Lesson 3

Comparing Positive and Negative Numbers

Goals

- Compare rational numbers in the context of temperature or elevation, and express (in writing) the comparisons by using the symbols > and <.
- Comprehend the word "sign" (in spoken language) to refer to whether a number is positive or negative.
- Critique (orally and in writing) statements comparing rational numbers, including claims about relative position and claims about distance from zero.

Learning Targets

- I can explain how to use the positions of numbers on a number line to compare them.
- I can use inequalities to compare positive and negative numbers.

Access for Students with Diverse Abilities

- Action and Expression (Activity 1)

Access for Multilingual Learners

- MLR7: Compare and Connect (Activity 1)
- MLR8: Discussion Supports (Activity 2)

Instructional Routines

- MLR7: Compare and Connect
- Which Three Go Together?

Lesson Narrative

In this lesson, students plot rational numbers on a number line and compare them. They write inequality statements that include negative numbers.

Students begin by considering four inequality statements. They are formally introduced to an **inequality** as a statement that uses symbols, such as > or <, to compare two values or expressions.

Next they plot a set of temperatures on a vertical or horizontal number line. By seeing the data represented in both ways, students are primed to recognize the x- and y-axes as number lines when introduced to the coordinate plane in following lessons. Students abstract from "hotter" and "colder" to "greater" and "less," and observe that if a number a is to the right of a number b, we can write the inequality statements $a > b$ and $b < a$.

Students use the structure of the number line to reason about relationships between numbers. They compare the size of two numbers as well as the distance from zero, finding that the greatest number is not always the one farthest from zero. Students are introduced to the word **sign** as a way to talk about whether numbers are positive or negative.

Student Learning Goal

Let's compare numbers on the number line.

Lesson Timeline

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

Warm-up

Which Three Go Together: Inequalities

10 min

Activity Narrative

This *Warm-up* prompts students to carefully analyze and compare four inequality statements. In making comparisons, students have a reason to use language precisely. The activity enables the terminologies that students know to be heard and enables the term "inequality" to be defined.

Launch

Arrange students in groups of 2–4. Display the inequality statements for all to see.

Give students 1 minute of quiet think time, and ask them to indicate when they have noticed three statements that go together and can explain why.

Next, tell students to share their response with their group and then together find as many sets of three as they can.

Student Task Statement

Which three go together? Why do they go together?

A. $\frac{5}{4} < 2$

B. 8.5 > 0.95

C. 8.5 < 7

D. 10.00 < 100

Sample responses:

A, B, and C go together because:

- They all have a number that is not a whole number.
- The numbers are all less than 10.

A, B, and D go together because:

- They are all true statements.

A, C, and D go together because:

- They each have a whole number.
- They all have a "less than" symbol.
- They all have values greater than 1.

B, C, and D go together because:

- They all have a decimal.
- They don't have a fraction.

Instructional Routines

Which Three Go Together?

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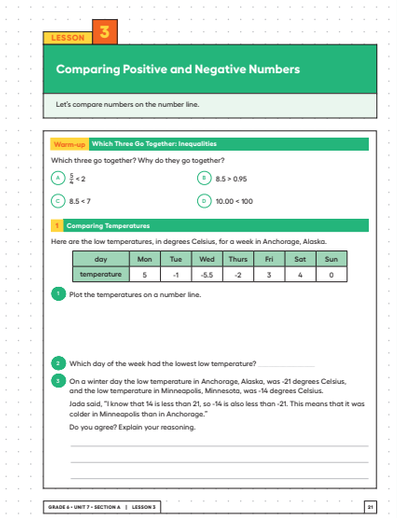
Student Workbook



LESSON 3

Comparing Positive and Negative Numbers

Let's compare numbers on the number line.

Warm-up Which Three Go Together: Inequalities

Which three go together? Why do they go together?

A. $\frac{5}{4} < 2$ B. 8.5 > 0.95

C. 8.5 < 7 D. 10.00 < 100

1 Comparing Temperatures

Here are the low temperatures, in degrees Celsius, for a week in Anchorage, Alaska.

day	Mon	Tue	Wed	Thurs	Fri	Sat	Sun
temperature	5	-1	-5.5	-2	3	4	0

1 Plot the temperatures on a number line.

2 Which day of the week had the lowest low temperature?

3 On a winter day the low temperature in Anchorage, Alaska, was -21 degrees Celsius, and the low temperature in Minneapolis, Minnesota, was -14 degrees Celsius.

