Lesson 7

Write Expressions with Variables

Goals

- Explain (orally) how to write an expression that represents a situation with an unknown amount.
- Write an expression with a variable to generalize the relationship between quantities in a situation.

Learning Targets

- I can use an expression that represents a situation to find an amount in a story.
- I can write an expression with a variable to represent a calculation where I do not know one of the numbers.

Lesson Narrative

In this lesson, students write expressions with one variables to represent situations in which a calculation can be carried out repeatedly with different numbers. Students build on their work in prior grades and units with writing expressions to represent operations, situations, and relationships. In the previous section, students identified equations with variables that represented diagrams and situations. They also wrote equations in percent situations where the equation structure was clearly stated (_____% of _____% equals _____%). Now, students practice interpreting situations, writing expressions with a variable, and explaining how the parts of the expression match the situation. Students complete tables and write both numerical and algebraic expressions.

Throughout the lesson, as students perform the same calculations and generalize relationships with algebraic expressions, they practice expressing regularity through repeated reasoning. They are also encouraged to attend to precision when describing how their expressions relate to situations, using the vocabulary they developed in previous lessons.

Student Learning Goal

Let's use expressions with variables to describe situations.

Access for Students with Diverse Abilities

- Engagement (Activity 2)
- Representation (Activity 1)

Access for Multilingual Learners

- MLR2: Collect and Display (Activity 2)
- MLR5: Co-Craft Questions (Warm-up)

Instructional Routines

- 5 Practices
- MLR2: Collect and Display
- MLR5: Co-Craft Questions

Lesson Timeline

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

Warm-up

Priya's Points

5 min

Activity Narrative

The purpose of this *Warm-up* is to invite students to interpret a comparison situation that can be represented with $p + x$. Students generate mathematical questions based on the context and consider how they might represent the answer to comparison questions with both numerical and algebraic expressions.

Launch

Tell students to close their books or devices (or to keep them closed). Arrange students in groups of 2. Introduce the context of esports and elicit what students know about esports, including teams, players, and the games played. If needed, explain that the term "esport" is short for "electronic sport," and it refers to video game competitions involving multiple players (individuals or teams). Then, use *Co-Craft Questions* to further orient students to the context and elicit possible mathematical questions.

Give students 1–2 minutes to write a list of mathematical questions that could be asked about the situation before comparing questions with a partner.

Student Task Statement

Priya is on her school's esport team. She scored 473 points in the last match. Noah, Elena, and Clare each scored fewer points than Priya did.

Sample responses:

- How many points did the team score altogether?
- How many more points did Priya score than Noah (or Elena, or Clare)?
- How many more points did Priya's team score than the other team?

Activity Synthesis

Invite several partners to share one question with the class and record responses. Ask the class to make comparisons among the shared questions and their own. Ask,

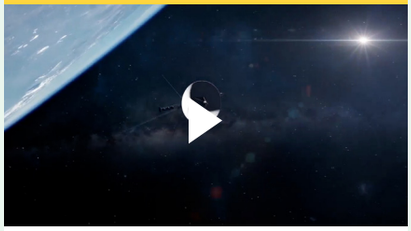
"*What do these questions have in common? How are they different?*"

Listen for and amplify language related to the learning goal, such as "the points Priya scored," "the points (others) scored," and "how many more (or fewer)."

Tell students that they will take a closer look at the relationship between the students' scores in the next activity.

Inspire Math

Voyager video



Go Online

Before the lesson, show this video to reinforce the real-world connection.

ilclass.com/l/614213

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Access for Multilingual Learners (Warm-up)

MLR5: Co-Craft Questions

This activity uses the *Co-Craft Questions* math language routine to advance reading and writing as students make sense of a context and practice generating mathematical questions.

