Lesson 16

Representing Contexts with Equations

Goals

- Coordinate (orally and in writing) verbal descriptions, equations, and diagrams that represent the same situation involving an unknown amount in the context of temperature or elevation.
- Write equations of the form $x + p = q$ or $px = q$ to represent and solve a problem in an unfamiliar context, and present the solution method (using words and other representations).

Learning Targets

- I can explain what the solution to an equation means for the situation.
- I can write and solve equations to represent situations that involve rational numbers.

Student Learning Goal

Let's write equations that represent situations.

Lesson Narrative

In this lesson, students consolidate their understanding of solving equations of the form $p + x = q$ or $px = q$, where p, q, and x are rational numbers. In this lesson, students choose equations that represent a context and solve it. They critique an incorrectly solved equation and construct an explanation about a correct solution.

In the optional activities, students have the opportunity to create their own equations for situations and solve them. They reason quantitatively and abstractly as they relate the situation to the variables, terms, and operations in their equations.

Access for Students with Diverse Abilities

- Action and Expression (Warm-up, Activity 2)
- Engagement (Activity 1, Activity 3)

Access for Multilingual Learners

- MLR3: Critique, Correct, Clarify (Activity 1)
- MLR7: Compare and Connect (Activity 3)
- MLR8: Discussion Supports (Warm-up, Activity 2)

Instructional Routines

- Math Talk
- MLR3: Critique, Correct, Clarify

Required Materials

Materials to Gather

- Tools for creating a visual display: Activity 3

Lesson Timeline

Warm-up	Activity 1	Activity 2	Activity 3	Lesson Synthesis	Assessment: Cool-down
5 min	15 min	15 min	15 min	10 min	5 min

Instructional Routines

Math Talk

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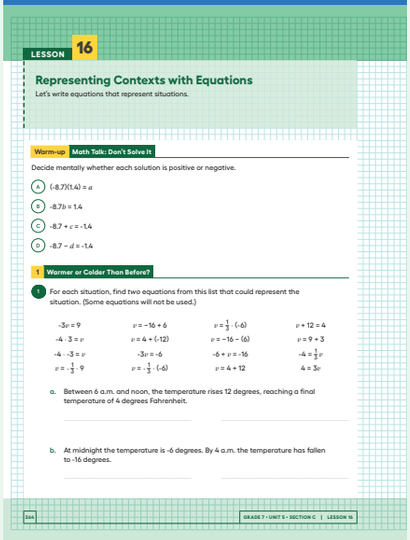
Access for Students with Diverse Abilities (Warm-up, Launch)

Action and Expression: Internalize Executive Functions.
To support working memory, provide students with sticky notes or mini whiteboards.

Supports accessibility for: Memory, Organization

Student Workbook



LESSON 16

Representing Contexts with Equations

Let's write equations that represent situations.

Warm-up Math Talk: Don't Solve It

Decide mentally whether each solution is positive or negative.

A. $(-8.7)(1.4) = a$

B. $-8.7b = 1.4$

C. $-8.7 + c = -1.4$

D. $-8.7 - d = -1.4$

1 Warmer or Colder Than Before?

For each situation, find two equations from this list that could represent the situation. (Some equations will not be used.)

$-3p = 9$ $p = -16 + 6$ $p = \frac{1}{3} \cdot (-6)$ $p + 12 = 4$

$-4 \cdot 3 = p$ $p = 4 + (-12)$ $p = -16 - (6)$ $p = 9 + 3$

$-4 \cdot -3 = p$ $-3p = -6$ $-6 + p = -16$ $-4 = \frac{1}{3}p$

$p = \frac{1}{3} \cdot 9$ $p = -\frac{1}{3} \cdot (-6)$ $p = 4 + 12$ $4 = 3p$

a. Between 6 a.m. and noon, the temperature rises 12 degrees, reaching a final temperature of 4 degrees Fahrenheit.

b. At midnight the temperature is -6 degrees. By 4 a.m. the temperature has fallen to -16 degrees.

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Warm-up

Math Talk: Don't Solve It

5 min

Activity Narrative

This *Math Talk* focuses on whether the solution to an equation will be positive or negative. It encourages students to think about the signs of the numbers and their relative magnitudes and to rely on what they know about operations with rational numbers to mentally solve problems. The strategies elicited here will be helpful later in the lesson when students find the solutions to different equations.

Launch

Tell students to close their books or devices (or to keep them closed). Reveal one problem at a time. For each problem:

- Give students quiet think time, and ask them to give a signal when they have an answer and a strategy.
- Invite students to share their strategies, and record and display their responses for all to see.
- Use the questions in the *Activity Synthesis* to involve more students in the conversation before moving to the next problem.

Keep all previous problems and work displayed throughout the talk.

Student Task Statement

Decide mentally whether each solution is positive or negative.

A. $(-8.7)(1.4) = a$

a is negative

Sample reasoning: The product of a negative number and a positive number is negative.

B. $-8.7b = 1.4$

b is negative

Sample reasoning: In order for the product of two numbers to be positive, the signs of the two factors have to be the same.

C. $-8.7 + c = -1.4$

c is positive

Sample reasoning: A positive number needs to be added to -8.7 to make the sum greater than -8.7, since -1.4 is greater than -8.7.

D. $-8.7 - d = -1.4$

d is negative

Sample reasoning: Since a subtraction expression can be written as the sum of the additive inverse, the sign of *d* will be opposite the sign of *c*.

