

Magnificent Magnitude

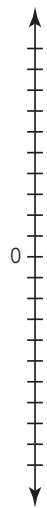
Absolute Value

2

WARM UP

Plot each set of numbers on the number line and describe the relationship between the numbers.

1. 5 and -5
2. $2\frac{3}{4}$ and $-2\frac{3}{4}$
3. 8.634 and -8.634



LEARNING GOALS

- Explain the meaning of the absolute value of a rational number as its distance from 0 on a number line.
- Interpret the meaning of absolute value as the magnitude for a positive or negative quantity in a real-world context.
- Evaluate the absolute value of a quantity.
- Compare and order numbers expressed as absolute value and distinguish absolute value comparisons from statements about order.

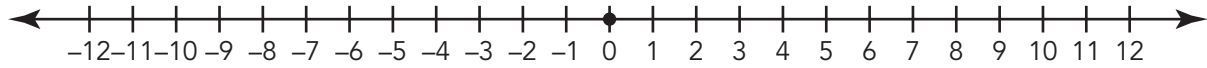
KEY TERM

- absolute value

Numbers can be described by their distance from 0 on the number line. How can you use these distances to solve real-world problems?

Getting Started

Going the Distance



1. Plot a point at -7 on the number line.
2. Describe the distance from -7 to 0 .
3. Plot as many other points as possible on the number line that are the same distance from 0 as -7 .
4. How many numbers did you plot? Why do you think this is true?



Let's revisit the number line from the *Human Number Line* lesson.

Your teacher will assign students to participate in the activity. Be sure to record what happens on the number line.

- Student A: Stand on 0 and hold one end of the string provided by your teacher.
- Student B: Hold the other end of the string and stand on the number line as far as possible from Student A. Are there other places on the number line that you could stand and be as far from Student A as possible?
- Repeat this activity with two more pieces of string of different lengths and two additional students, Students C and D. Student A will hold the 0 end of each string.

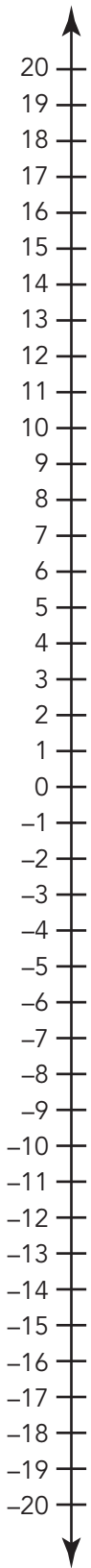


1. Compare the locations where each student stood.

- What do you notice about the distances each time the students moved?
- What do you notice about the approximate values for the numbers where each stood?

The magnitude, or **absolute value**, of a number is its distance from zero on a number line. The symbol for absolute value is $| |$. The expression $|n|$ is read as "the absolute value of a number n ."

Because distance cannot be negative, the absolute value of a number is always positive or 0.



2. Plot 5 on the number line.

a. How far is 5 from 0?

b. $|5| = \underline{\quad}$

3. Plot -7.2 on the number line.

a. How far is -7.2 from 0?

b. $|-7.2| = \underline{\quad}$

4. Explain what each statement means. Name any other values that have the same absolute value, if possible.

a. $|-5|$

b. $|1\frac{5}{6}|$

c. $|0.75|$

d. $|-1.36|$

Use your investigation and a number line to answer each question.

5. Can two different numbers have the same absolute value? If so, provide examples.

6. What can you say about the absolute value of

a. any positive number?

b. any negative number?

c. zero?

ACTIVITY
2.2

Interpreting Absolute Value Statements



Absolute values are used in real-world applications when you are interested in only the number and not in the sign of the number. When you look at temperature changes, you could say the temperature “fell by,” “decreased by,” or “increased by” an absolute value.

- 1. Complete the table with an appropriate situation, absolute value statement, and/or number. For the last row, assign the correct units to the number based on your situation.**

| Situation | Absolute Value Statement | Numeric Example (with units) |
|--|--|------------------------------|
| The temperature went from 55°F to 5°F. | The temperature fell by 50°F. | -50°F |
| The bank account balance went from \$2500 to \$2250. | | |
| The bank account balance went from \$495 to \$615. | | \$120 |
| | The water level increased by 4.9 feet. | |
| During the hike, the elevation went from 1125 feet to 1750 feet. | | |
| | | -10_____ |

You also use absolute value statements to describe how numbers compare with other numbers. You often use these statements without thinking about "less than" or "greater than." Rather, you use words like "debt," "lost," "colder," "depth," "above," "hotter," or "below."

