Hot Chocolate Worksheet Answer Key

1. Prediction: At what temperature would it be BEST to drink hot chocolate? Make an estimate in °C.

   Answers will vary. Example answer: 27 °C

2. Prediction: Assuming you start with boiling water (100 °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 °C (or 80 °F) is a good temperature. Humans are very comfortable in 80 °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.

<table>
<thead>
<tr>
<th>Time After Mixing</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 minutes</td>
<td>100 °C</td>
</tr>
<tr>
<td>2 minutes</td>
<td>71 °C</td>
</tr>
<tr>
<td>5 minutes</td>
<td>47 °C</td>
</tr>
<tr>
<td>8 minutes</td>
<td>35 °C</td>
</tr>
<tr>
<td>11 minutes</td>
<td>26 °C</td>
</tr>
<tr>
<td>13 minutes</td>
<td>25 °C</td>
</tr>
</tbody>
</table>
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.
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.

\[
57 = 89.399 \times (0.898)^x
\]
\[
\frac{57}{89.399} = 0.898^x
\]
\[
\log \left( \frac{57}{89.399} \right) = \log (0.898^x)
\]
\[
\log \left( \frac{57}{89.399} \right) = x \log 0.898
\]
\[
\log \left( \frac{57}{89.399} \right) = \frac{x \log 0.898}{\log 0.898}
\]
\[
4.2 \text{ minutes} \approx x
\]

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