

Activity 5

Two Hot, Two Cold

How do we measure temperatures? In almost all countries of the world, the Celsius scale (formerly called the centigrade scale) is used in everyday life and in science and industry. This scale sets the freezing temperature of water at **0** and the boiling temperature at **100**, with the distance between these two points divided into 100 equal intervals called *degrees*. The United States uses the Fahrenheit scale. This scale employs a smaller degree unit than the Celsius scale and its freezing point is set to a different temperature. For the temperatures we commonly use and observe, Celsius readings are lower than Fahrenheit values. You have probably noticed this if you have ever seen a thermometer that has both Celsius and Fahrenheit markings, or if you have ever driven by signs at banks and other businesses that display time and dual temperatures.

Introduction

In this experiment, you will use the TI InterActive!™ browser to access data relating to Celsius and Fahrenheit temperatures for a variety of cities all over the world. Based on the data collected, you will develop and test a mathematical relationship between these two temperature scales.

Equipment Required

- ◆ TI InterActive! software
- ◆ A working Internet connection

Collecting the Data

1. Start TI InterActive! The software opens to a new, blank document.
2. Title your new document *Two Hot, Two Cold* and add your name and the date. Click the Save button  to save and name your document.
3. Click the Web Browser  to open the TI InterActive! browser. Click on the Data Sites button . Under the **Activity Book Links** category, click on *TI InterActive! Data Collection and Analysis*. Choose **Activity 5: Two Hot, Two Cold**.

4. Once the page has been loaded in the browser, scroll down the main page index and click on **WEATHER**.
5. To find the forecasted temperature for today in Dallas, Texas, click on the down arrow next to the “choose a state” dialog box and click on Texas. Select Dallas from the options list and click **Go**. Record today’s high and low temperatures in Celsius and Fahrenheit in the table below.
6. Press the back button twice to return to the state list. Repeat the procedure described above for the other United States cities listed in the table. For cities in other countries, click the back button, select a region from the “choose a world region” box, then navigate to the city as you did before. Record all information in the data table.
7. Use the last two rows of the data table to record today’s high and low temperatures for any city in the world that you choose. Be sure to record the name of the city in the first column.

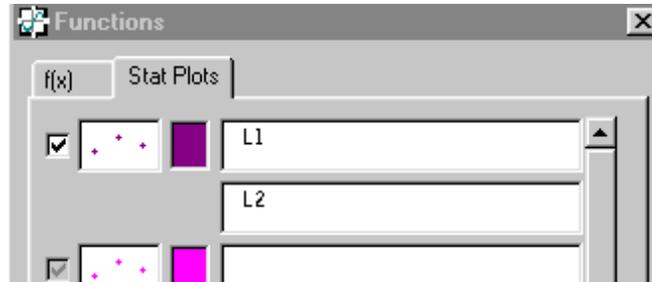
City	Celsius Temperature	Fahrenheit Temperature
Dallas, Texas (high)		
Dallas, Texas (low)		
Anchorage, Alaska (high)		
Anchorage, Alaska (low)		
New York, New York (high)		
New York, New York (low)		
Paris, France (high)		
Paris France (low)		

Recording the Data

1. Close the browser window, then click the List button . Click the empty cell at the top of list **L1**. Enter the Celsius scale high temperature for Dallas, then press the down arrow key to move to the next cell. Enter the Celsius low temperature for Dallas, then press the down arrow key to move to the next cell. Continue entering the Celsius temperatures until you have entered all of them into **L1**.
2. Click the empty cell at the top of list **L2**. Enter the Fahrenheit scale high temperature for Dallas, then press the down arrow key to move to the next cell. Enter the Fahrenheit scale low temperature for Dallas, then press the down arrow key to move to the next cell. Continue entering the Fahrenheit temperatures until you have entered all of them into **L2**.

When you are finished, check to be sure that **L1** and **L2** match your data table values exactly.

3. Click the Scatter Plot button , and then click the Stat Plots tab. In the uppermost text box, type **L1** to specify it as the list containing the x coordinates. Press the Tab key to move to the second text box, and type **L2** to specify the list containing the y -coordinates.



4. Press Enter, and then click the Zoom Statistics button . The viewing boundaries adjust automatically to show all the plotted data.
5. The plot of Fahrenheit temperatures versus Celsius temperatures should be linear and increasing. If you are not satisfied with your results, check to see that your temperatures are entered properly.

If you are satisfied with your data, make a sketch of the Fahrenheit versus Celsius data that you collected on the axes on a blank grid in the Appendix. Label the horizontal and vertical axes on your sketch.

6. Click the Save to Document button  to save the graph in your TI InterActive! document.

Analysis and Questions

1. Click the Graph close box . Choose **Yes** when asked if you want to save changes. Click the Data Editor close box  to return to the main document.

You can model the Fahrenheit versus Celsius data using a linear equation of the form $y = mx + b$. To start, you will need to compute the slope of the line using the formula:

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

In this case, the y -values have been recorded in list **L2** and the x -values have been recorded in list **L1**. To find the slope, use the first two elements in each list. Click the Math

Box button  and enter the slope expression exactly as shown below:

$$(L2[2] - L2[1]) / (L1[2] - L1[1])$$

Press Enter to compute the slope. Enter the resulting value, to two decimal places, in the space below:

$m =$

2. To find the y -intercept, b , in the linear equation $y = mx + b$, you will first need to choose any one of the data points you collected and identify the x -value (Celsius temperature) and corresponding y -value (Fahrenheit temperature) below:

$x =$

$y =$

Now substitute the number values for m , x , and y from above into the equation $y = mx + b$ and record the resulting equation below.

