ENTER].



2. For lists **L1** through **L6**, add a 13th value by repeating the first value in each list, just as it is recorded on the climate data table.

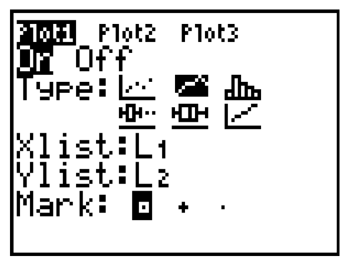


3. Press [2nd] [STAT PLOT] and select **1:Plot1** by pressing [ENTER].

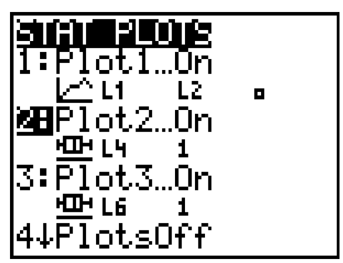


4. Set up the plot as shown by pressing [ENTER] [▼] [▶] [ENTER] [▼] [2nd] [L1] [ENTER] [2nd] [L2] [ENTER] [ENTER].

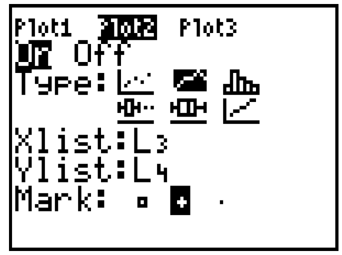
Note: *Press* [▼] [▼] *if* **L1** *and* **L2** *are already displayed.*



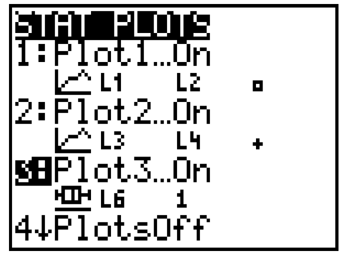
5. Press [2nd] [STAT PLOT] and select **2:Plot2**. Press [ENTER].



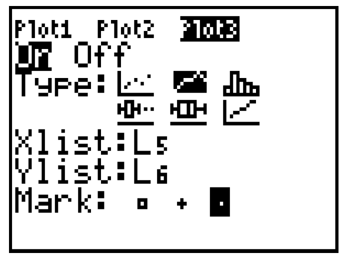
6. Set up the plot as shown by pressing [ENTER] [▼] [▶] [ENTER] [▼] [2nd] [L3] [ENTER] [2nd] [L4] [ENTER] [▶] [ENTER].



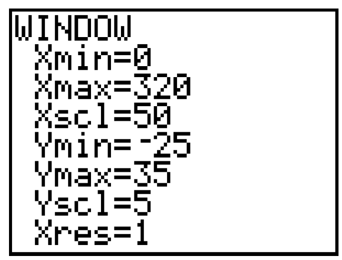
7. Press [2nd] [STAT PLOT] and select **3:Plot3**. Press [ENTER].



8. Set up the plot as shown by pressing [ENTER] [▼] [▶] [ENTER] [▼] [2nd] [L5] [ENTER] [2nd] [L6] [ENTER] [▶] [▶] [ENTER].

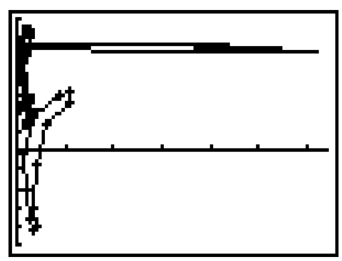


9. Press [WINDOW] and set the window values as shown.



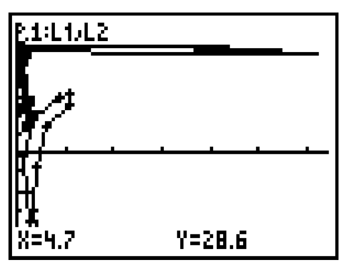
10. Press [GRAPH] to see the plots.

It may be difficult to distinguish which plot applies to which set of data.

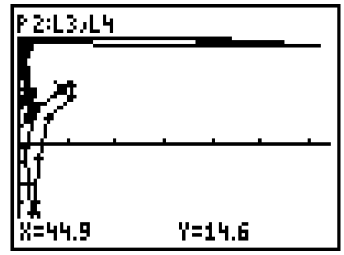


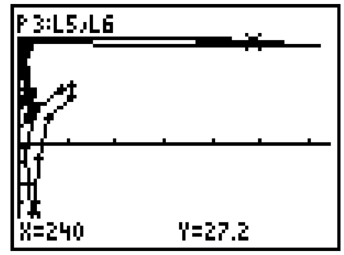
11. Press [TRACE] and move the cursor to the right five times.

Observe that the blinking cursor is on **Plot1**.