Instructional Routines

MLR5: Co-Craft Questions

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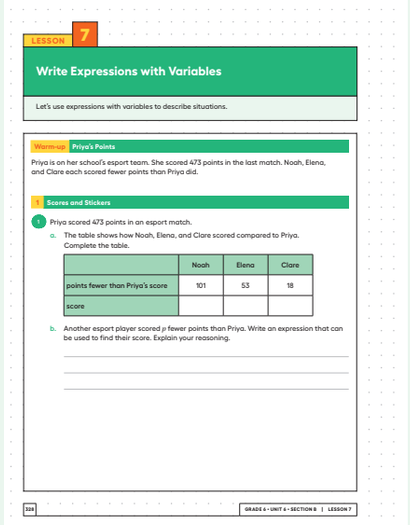
Student Workbook



LESSON 7

Write Expressions with Variables

Let's use expressions with variables to describe situations.

Warm-up Priya's Points

Priya is on her school's esport team. She scored 473 points in the last match. Noah, Elena, and Clare each scored fewer points than Priya did.

1 Scores and Stickers

1 Priya scored 473 points in an esport match.

a. The table shows how Noah, Elena, and Clare scored compared to Priya. Complete the table.

	Noah	Elena	Clare
points fewer than Priya's score	101	53	18
score			

b. Another esport player scored p fewer points than Priya. Write an expression that can be used to find their score. Explain your reasoning.

Instructional Routines

5 Practices

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Access for Students with Diverse Abilities (Activity 1, Launch)

Representation: Internalize Comprehension.
Differentiate the degree of difficulty or complexity by beginning with more accessible values. Extend the given table, and begin by exploring values for money collected based on 1, 2, 3, 5, and 10 stickers sold. Draw students' attention to what changes and what stays the same each time they calculate the money collected.

Supports accessibility for: Conceptual Processing, Memory

Activity 1
Scores and Stickers

15 min

Activity Narrative

In this activity, students encounter two situations in which performing the same calculation with different values of one quantity gives the values of another quantity. Students interpret a situation with the support of tables. Through repeated reasoning, students see that they can summarize the calculations they performed with an algebraic expression and use these expressions to answer questions about specific values. As students relate quantities in situations to numerical and variable expressions, they practice reasoning quantitatively and abstractly.

Monitor for students who use different strategies to answer the last question about the number of stickers Noah sold. Here are some likely strategies, listed from more concrete to more abstract:

- Guess a number and multiply it by 0.5 to see if it gives 127.5.
- Reason about a relationship seen in the table but is not explicit in the expression. (For example, the number of stickers is twice the number of dollars.)
- Write and solve an equation.

Launch

Keep students in groups of 2. Tell students that they now have some information about how many fewer points Noah, Elena, and Clare scored compared to Priya and will calculate their scores. Then, they will solve another problem about Noah's sticker sale.

Give students 7–8 minutes of partner work time, followed by a whole-class discussion.

Student Task Statement

1. Priya scored 473 points in an esport match.

a. The table shows how Noah, Elena, and Clare scored compared to Priya. Complete the table.

	Noah	Elena	Clare
points fewer than Priya's score	101	53	18
score	362	420	455

b. Another esport player scored p fewer points than Priya. Write an expression that can be used to find their score. Explain your reasoning.

$473 - p$

Sample reasoning: Earlier, we subtracted the 101, 53, and 18 from 473, so subtracting p from 473 would also give this player's score.

2. Noah made stickers that show his team's logo. He sells them for $0.50 per sticker.

a. Complete the table to show how much money Noah would collect if he sold each number of stickers.

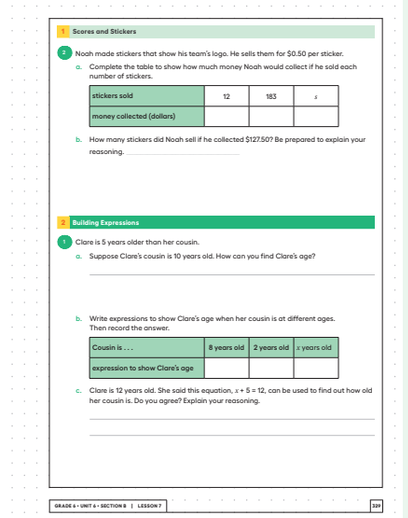
stickers sold	12	183	s
money collected (dollars)	6	91.50	0.5s

b. How many stickers did Noah sell if he collected $127.50? Be prepared to explain your reasoning. 255 stickers

