Name: ______________________________________ Date: ____________________ Class: ___________________

Hot Chocolate Worksheet Answer Key

1. *Prediction*: At what temperature would it be BEST to drink hot chocolate? Make an estimate in ^{o}C.

   Answers will vary. *Example answer*: 27 ^{0}C

2. *Prediction*: Assuming you start with boiling water (100 ^{o}C), how long do you think it would take for hot chocolate to cool to that ideal drinking temperature?

   Answers will vary. *Example answers*: 8 minutes.

3. Why did you choose this time? What factors did you take into account?

   Answers will vary. Example: 27 ^{0}C (or 80 ^{0}F) is a good temperature. Humans are very comfortable in 80 ^{0}F weather, so it makes sense that hot chocolate should be around the same temperature when we drink it. My personal experience with hot chocolate has shown that if I wait a little less than 10 minutes, my hot chocolate is usually ready to drink.

4. After receiving the boiling water, carefully mix the hot chocolate mix into the water. *Don't drink it!* Be ready to use a thermometer to measure its temperature at the times listed in the table below. Record your data in the table. Answers will vary; example answers provided in the table.

Time After Mixing	Temperature (°C)
0 minutes	100 °C
2 minutes	71 °C
5 minutes	47 °C
8 minutes	35 °C
11 minutes	26 °C
13 minutes	25 °C

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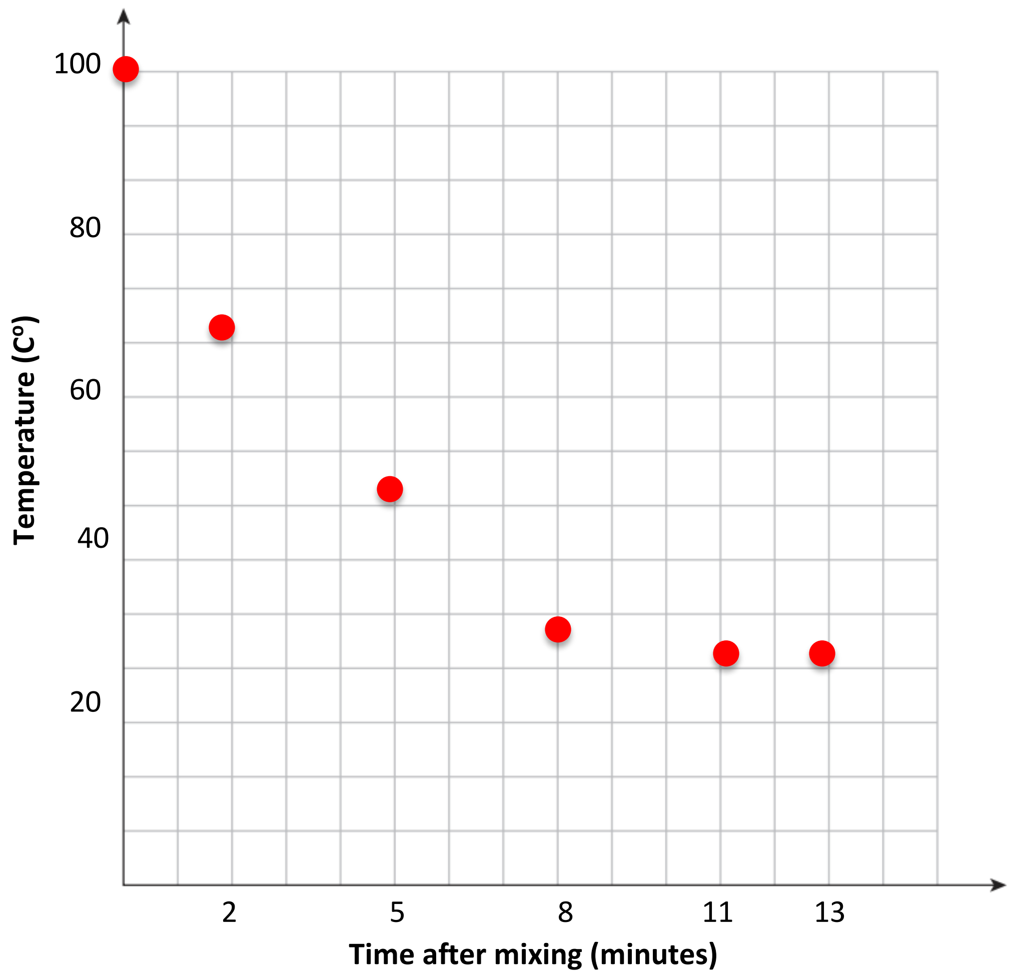
5. Graph your data on the grid below. Example plotted data.



6. What do you notice about the graph? What do you wonder?

   Answers will vary. *Example answer*: The graph shows a decreasing line. The temperature goes down steeply between 0-5 minutes, then decreases more slowly.

7. How long did it take for the hot chocolate to reach the time you predicted? (It is okay to estimate an answer.)

   Example answer: A little less than 11 minutes.

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Research shows that the optimal temperature to drink a hot beverage is 57 °C.

8. Write an exponential regression equation that models the temperature of the hot chocolate vs. time. Round each of your coefficients to the *nearest thousandth*.

   $y = 89.399(0.898)^x$ where *y* is the temperature of the hot chocolate and *x* is time, in minutes

9. Find the correlation coefficient, rounding it to the *nearest thousandth*. Explain how well your regression models your data.

   r = -0.984

   Since the correlation coefficient is very close to 1, my equation is an excellent model for the data.

10. Determine when, to the nearest second, the hot chocolate reaches *57* °C.

$$57 = 89.399(0.898)^x$$

$$\frac{57}{89.399} = 0.898^x$$

$$\log\left(\frac{57}{89.399}\right) = \log\left(0.898^x\right)$$

$$\log\left(\frac{57}{89.399}\right) = x \log 0.898$$

$$\frac{\log\left(\frac{57}{89.399}\right)}{\log 0.898} = x$$

$$4.2 \text{ minutes} \approx x$$

It would take 4 minutes and 12 seconds for the hot chocolate to reach 57°.

Page 1 glass of hot chocolate photo source: © 2016 Charles M. Carlson. Used with permission.