6:3 South Pole Temperatures

Teacher Notes

Central math concepts

How large a number system do we need for mathematics? Students in the elementary grades have solved so wide an array of problems using only the positive fractions that it may seem unnecessary to extend the number system any further. But there are many contexts in which signed numbers are a good model for real-world quantities. Examples include temperature above/below zero, elevation above/below sea level, credits/debits, in-migration/out-migration across a state line or national border, changes in an index such as the stock market or in a rate such as the poverty rate, physical entities like positive/negative electric charge, and the study of motion itself, which is based on measuring an object's position left/right, up/down, and forward/back relative to a reference point in space.

Temperature is one important use of positive and negative numbers in everyday life. Worldwide, most people refer to temperatures as measured on the Celsius scale, but the Fahrenheit temperature scale is predominant in the United States. Temperatures on the Fahrenheit scale can be positive, negative, or 0, although the 0 point of the Fahrenheit scale does not have scientific significance. (On the Celsius scale, the 0 point indicates the temperature at which a quantity of H_2O can exist as either water or ice. For positive Celsius temperatures, H_2O is water, while for negative Celsius temperatures, H_2O is ice.)

The introduction of negative numbers extends the number line by reflecting the positive numbers across 0. Furthermore, with the introduction of negative numbers, points can be plotted in every quadrant of the entire coordinate plane relative to the origin (0, 0).

Students' statistical work in grade 6 centers on univariate measurement data. A set of univariate measurement data is a list of numbers that are measurements in context relative to a specified unit. (For a task about a set of univariate measurement data, see **6:7 Song Length Distribution**.) By contrast, the data table in task 6:3 presents a set of bivariate measurement data. A set of bivariate measurement data is conceptually a list of pairs of coordinated measurements. For example, the pair of numbers (-4, -42) records the fact that 4 hours before midnight, the temperature was -42°F. When plotted on the marvelous representational device of the coordinate plane, that single fact becomes a single point; and the totality of recorded facts forms a spatial pattern.

Relevant prior knowledge

The following mathematics knowledge may be activated, extended, and deepened while students work on the task: choosing scales on graph paper to plot points; relating order properties of negative numbers to ideas of increase/decrease; and describing patterns.

6:3 The table shows temperatures at the South Pole before and after midnight on October 10–11, 2019.

Time	Hours after Midnight	Temp °F
8:00 pm	−4	−42
9:00 pm	−3	−42
10:00 pm	−2	−41
11:00 pm	−1	−40
Midnight	0	−39
1:00 am	1	−39
2:00 am	2	−38

Plot the data on graph paper and label the plot. Describe any patterns you see.

Answer

See example plot. Characteristics of a strong data plot:

- There is an overall title (such as "South Pole Temperatures" or similar).
- There is a horizontal axis title (such as "Hours after midnight" or similar) and a vertical axis title (such as "Temperature °F" or similar).
- Axis titles indicate the units of measure for each scale.
- On both horizontal and vertical axes, numbers are present to mark the scales.
- Showing the clock times is optional.
- Connecting the data points with straight segments is optional.†
- Data values should be increasing upwards and to the right.

In describing patterns, answers may vary but should include the observation that temperatures showed a warming trend over the time period shown. Other observations that could be made are that the temperature was very cold over the time period shown, that the temperature was between -42°F and -38°F over the time period shown, and that the temperature was never observed to decrease.

Extending the task

How might students drive the conversation further?

- Students could use rate language to describe the temperature trend during the period between 9pm and midnight.
- Students could use the internet to check current weather conditions at the South Pole and collect data over time to display and summarize.

Related Math Milestones tasks

6:5

6:5 **(1)** Which of the numbers 5, −7, $\frac{2}{3}$, $-\frac{1}{2}$ is farthest from 0 on a number line? Which is closest to 0? **(2)** True or False: $\frac{1}{2} > -8$. **(3)** Explain why $-(-0.2) = 0.2$ makes sense.

6:12

6:12 **(1)** What is the area of the triangle in the coordinate plane with vertices (1, 2), (−5, 2), and (−8, 9)? **(2)** How does the area change if we change the third vertex to (−3, 9)?

7:12

7:12 In 1972 in Loma, Montana, the temperature changed from −54°F to +49°F in a 24-hr period. Calculate the average rate at which the temperature changed. Answer to the nearest tenth in units of degrees/hr.

8:8

8:8 A researcher asked people doing exercise to rate their effort level. The researcher also measured people's heart rates. Data were taken on two different days. **(1)** Use technology to plot the data from both days. (View heart rates in a window from 145 to 175.) Describe the main patterns you see. **(2)** On one of the days, the exercise room was warm, and on the other day, the room was cool. Which day do you think was the warm day? Tell how you decided, and support your answer with calculations.