Sample reasoning:

- The number of stickers is twice the number of dollars, and $2 \cdot (127.5) = 255$.
- $0.5s = 127.5$, and dividing each side of the equation by 0.5 gives s on one side and $127.5 \div 0.5$ on the other side. Dividing 127.5 by 0.5 is equivalent to dividing 1,270 by 5, which is 255.

Student Workbook


1 Scores and Stickers

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a. Complete the table to show how much money Noah would collect if he sold each number of stickers.

stickers sold	12	183	s
money collected (dollars)			

b. How many stickers did Noah sell if he collected $127.50? Be prepared to explain your reasoning.

2 Building Expressions

1 Clare is 5 years older than her cousin.

a. Suppose Clare's cousin is 10 years old. How can you find Clare's age?

b. Write expressions to show Clare's age when her cousin is at different ages. Then record the answer.

Cousin is . . .	8 years old	2 years old	x years old
expression to show Clare's age			

c. Clare is 12 years old. She said this equation, $x + 5 = 12$, can be used to find out how old her cousin is. Do you agree? Explain your reasoning.

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Activity Synthesis

The goal of the discussion is to make it explicit to students that we can write a mathematical expression to represent a calculation, even if we do not know what one of the numbers is in the calculation.

Invite students to share their expression for finding the score of an esport player who scored p points fewer than Priya did, and to explain their reasoning. If no students mentioned that the same calculation—subtracting the difference in points from 473—was done to find the other students' scores, emphasize this idea. (Consider displaying 473 – 101, 473 – 53, and 473 – 18 for all to see.)

Next, ask previously selected groups to share their reasoning for the last question. Sequence the discussion of the strategies in the order listed in the *Activity Narrative*. If possible, record and display the students' work for all to see. Connect the different responses by asking questions, such as:

- *"How are these strategies alike? How are they different?"*

  "How does each strategy use the relationship between the number of stickers and the number of dollars?"

If no students wrote and solved the equation $0.50c = 127.50$ (or equivalent), display the equation for all to see. Ask students to explain how this equation represents the question and why and how it can be used to answer the question. Discuss questions such as:

- *"What does 0.5c represent?"*

  the amount of money collected for selling c stickers

- *"What does 127.50 represent?"*

  the amount of money collected for selling c stickers

- *"How can we find the value of c?"*

  Divide each side by 0.5.

During the discussion, emphasize the use of terms such as "coefficient," "variable," and "solution" to reinforce students' knowledge of mathematical language.

Access for Multilingual Learners (Activity 2)

MLR2: Collect and Display
This activity uses the *Collect and Display* math language routine to advance conversing and reading as students clarify, build on, or make connections to mathematical language.

Instructional Routines

MLR2: Collect and Display

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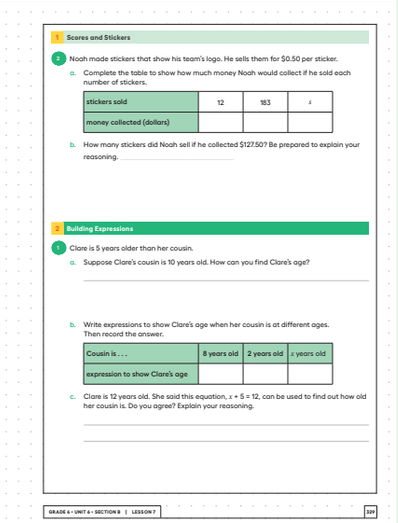
Access for Students with Diverse Abilities (Activity 2, Launch)

Engagement: Develop Effort and Persistence.
Connect a new concept to one with which students have experienced success. For example, invite students to draw a picture or tape diagram to help understand the situation and relationships as an intermediate step before writing an equation.