Activity Synthesis

To involve more students in the conversation, consider asking:

- *"Who can restate _____'s reasoning in a different way?"*
- *"Did anyone use the same strategy but would explain it differently?"*
- *"Did anyone solve the problem in a different way?"*
- *"Does anyone want to add on to _____'s strategy?"*
- *"Do you agree or disagree? Why?"*
- *"What connections to previous problems do you see?"*

Activity 1

Warmer or Colder Than Before?

15 min

Activity Narrative

In this activity, students work with changing temperatures to build understanding of equations that represent situations with negative coefficients, variables, and solutions. Students choose from a bank of equations to find two equations, one that represents the situation using a variable and the other that represents a path to solve for the variable. Students contextualize and decontextualize between the contexts of changing temperatures and the equations that represent them. In this activity, students also critique a statement or response that is intentionally unclear, incorrect, or incomplete and improve it by clarifying meaning, correcting errors, and adding details.

Launch

Give students 5 minutes of quiet work time, and follow with a whole-class discussion.

Student Task Statement

1. For each situation, find *two* equations from this list that could represent the situation. (Some equations will not be used.)

$-3v = 9$	$v = -16 + 6$	$v = \frac{1}{3} \cdot (-6)$	$v + 12 = 4$
$-4 \cdot 3 = v$	$v = 4 + (-12)$	$v = -16 - (6)$	$v = 9 + 3$
$-4 \cdot -3 = v$	$-3v = -6$	$-6 + v = -16$	$-4 = \frac{1}{3}v$
$v = -\frac{1}{3} \cdot 9$	$v = -\frac{1}{3} \cdot (-6)$	$v = 4 + 12$	$4 = 3v$

a. Between 6 a.m. and noon, the temperature rises 12 degrees, reaching a final temperature of 4 degrees Fahrenheit.

$v = 4 + (-12)$; $v + 12 = 4$

b. At midnight the temperature is -6 degrees. By 4 a.m. the temperature has fallen to -16 degrees.

$-6 + v = -16$; $v = -16 + 6$

Access for Multilingual Learners (Warm-up, Synthesis)

MLR8: Discussion Supports. Display sentence frames to support students when they explain their strategy. For example, "First, I_____ because ..." or "I noticed _____ , so I ..." Some students may benefit from the opportunity to rehearse what they will say with a partner before they share with the whole class.

Advances: Speaking, Representing

Instructional Routines

MLR3: Critique, Correct, Clarify

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Access for Multilingual Learners (Activity 1)

MLR3: Critique, Correct, Clarify This activity uses the *Critique, Correct, Clarify* math language routine to advance representing and conversing as students critique and revise mathematical arguments.

Access for Students with Diverse Abilities (Activity 1, Student Task)

Engagement: Develop Effort and Persistence. Chunk this task into more manageable parts, such as the first two situations, the next three situations, and the solution and explanation. Check in with students to provide feedback and encouragement after each chunk. Ensure that students have correctly matched the equations with the situations before they solve the equation.

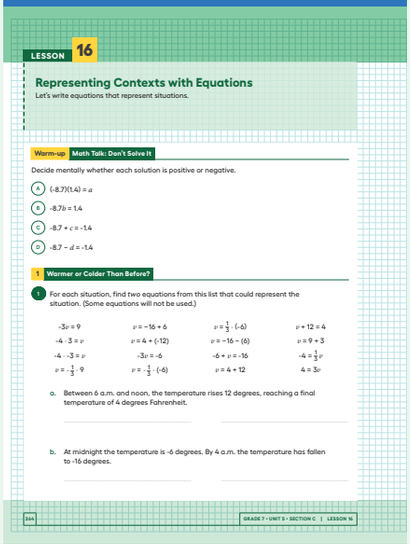
Supports accessibility for: Attention, Social-Emotional Functioning

Building on Student Thinking

If some students struggle to represent these situations with an equation, consider asking:

"What is the unknown value, and what is happening in this situation?"
"How can you represent this situation on a vertical number line?"

Student Workbook



LESSON 16

Representing Contexts with Equations

Let's write equations that represent situations.

Warm-up Math Talk: Don't Solve It

Decide mentally whether each solution is positive or negative.

A. $(-8.7)(1.4) = a$
B. $-8.7b = 1.4$
C. $-8.7 \div c = -1.4$
D. $-8.7 - d = -1.4$

1 Warmer or Colder Than Before?

1. For each situation, find two equations from this list that could represent the situation. (Some equations will not be used.)

$-3v = 9$ $v = -16 + 6$ $v = \frac{1}{3} \cdot (-6)$ $v + 12 = 4$
$-4 \cdot 3 = v$ $v = 4 + (-12)$ $v = -16 - (6)$ $v + 9 = 3$
$-4 \cdot -3 = v$ $-3v = -6$ $-6 + v = -16$ $-4 = \frac{1}{3}v$
$v = \frac{1}{3} \cdot 9$ $v = -\frac{1}{3} \cdot (-6)$ $v = 4 + 12$ $4 = 3v$

a. Between 6 a.m. and noon, the temperature rises 12 degrees, reaching a final temperature of 4 degrees Fahrenheit.

b. At midnight the temperature is -6 degrees. By 4 a.m. the temperature has fallen to -16 degrees.

