Lesson 13: Statements of Order in the Real World

Student Outcomes

- Students apply understanding of order and absolute value when examining real world scenarios. Students realize, for instance, that the depth of a location below sea level is the absolute value of a negative number, while the height of an object above sea level is the absolute value of a positive number.

Classwork

Opening Exercise (4 minutes)

Students discuss the meaning of the report below, write a summary of their conclusions in their student materials, and provide their feedback to the whole group.

Opening Exercise

A radio disc jockey reports that the temperature outside his studio has changed 10 degrees since he came on the air this morning. Discuss with your group what listeners can conclude from this report.

The report is not specific enough to be conclusive because 10 degrees of change could mean an increase or decrease in temperature. A listener might assume the report says an increase in temperature, however, the word "changed" is not specific enough to conclude a positive or negative change.

- How could you change the report to make it more informative?
  - *Using the words "increased" or "decreased" instead of "changed" would be much more informative.*

In real world contexts, descriptive words such as debt, credit, increase, and decrease, help us indicate when a given magnitude is representative of a positive or negative value.

Example 1 (4 minutes): Ordering Numbers in the Real World

Students saw in Lesson 11 that absolute value represents the magnitude of a positive or negative quantity. To order rational numbers given in a real world context, students need to consider the meaning of descriptors and what they indicate about a given quantity.

Scaffolding:

Review the financial terms if necessary. Have students develop a poster to categorize the terms and include examples of their meaning.

Example 1: Ordering Numbers in the Real World

A $\$25$ credit and a $\$25$ charge appear similar, yet they are very different.

Describe what is similar about the two transactions.

The transactions look similar because they are described using the same number. Both transactions have the same magnitude (or absolute value) and therefore result in a change of $\$25$ to an account balance.

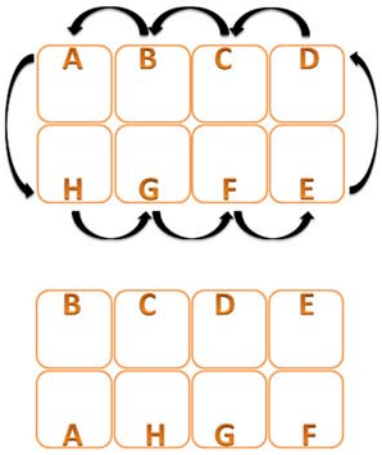
How do the two transactions differ?

The credit would cause an increase to an account balance and therefore should be represented by 25, while the charge would instead decrease an account balance and should be represented by -25. The two transactions represent changes that are opposites.

Exercises 1–4 (22 minutes)

Students use absolute value to solve various real world problems with partners, then share and support their conclusions with the whole group.

Allow two minutes for setup. Have eight students arrange their desks into two rows of four so that the rows are facing each other. Additional groups of eight students should be formed per individual class size. If using tables, have four students sit on one side of the table(s) and the other four students sit opposite them. Students will rotate when each problem is completed. When the rotation occurs, the students who are in the right most seat of each row will rotate to a position in the opposite row (see diagram at right). Having students move in opposite directions allows each student to work with a different partner on each of the four problems.



Students should work at their station for 15 minutes, completing Exercise 1 in their student materials with their first partner, Exercise 2 with a new partner, Exercise 3 with a different new partner, and finally Exercise 4 with a different new partner. Partners are given three minutes to complete their problem in the student materials, then given one minute to rotate seats.

Each problem requires that students determine appropriate rational numbers to represent given quantities and order the numbers as specified. Students also provide reasoning for their choices of rational numbers in each case.

Exercises 1–4

1. Scientists are studying temperatures and weather patterns in the Northern Hemisphere. They recorded temperatures (in degrees Celsius) in the table below, as reported in emails from various participants. Represent each reported temperature using a rational number. Order the rational numbers from least to greatest. Explain why the rational numbers that you chose appropriately represent the given temperatures.

MP.3

Temperatures as Reported	8 below zero	12	-4	13 below zero	0	2 above zero	6 below zero	-5
Temperature (°C)	-8	12	-4	-13	0	2	-6	-5

$-13 < -8 < -6 < -5 < -4 < 0 < 2 < 12$

*The words "***below zero***" refer to negative numbers because they are located below zero on a vertical number line.*

2. Jami's bank account statement shows the transactions below. Represent each transaction as a rational number describing how it changes Jami's account balance, then order the rational numbers from greatest to least. Explain why the rational numbers that you chose appropriately reflect the given transactions.