Supports accessibility for: Social-Emotional Functioning, Conceptual Processing

Student Workbook



1 Scores and Stickers

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money collected (dollars)			

b. How many stickers did Noah sell if he collected $127.50? Be prepared to explain your reasoning.

2 Building Expressions

1 Clare is 5 years older than her cousin.

a. Suppose Clare's cousin is 10 years old. How can you find Clare's age?

b. Write expressions to show Clare's age when her cousin is at different ages. Then record the answer.

Cousin is . . .	8 years old	2 years old	x years old
expression to show Clare's age			

c. Clare is 12 years old. She said this equation, $x + 5 = 12$, can be used to find out how old her cousin is. Do you agree? Explain your reasoning.

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Activity 2

Building Expressions

15 min

Activity Narrative

This activity prompts students to write expressions to find unknown values in a situation and to describe the calculation process more generally. Then students use the expression with a variable to write and solve an equation involving the same situation.

The activity is structured in a way that allows students to progress gradually from concrete reasoning toward abstraction and to notice regularity. For the first three questions, students reason about numbers repeatedly before they write an expression that uses a variable.

Launch

Arrange students in groups of 2.

Give students 8–10 minutes of quiet work time and time to share with a partner, followed by a whole-class discussion.

Student Task Statement

1. Clare is 5 years older than her cousin.

a. Suppose Clare's cousin is 10 years old. How can you find Clare's age?

Sample responses: Add 5 to 10. Find 10 + 5.

b. Write expressions to show Clare's age when her cousin is at different ages. Then record the answer.

Cousin is ...	8 years old	2 years old	x years old
expression to show Clare's age	$8 + 5$	$2 + 5$	$x + 5$

c. Clare is 12 years old. She said this equation, $x + 5 = 12$, can be used to find out how old her cousin is. Do you agree? Explain your reasoning.

Sample reasoning: Both $x + 5$ and 12 represent Clare's age, so they are equal to each other. We can see what number added by 5 gives 12. That number is 7, so her cousin is 7 years old.

2. Diego has 3 times as many comic books as Han does.

a. Suppose Han has 10 comic books. How can you find the number of comic books Diego has?

Sample responses: Triple 10. Find $3 \cdot 10$.

b. Write expressions that can show how many comic books Diego has for different numbers of comic books that Han has. Then record the answer.

Han has ...	6 books	17 books	n books
expression to show how many books Diego has	$3 \cdot 6$	$17 \cdot 6$	$3n$

c. Diego has 27 comic books. How many comic books does Han have? Write an equation that represents the question and use it to find the answer.

$3n = 27$

Han has 9 books. Dividing each side by 3 gives $n = 9$.

3. Two-fifths of the vegetables in Priya's garden are tomatoes.

a. Suppose Priya's garden has 20 vegetables. How can you find the number of tomatoes?

Sample responses:

Multiply 20 by $\frac{2}{5}$. Divide 20 by 5 to find one-fifth of the vegetables, and then multiply that number by 2.

b. How many tomatoes are in Priya's garden if it has v vegetables?

$\frac{2}{5}v$ (or equivalent)

c. If Priya's garden has 6 tomatoes, how many vegetables are there? Write an equation that represents the question and use it to find the answer.

$\frac{2}{5}v = 6$

The answer is 15 vegetables, because the equation is true when v is 15.

4. A school paid $31.25 for each calculator.

a. If the school bought c calculators, how much did they pay?

$31.25c$

b. The school spent $500 on calculators. How many did the school buy?

$31.25c = 500$

The school bought 16 calculators. Dividing 500 by 31.25 gives 16.

Activity Synthesis

The goal of this discussion is to make sure students see the connection between the expressions they write and the value given in the last part of each problem.