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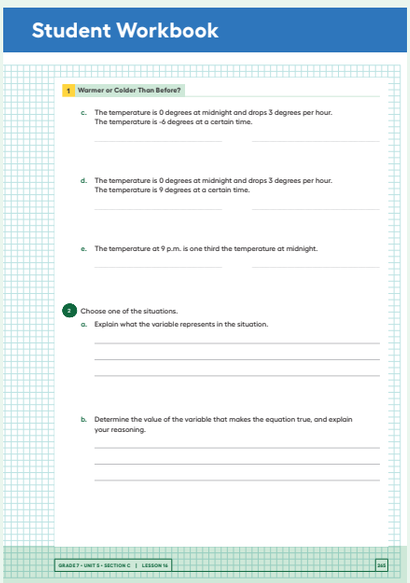
Student Workbook



1 Warmer or Colder Than Before?

c. The temperature is 0 degrees at midnight and drops 3 degrees per hour. The temperature is -6 degrees at a certain time.

d. The temperature is 0 degrees at midnight and drops 3 degrees per hour. The temperature is 9 degrees at a certain time.

e. The temperature at 9 p.m. is one third the temperature at midnight.

2 Choose one of the situations.

a. Explain what the variable represents in the situation.

b. Determine the value of the variable that makes the equation true, and explain your reasoning.

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c. The temperature is 0 degrees at midnight and drops 3 degrees per hour. The temperature is -6 degrees at a certain time.

$-3v = -6$; $v = -\frac{1}{3} \cdot (-6)$

d. The temperature is 0 degrees at midnight and drops 3 degrees per hour. The temperature is 9 degrees at a certain time.

$-3v = 9$; $v = -\frac{1}{3} \cdot 9$

e. The temperature at 9 p.m. is one third the temperature at midnight.

$-4 = \frac{1}{3}v$; $-4 \cdot 3 = v$ (Note that $v = \frac{1}{3} \cdot -6$ could also work if v represents the temperature at 9 p.m., but there is no equivalent equation to partner it with.)

2. Choose one of the situations.

a. Explain what the variable represents in the situation.

b. Determine the value of the variable that makes the equation true, and explain your reasoning.

Sample responses:

a. v represents the temperature at 6 a.m. $v = -8$. Adding 12 to -8 will bring the temperature to 4.

b. v represents the change in temperature between midnight and 4 a.m. $v = -10$. The temperature has to drop 10 degrees to go from -6 to -16.

c. v represents the number of hours after midnight that it takes to reach -6 degrees. $v = 2$. Dropping at a rate of 3 degrees per hour, it will take 2 hours to go from 0 degrees to -6 degrees, so the time is 2 a.m.

d. v represents the change in time from midnight to when the temperature is 9 degrees. $v = -3$. If the temperature has been dropping at 3 degrees per hour, and is at 0 degrees at midnight, then the temperature has been 9 degrees sometime before midnight, so the change in time is negative. It takes 3 hours for the temperature to fall from 9 degrees to 0 degrees, so the time is 3 hours before midnight, or 9 p.m.

e. v represents the temperature at midnight. $v = -12$. We expect that the temperature at midnight would be lower than the temperature at 9 p.m., so $-4 = \frac{1}{3}v$ matches this situation.

Activity Synthesis

This goal of this discussion is for students to connect the equation that represents a situation to the equation that represents the solution strategy. Begin by inviting students to share examples of how they chose:

- The equation that represents the situation.
- The equation that represents the solution strategy.
- The order in which they chose the two equations.

Then use *Critique, Correct, Clarify* to give students an opportunity to improve a sample written response for the 3rd situation, in which the temperature is dropping by 3 degrees per hour and is -6 degrees at a certain time, by correcting errors, clarifying meaning, and adding details.

Display this first draft:

> *"The equation $-3v = -6$ represents a situation where the temperature is dropping by 3 degrees per hour and is -6 degrees at a certain time. The variable v represents the number of hours that it takes to reach -6 degrees, and $v = -2$. It takes 2 hours to go from 0 degrees to -6 degrees, and since the temperature is decreasing, the answer is -2."*

Ask,

> *"What parts of this response are unclear, incorrect, or incomplete?"*

As students respond, annotate the display with 2–3 ideas to indicate the parts of the writing that could use improvement.

Give students 2–4 minutes to work with a partner to revise the first draft.

Select 1–2 students or groups to slowly read aloud their draft. Record for all to see as each draft is shared. Then invite the whole class to contribute additional language and edits to make the final draft even more clear and more convincing.

Here is a sample second draft:

> *"The equation $-3v = -6$ represents a situation where the temperature drops by 3 degrees per hour and is -6 degrees at a certain time. The variable v represents the number of hours after midnight that it takes to reach -6 degrees, and $v = 2$. Since it takes 2 hours to go from 0 degrees to -6 degrees, the time will be 2 a.m."*

Activity 2: Optional

Animals Changing Altitudes

15 min

Activity Narrative

In this activity, students match number line diagrams to situations involving the changing height and depth of sea animals. They reason abstractly and quantitatively when they write equations to represent each situation and interpret their answers in context.

There is more than one correct equation that represents each situation. Monitor for students who come up with different equations for each situation.

Student Task Statement

1. Match each situation with a diagram.

a. A penguin is standing 3 feet above sea level and then dives down 10 feet. What is its depth?

Diagram A

b. A dolphin is swimming 3 feet below sea level and then jumps up 10 feet. What is its height at the top of the jump?