2. Complete the table with an appropriate situation, absolute value statement, and/or example. For the last row, assign the correct units to the numeric example based on your situation.

| Situation | Absolute Value Statement | Numeric Example (with units) |
|---|--|------------------------------|
| A water level less than $-2\frac{1}{2}$ feet | More than $2\frac{1}{2}$ feet below a full pool | -3 feet |
| An account balance less than $-\$30$ | A debt greater than $\$30$ | |
| A weight less than -7.5 pounds of previous weight | Lost more than 7.5 pounds | |
| A dive to a height less than -350 feet | | |
| | Colder than 10 degrees below 0 | |
| | A depth greater than 15 m | |
| | A golf tournament stroke total more than 7 strokes below par | |
| | | -100_____ |

“Par is the number of strokes, or swings, a golfer is expected to take.”

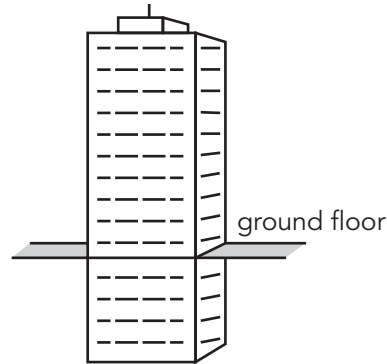


ACTIVITY
2.3

Using Absolute Value to Solve Real-World Problems



1. In many buildings, particularly outside of the United States, the ground floor of a building is labeled as G or Lobby. The first floor of the building is one floor above the ground floor. The building pictured has a lobby, 10 floors of offices, and 4 floors of garage below the lobby.



- a. Melanie has an office on the 9th floor and parks on the 3rd floor below the ground floor. Taylor and Cecelia are determining how many floors Melanie must go up from her car to reach her office.

Taylor represents the 9th floor as 9 and the 3rd floor below ground as -3 . Therefore, since $9 - 3 = 6$, Melanie traveled 6 floors to get from her car to her office.

Cecelia says that the ground floor to the 9th floor is 9 floors, and from the ground floor to the 3rd garage level is 3 floors. Melanie traveled $|9| + |-3| = 9 + 3 = 12$ floors.

Who is correct? Explain your reasoning.



Write a numeric expression using absolute values that would represent each situation. Then calculate the answer.

b. Caleb parks his car on the 2nd floor below ground and works on the 7th floor. How many floors must he go up from his car to reach his office?

c. Lucinda is working on the 8th floor. At lunch, she goes to her car on the 4th floor below ground, and then back up to the lobby. How many total floors does Lucinda travel?

d. If Damon goes from his office on the 10th floor to a meeting on the 5th floor, how many floors does he travel and in which direction?

2. The Top Notch company's bank balances are shown. The table represents the first 10 weeks of operation. Overdrafts are represented by amounts within parentheses.

| Week | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---------|----------|------------|----------|------------|---------|-----------|----------|-------|----------|-------|
| Balance | \$159.25 | (\$201.35) | \$231.57 | (\$456.45) | (\$156) | (\$12.05) | \$281.34 | \$175 | \$192.34 | \$213 |

a. Use estimation to determine the gains/losses between consecutive weeks.

b. Between which two weeks did Top Notch have the largest gain in money? What was the actual gain?

c. Between which two weeks did Top Notch have the largest loss in money? What was the actual loss?

d. What was the difference between the company's lowest balance and its highest balance?

e. Order the estimated gains and losses that you determined in part (a) from least to greatest. Use a negative sign to indicate losses.

f. Order the estimated gains and losses that you determined in part (a) from least to greatest according to their absolute values. What does the absolute value mean in the context of this problem?

g. Why are the orders different in parts (e) and (f)?

3. As part of a long-term science experiment, two rulers were connected at zero and used to measure the water level in a pond. The connected rulers were placed in the pond so that the water level aligned at zero. The water level was measured each week for 10 weeks.

| Week | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|-------------|----------------|-----------------|----------------|----------------|---------------|----------------|----------------|----------------|------|-----------------|
| Water level | $2\frac{3}{4}$ | $-2\frac{1}{8}$ | $1\frac{7}{8}$ | $-\frac{3}{4}$ | $\frac{3}{4}$ | $1\frac{1}{8}$ | $-\frac{7}{8}$ | $1\frac{1}{4}$ | -2 | $-\frac{3}{16}$ |

a. What do the positive numbers represent? What do the negative numbers represent?

b. Between which two weeks did the water level change the most? What was the change?

c. Between which two weeks did the water level change the least? What was the change?

d. How much did the water level change between Weeks 4 and 5? What was the change?



TALK the TALK **You Absolutely MUST Compare These!**

Insert a $>$, $<$, or $=$ symbol to make each statement true.
Justify each answer in terms of the definition of absolute value and number lines.