Iada said, "I know that 14 is less than 21, so -14 is also less than -21. This means that it was colder in Minneapolis than in Anchorage."

Do you agree? Explain your reasoning.

GRADE 6 • UNIT 7 • SECTION A | LESSON 3 21

Access for Multilingual Learners (Activity 1)

MLR7: Compare and Connect
This activity uses the *Compare and Connect* math language routine to advance representing and conversing as students use mathematically precise language in discussion.

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

Action and Expression: Develop Expression and Communication.
Invite students to talk about their ideas with a partner before writing them down. Display sentence frames to support students when they explain their ideas, such as "I noticed _____, so I ..." or "I agree/disagree because ..."

Supports accessibility for: Language, Organization

Activity Synthesis

Invite each group to share one reason why a particular set of three go together. Record and display the responses for all to see. After each response, ask the class if they agree or disagree. Since there is no single correct answer to the question of which three go together, attend to students' explanations, and ensure the reasons given are correct.

During the discussion, prompt students to explain the meaning of any terminology they use, such as "less than" or "greater than," and to clarify their reasoning as needed. Consider asking:

- *"How do you know ... ?"*
- *"What do you mean by ... ?"*
- *"Can you say that in another way?"*

Explain to students that they have used the > and < symbols previously. Remind students that:

- The symbol ">" means "is greater than."
- The symbol "<" means "is less than."

Tell students that a statement that uses these symbols to compare two values or expressions is called an **inequality.**

Activity 1

Comparing Temperatures

15 min

Activity Narrative

In this activity, students connect a visual number line representation of positive and negative numbers with inequality symbols in a real-world situation. Students compare signed numbers and see that larger numbers are to the right on a horizontal number line and at the top of a vertical number line, and that smaller numbers are to the left or bottom. The familiar context of temperature helps students connect "less than" or "greater than" language to signed numbers. Students also evaluate and critique another's reasoning.

Monitor for students who use these different representations when creating a number line in the first question:

- A vertical number line
- A horizontal number line

Students have seen both horizontal and vertical number lines in previous activities, and either one can be used to represent the temperatures given in the table. Visualizing both vertical and horizontal number lines here prepares students for later work in the coordinate plane.

Launch

Give students 4–5 minutes quiet work time, and follow with whole-class discussion.

Select work from students with different strategies, such as those described in the *Activity Narrative*, to share later.

Student Task Statement

Here are the low temperatures, in degrees Celsius, for a week in Anchorage, Alaska.

day	Mon	Tue	Wed	Thurs	Fri	Sat	Sun
temperature	5	-1	-5.5	-2	3	4	0

1. Plot the temperatures on a number line.

(Points could also be plotted on a vertical number line.)

2. Which day of the week had the lowest low temperature?

Wednesday

3. On a winter day the low temperature in Anchorage, Alaska, was -21 degrees Celsius, and the low temperature in Minneapolis, Minnesota, was -14 degrees Celsius.

Jada said, "I know that 14 is less than 21, so -14 is also less than -21. This means that it was colder in Minneapolis than in Anchorage."

Do you agree? Explain your reasoning.

I disagree with Jada.

Sample reasoning: On the number line, -14 is closer to the positive numbers than -21. Positive temperatures are warmer than negative temperatures. This means that -14 degrees Celsius is warmer than -21 degrees Celsius.

Are You Ready for More?

Another temperature scale frequently used in science is the *Kelvin scale*. In this scale, 0 K is the lowest possible temperature of anything in the universe, and it is -273.15 degrees in the Celsius scale. Each 1 K is the same as 1 °C, so 10 K is the same as -263.15 °C.

1. Water boils at 100 °C. What is this temperature in K?

373.15

Sample reasoning: Water boils at 100 degrees Celsius, and 0 Kelvin is the same as 273.15 degrees below zero Celsius, so these two numbers are added together to get the temperature in Kelvin.