Diagram D

c. A sea turtle is swimming 3 feet below sea level and then dives down 10 feet. What is its depth?

Diagram E

Student Workbook

2 Animals Changing Altitudes

1. Match each situation with a diagram.

a. A penguin is standing 3 feet above sea level and then dives down 10 feet. What is its depth?

b. A dolphin is swimming 3 feet below sea level and then jumps up 10 feet. What is its height at the top of the jump?

c. A sea turtle is swimming 3 feet below sea level and then dives down 10 feet. What is its depth?

d. An eagle is flying 10 feet above sea level and then dives down reaching 3 feet above sea level. What is its change in altitude?

e. A pelican is flying 10 feet above sea level and then dives down reaching 3 feet below sea level. What is its change in altitude?

f. A shark is swimming 10 feet below sea level and then swims up reaching 3 feet below sea level. What is its change in depth?

2. Next, write an equation to represent each animal's situation, and answer the question. Be prepared to explain your reasoning.

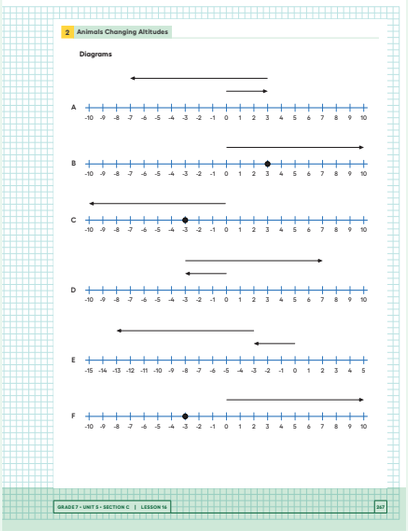
Building on Student Thinking

If some students struggle to match the verbal descriptions with the number line diagrams, consider asking:

"Is this situation looking for the animal's final altitude or the animal's change in altitude?"
"How will the diagrams look different depending on what the situation is looking for?"

If it is asking for a change in altitude, the number line will have one arrow and one point, instead of two arrows.

Student Workbook


2 Animals Changing Altitudes

Diagrams

d. An eagle is flying 10 feet above sea level and then dives down reaching 3 feet above sea level. What is its change in altitude?

Diagram B

e. A pelican is flying 10 feet above sea level and then dives down reaching 3 feet below sea level. What is its change in altitude?

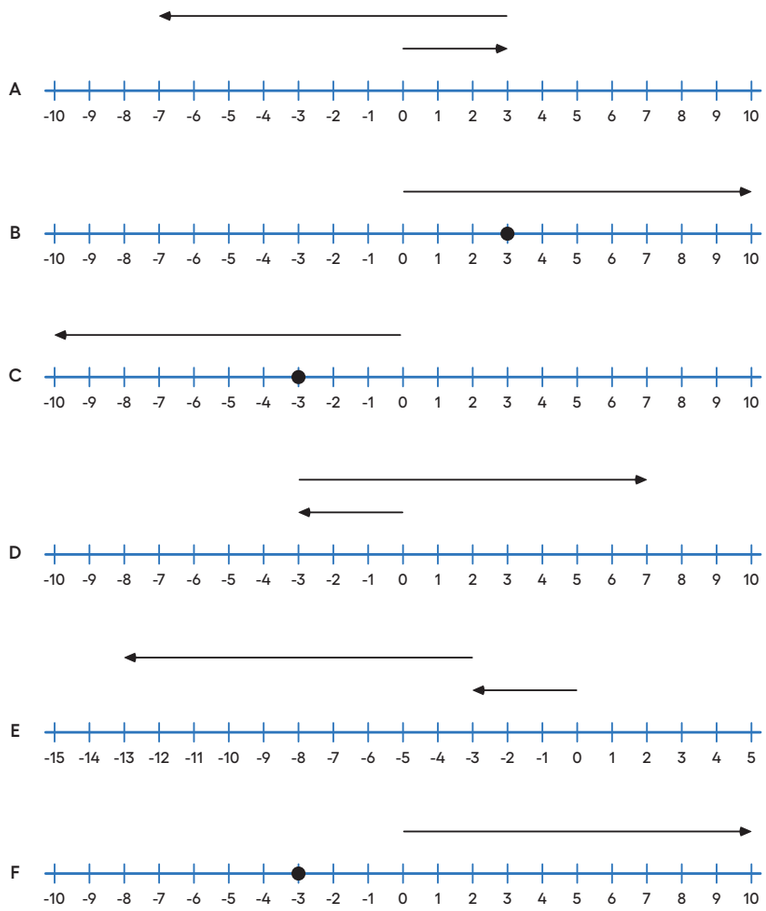
Diagram F

f. A shark is swimming 10 feet below sea level and then swims up reaching 3 feet below sea level. What is its change in depth?

Diagram C

2. Next, write an equation to represent each animal's situation, and answer the question. Be prepared to explain your reasoning.