3. Your equation should contain only one unknown value, b . Use the space below to solve for b using basic algebra techniques, then record the b -value.

$b =$

TI InterActive!™ has a built-in feature that allows you to solve for an unknown. Click the



Math Box button, and type the **solve** command exactly as shown below, using the same number values for x , y , and m that you used above:

solve(y=m*x+b, b)

The only variable in the equation should be b . The b at the end of the **solve** command tells the computer to solve the equation for b . Press Enter to execute the command. How does the b -value found by the computer compare to the value you found using basic algebra techniques?

4. Double-click on the graph in the TI InterActive! document to refresh the Graph window. Click the $f(x)$ tab in the upper left corner of the Functions window. Type **f(x):= m*x + b** in the uppermost text box of the $f(x)$ tab, using the numerical value for m and b from above. Press Enter to superimpose the graph on the plotted data. How well does the linear model you found fit the data set?
5. TI InterActive! lets you check the value of m and b you found by calculating the line of best fit.
- Click the Graph close box  to return to the Data Editor.
 - Click Statistical Regressions .

- c. Click the down arrow  next to Calculation Type, scroll down the list and click on **Linear Regression (ax + b)**. In the text box labeled **X List**, type **L1**. In the box labeled **Y List**, type **L2**. Click **Calculate** to find the regression equation, $y = ax + b$, and its variables. Record the regression equation values of a and b below:

$y = ax + b$
$a =$
$b =$

Click **Save Results**. TI InterActive!™ stores the results in variables, closes the Statistical Regressions tool, and displays the selected results in your document.

How does the value of a in the linear regression equation compare with the m -value and b -value you found using algebraic techniques?

6. Double-click on the graph in the TI InterActive! document to refresh the Graph window. In the second text box of the $f(x)$ tab, type **$f(x) := \text{regeq}(x)$** and then press Enter. TI InterActive! graphs the equation that was created as the Statistical Regressions Result together with the linear model you entered earlier.

Which equation seems to fit the data better?

7. You can use the equations you found in this activity to predict a Fahrenheit temperature for any given Celsius temperature. Click  in the upper-right

corner of the Graph window to display the table screen. Click Table Setup . Set the Independent Mode to **Ask** and the Dependent Mode to **Auto**, as shown below, then click **OK**.

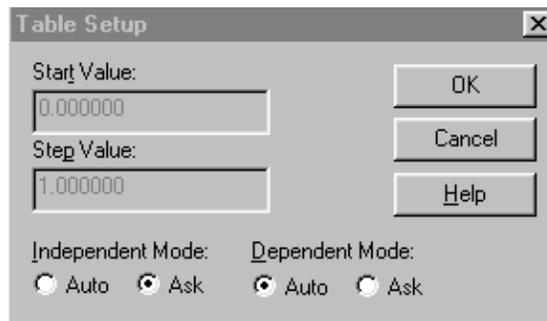


Table Setup

Start Value:

Step Value:

Independent Mode: Auto Ask

Dependent Mode: Auto Ask

OK Cancel Help

An empty table is displayed. As you enter values for the independent variable (x), values for the dependent variable (y), will be generated using the equations in the function editor.

To start, type the number **100** (corresponding to 100 degrees Celsius, the boiling point for water) into the first x -cell, then click on the corresponding y -cell to display corresponding Fahrenheit temperature. Repeat for $x = 22$ (corresponding to 22 degrees Celsius, room temperature), and record your values in the second column of the table below.

Celsius temperature	Fahrenheit temperature (model)	Fahrenheit temperature (regression)
100		
22		

How do the results compare with known Fahrenheit temperatures for boiling water and room temperature?

8. Save and print your TI InterActive!™ document.

Extensions

- ♦ Use the data you collected together with the TI InterActive! tools used in this activity to build a mathematical model that converts Fahrenheit temperatures to Celsius temperatures.
- ♦ Find a physical science or physics textbook that gives a conversion formula from Celsius temperatures to Fahrenheit temperatures. How does this conversion formula compare to the linear model you found in this activity?

Teacher Notes

Activity 5: Two Hot, Two Cold



Math Concepts

- ◆ Internet Data Collection
- ◆ Tables
- ◆ Linear Function

Activity Notes

- ◆ Start by asking students to describe the differences between Celsius and Fahrenheit temperatures. Can they predict what a graph of Fahrenheit versus Celsius would look like?
- ◆ If you do not have access to the Internet, you can use temperature listings in *USA TODAY*® for data.

Sample Data

City	Celsius Temperature	Fahrenheit Temperature
Dallas, Texas (high)	22	72
Dallas, Texas (low)	9	48
Anchorage, Alaska (high)	-13	8
Anchorage, Alaska (low)	-21	-7
New York, New York (high)	12	55
New York, New York (low)	1	35
Paris, France (high)	3	39
Paris, France (low)	-1	30

Analysis and Questions - Key

1. $m = 1.83$.
2. $x = 22, y = 72; 72 = 1.83(22) + b; b = 31.76$.
3. $b = 31.76$. They have the same value.
4. The line fits the data reasonably well.
5. $a = 1.845, b = 32.232$. They match closely.
6. The regression equation seems to fit the data slightly better.
7. For $C = 100$, $F(\text{model}) = 214.76$ and $F(\text{regression}) = 216.76$. For $C = 22$, $F(\text{model}) = 72.02$ and $F(\text{regression}) = 72.83$. These values agree with the actual Fahrenheit values for boiling water (212 degrees F) and room temperature (about 70 degrees F).