2. Ammonia boils at -35.5 °C What is the boiling point of ammonia in K?

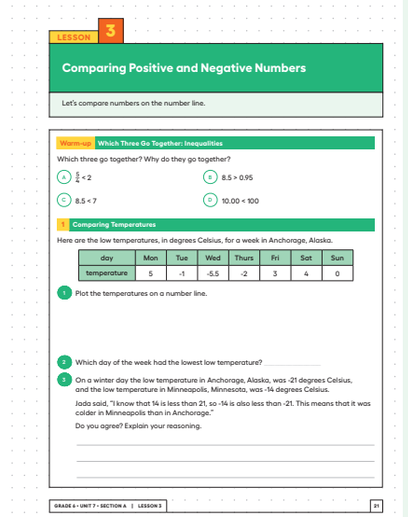
237.65

Sample reasoning: Since 0 Kelvin is 273.15 degrees Celsius below zero and the boiling point of ammonia is 35.5 degrees Celsius below zero, in Kelvin this will be 273.15 – 35.5.

3. Explain why only positive numbers (and 0) are needed to record temperature in K.

The temperature cannot go below absolute zero so, in Kelvin, all temperatures will be 0 or positive.

Student Workbook


LESSON 3

Comparing Positive and Negative Numbers

Let's compare numbers on the number line.

Warm-up Which Three Go Together: Inequalities

Which three go together? Why do they go together?

A. $\frac{2}{4} < 2$ B. 8.5 > 0.95

C. 8.5 < 7 D. 10.00 < 100

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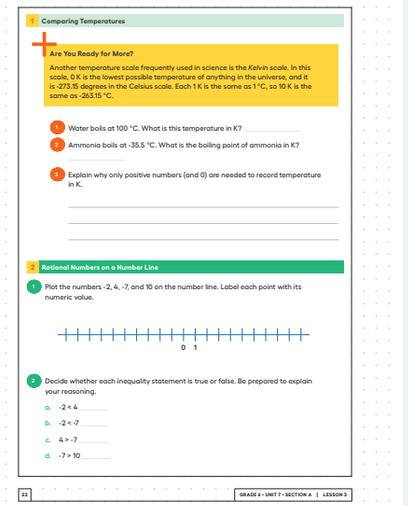
Do you agree? Explain your reasoning.

GRADE 6 • UNIT 7 • SECTION A | LESSON 3 21

Student Workbook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2. Ammonia boils at -35.5 °C. What is the boiling point of ammonia in K?
3. Explain why only positive numbers (and 0) are needed to record temperature in K.

2 Rational Numbers on a Number Line

1. Plot the numbers -2, 4, -7, and 10 on the number line. Label each point with its numeric value.

0 1

2. Decide whether each inequality statement is true or false. Be prepared to explain your reasoning.
   a. -2 < 4
   b. -2 < -7
   c. 4 > -7
   d. -7 > 10

22 GRADE 6 • UNIT 7 • SECTION A | LESSON 3

Activity Synthesis

The goal of this discussion is for students to compare horizontal and vertical number lines, and then to use them to help write inequality statements. Display two representations from previously selected students for all to see. Use *Compare and Connect* to help students compare, contrast, and connect the different representations of a number line. Here are some questions for discussion:

- *"What do the representations have in common? How are they different?"*

  They both show the same information, but one is horizontal, and one is vertical.

- *"How do colder temperatures show up in each representation?"*

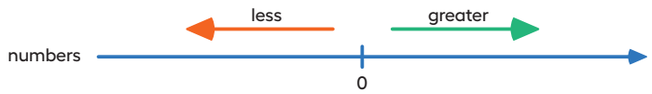
  Colder temperatures are to the left in a horizontal number line and towards the bottom in a vertical number line.

- *"How do warmer temperatures show up in each representation?"*

  Warmer temperatures are to the right in a horizontal number line and towards the top in a vertical number line.

- *"Are there any benefits or drawbacks to one representation compared to another?"*

  Answers vary.



Then explain to students that numbers don't only describe temperature, though. We use the word "greater" to describe a number that is farther to the right or farther up, and "less" to describe numbers that are farther to the left or farther down. Display this image and the inequality statement 6 > -50 for all to see:

Say, "6 is greater than -50 because it is farther to the right on the number line." We could also write -50 < 6 and say, "-50 is less than 6 because -50 is farther to the left on the number line."