Diagrams



Sample responses:

A. $3 - 10 = a$; $a = -7$

B. $-3 + 10 = b$; $b = 7$

C $-3 - 10 = c$; $c = -13$

D. $10 - d = 3$; $d = 7$

E. $10 - e = -3$; $e = 13$

F. $-10 + f = -3$; $f = 7$

Activity Synthesis

The purpose of this discussion is for students to share their reasoning when writing an equation to match each situation and number line diagram. Invite previously identified students to share their equations, and record them for all to see. For each situation and set of equations, discuss the following questions:

- *"Do all of these equations correctly represent this situation?"*
- *"What do all of the correct equations have in common? How are they different?"*
- *"How do you see the animal's final altitude (or change in altitude) in these equations?"*

Activity 3: Optional
Equations Tell a Story

15 min

Activity Narrative

In this activity, students work in groups to create a visual display to represent a given situation. Students reason abstractly and quantitatively when they write an equation to represent their situation, define the variables they use, explain the meaning of each term, and explain how they can use inverses to find the solution.

Launch

Arrange students in groups of 2–3, and provide tools for making a visual display. Assign one situation to each group. Note that the level of difficulty increases for the situations, so this is an opportunity to differentiate by assigning more or less challenging situations to different groups.

Student Task Statement

Your teacher will assign your group *one* of these situations. Create a visual display about your situation that includes:

- An equation that represents your situation.
- What your variable and each term in the equation represent.
- How the operations in the equation represent the relationships in the story.
- How you use inverses to solve for the unknown quantity.
- The solution to your equation.

1. As a $7\frac{1}{4}$ inch candle burns down, its height decreases $\frac{3}{4}$ inch each hour. How many hours does it take for the candle to burn completely?

   Sample response: $-\frac{3}{4}h = -7\frac{1}{4}$, where h represents how many hours the candle has been burning. $-\frac{3}{4}h$ represents how much the height of the candle has changed, and $-7\frac{1}{4}$ represents the entire height of the candle burning down. The situation involves multiplication by a negative to show how much of the candle has burned away after each hour. The equation can be solved by multiplying by $-\frac{4}{3}$. The solution is $h = 9\frac{2}{3}$, which means that at this rate it will take $9\frac{2}{3}$ hours for the candle to burn down completely.

Access for Multilingual Learners (Activity 2, Synthesis)

MLR8: Discussion Supports. Provide students with the opportunity to rehearse what they will say with a partner before they share with the whole class. Display the following sentence frames for all to see: "I noticed _____, so I matched ..." "_____ represents ..." and "Another way to show _____ is ..." Encourage students to challenge each other when they disagree.

Advances: Speaking

Access for Students with Diverse Abilities (Activity 2, Synthesis)

Action and Expression: Develop Expression and Communication. Identify connections between strategies that result in the same outcomes but use differing approaches. For example, two different equations that represent the shark situation are $-10 + x = -3$ and $-3 - (-10) = x$.

Supports accessibility for: Conceptual Processing, Language

Access for Students with Diverse Abilities (Activity 3, Student Task)

Engagement: Develop Effort and Persistence. Provide guides or checklists that focus on increasing the length of on-task orientation in the face of distractions. For example, create an exemplar display including all the required components. Highlight the explanation about how inverses were used in solving the problem.

Supports accessibility for: Attention, Social-Emotional Functioning

Instructional Routines

MLR7: Compare and Connect

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Access for Multilingual Learners (Activity 3, Launch)

MLR7: Compare and Connect. Invite groups to prepare a visual display that shows their response and reasoning to the questions about their assigned situation. Encourage students to include details that will help others interpret their thinking. Examples might include using specific language, different colors, shading, arrows, labels, notes, diagrams, or drawings. Give students time to investigate each other's work. During the whole-class discussion, ask students, "What kinds of additional details or language helped you understand the displays?" "Were there any additional details or language that you have questions about?" "How did the operations in the equation represent the relationships in the situation?"

Advances: Representing, Conversing

Student Workbook

3 Equations Tell a Story

Your teacher will assign your group one of these situations. Create a visual display about your situation that includes:

- An equation that represents your situation.
- What your variable and each term in the equation represent.
- How the operations in the equation represent the relationships in the story.
- How you use inverses to solve for the unknown quantity.
- The solution to your equation.

1. As a $7\frac{1}{2}$ inch candle burns down, its height decreases $\frac{3}{4}$ inch each hour. How many hours does it take for the candle to burn completely?
2. On Monday $\frac{1}{9}$ of the enrolled students in a school were absent. There were 4,512 students present. How many students are enrolled at the school?
3. A hiker begins at sea level and descends 25 feet every minute. How long will it take to get to an elevation of -750 feet?
4. Jada practices the violin for the same amount of time every day. On Tuesday she practices for 35 minutes. How much does Jada practice in a week?
5. The temperature has been dropping $2\frac{1}{2}$ degrees every hour, and the current temperature is -15 °F. How many hours ago was the temperature 0 °F?
6. The population of a school increased by 12%, and now the population is 476. What was the population before the increase?
7. During a 5% off sale, Diego pays $74.10 for a new hockey stick. What was the original price?
8. A store buys sweaters for $8 and sells them for $26. How many sweaters does the store need to sell to make a profit of $990?

2. On Monday $\frac{1}{9}$ of the enrolled students in a school were absent. There were 4,512 students present. How many students are enrolled at the school?

Sample response: $\left(s - \frac{1}{9}s\right) = 4{,}512$, where s represents the total number of students enrolled at the school. $\frac{1}{9}s$ represents the students that were absent, and 4,512 represents the students that were at school on Monday. Students may not know how to solve this because they haven't practiced any equations with more than one variable yet. Students can reason that if $\frac{1}{9}$ of the students are absent, then $\frac{8}{9}$ of the students are present. They can write $\frac{8}{9}s = 4{,}512$ and solve $s = \frac{9}{8} \cdot 4{,}512 = 5{,}076$. This means that there are 5,076 students enrolled at the school.

