Interpolation

Subject: Science, math
Grade: 6-8
Time: 40 minutes

Topic: Reading Graphs
Designer: Nathan Kimball

Stage 1 – Desired Results

Lesson Overview: In this activity students work with the direct linear relationships between temperature in the environment and cricket chirping rate. Students will have practice finding a linear trend in experimental data using a graph, learn how to interpolate between data points on a graph, find the equation of a linear relationship using the slope-intercept method, and calculate values with that relationship. Context and scaffolding is provided to support the development of these skills.

Standards Addressed:

CCSS.Math.Content.6.RP.A.3	Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations.
NGSS MS-PS3-1	Analyzing data in 6–8 builds on K–5 and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. Construct and interpret graphical displays of data to identify linear and nonlinear relationships.
CCSS.Math.Content.7.RP.A.2	Recognize and represent proportional relationships between quantities.

Students will be able to:

- Find a linear trend in experimental data
- Estimate values not part of the original data using a graph through linear interpolation
- Determine a linear relationship between variables using the slope-intercept method
- Calculate the unknown variable using this linear relationship

Essential Questions:

- How does recognizing a relationship between two or more data points allow you to make inferences about the points in between them?
- How can you estimate the value of a variable based on a line graph the other variable?
- Given a linear relationship between two variables, how can you calculate one value given the other?

Stage 2 – Lesson Plan

Lesson preparation

This activity is designed to give students practice with linear relationships in graphical and algebraic form. As such, students should

- have basic graph reading skills, e.g., can interpret scales and labels with units on graph axes
- be familiar with the concepts of slope, intercept, and linear relationships
- be familiar with the slope-intercept form of a line
- be able to solve simple linear functions for either variable

Procedure

1. Students will use computers/tablets for this activity. Calculators, will be useful for the later questions in the activity. Students can use the calculator built into the device they are using. The activity takes about 30-40 minutes.

2. You may wish to bring the class together after students work on this activity. Possible discussion questions are provided below.

3. As an extension, the worksheet at the end of this lesson provides practice with two more examples of linear relationships. Both activities relate to temperature, and each one takes about 20 minutes. They can be assigned together or singly. In the first activity, students practice finding trends with different cricket data, interpolating from a graph, and developing a linear equation from a graph. In the second activity, students create a conversion graph for Celsius to Fahrenheit from the known data of the freezing point and boiling point of water. They use the graph to estimate corresponding temperatures, and then find the conversion formula.

Further discussion questions

1. **You discovered the equation to find temperature in degrees Celsius from chirp rate. What if you wanted to find the reverse, that is, an equation to find the chirp rate from the temperature? Think of different ways to solve this problem.**
   This could be solved algebraically or by re-plotting the graph with the x and y variables reversed using the slope-intercept procedure. Do students have other ideas?

2. **You have discovered a new species of cricket. How would you conduct an investigation to find out the chirp rate to temperature relationship of this species? What equipment would you need? How long would it take? How would you be sure that your data is correct? How would you record your data and summarize your findings?**
   Have students imagine that they are biologists investigating a cricket new to science. Ask what they think would be needed to carry out a chirp rate study. How many things can they think of? Student may think of obvious physical equipment such as, a thermometer, a timer, and recording paper, but do they also think about varying temperature conditions so that they can assess change? Would they also think about gathering data on several nights, to be sure the data are linear. How would they corroborate their data and present it to others?

3. **With the cricket chirp rate data, you were able to interpolate points within the range of the experimental data. Would it be valid to estimate temperatures with chirp rates outside the range of the experimental data? (Extending the line outside the available data is called *extrapolation*.)**
   In many instances, and particularly in the case of a biological system like crickets, extrapolation may not provide reliable estimation. To fully describe how crickets chirp, it would be good to define the applicable range along with the equation.

Name:_____ Date:_____

Interpolation Post-Activity: More Crickets

When investigating a new species of cricket, students made measurements of cricket chirp rate vs. temperature shown below. They logged their measurements with temperature in degrees Fahrenheit:

Chirps per minute	Temperature (in Fahrenheit degrees)
40	51ºF
62	54ºF
79	58ºF
102	66ºF
123	72ºF
143	82ºF

1) Plot the data in the table above on graph paper. Then draw the trend line using a ruler or straight-edge.

2) If the cricket is chirping 48 times per minute, what is the temperature? _____

3) If the temperature is 76ºF, how many chirps would you expect per minute? _____

4) Create a formula that will convert from chirp rate to degrees Fahrenheit?

5) Use your formula to find the temperature when the chirp rate is 110 chirps per minute. (Check with interpolation.)

6) Use your formula to find the number of chirps per minute when the temperature in degrees Fahrenheit is 69.