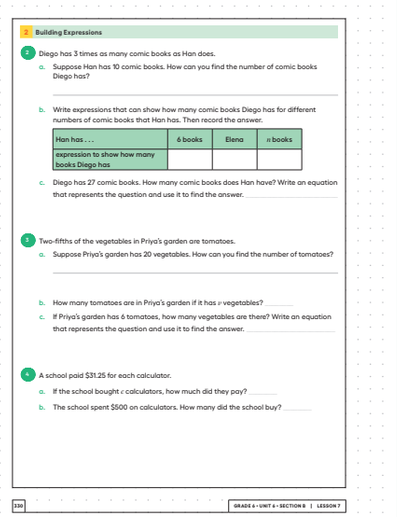
Invite students to share the variable expression they wrote for each situation and the equation in the last part of each question. Ask students how they know that each equation represents the question and can be asked to find the answer. If not mentioned by students, point out that the expression and the given value both represent the same quantity. (Consider displaying the pairs of quantities, as shown.) An equation can be written to describe that equality, and then solved to find the answer.

Clare's age: $x + 5$	Diego's books: $3n$	Tomatoes: $\frac{2}{5}v$	Cost: $31.25c$
Clare's age: 12	Diego's books: 27	Tomatoes: 8	Cost: 500

Then, ask students to share how they solved each equation.

Continue to highlight the use of "expression," "variable," and "coefficient" as students discuss expressions and equations in context.

Student Workbook


2 Building Expressions

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   a. Suppose Han has 10 comic books. How can you find the number of comic books Diego has?
   b. Write expressions that can show how many comic books Diego has for different numbers of comic books that Han has. Then record the answer.

Han has . . .	6 books	Elena	n books
expression to show how many books Diego has			

   c. Diego has 27 comic books. How many comic books does Han have? Write an equation that represents the question and use it to find the answer.

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   b. How many tomatoes are in Priya's garden if it has v vegetables?
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4. A school paid $31.25 for each calculator.
   a. If the school bought c calculators, how much did they pay?
   b. The school spent $500 on calculators. How many did the school buy?

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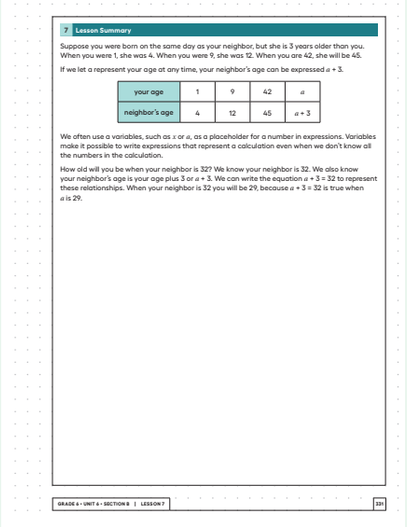
Building on Student Thinking

There are multiple quantities in each problem. Students may write expressions that match, but make errors when solving the second part of each problem—with or without writing an equation. Ask students to explain what their expression represents. Then ask what they need to do to answer the last part of each problem. If needed, invite students to draw a tape diagram to represent the problem.

Student Workbook



7 Lesson Summary

Suppose you were born on the same day as your neighbor, but she is 3 years older than you. When you were 1, she was 4. When you were 9, she was 12. When you are 42, she will be 45.

If we let a represent your age at any time, your neighbor's age can be expressed $a + 3$.

your age	1	9	42	a
neighbor's age	4	12	45	$a + 3$

We often use a variables, such as x or a, as a placeholder for a number in expressions. Variables make it possible to write expressions that represent a calculation even when we don't know all the numbers in the calculation.

How old will you be when your neighbor is 32? We know your neighbor is 32. We also know your neighbor's age is your age plus 3 or $a + 3$. We can write the equation $a + 3 = 32$ to represent these relationships. When your neighbor is 32 you will be 29, because $a + 3 = 32$ is true when a is 29.

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Lesson Synthesis

To highlight the key ideas of the lesson, invite students to refer back to the work they did in all activities. Ask them to notice any pattern in the situations and in how they answered questions about the situation. Discuss questions such as:

- *"What do all situations in this activity have in common?"*

  They are about two quantities, how they are related, and how to find one quantity when we know the other.

