



Lesson 1: Positive and Negative Numbers on the Number Line—Opposite Direction and Value

Student Outcomes

- Students extend their understanding of the number line, which includes zero and numbers to the right or above zero that are greater than zero and numbers to the left or below zero that are less than zero.
- Students use positive integers to locate negative integers by moving in the opposite direction from zero.
- Students understand that the set of integers includes the set of positive whole numbers and their opposites, as well as zero. They also understand that zero is its own opposite.

Lesson Notes

Each student needs a compass to complete the Exploratory Challenge in this lesson.

Classwork

Opening Exercise (3 minutes): Number Line Review

Display two number lines (horizontal and vertical), each numbered 0–10. Allow students to discuss the following questions in cooperative learning groups of three or four students each.

Students should remain in the groups for the entire lesson.

Discuss the following:

- What is the starting position on both number lines?
 - 0 (*zero*)
- What is the last whole number depicted on both number lines?
 - 10 (*ten*)
- On a horizontal number line, do the numbers increase or decrease as you move farther to the right of zero?
 - *Increase*
- On a vertical number line, do the numbers increase or decrease as you move farther above zero?
 - *Increase*

Scaffolding:

- Create two floor models for vertical and horizontal number lines using painter's tape for visual learners.
- Have a student model movement along each number line for kinesthetic learners.
- Use polling software for questions to gain immediate feedback while accessing prior knowledge.

Exploratory Challenge (10 minutes): Constructing the Number Line

The purpose of this exercise is to let students construct the number line (positive and negative numbers and zero) using a compass.

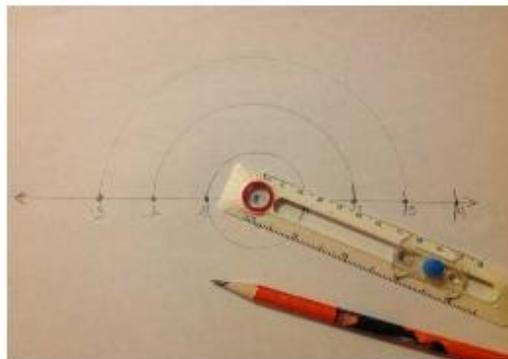
Have students draw a line, place a point on the line, and label it 0.

Have students use the compass to locate and label the next point 1, thus creating the scale. Students continue to locate other whole numbers to the right of zero using the same unit measure.

Using the same process, have students locate the opposites of the whole numbers. Have students label the first point to the left of zero -1 .

Introduce to the class the definition of the opposite of a number.

Sample student work is shown below.



Given a nonzero number, a , on a number line, the opposite of a , labeled $-a$, is the number such that

- 0 is between a and $-a$.
- The distance between 0 and a is equal to the distance between 0 and $-a$.

The opposite of 0 is 0.

- The set of whole numbers and their opposites, including zero, are called **integers**. Zero is its own opposite. The number line diagram shows integers listed in order from least to greatest using equal spaces.

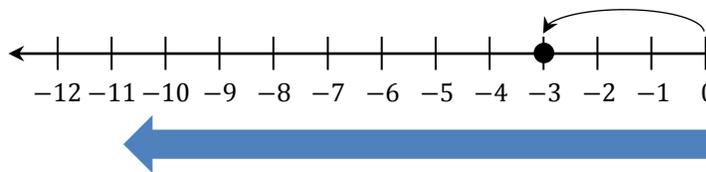
MP.6 Monitor student constructions, making sure students are paying close attention to the direction and sign of a number.

Example 1 (5 minutes): Negative Numbers on the Number Line

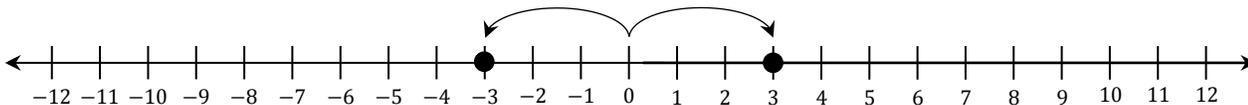
Students use their constructions to model the location of a number relative to zero by using a curved arrow starting at zero and pointing away from zero toward the number. Pose questions to students as a whole group, one question at a time.