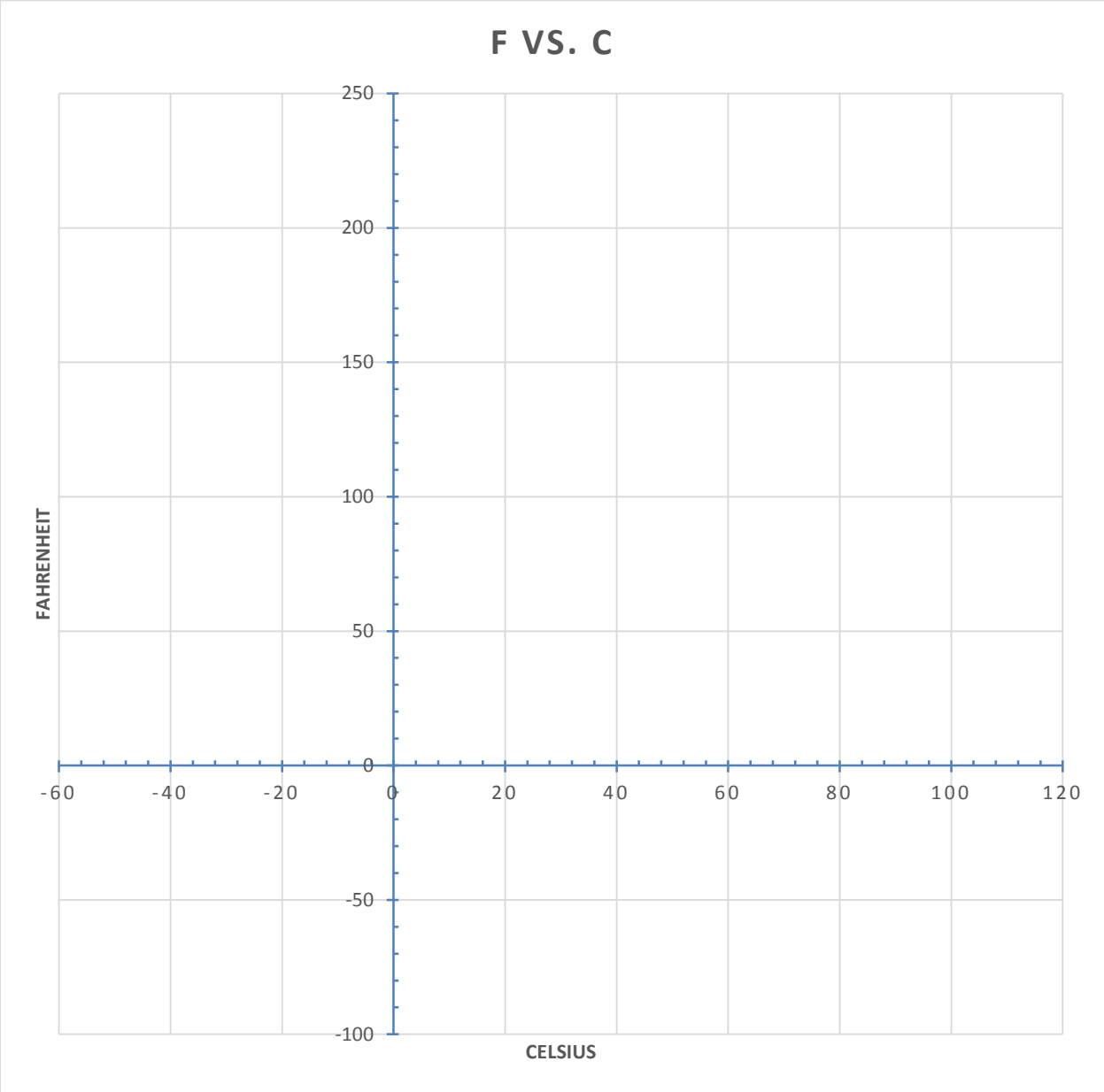
Name:_____ Date:_____

Interpolation Post-Activity: Conversion Graph for Celsius to Fahrenheit

The freezing and boiling points of water are two well-known corresponding values on the Celsius and Fahrenheit temperature scales. This is all the data that is needed to create a graph for converting between the two temperature scales because the relationship of the scales is linear.

Water	Celsius	Fahrenheit
Freezing Point	0	32
Boiling Point	100	212

1) Plot these two points on the graph below and connect them with a straight line.



2) **Using your knowledge of temperatures around you, and interpolating from the graph, fill in the table below in round numbers.**

	Celsius	Fahrenheit
A comfortable room temperature		
Temperature of a hot shower		
Temperature of your refrigerator		
Temperature of your freezer		

3) **Use the slope-intercept method to find the equation for the conversion of Celsius to Fahrenheit. Clearly show your slope, y-intercept, and the whole equation. Try to write the slope in reduced fractional form and also in decimal form.**

4) **Use your equation to convert the data in the following table. Round answer to the nearest who number.**

Celsius	Fahrenheit
0	
	212
16	
32	
	0
	-40