- *"In each situation, we know the relationship of the quantities. When we have the value of one quantity, we are able to calculate the other. What if we don't have the value of that first quantity? Can we still describe how to find the other?"*

  Yes

- *"How?"*

  Use a variable and write an expression.

- *"Here's another situation: You have $20 and spend $4. How much money would you have left?"*

  16

- *"How much would you have left if you spent $8 or $13.50?"*

  $12 or $6.50

- *"Can you describe how much you would have left if you spent d dollars?"*

  Yes, by writing $20 - d$

- *"Why might it be helpful to write an expression like 20 – d?"*

  It is an efficient way to describe the leftover money for any amount spent.

- *"If we know the amount left over, say, $4.75, how can we use the expression to find out how much was spent?"*

  Write $20 - d = 4.75$ and think about what value of d makes the equation true.

Lesson Summary

Suppose you were born on the same day as your neighbor, but she is 3 years older than you. When you were 1, she was 4. When you were 9, she was 12. When you are 42, she will be 45.

If we let a represent your age at any time, your neighbor's age can be expressed $a + 3$.

your age	1	9	42	a
neighbor's age	4	12	45	$a + 3$

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How old will you be when your neighbor is 32? We know your neighbor is 32. We also know your neighbor's age is your age plus 3 or $a + 3$. We can write the equation $a + 3 = 32$ to represent these relationships. When your neighbor is 32 you will be 29, because $a + 3 = 32$ is true when a is 29.

Cool-down

Growth

5 min

Student Task Statement

1. A plant measured x inches tall last week and 8 inches tall this week.

Circle the expression that represents the number of inches the plant grew this week. Explain how you know.

- $x - 8$
- $8 - x$

8 – x

Sample reasoning:

Since the plant grew taller this week, 8 is greater than x. The difference of 8 and x is the amount that the plant grew.

2. Each tree needs 1.2 liters of water. Write an expression that represents the amount of water needed for n trees.

1.2n (or equivalent)

Responding To Student Thinking

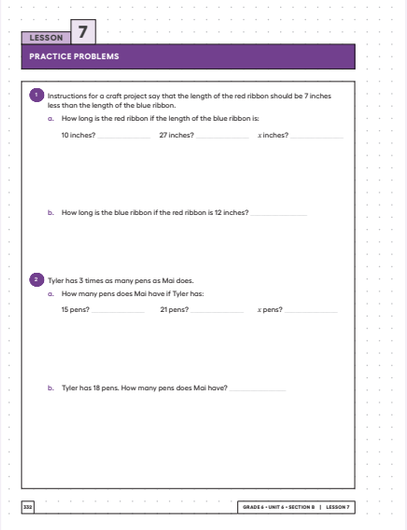
More Chances
Students will have more opportunities to understand the mathematical ideas addressed here. There is no need to slow down or add additional work to the next lessons.

Lesson 7

Practice Problems

7 Problems

Student Workbook



LESSON 7

PRACTICE PROBLEMS

1. Instructions for a craft project say that the length of the red ribbon should be 7 inches less than the length of the blue ribbon.
   a. How long is the red ribbon if the length of the blue ribbon is:
      10 inches? _____ 27 inches? _____ x inches? _____
   b. How long is the blue ribbon if the red ribbon is 12 inches? _____
2. Tyler has 3 times as many pens as Mai does.
   a. How many pens does Mai have if Tyler has:
      15 pens? _____ 21 pens? _____ x pens? _____
   b. Tyler has 18 pens. How many pens does Mai have? _____

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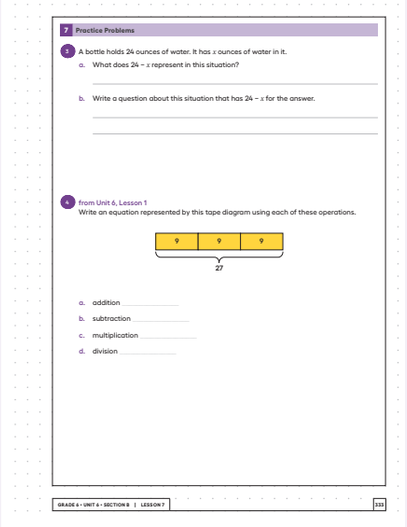
Student Workbook