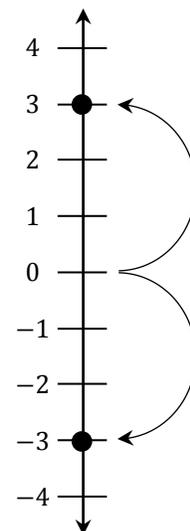
- Starting at 0, as I move to the right on a horizontal number line, the values get larger. These numbers are called *positive numbers* because they are greater than zero. Notice the curved arrow is pointing to the right to show a positive direction.
- How far is the number from zero on the number line?
 - 3 units
- If 0 was a mirror facing toward the arrow, what would be the direction of the arrow in the mirror?
 - To the left
- Would the numbers get larger or smaller as we move to the left of zero?
 - Smaller
- Starting at 0, as I move farther to the left of zero on a horizontal number line, the values get smaller. These numbers are called *negative numbers* because they are less than zero. Notice the curved arrow is pointing to the left to show a negative direction. The position of the point is now at negative 3, written as -3 .



- Negative numbers are less than zero. As you move to the left on a horizontal number line, the values of the numbers decrease.



- What is the relationship between 3 and -3 on the number line?
 - 3 and -3 are located on opposite sides of zero. They are both the same distance from zero. 3 and -3 are called *opposites*.
- As we look farther right on the number line, the values of the numbers increase. For example, $-1 < 0 < 1 < 2 < 3$.
- This is also true for a vertical number line. On a vertical number line, positive numbers are located above zero. As we look upward on a vertical number line, the values of the numbers increase. On a vertical number line, negative numbers are located below zero. As we look farther down on a vertical number line, the values of the numbers decrease.
- The set of whole numbers and their opposites, including zero, are called *integers*. Zero is its own opposite. A number line diagram shows integers listed in increasing order from left to right, or from bottom to top, using equal spaces. For example: $-4, -3, -2, -1, 0, 1, 2, 3, 4$.



Allow students to discuss the example in their groups to solidify their understanding of positive and negative numbers.

Possible discussion questions:

- Where are negative numbers located on a horizontal number line?
 - Negative numbers are located to the left of 0 on a horizontal number line.

- Where are negative numbers located on a vertical number line?
 - *Negative numbers are located below 0 on a vertical number line.*
- What is the opposite of 2?
 - -2
- What is the opposite of 0?
 - 0
- Describe the relationship between 10 and -10 .
 - *10 and -10 are opposites because they are on opposite sides of 0 and are both 10 units from 0.*

Example 2 (5 minutes): Using Positive Integers to Locate Negative Integers on the Number Line

Have students establish elbow partners, and tell them to move their fingers along their number lines to answer the following set of questions. Students can discuss answers with their elbow partners. Circulate around the room, and listen to the student-partner discussions.

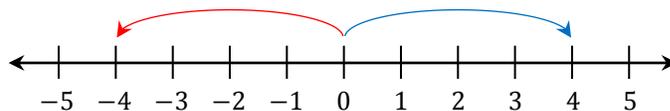
- Describe to your elbow partner how to find 4 on a number line. Describe how to find -4 .
 - *To find 4, start at zero, and move right to 4. To find -4 , start at zero, and move left to -4 .*

Scaffolding:

As an extension activity, have students identify the *unit* differently on different number lines, and ask students to locate two whole numbers other than 1 and their opposites.

Model how the location of a positive integer can be used to locate a negative integer by moving in the opposite direction.