3. A hiker begins at sea level and descends 25 feet every minute. How long will it take to get to an elevation of -750 feet?

Sample response: $-25m = -750$, where m represents how many minutes they have been hiking. $-25m$ represents the elevation they have hiked to after m minutes, and -750 represents the goal elevation they are trying to get to. The situation involves multiplication by a negative to show how far the hiker has descended after the number of minutes. The equation can be solved by multiplying by $-\frac{1}{25}$. The solution is $m = 30$, which means that at this rate it will take the hiker 30 minutes to reach an elevation of -750 feet.

4. Jada practices the violin for the same amount of time every day. On Tuesday she practices for 35 minutes. How much does Jada practice in a week?

Sample response: $35 \cdot 7 = p$ (or $\frac{1}{7}p = 35$), where p represents the total amount of time Jada practices in a week. $\frac{1}{7}p$ represents the amount of time Jada practices on one day, and 35 is the number of minutes that she practiced on Tuesday. The situation involves multiplication by a fraction to show that the time she practices on Tuesday is $\frac{1}{7}$ of the total time she practices during the week. The equation can be solved by multiplying by 7. The solution is $p = 245$, which means that Jada practices a total of 245 minutes, or 4 hours and 5 minutes, during the week.

5. The temperature has been dropping $2\frac{1}{2}$ degrees every hour, and the current temperature is -15 °F. How many hours ago was the temperature 0 °

Sample response: $-2\frac{1}{2}h = -15$, where h represents the number of hours since the temperature was 0 degrees Fahrenheit. $-2\frac{1}{2}h$ represents how much the temperature has dropped after h hours, and -15 represents the current temperature. The situation involves multiplication by a negative to show how far the temperature has dropped after a given number of hours. The equation can be solved by multiplying by $-\frac{2}{5}$ because that is the reciprocal of $-\frac{5}{2}$, which is equivalent to $-2\frac{1}{2}$. The solution is $h = 6$, which means that the temperature was 0 degrees Fahrenheit 6 hours ago.

6. The population of a school increased by 12%, and now the population is 476. What was the population before the increase?

Sample response: $p + 0.12p = 476$, where p represents the school's population before the increase. $0.12p$ represents 12% of the original population that the school increased by, and 476 represents the new population of the school after the increase. The equation can be solved by reasoning that 112% of the original population is 476. Then $1.12p = 476$ and $p = 476 \div 1.12 = 425$. This means that the school population before the increase was 425 students.

7. During a 5% off sale, Diego pays $74.10 for a new hockey stick. What was the original price?

Sample response: $p - 0.05p = 74.10$, where p represents the original price of the hockey stick. $0.05p$ represents the discount of 5% of the original price, and 74.10 represents the price Diego pays for the stick, assuming there is no sales tax. The equation can be solved by reasoning that 95% of the original price is 74.10. Then $0.95p = 74.10$ and $p = 74.10 \div 0.95 = 78$. This means that the original price of the hockey stick was $78.

8. A store buys sweaters for $8 and sells them for $26. How many sweaters does the store need to sell to make a profit of $990?

Sample response: $(26 - 8)s = 990$, where s represents the number of sweaters sold. $(26 - 8)$ represents the profit the store makes on each sweater, and 990 represents the total profit they want to make. The equation can be solved by dividing by $26 - 8 = 18$. The solution is $s = 55$, which means the store has to sell 55 sweaters to make the desired profit.

Are You Ready for More?

Diego and Elena are 2 miles apart and begin walking towards each other. Diego walks at a rate of 3.7 miles per hour, and Elena walks 4.3 miles per hour. While they are walking, Elena's dog runs back and forth between the two of them at a rate of 6 miles per hour. Assuming the dog does not lose any time in turning around, how far has the dog run by the time Diego and Elena reach each other?

1.5 miles

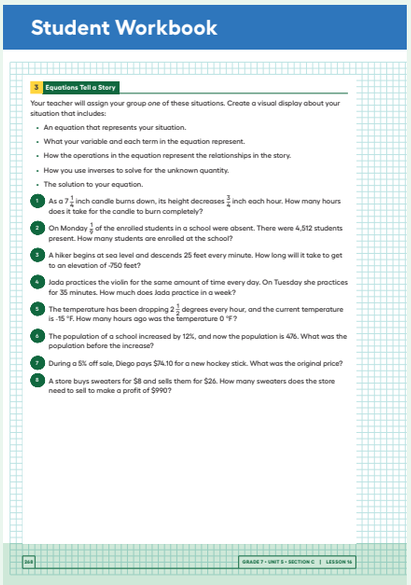
Diego and Elena are approaching each other at a rate of $3.7 + 4.3$, or 8, miles per hour. We can write the equation $2 = 8t$ to find the time, t, it takes them to cover 2 miles together. Solving the equation, we find $t = \frac{1}{4}$. This means they walk and the dog runs for a quarter of an hour. In that time, the dog covers $\left(\frac{1}{4}\right)(6)$, or 1.5, miles.