7 Practice Problems

3. A bottle holds 24 ounces of water. It has x ounces of water in it.
   a. What does $24 - x$ represent in this situation?
   b. Write a question about this situation that has $24 - x$ for the answer.
4. from Unit 6, Lesson 1
   Write an equation represented by this tape diagram using each of these operations.

   a. addition _____
   b. subtraction _____
   c. multiplication _____
   d. division _____

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Problem 1

Instructions for a craft project say that the length of the red ribbon should be 7 inches less than the length of the blue ribbon.

a. How long is the red ribbon if the length of the blue ribbon is:

10 inches?

3 inches (10 – 7 = 3)

27 inches?

20 inches (27 – 7 = 20)

x inches?

x – 7 inches

b. How long is the blue ribbon if the red ribbon is 12 inches?

19 inches (x + 7 = 12 is true when x = 19)

Problem 2

Tyler has 3 times as many pens as Mai does.

a. How many pens does Mai have if Tyler has:

15 pens?

5 pens (15 ÷ 3 = 5)

21 pens?

7 pens (21 ÷ 3 = 7)

x pens?

x ÷ 3 pens

b. Tyler has 18 pens. How many pens does Mai have?

6 pens (x ÷ 3 = 6 is true when x = 18.)

Problem 3

A bottle holds 24 ounces of water. It has x ounces of water in it.

a. What does $24 - x$ represent in this situation?

Sample responses:

- It represents the amount of water that has been removed from the bottle.
- It represents the amount of water that is needed to fill the bottle.

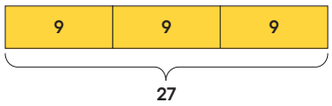
b. Write a question about this situation that has $24 - x$ for the answer.

Sample response: How many ounces of water did Jada drink from the full bottle if there are x ounces left?

Problem 4

from Unit 6, Lesson 1

Write an equation represented by this tape diagram using each of these operations.



a. addition

Sample response: 9 + 9 + 9 = 27

b. subtraction

Sample response: 27 – 9 = 9 + 9

c. multiplication

Sample response: 3 · 9 = 27

d. division

Sample response: 27 ÷ 3 = 9

Problem 5

from Unit 6, Lesson 5

Select **all** the equations that describe each situation and then find the solution.

a. Han's house is 450 meters from school. Lin lives 135 meters closer to school than Han does. What is the distance of Lin's house from school, z?

A. $z = 450 + 135$

B. $z = 450 - 135$

C. $z - 135 = 450$

D. $z + 135 = 450$

$z = 315$; Lin's house is 315 meters from school.

b. Tyler's playlist has 36 songs. Noah's playlist has one quarter as many songs as Tyler's playlist. How many songs are on Noah's playlist, w?

A. $w = 4 \cdot 36$

B. $w = 36 \div 4$

C. $4w = 36$

D. $\frac{w}{4} = 36$

$w = 9$; Noah's playlist has 9 songs.

Problem 6

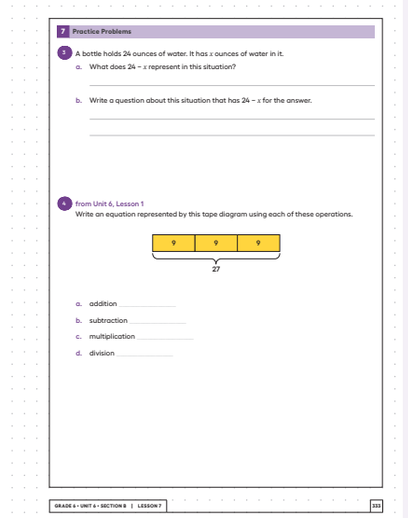
from Unit 3, Lesson 12

You had $30. You spent 70% of the money on books. How much money did you spend on books?