Activity 2

Rational Numbers on a Number Line

10 min

Activity Narrative

In this activity, students plot positive and negative numbers on a horizontal number line and use their location to evaluate whether given inequality statements are true or false. Students also consider a number's distance from 0 in preparation for the concept of "absolute value," which will be introduced in a following lesson.

Launch

Give students 6–7 minutes of quiet work time, and follow with a whole-class discussion.

Student Task Statement

1. Plot the numbers -2, 4, -7, and 10 on the number line. Label each point with its numeric value.

2. Decide whether each inequality statement is true or false. Be prepared to explain your reasoning.

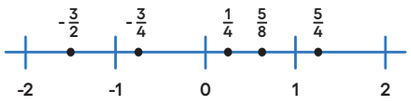
   a. $-2 < 4$ True

   b. $-2 < -7$ False

   c. $4 > -7$ True

   d. $-7 > 10$ False

Activity Synthesis



The goal of this discussion is for students to practice using a number line to compare numbers in statements using inequality symbols. Begin by inviting students to share their reasoning and responses to whether each given inequality statement was true or false. Record and display their reasoning for all to see. The key idea to emphasize is that the greater number is the number farther to the right on a horizontal number line. Then display the number line for all to see:

Display one inequality at a time, and ask students to indicate whether they think the statement is true or false and to explain their reasoning:

- $\frac{5}{4} > -\frac{3}{2}$
  true
- $\frac{5}{4}$ is farther from 0 than $-\frac{3}{2}$
  false
- $-\frac{3}{2} < -\frac{3}{4}$
  true
- $-\frac{3}{2}$ is farther from 0 than $-\frac{3}{4}$
  true

Instructional Routines

MLR7: Compare and Connect

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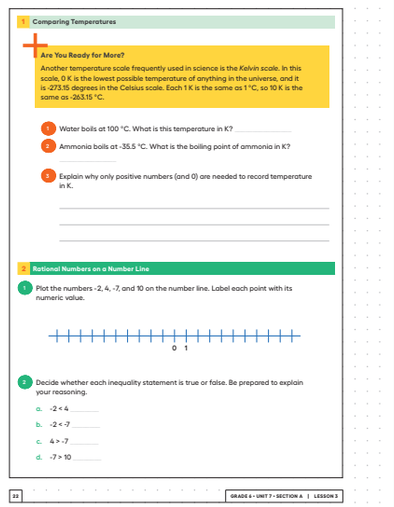
Student Workbook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1. Plot the numbers -2, 4, -7, and 10 on the number line. Label each point with its numeric value.

0 1

2. Decide whether each inequality statement is true or false. Be prepared to explain your reasoning.

a. $-2 < 4$ _____
b. $-2 < -7$ _____
c. $4 > -7$ _____
d. $-7 > 10$ _____

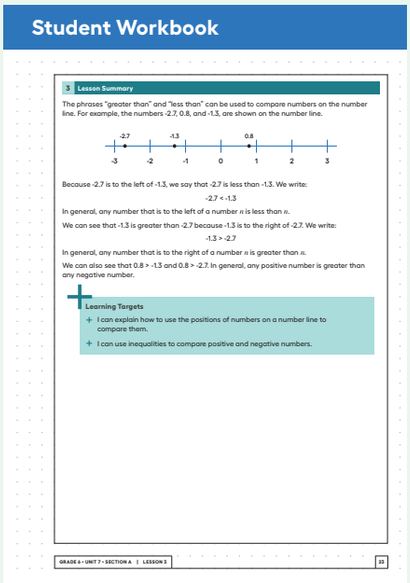
22 GRADE 6 • UNIT 7 • SECTION A | LESSON 3

Access for Multilingual Learners (Activity 1, Synthesis)

MLR8: Discussion Supports. Display sentence frames to support whole-class discussion: "_____ is greater (less) than _____ because _____." and "_____ is farther from 0 than _____ because _____."

Advances: Speaking, Conversing

Student Workbook


3 Lesson Summary

The phrases "greater than" and "less than" can be used to compare numbers on the number line. For example, the numbers -2.7, 0.8, and -1.3, are shown on the number line.

-2.7 -1.3 0.8
-3 -2 -1 0 1 2 3

Because -2.7 is to the left of -1.3, we say that -2.7 is less than -1.3. We write:

$-2.7 < -1.3$

In general, any number that is to the left of a number n is less than n.