Listed Transactions	Debit $12.20	Credit $4.08	Charge $1.50	Withdrawal $20.00	Deposit $5.50	Debit $3.95	Charge $3.00
Change to Jami's Account	-12.2	4.08	-1.5	-20	5.5	-3.95	-3

$5.5 > 4.08 > -1.5 > -3 > -3.95 > -12.2 > -20$

The words "debit"," charge", and "withdrawal" all describe transactions in which money is taken out of Jami's account, decreasing its balance. These transactions are represented by negative numbers. The words "credit" and "deposit" describe transactions that will put money into Jami's account, increasing its balance. These transactions are represented by positive numbers.

3. During the summer, Madison monitors the water level in her parents' swimming pool to make sure it is not too far above or below normal. The table below shows the numbers she recorded in July and August to represent how the water levels compare to normal. Order the rational numbers from least to greatest. Explain why the rational numbers that you chose appropriately reflect the given water levels.

MP.3

Madison's Readings	$\frac{1}{2}$ inch above normal	$\frac{1}{4}$ inch above normal	$\frac{1}{2}$ inch below normal	$\frac{1}{8}$ inch above normal	$1\frac{1}{4}$ inch below normal	$\frac{3}{8}$ inch below normal	$\frac{3}{4}$ inch below normal
Compared to Normal	$\frac{1}{2}$	$\frac{1}{4}$	$-\frac{1}{2}$	$\frac{1}{8}$	$-1\frac{1}{4}$	$-\frac{3}{8}$	$-\frac{3}{4}$

$-1\frac{1}{4} < -\frac{3}{4} < -\frac{1}{2} < -\frac{3}{8} < \frac{1}{8} < \frac{1}{4} < \frac{1}{2}$

The measurements are taken in reference to normal level which is considered to be 0. The words "above normal" refer to the positive numbers located above zero on a vertical number line and the words "below normal" refer to the negative numbers located below zero on a vertical number line.

4. Changes in the weather can be predicted by changes in the barometric pressure. Over several weeks, Stephanie recorded changes in barometric pressure seen on her barometer to compare to local weather forecasts. Her observations are recorded in the table below. Use rational numbers to record the indicated changes in the pressure in the second row of the table. Order the rational numbers from least to greatest. Explain why the rational numbers that you chose appropriately represent the given pressure changes.

Barometric Pressure Change (inches of Mercury)	Rise 0.04	Fall 0.21	Rise 0.2	Fall 0.03	Rise 0.1	Fall 0.09	Fall 0.14
Barometric Pressure Change (inches of Mercury)	0.04	-0.21	0.2	-0.03	0.1	-0.09	-0.14

$-0.21, -0.14, -0.09, -0.03, 0.04, 0.1, 0.2$

The records that include the word "rise" refer to increases and therefore are represented by positive numbers. The records that include the word "fall" refer to decreases and therefore are represented by negative numbers.

MP.3 After completing all stations, ask students to report their answers and reasoning for the given problems. Look for differences in valid reasoning and discuss those differences where appropriate. Encourage students to politely challenge the reasoning of their classmates if applicable. This activity should take five minutes.

Example 2 (5 minutes): Using Absolute Value to Solve Real-World Problems

Students use the absolute values of positive and negative numbers to solve problems in real world contexts. Students may find it helpful to draw a picture as a problem-solving strategy. Grid paper may be provided so that they can accurately construct a picture and number line diagram. Discuss and model how we can construct a number line and use number sense to find the approximate location of 23 and -38 without grid paper.

Example 2: Using Absolute Value to Solve Real-World Problems

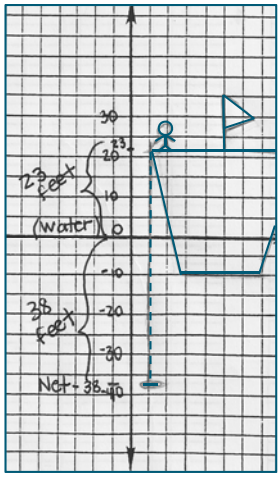
The captain of a fishing vessel is standing on the deck at 23 feet above sea level. He holds a rope tied to his fishing net that is below him underwater at a depth of 38 feet.

Draw a diagram using a number line, then use absolute value to compare the lengths of rope in and out of the water.

The captain is above the water and the fishing net is below the water's surface. Using the water level as reference point zero I can draw the diagram using a vertical number line. The captain is located at 23and the fishing net is located at -38.

$|23| = 23$ *and* $|-38| = 38$*, so there is more rope underwater than above.*

$38 - 23 = 15$*; The length of rope below the water's surface is 15 feet longer than the rope above water.*



Example 3 (4 minutes): Making Sense of Absolute Value and Statements of Inequality

Students examine absolute values of negative numbers in a real-world context and make sense of statements about inequalities involving those values.