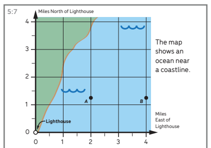
Heart Rate & Effort in Exercise

Day 1 HR, Effort	Day 2 HR, Effort
150.9, 1.3	148.6, 1.6
155.2, 1.5	152.7, 1.9
158.5, 1.8	153.9, 2.3
159.4, 2.1	155.4, 2.9
161.2, 2.1	156.6, 2.9
162.2, 2.3	157.9, 3.1
163.5, 2.4	158.9, 3.6
163.5, 2.7	159.7, 3.7
164.8, 2.7	160.6, 4.1
166.3, 2.9	161.3, 4.2
167.2, 3.0	162.3, 4.3
167.2, 3.3	162.4, 4.6
168.1, 3.4	163.4, 4.7
169.2, 3.4	164.2, 4.8
169.2, 3.5	164.8, 4.7
170.3, 3.5	165.0, 5.0
170.8, 3.6	165.4, 5.1
170.4, 3.7	167.0, 5.2
171.9, 3.7	166.5, 5.3
172.3, 3.9	166.7, 5.4

Click here to get the data online. Each person's heart rate (beats per min.) and effort (1–6 scale) were recorded every 3 min. A group average was then calculated, creating one data point such as (150.9, 1.3).

5:7

5:7



The map shows an ocean near a coastline.

Shipwrecks are at locations A $(2, 1\frac{1}{4})$ and B $(4, 1\frac{1}{4})$. Shipwrecks are also at locations C $(4, 3\frac{1}{2})$ and D $(2, 3\frac{1}{2})$. **(1)** Mark C and D on the map and shade rectangle $ABCD$. **(2)** Some believe there is sunken treasure in the region you shaded. How large is that region in mi^2?

Task **6:5 Positive and Negative Numbers** involves concepts of rational number ordering and magnitude. In task **6:12 Coordinate Triangle**, some of the coordinates of the triangle vertices are negative.

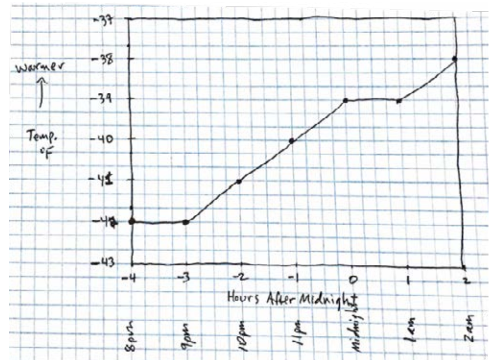
In later grades, the given information for task **7:12 Temperature Change** could be plotted in a similar way to the temperature data in task 6:3. Task **8:8 Heart Rate and Effort in Exercise** involves two distributions of bivariate data.

In earlier grades, task **5:7 Shipwrecks** involves the positive quadrant of the coordinate plane.

† From the Progression document, p. 12: "It is traditional to connect ordered pairs with line segments in such a graph, not in order to make any claims about the actual temperature value at unmeasured times, but simply to aid the eye in perceiving trends."

* Math Milestones™ tasks are not designed for summative assessment. Used formatively, the tasks can reveal and promote student thinking.

Answer (continued)



Click here for a student-facing version of the task.

Refer to the Standards

6.NS.C.7, 8; MP.2. Standards codes refer to www.corestandards.org. One purpose of the codes is that they may allow a task to shed light on the Standards cited for that task. Conversely, reading the cited Standards may suggest opportunities to extend a task or draw out its implications. Finally, Standards codes may also assist with locating relevant sections in curriculum materials, including materials aligned to comparable standards.

Aspect(s) of rigor:

Concepts, Application

Additional notes on the design of the task

The data source for the table was a website giving historical data about temperatures at the Amundsen-Scott South Pole Station.

Curriculum connection

1. In which unit of your curriculum would you expect to find tasks like 6:3? Locate 2-3 similar tasks in that unit. How are the tasks you found similar to each other, and to 6:3? In what specific ways do they differ from 6:3?
2. Thinking about the curriculum unit you identified, at what point in the unit might a task like 6:3 help students converge toward grade-level thinking about the important mathematics in the task? What factors would you consider in choosing when to use such a task in the unit?*

Anticipating and responding to student thinking about the task

Imagine how students might think about the task, and what you might see and hear while they work.

On this page, you can write your thoughts on the following questions.

Solution Paths

- What solution paths might you expect to see?
- What representations might you see? What correspondences between those representations might be noticed by students (or be worth pointing out to students) and discussed by them?
- What misconceptions or partial understandings might be revealed as students work on the task? How could you respond to these positively and productively?

Language

- What might you expect to hear from students engaged with the task? What does that language reveal about their mathematical thinking, and how might you respond to different ways of thinking?
- If students are using early English or using multiple languages in an integrated communication system, how might you help their classmates see those mathematical ideas as valuable?
- Even when using nascent language, students are thinking and communicating their thinking. What might it look like to respond positively and productively to the mathematics in their thinking before giving feedback on the language used?

Identity, Agency, and Belonging

- How can you engage students' interests, experiences, or funds of knowledge?
- How can you build students' self-confidence as learners, thinkers, and doers of mathematics?
- What choices are there for a student to make in the task? How can you build students' agency to the point where they notice and make these choices to solve problems?
- How might one use feedback to build student agency? Where might there be opportunities to build students' self-confidence?