Activity Synthesis

The purpose of this discussion is for students to share their visual display and view other groups' displays. Invite groups to present their solutions or to view all the solutions on display. Consider discussing the following questions:

- *"How did you decide what your variable would represent?"*
- *"What negative quantities are there in your equation, and what do they mean in terms of this situation?"*
- *"How did you come up with your equation?"*
- *"What strategy did you use to solve the equation?"*
- *"What does your solution mean in terms of this situation?"*

Student Workbook



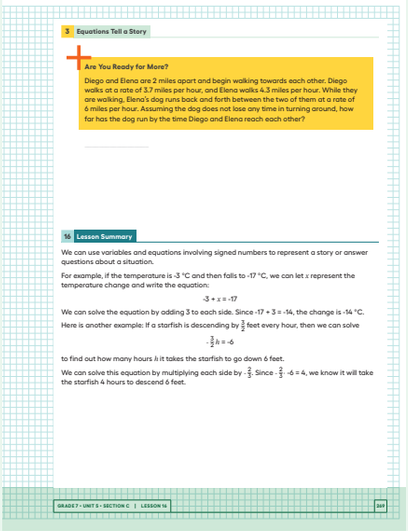
3 Equations Tell a Story

Your teacher will assign your group one of these situations. Create a visual display about your situation that includes:

- An equation that represents your situation.
- What your variable and each term in the equation represent.
- How the operations in the equation represent the relationships in the story.
- How you use inverses to solve for the unknown quantity.
- The solution to your equation.

1. As a $7\frac{1}{2}$ inch candle burns down, its height decreases $\frac{3}{4}$ inch each hour. How many hours does it take for the candle to burn completely?
2. On Monday $\frac{1}{8}$ of the enrolled students in a school were absent. There were 4,512 students present. How many students are enrolled at the school?
3. A hiker begins at sea level and descends 25 feet every minute. How long will it take to get to an elevation of -750 feet?
4. Jada practices the violin for the same amount of time every day. On Tuesday she practices for 35 minutes. How much does Jada practice in a week?
5. The temperature has been dropping $2\frac{1}{2}$ degrees every hour, and the current temperature is -15 °F. How many hours ago was the temperature 0 °F?
6. The population of a school increased by 12%, and now the population is 476. What was the population before the increase?
7. During a 5% off sale, Diego pays $74.10 for a new hockey stick. What was the original price?
8. A store buys sweaters for $8 and sells them for $26. How many sweaters does the store need to sell to make a profit of $990?

Student Workbook



3 Equations Tell a Story

Are You Ready for More?

Diego and Elena are 2 miles apart and begin walking towards each other. Diego walks at a rate of 3.7 miles per hour, and Elena walks 4.3 miles per hour. While they are walking, Elena's dog runs back and forth between the two of them at a rate of 6 miles per hour. Assuming the dog does not lose any time in turning around, how far has the dog run by the time Diego and Elena reach each other?

16 Lesson Summary

We can use variables and equations involving signed numbers to represent a story or answer questions about a situation.

For example, if the temperature is -3 °C and then falls to -17 °C, we can let x represent the temperature change and write the equation:

$$-3 + x = -17$$

We can solve the equation by adding 3 to each side. Since -17 + 3 = -14, the change is -14 °C.

Here is another example: If a starfish is descending by $\frac{3}{2}$ feet every hour, then we can solve

$$-\frac{3}{2}h = -6$$

to find out how many hours h it takes the starfish to go down 6 feet.

We can solve this equation by multiplying each side by $-\frac{2}{3}$. Since $-\frac{2}{3} \cdot -6 = 4$, we know it will take the starfish 4 hours to descend 6 feet.

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Responding To Student Thinking

Press Pause

By this point in the unit, there should be some student mastery of interpreting and solving equations that involve negative numbers. If students struggle, make time to revisit related work in the lessons referred to here. See the Course Guide for ideas to help students re-engage with earlier work.

Grade 7, Unit 5, Lesson 15 Solving Equations with Rational Numbers

Grade 7, Unit 5, Lesson 16 Representing Contexts with Equations

Lesson Synthesis

Share with students,

"Today we represented situations using variables and equations with signed numbers."

If students created displays, select some of the situations from the displays to continue the discussion. If students did not create displays, highlight one of the temperature situations for the discussion.

To help students articulate their methods for writing or solving equations, consider asking:

"When writing an equation to represent a situation, how do you decide what your variable represents?"

"What are some ways you might solve the equation?"

Listen for and elicit multiple strategies, highlighting words like "inverse," "opposite," and "reciprocal" in the explanations.

Lesson Summary

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Cool-down

Floating above a Sunken Canoe

5 min

Student Task Statement

A balloon is floating above a lake, and a sunken canoe is below the surface of the lake. The balloon's vertical position is 12 meters, and the canoe's is -4.8 meters. The equation $12 + d = -4.8$ represents this situation.

1. What does the variable d represent?

The difference (or change) in elevation.

2. What value of d makes the equation true? Explain your reasoning.

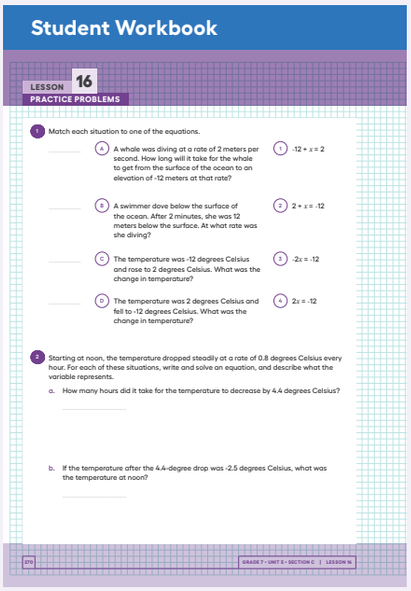
-16.8

Sample reasoning: The equation $12 + d = -4.8$ can be rewritten as $d = -4.8 - 12$, and $-4.8 - 12 = -16.8$.