12. Move from plot to plot by moving the cursor up and down.





Answer Part III questions 6 through 10 on the **Data Collection and Analysis** page.

Data Collection and Analysis

Name ____________________

Date ____________________

Activity 13: Do You Have a Temperature?

Collecting the data

Temperature (°C)												
Temperature (°F)												

Analyzing the data — Part I

1. What is the equation for the linear regression in **Y1**? (You can see the equation by pressing [Y=].)

   ____

2. What does *y* represent in this equation? What does *x* represent in this equation?

   ____

3. How might this equation be used to convert the temperature in one scale to the temperature in another scale?

   ____

   ____

4. How does this conversion equation compare to that in a science textbook?

   ____

   ____

5. What is the *slope* of this function?

   ____

6. What does the *slope* tell you? (Use the words degrees Fahrenheit and degrees Celsius to answer this question.)

   ____

   ____

Analyzing the data — Part II

1. Examine the general appearance of the two functions (**Y1** and **Y2**) and answer the following questions:

   a. In which quadrant do the **Y1** and **Y2** functions intersect? ______________

   b. Describe the symmetry of the two functions.

   ____

   ____

   c. What function serves as a line of symmetry for the two functions? (Provide an equation with your answer.)

   ____

   ____

2. Rounding it off to the nearest whole number, what is the point of intersection of functions **Y1** and **Y2**? ______________________________

3. How do the *x* and *y* values compare?

   ____

   ____

4. Press [Y=] and copy the equations for **Y1** and **Y2** next to each other. Show that the point of intersection is correct for these two equations by substituting the *x* and *y* values. Show your work.

   ____

   ____

   ____

5. Based on the appearance of the three functions, confirm your answers to questions 1b and 1c. Explain.

   ____

   ____

   ____

   ____

Analyzing the data — Part III

1. Describe the temperature pattern for Las Vegas, Nevada, over a one-year period.

2. What do you think the plot of Las Vegas, Nevada, temperatures would look like for 36 months (3 years)? Create a sketch of your work.

3. Which two ecosystems have overlapping temperature ranges during the course of the year? During which months are the temperatures of these two ecosystems approximately the same?

   Hint: *It is a different month for each of the two ecosystems.*

4. Which ecosystem is most stable according to temperature? How does the box-and-whisker plot show this?

5. Examine the box-and-whisker plot for the tundra (Plot2). During which three-month period is the temperature most stable? How does the plot show this?

6. Which ecosystem has the lowest average temperature during the course of the year?

7. Which ecosystem has the highest average temperature during the course of the year?

8. Which ecosystem has the highest average rainfall during the course of the year?

____

9. Which ecosystem has the lowest average rainfall during the course of the year? (This is hard to see from the graph.)

____

10. How does the climagraph of the tropical rain forest support your answer to Part III question number 4?

____

____

Teacher Notes

Activity 13

Do You Have a Temperature?

Objectives

- To graphically represent and analyze climate data
- To use linear regressions to understand the relationship between temperatures as measured in the Fahrenheit and Celsius scale
- To use linear regressions to understand conversion factors
- To use technology to find a linear regression

Materials

- TI-83 Plus
- Climate data for different ecosystems
- Cold cup with ice water
- Hot cup with boiling water
- Rubber band
- Watch with a second hand
- Celsius thermometer and Fahrenheit thermometer

Preparation

- This activity shows that conversions between scientific units of measurement are linear. Similar conversions could be done with centimeters to inches and pounds to kilograms. Since the y-intercept for these two conversions is 0, the slope is the conversion factor. In the examples used in this activity, the conversion equations are:

  $F = 1.8\ C + 32$ and $C = 0.56\ F - 17.8$

  These equations form mirror images on both sides of the $X = Y$ line. They intersect at the one temperature where °C = °F (-40°).

Answers to Data Collection and Analysis

Collecting the data

- Sample data — Las Vegas, Nevada.

Month	J	F	M	A	M	J	J	A	S	O	N	D
Temperature (°C)	7.0	9.9	13.3	18.1	23.2	28.6	32.1	30.9	26.6	19.6	11.9	7.5
Temperature (°F)	44.6	49.8	55.9	64.6	73.8	83.5	89.8	87.6	79.9	67.3	53.4	45.5

Source: Reprinted with permission from WorldClimate (http://www.worldclimate.com).

- If the students collect their own data using thermometers, do not expect the equation to fit as perfectly as using the Las Vegas, Nevada data in the table. There are several reasons for this:
  - The thermometer bulbs are not in the same place.
  - Slight errors in reading the thermometers may occur.
  - Convection currents within the container result in slight temperature differences.
  - Students may not take the reading at the same time.

  There are benefits to discussing the discrepancies that occur when using real world data.

