Graphs Tell A Story: Paul and the Coffee

Date:_____

Subject: Math/Science
Grade: 6-7
Time: 45 minutes

Topic: Reading Graphs
Designer: Sara Remsen

Stage 1 – Desired Results

Lesson Overview: This activity examines a story and asks students to match the varied line shapes shown on a graph to different parts of the story. This activity is intended for middle school math students who are learning how graphing relates to real-world experiences. Students should have a basic understanding of how to read a graph (but understanding slopes is not necessary). By the end of the activity, students will be able to construct and read graphs that faithfully represent processes that take place over time.

Standards Addressed:

CCSS.Math.Content.6.NS.C.8	Solve real-world and mathematical problems by graphing points in all four quadrants of the coordinate plane. Include use of coordinates and absolute value to find distances between points with the same first coordinate or the same second coordinate.
CCSS.Math.Content.6.EE.C.9	Use variables to represent two quantities in a real-world problem that change in relationship to one another; write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation.
CCSS.Math.Content.7.RP.A.2	Recognize and represent proportional relationships between quantities.

Students will be able to:

- Read graph axes
- Interpret real events that take place over time
- Match graphs to the story
- Distinguish between increasing and decreasing temperature over time

Essential Questions:

- How are changes in a real-world setting reflected on a graph?
- How are heating and cooling represented on a graph?
- How can changing the axes on a graph affect whether a graph represents a story?

Stage 2 – Lesson Plan

Lesson preparation

- Students should understand how to measure temperature. It would be useful to identify examples of different (approximate) Fahrenheit temperatures (e.g., ice, boiling water, room temperature, body temperature, a hot shower, etc.).
    - This is also an opportunity to explore "relative" temperature—like why pizza might feel hot in your hand but warm in your mouth (because your hand has a much lower temperature than mouth, which is your internal body temperature of ~98.6˚ F).
- Students should be able to read graph axes.
- Students should be familiar with plotting points on a graph and with ordered pairs i.e. (0,0).
- No knowledge of slope is necessary.

Procedure

1. Students will use computers/tablets for this activity (20-30 minutes).

2. As an **extension** (10-20 minutes), you can print out the graphs on the last pages of this lesson plan. These graphs are similar to but not exactly the same as the graphs the students see on the computer activity.

3. Then, either continue the discussion by asking students to pick a graph that they think represents the story in the activity and then have a discussion, OR

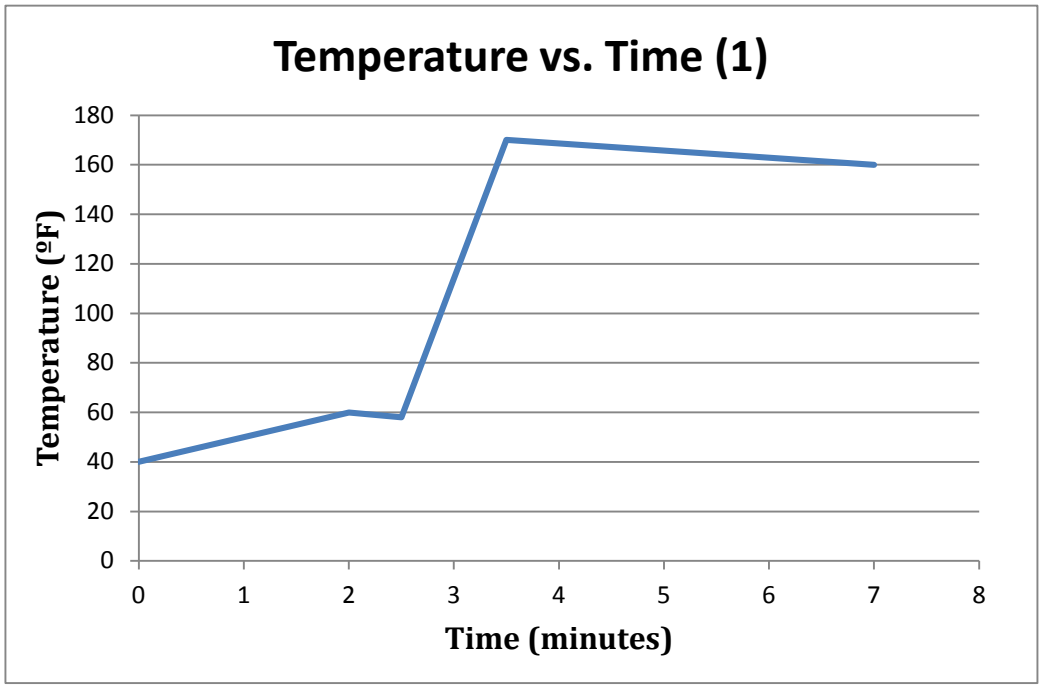
4. Assign a pair of students to each graph and ask them to explain why it is wrong (except for graph 3, which is correct). You could set up the pairs so that they each explain to another group for another 15 minutes.