Lesson 16

Practice Problems

5 Problems



Problem 1

Match each situation to one of the equations.

A matches 3	**A.** A whale was diving at a rate of 2 meters per second. How long will it take for the whale to get from the surface of the ocean to an elevation of -12 meters at that rate?	**1.** $-12 + x = 2$
B matches 4	**B.** A swimmer dove below the surface of the ocean. After 2 minutes, she was 12 meters below the surface. At what rate was she diving?	**2.** $2 + x = -12$
C matches 1	**C.** The temperature was -12 degrees Celsius and rose to 2 degrees Celsius. What was the change in temperature?	**3.** $-2x = -12$
D matches 2	**D.** The temperature was 2 degrees Celsius and fell to -12 degrees Celsius. What was the change in temperature?	**4.** $2x = -12$

Problem 2

Starting at noon, the temperature dropped steadily at a rate of 0.8 degrees Celsius every hour.

For each of these situations, write and solve an equation, and describe what the variable represents.

a. How many hours did it take for the temperature to decrease by 4.4 degrees Celsius?

5.5 hours

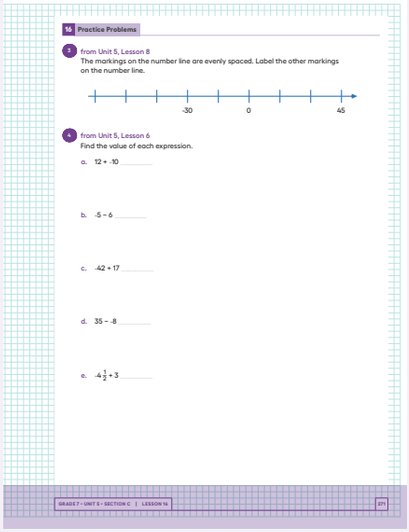
Sample response: $-0.8h = -4.4$, where h is the number of hours it took for the temperature to decrease. Solve the equation by multiplying each side by $\frac{-1}{0.8}$. It took $5\frac{1}{2}$ hours for the temperature to drop 4.4 degrees Celsius.

b. If the temperature after the 4.4-degree drop was -2.5 degrees Celsius, what was the temperature at noon?

1.9 degrees Celsius

Sample response: $T - 4.4 = -2.5$, where T is the temperature at noon.

Student Workbook


16 Practice Problems

3 from Unit 5, Lesson 8
The markings on the number line are evenly spaced. Label the other markings on the number line.

-30 0 45

4 from Unit 5, Lesson 6
Find the value of each expression.

a. 12 + -10

b. -5 − 6

c. -42 + 17

d. 35 − -8

e. $-4\frac{1}{2} + 3$

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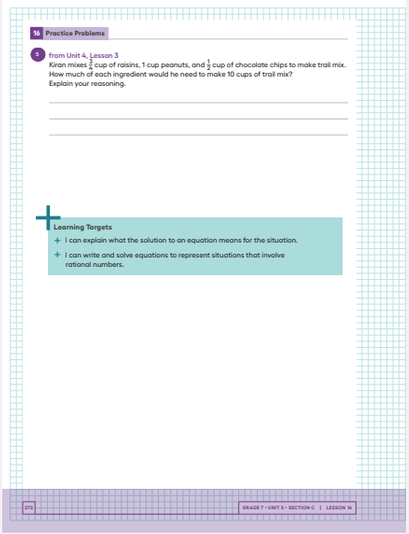
Student Workbook


16 Practice Problems

5 from Unit 4, Lesson 3
Kiran mixes $\frac{3}{4}$ cup of raisins, 1 cup peanuts, and $\frac{1}{2}$ cup of chocolate chips to make trail mix. How much of each ingredient would he need to make 10 cups of trail mix? Explain your reasoning.

Learning Targets
+ I can explain what the solution to an equation means for the situation.
+ I can write and solve equations to represent situations that involve rational numbers.

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Problem 3

from Unit 5, Lesson 8

The markings on the number line are evenly spaced. Label the other markings on the number line.

Problem 4

from Unit 5, Lesson 6

Find the value of each expression.

a. 12 + -10

2

b. -5 − 6

-11

c. -42 + 17

-25

d. 35 − -8

43

e. $-4\frac{1}{2} + 3$

$-1\frac{1}{2}$

Problem 5

from Unit 4, Lesson 3

Kiran mixes $\frac{3}{4}$ cup of raisins, 1 cup peanuts, and $\frac{1}{2}$ cup of chocolate chips to make trail mix. How much of each ingredient would he need to make 10 cups of trail mix? Explain your reasoning.

$\frac{30}{9}$ cups of raisins, $\frac{40}{9}$ cups of peanuts, and $\frac{20}{9}$ cups of chocolate chips.

Sample reasoning: The ingredients listed will make $2\frac{1}{4}$ cups of trail mix. So to get 10 cups of trail mix, multiply each amount by $10 \div 2\frac{1}{4} = \frac{40}{9}$.