- Learning to graphically evaluate data is an important skill. Students may have numerous questions after viewing and interpreting the climagraphs. For example, students may observe that the tundra and the desert both have little precipitation. Yet, most students think of the tundra as a snowy place in the winter and a marshy place in the summer. That is because of the poor drainage of the permanently frozen subsoil (called permafrost) and the low rate of evaporation that occurs in the tundra. The little precipitation that does occur remains on the ground.
- Having students load the climate data in the TI-83 Plus takes an enormous amount of time. You may want to do it once yourself and then have the students link to you (and then to each other) to get the data. The analysis of the data is the crucial part of this activity, not loading many data points. You may want to save this data as a group.
- You might want to have the students determine the means (averages) of the temperature and/or rainfall data using the TI-83 Plus. Press [2nd] [LIST], move the cursor to the **MATH** menu, select **3:mean(** and press [ENTER], type in the appropriate data list, and press [ENTER]. The mean for the list is displayed.
- The web page mentioned on the previous page is an excellent source of data for cities all over the world. You may want to make this a web-based activity.

Analyzing the data — Part I

1. What is the equation for the linear regression in **Y1**? (You can see the equation by pressing [Y=].)

   Y = 1.799X + 32.003.

2. What does *y* represent in this equation? What does *x* represent in this equation?

   The y represents the temperature in degrees Fahrenheit.

3. How might this equation be used to convert the temperature in one scale to the temperature in another scale?

   If you know the temperature in degrees Celsius, substitute the value for x and solve to get the temperature in degrees Fahrenheit.

4. How does this conversion equation compare to that in a science textbook?

   F = 1.8 C + 32 (Textbook Equation).

5. What is the *slope* of this function?

   1.8

6. What does the *slope* tell you? (Use the words degrees Fahrenheit and degrees Celsius to answer this question.)

   The slope tells you that for each increase in a Celsius degree, the Fahrenheit temperature rises 1.8 degrees.

Analyzing the data — Part II

1. Examine the general appearance of the two functions (**Y1** and **Y2**) and answer the following questions:

   a. In which quadrant do the **Y1** and **Y2** functions intersect?

   The **Y1** *and* **Y2** *functions intersect in the third quadrant.*

   b. Describe the symmetry of the two functions.

   The two functions are mirror images of each other.

   c. What function serves as a line of symmetry for the two functions? (Provide an equation with your answer.)

   They are symmetrical on both sides of the X = Y line.

2. Rounding it off to the nearest whole number, what is the point of intersection of functions **Y1** and **Y2**?

   (-40, -40)

3. How do the *x* and *y* values compare?

The x and y values are the same at the point of intersection.

4. Press [Y=] and copy the equations for **Y1** and **Y2** next to each other. Show that the point of intersection is correct for these two equations by substituting the *x* and *y* values. Show your work.

By substituting –40 for the x and y values of the two equations, and solving, the equality will be shown.

5. Based on the appearance of the three functions, confirm your answers to questions 1b and 1c. Explain.

The equations all intersect at (-40, -40).

Analyzing the data — Part III

1. Describe the temperature pattern for Las Vegas, Nevada, over a one-year period.

The temperature pattern starts low, rises, and then falls to the same level.

2. What do you think the plot of Las Vegas, Nevada, temperatures would look like for 36 months (3 years)? Create a sketch of your work.

It is essentially sinusoidal.

3. Which two ecosystems have overlapping temperature ranges during the course of the year? During which months are the temperatures of these two ecosystems approximately the same?

Hint: *It is a different month for each of the two ecosystems.*

The two ecosystems that have overlapping temperature ranges during the course of the year are the Desert and Tundra, Desert and Tropical Rain Forest, but not the Tundra and Tropical Rain Forest.

4. Which ecosystem is most stable according to temperature? How does the box-and-whisker plot show this?

The Tropical Rain Forest is the most stable according to temperature. The plot is the most narrow.

5. Examine the box-and-whisker plot for the tundra (Plot2). During which three-month period is the temperature most stable? How does the plot show this?

The temperature is most stable during the first three months (the first quartile — left whisker).

6. Which ecosystem has the lowest average temperature during the course of the year?

The Tundra has the lowest average temperature during the course of the year.

7. Which ecosystem has the highest average temperature during the course of the year?

The Tropical Rain Forest has the highest average temperature during the course of the year.

8. Which ecosystem has the highest average rainfall during the course of the year?

The Tropical Rain Forest has the highest average rainfall during the course of the year.

9. Which ecosystem has the lowest average rainfall during the course of the year? (This is hard to see from the graph.)

The Desert has the lowest average rainfall during the course of the year, but the Tundra is a close second.

10. How does the climagraph of the tropical rain forest support your answer to Part III question number 4?

The climagraph of the tropical rain forest is vertically thin.