- Explain and show how to find 4 and the opposite of 4 on a number line.
 - *Start at zero, and move 4 units to the right to locate 4 on the number line. To locate -4 , start at zero, and move 4 units to the left on the number line.*
- Where do you start when locating an integer on the number line?
 - *Always start at zero.*
- What do you notice about the curved arrows that represent the location of 4 and -4 ?
 - *They are the same distance but pointing in opposite directions.*



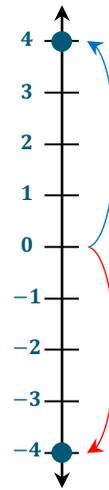
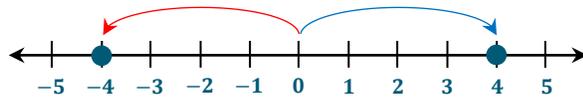
Exercises 1–5 (13 minutes)

Create and display two large number lines on the board, one horizontal and one vertical, each numbered -12 to 12 , for the class. Distribute an index card with an integer from -12 to 12 on it to each group.¹ Students work in groups first, completing the exercises in their student materials. Conclude the exercise by having students locate and label their integers on the teacher's number lines.

¹Depending on the class size, label enough index cards for ten groups (one card per group). Vary the numbers using positives and negatives, such as -5 through 5 , including zero. If each group finds and locates the integer correctly, each group will have a card that is the opposite of another group's card.

Exercises

Complete the diagrams. Count by ones to label the number lines.



1. Plot your point on both number lines.

Answers may vary.

2. Show and explain how to find the opposite of your number on both number lines.

In this example, the number chosen was -4 . So -4 is the first number plotted, and the opposite is 4 .

Horizontal Number Line: I found my point by starting at zero and counting four units to the left to end on -4 . Then, to find the opposite of my number, I started on zero and counted to the right four units to end on 4 .

Vertical Number Line: I found my point by starting at zero and counting four units down to end on -4 .

I found the opposite of my number by starting at zero and counting four units up to end on 4 .

3. Mark the opposite on both number lines.

Answers may vary.

4. Choose a group representative to place the opposite number on the class number lines.

5. Which group had the opposite of the number on your index card?

Answers may vary. Jackie's group had the opposite of the number on my index card. They had 4 .

Closing (2 minutes)

- Give an example of two opposite numbers, and describe their locations first on a horizontal and then on a vertical number line.
 - *For example, 6 and -6 are the same distance from zero but on opposite sides. Positive 6 is located 6 units to the right of zero on a horizontal number line and 6 units above zero on a vertical number line. Negative 6 is located 6 units to the left of zero on a horizontal number line and 6 units below zero on a vertical number line.*

Exit Ticket (7 minutes)



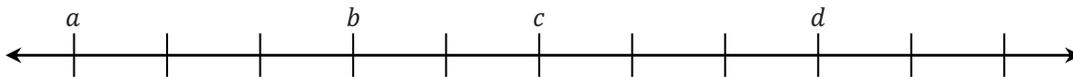
Name _____

Date _____

Lesson 1: Positive and Negative Numbers on the Number Line— Opposite Direction and Value

Exit Ticket

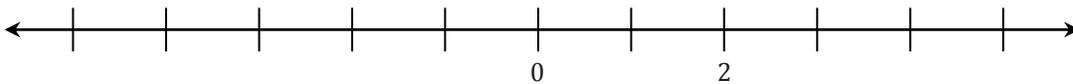
1. If zero lies between a and d , give one set of possible values for a , b , c , and d .



2. Below is a list of numbers in order from least to greatest. Use what you know about the number line to complete the list of numbers by filling in the blanks with the missing integers.

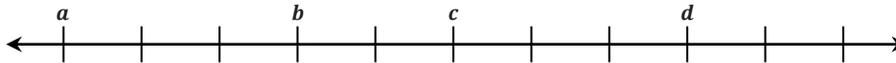
$-6, -5, \underline{\hspace{1cm}}, -3, -2, -1, \underline{\hspace{1cm}}, 1, 2, \underline{\hspace{1cm}}, 4, \underline{\hspace{1cm}}, 6$

3. Complete the number line scale. Explain and show how to find 2 and the opposite of 2 on a number line.



Exit Ticket Sample Solutions

1. If zero lies between a and d , give one set of possible values for a , b , c , and d .



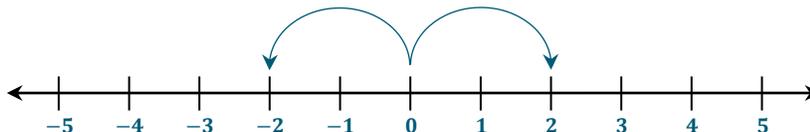
Answers will vary. One possible answer is $a: -4$; $b: -1$; $c: 1$; $d: 4$.