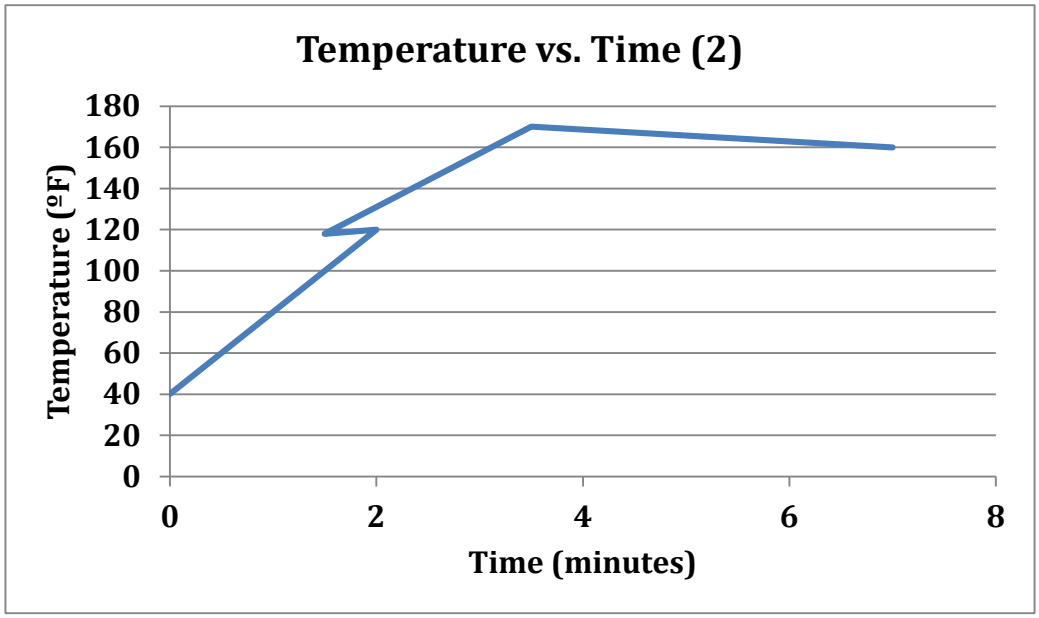
5. Further discussion: http://graphingstories.com/ contains a collection of videos of processes that take place over time, each linked to a graph of the process.