1. $|-4.67| \underline{\hspace{1cm}} |3|$

2. $|-15| \underline{\hspace{1cm}} |15|$

3. $|25\frac{9}{10}| \underline{\hspace{1cm}} |-33\frac{2}{3}|$

4. $|13.45| \underline{\hspace{1cm}} |-27|$

5. $|-15.34| \underline{\hspace{1cm}} |-1\frac{11}{12}|$

6. $|-19\frac{1}{2}| \underline{\hspace{1cm}} |5.5|$

Assignment

Write

Explain the relationship between a number, its opposite, and its absolute value.

Remember

The absolute value of a rational number is its distance from zero on a number line. Absolute value equations can be used to calculate the distance between positive and negative numbers.

Practice

1. Julio is a wrestler for his high school wrestling team in the winter. Julio needs to stay around 140 pounds in the off-season. He charted his weight over the summer by listing the differences his weight was from 140 pounds. He uses negative numbers when his weight was under 140 pounds and positive numbers when his weight was above 140 pounds.

| Week | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|-------------------|------|------|------|------|------|------|-------|------|---|------|------|----|
| Weight Difference | +4.5 | +2.1 | -1.5 | -0.5 | -2.5 | +1.5 | -3.75 | -2.8 | 0 | +1.3 | -1.5 | -5 |

a. Was the amount his weight varied from 140 pounds in week 4 more or less than the amount it varied from 140 pounds in week 8?

Insert a $>$, $<$, or $=$ symbol to make the statement true. Explain your answer.

$$|-0.5| \bigcirc |-2.8|$$

b. Was the amount his weight varied from 140 pounds in week 6 more or less than the amount it varied from 140 pounds in week 11?

Insert a $>$, $<$, or $=$ symbol to make the statement true. Explain your answer.

$$|+1.5| \bigcirc |-1.5|$$

c. Use absolute values to determine the difference in Julio's weight from week 7 to week 10.

d. Use absolute values to determine the difference in Julio's weight from week 8 to week 12.

2. The table shown tracks Julio's weight changes that he reports to his coach for the first 4 weeks of school. Complete the table to explain the changes.

| Situation | Absolute Value Statement | Rational Number |
|--|------------------------------|-----------------|
| His weight went from 140 to 135 pounds. | His weight fell by 5 pounds. | |
| His weight went from 135 pounds to 141 pounds. | | 6 lb |
| His weight went from 141 pounds to 140.5 pounds. | | |
| His weight went from 140.5 pounds to 139 pounds. | | |

3. Weather experts collect many types of data to study and analyze, including extreme temperature changes. The interior West of North America experiences great temperature changes due to Chinook Winds. The table shows extreme temperature rises in three cities.

| | | | |
|---------------------------|--|---|---|
| Place | Granville, ND | Fort Assiniboine, MT | Spearfish, SD |
| Date | Feb. 21, 1918 | Jan. 19, 1892 | Jan. 22, 1943 |
| Time Period | 12 hours | 15 minutes | 2 minutes |
| Temperature Change | From -33°F to 50°F | From -5°F to 37°F | From -4°F to 45°F |

For each city, write an absolute value equation and use it to determine how much the temperature rose.

- a. Granville, ND b. Fort Assiniboine, MT c. Spearfish, SD

4. Tyler measured the rainfall and evaporation using a rain gauge in his backyard for 8 days. Tyler marked his rain gauge with values from -6 inches to $+6$ inches and filled the gauge with water to the zero mark. For each question, write an expression using absolute value and then calculate the answer.

| | | | | | | | | |
|----------------------|-----|--------|-----|-----|-----|--------|--------|-----|
| Days | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Gauge Reading | 0.5 | -1.3 | 3.7 | 4.2 | 2.1 | -0.9 | -2.4 | 5.6 |

- a. On how many days out of the eight did it rain?
b. Between which two consecutive readings did it rain the most? How many inches were recorded?
c. Between which two consecutive readings was evaporation the greatest? How many inches of water evaporated?
d. Calculate the gain or loss of water in the rain gauge between days 1 and 2. Express the change in the water level in the gauge as a positive or negative number.
e. Calculate the gain or loss of water in the rain gauge between days 2 and 3. Express the change in the water level in the gauge as a positive or negative number.

Stretch

Write a scenario to represent each rational number.

1. -12 2. $-4\frac{1}{2}$ 3. 7.3 4. -0.7

Review

1. Use the $>$, $<$, or $=$ symbol to complete each statement.

a. $-5 \bigcirc -8$ b. $-3 \bigcirc 0$ c. $5 \bigcirc -5$

2. Five employees work on the receiving dock at a factory. They divide the number of crates they unload from each truck equally. Define variables for the number of crates on a truck and for the number of crates each employee unloads from the truck. Write an equation that models the relationship between these variables.

3. Solve for the variable in each equation.

a. $\frac{t}{2} = 15$

b. $y - 8 = 19$