Example 3: Making Sense of Absolute Value and Statements of Inequality

A recent television commercial asked viewers "Do you have over $\$10,000$ in credit card debt?"

What types of numbers are associated with the word "debt" and why? Write a number that represents the value from the television commercial.

Negative numbers; debt describes money that is owed; $-10,000$

Give one example of "over $\$10,000$ in credit card debt" then write a rational number that represents your example.

Credit card debt of $\$11,000$; $-11,000$.

How do the debts compare and how do the rational numbers that describe them compare? Explain.

The example $\$11,000$ is greater than $\$10,000$ from the commercial; however, the rational numbers that represent these debt values have the opposite order because they are negative numbers. $-11,000 < -10,000$. The absolute values of negative numbers have the opposite order of the negative values themselves.

Closing (3 minutes)

- Your friend Samuel says he is 50 feet from sea level. What additional information should Samuel give you in order for you to identify his elevation?
- Identify three real world situations that are represented by negative rational numbers.
- Identify three real-world situations that are represented by positive rational numbers.

Lesson Summary

When comparing values in real world situations, descriptive words will help you to determine if the number represents a positive or negative number. Making this distinction is critical when solving problems in the real world. Also critical is to understand how an inequality statement about an absolute value compares to an inequality statement about the number itself.

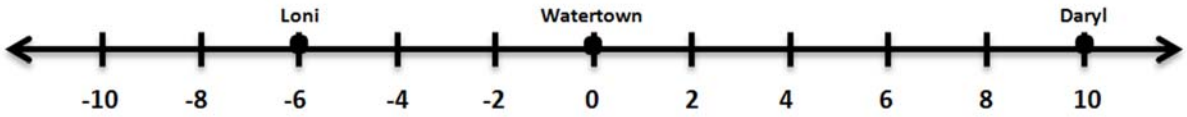
Exit Ticket (3 minutes)

Name _____ Date_____

Lesson 13: Statements of Order in the Real World

Exit Ticket

1. Loni and Daryl call each other from opposite sides of Watertown. Their locations are shown on the number line below using miles. Use absolute value to explain who is a further distance (in miles) from Watertown. How much closer is one than the other?



2. Claude recently read that no one has ever scuba-dived more than 330 meters below sea level. Describe what this means in terms of elevation using sea level as a reference point.

Exit Ticket Sample Solutions

1. Loni and Daryl call each other from opposite sides of Watertown. Their locations are shown on the number line below using miles. Use absolute value to explain who is a further distance (in miles) from Watertown. How much closer is one than the other?

Loni's location is -6 and $|-6| = 6$ because -6 is 6 units from 0 on the number line. Daryl's location is 10 and $|10| = 10$ because 10 is 10 units from 0 on the number line. We know that $10 > 6$, so Daryl is farther from Watertown than Loni.

$10 - 6 = 4$; Loni is 4 miles closer to Watertown than Daryl.

2. Claude recently read that no one has ever scuba-dived more than 330 meters below sea level. Describe what this means in terms of elevation using sea level as a reference point.

330 meters below sea level is an elevation of -330 feet. "More than 330 meters below sea level" means that no one has ever had more than 330 meters between them and sea level when they were below the water's surface while scuba-diving.

Problem Set Sample Solutions

1. Negative air pressure created by an air pump makes a vacuum cleaner able to collect air and dirt into a bag or other container. Below are several readings from a pressure gauge. Write rational numbers to represent each of the readings, and then order the rational numbers from least to greatest.

Gauge Readings (pounds per square inch)	25 psi pressure	13 psi vacuum	6.3 psi vacuum	7.8 psi vacuum	1.9 psi vacuum	2 psi pressure	7.8 psi pressure
Pressure Readings (pounds per square inch)	25	-13	-6.3	-7.8	-1.9	2	7.8

$-13 < -7.8 < -6.3 < -1.9 < 2 < 7.8 < 25$

2. The fuel gauge in Nic's car says that he has 26 miles to go until his tank is empty. He passed a fuel station 19 miles ago and a sign says there is a town only 8 miles ahead. If he takes a chance and drives ahead to the town and there isn't a fuel station there, does he have enough fuel to go back to the last station? Draw a diagram along a number line and use absolute value to find your answer.

No, he does not have enough fuel to drive to the town then back to the fuel station. He needs 8 miles worth of fuel to get to the town which lowers his limit to 18 miles. The total distance between the fuel station and the town is $|8| + |-19| = 8 + 19 = 27$ miles. Nic would be 9 miles short on fuel. It would be safer to go back to the fuel station without going to the town first.