$21

Sample reasoning: 10% of 30 is 3, so 70% of 30 is 7 times 3, which is 21.

Student Workbook


7 Practice Problems

3 A bottle holds 24 ounces of water. It has z ounces of water in it.

a. What does $24 - z$ represent in this situation?

b. Write a question about this situation that has $24 - z$ for the answer.

4 from Unit 6, Lesson 1

Write an equation represented by this tape diagram using each of these operations.

9 9 9

27

a. addition

b. subtraction

c. multiplication

d. division

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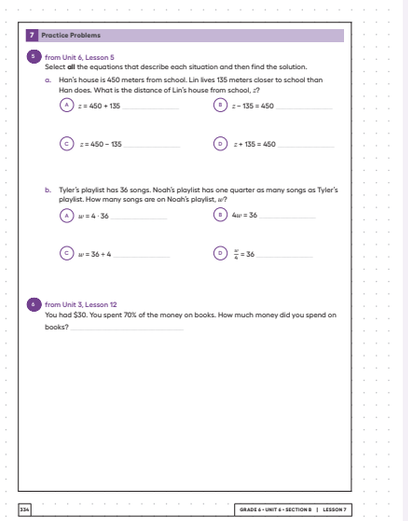
Student Workbook


7 Practice Problems

3 from Unit 6, Lesson 5

Select **all** the equations that describe each situation and then find the solution.

a. Han's house is 450 meters from school. Lin lives 135 meters closer to school than Han does. What is the distance of Lin's house from school, z?

A $z = 450 + 135$ B $z - 135 = 450$

C $z = 450 - 135$ D $z + 135 = 450$

b. Tyler's playlist has 36 songs. Noah's playlist has one quarter as many songs as Tyler's playlist. How many songs are on Noah's playlist, w?

A $w = 4 \cdot 36$ B $4w = 36$

C $w = 36 + 4$ D $\frac{w}{4} = 36$

4 from Unit 3, Lesson 12

You had $30. You spent 70% of the money on books. How much money did you spend on books?

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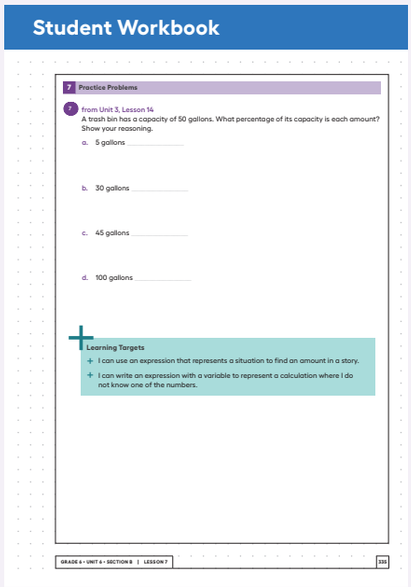
Student Workbook

7 Practice Problems

7 from Unit 3, Lesson 14
A trash bin has a capacity of 50 gallons. What percentage of its capacity is each amount? Show your reasoning.

a. 5 gallons _____

b. 30 gallons _____

c. 45 gallons _____

d. 100 gallons _____

Learning Targets
+ I can use an expression that represents a situation to find an amount in a story.
+ I can write an expression with a variable to represent a calculation where I do not know one of the numbers.

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Problem 7

from Unit 3, Lesson 14

A trash bin has a capacity of 50 gallons. What percentage of its capacity is each amount? Show your reasoning.

a. 5 gallons

5 gallons is 10% of 50 gallons, because 5 ÷ 50 = 0.1.

b. 30 gallons

30 gallons is 60% of 50 gallons, because 30 ÷ 50 = 0.6.

c. 45 gallons

45 gallons is 90% of 50 gallons, because 45 ÷ 50 = 0.9.

d. 100 gallons

100 gallons is 200% of 50 gallons, because 100 ÷ 50 = 2.