2. Below is a list of numbers in order from least to greatest. Use what you know about the number line to complete the list of numbers by filling in the blanks with the missing integers.

$-6, -5, \underline{-4}, -3, -2, -1, \underline{0}, 1, 2, \underline{3}, 4, \underline{5}, 6$

3. Complete the number line scale. Explain and show how to find 2 and the opposite of 2 on a number line.

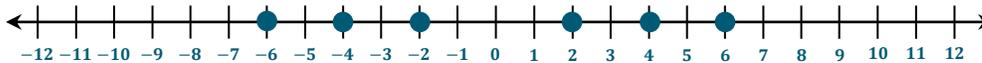
I would start at zero and move 2 units to the left to locate the number -2 on the number line. So, to locate 2, I would start at zero and move 2 units to the right (the opposite direction).



Problem Set Sample Solutions

1. Draw a number line, and create a scale for the number line in order to plot the points -2 , 4 , and 6 .

- a. Graph each point and its opposite on the number line.

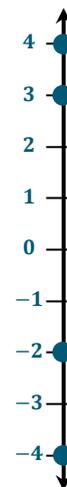


- b. Explain how you found the opposite of each point.

To graph each point, I started at zero and moved right or left based on the sign and number (to the right for a positive number and to the left for a negative number). To graph the opposites, I started at zero, but this time I moved in the opposite direction the same number of times.

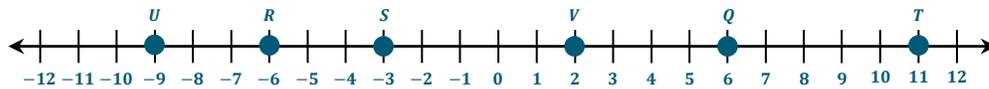
2. Carlos uses a vertical number line to graph the points -4 , -2 , 3 , and 4 . He notices that -4 is closer to zero than -2 . He is not sure about his diagram. Use what you know about a vertical number line to determine if Carlos made a mistake or not. Support your explanation with a number line diagram.

Carlos made a mistake because -4 is less than -2 , so it should be farther down the number line. Starting at zero, negative numbers decrease as we look farther below zero. So, -2 lies before -4 on a number line since -2 is 2 units below zero and -4 is 4 units below zero.



3. Create a scale in order to graph the numbers -12 through 12 on a number line. What does each tick mark represent?

Each tick mark represents 1 unit.



4. Choose an integer between -5 and -10 . Label it R on the number line created in Problem 3, and complete the following tasks.

Answers may vary. Refer to the number line above for sample student work. $-6, -7, -8,$ or -9

- a. What is the opposite of R ? Label it Q .

Answers will vary. 6

- b. State a positive integer greater than Q . Label it T .

Answers will vary. 11

- c. State a negative integer greater than R . Label it S .

Answers will vary. -3

- d. State a negative integer less than R . Label it U .

Answers will vary. -9

- e. State an integer between R and Q . Label it V .

Answers will vary. 2

5. Will the opposite of a positive number *always, sometimes, or never* be a positive number? Explain your reasoning.

The opposite of a positive number will never be a positive number. For two nonzero numbers to be opposites, zero has to be in between both numbers, and the distance from zero to one number has to equal the distance between zero and the other number.

6. Will the opposite of zero *always, sometimes, or never* be zero? Explain your reasoning.

The opposite of zero will always be zero because zero is its own opposite.

7. Will the opposite of a number *always, sometimes, or never* be greater than the number itself? Explain your reasoning. Provide an example to support your reasoning.

The opposite of a number will sometimes be greater than the number itself because it depends on the given number. For example, if the number given is -6 , then the opposite is 6 , which is greater than -6 . If the number given is 5 , then the opposite is -5 , which is not greater than 5 . If the number given is 0 , then the opposite is 0 , which is never greater than itself.