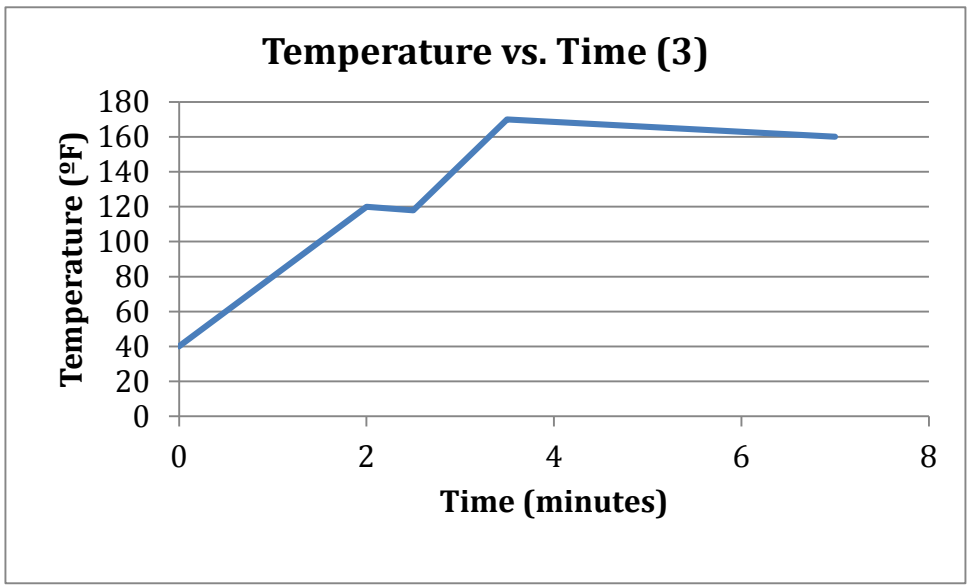
Further discussion questions

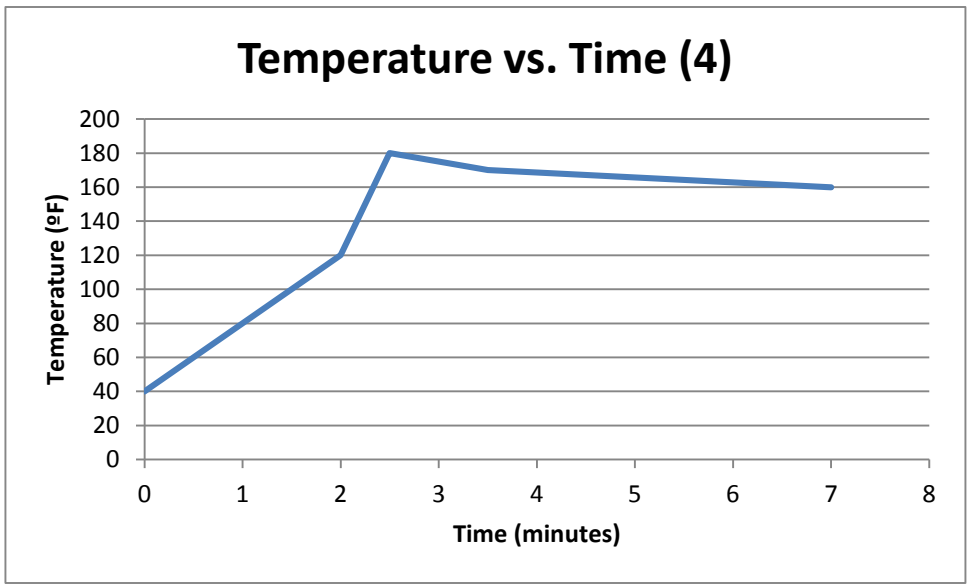
1. **Looking at this correct graph, how cold was the refrigerator that stored the coffee?** About 40 degrees.
2. **Why do you think we measured the temperature in degrees Fahrenheit instead of Celsius?** Even though scientists more often use Celsius, most students and adults are probably more familiar with Fahrenheit.
3. **(Introduce slope by comparing between graphs) What can you tell me about how fast it was heating up compared to how fast it was cooling down (graph a vs. b)? Ask students to count how many degrees it changed for 1 minute in the microwave.** They should be able to tell you that the coffee was heating up faster in the microwave than it was cooling down and that a flat line showed it wasn't heating at all.
4. **What is wrong with Graph #2?**
   Graph #2 shows time going backwards. This is impossible because even though the coffee is cooling, time is still moving forwards.
5. **Ask students to explain how thermostats work in their house. What would a graph of temperature vs. time be during the heating season or the cooling season?**
   A thermostat works by turning on a heater or cooler at a given "setpoint" temperature and turning them off at a small differential above or below the setpoint. When the thermostat detects the setpoint, it will either increase heating (winter) or increase cooling (summer) to keep the temperature between the setpoint and the differential temperature.

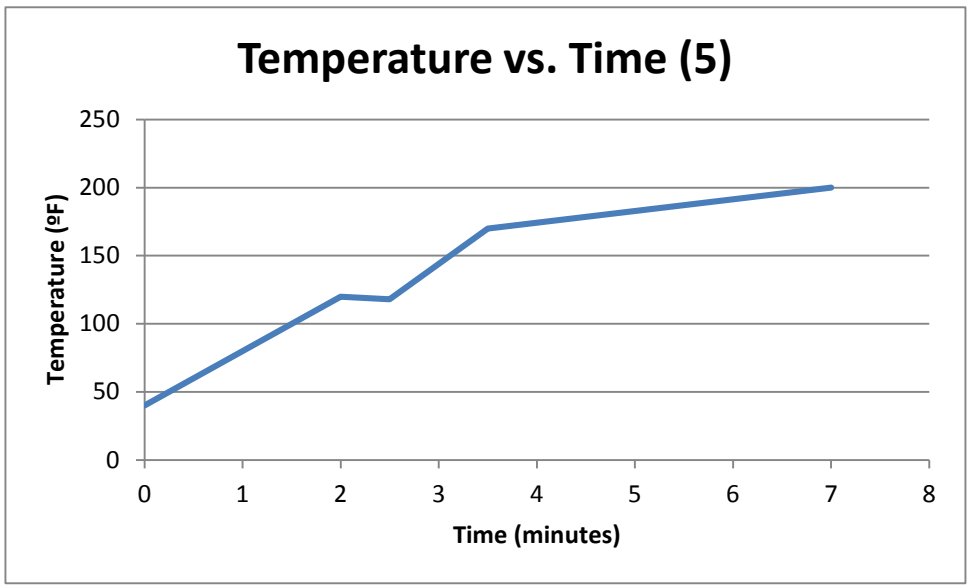
Resource Graphs

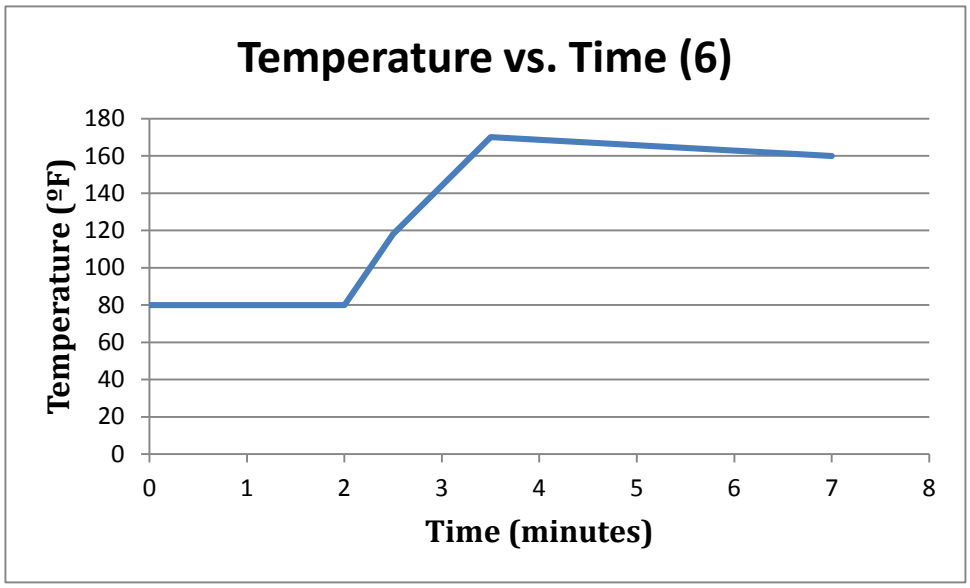


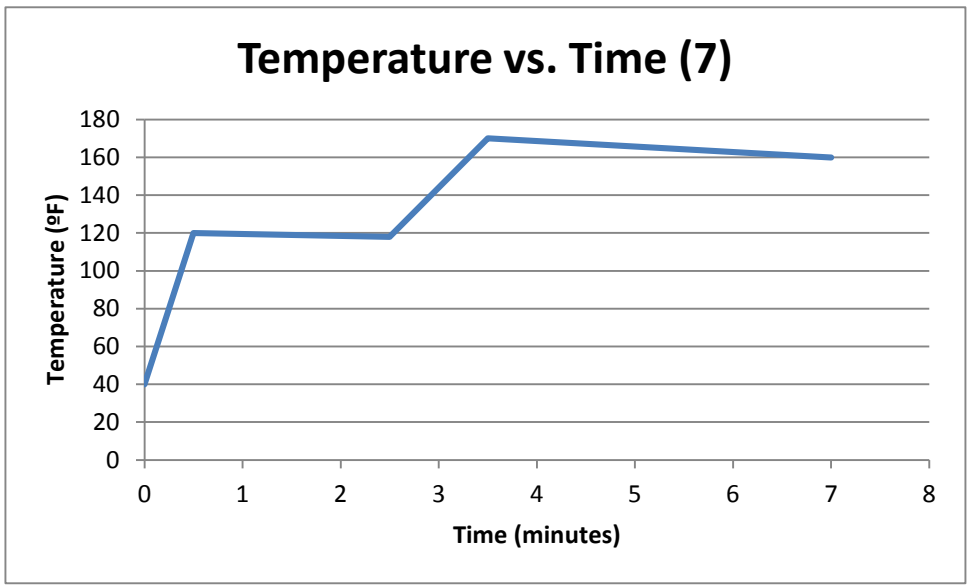



Temperature vs. Time (3)
Temperature (ºF)
180
160
140
120
100
80
60
40
20
0
0
2
4
6
8
Time (minutes)


Temperature vs. Time (4)
Temperature (ºF)
200
180
160
140
120
100
80
60
40
20
0
0
1
2
3
4
5
6
7
8
Time (minutes)


Temperature vs. Time (5)
Temperature (ºF)
250
200
150
100
50
0
0
1
2
3
4
5
6
7
8
Time (minutes)


Temperature vs. Time (6)
Temperature (ºF)
180
160
140
120
100
80
60
40
20
0
0
1
2
3
4
5
6
7
8
Time (minutes)


Temperature vs. Time (7)
Temperature (ºF)
180
160
140
120
100
80
60
40
20
0
0
1
2
3
4
5
6
7
8
Time (minutes)