We can see that -1.3 is greater than -2.7 because -1.3 is to the right of -2.7. We write:

$-1.3 > -2.7$

In general, any number that is to the right of a number n is greater than n.

We can also see that 0.8 > -1.3 and 0.8 > -2.7. In general, any positive number is greater than any negative number.

Learning Targets

+ I can explain how to use the positions of numbers on a number line to compare them.
+ I can use inequalities to compare positive and negative numbers.

GRADE 6 • UNIT 7 • SECTION A | LESSON 3 23

Lesson Synthesis

Introduce the word **sign** to mean whether a number is positive or negative, and give a few examples. For example, "The sign of -3 is negative. The sign of 5 is positive." Explain that 0 has no sign because it is neither positive nor negative. Then display the number line for all to see.

What is the sign of A? of B? of C? Which number is closest to 0?

- A: negative
- B: negative
- C: positive
- C is closest to 0

"*Which is greater: A or B? How can we write an inequality statement comparing A and B?*"

B is greater because it is farther to the right.

B > A or A < B

"*Which is less: A or C? How can we write an inequality statement comparing A and C?*"

A is less because it is farther to the left.

C > A or A < C

"*If we plot any two numbers on a horizontal number line, how can we tell which one is greater?*"

The one to the right is greater.

Lesson Summary

The phrases "greater than" and "less than" can be used to compare numbers on the number line. For example, the numbers -2.7, 0.8, and -1.3, are shown on the number line.

Because -2.7 is to the left of -1.3, we say that -2.7 is less than -1.3. We write:

$-2.7 < -1.3$

In general, any number that is to the left of a number n is less than n.

We can see that -1.3 is greater than -2.7 because -1.3 is to the right of -2.7. We write:

$-1.3 > -2.7$

In general, any number that is to the right of a number n is greater than n.

We can also see that 0.8 > -1.3 and 0.8 > -2.7. In general, any positive number is greater than any negative number.

Cool-down

Making More Comparisons

5 min

Student Task Statement

The elevation of Death Valley, California, is -282 feet. The elevation of Tallahassee, Florida, is 203 feet. The elevation of Westmorland, California, is -157 feet.

1. Label each point on the number line with the name of the city whose elevation is represented by the point.

A: Death Valley, California
B: Westmorland, California
C: Tallahassee, Florida

2. Use the symbol < or > to compare the elevations of Death Valley and Tallahassee.

-282 < 203 or 203 > -282

3. Use the symbol < or > to compare the elevations of Death Valley and Westmorland.

-282 < -157 or -157 > -282

Responding To Student Thinking

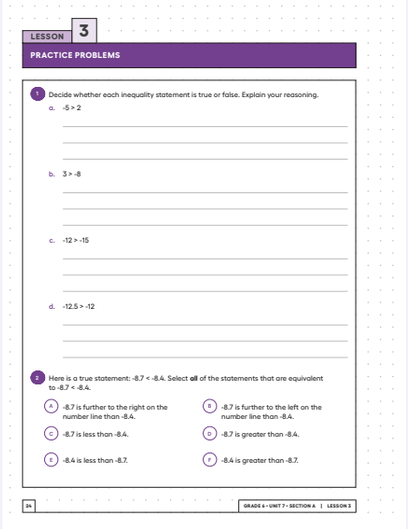
More Chances
Students will have more opportunities to understand the mathematical ideas addressed here. There is no need to slow down or add additional work to the next lessons.

Lesson 3

Practice Problems

5 Problems

Student Workbook



LESSON 3

PRACTICE PROBLEMS

1. Decide whether each inequality statement is true or false. Explain your reasoning.

   a. -5 > 2

   b. 3 > -8

   c. -12 > -15

   d. -12.5 > -12

2. Here is a true statement: -8.7 < -8.4. Select **all** of the statements that are equivalent to -8.7 < -8.4.

   A. -8.7 is further to the right on the number line than -8.4.

   B. -8.7 is further to the left on the number line than -8.4.

   C. -8.7 is less than -8.4.

   D. -8.7 is greater than -8.4.

   E. -8.4 is less than -8.7.

   F. -8.4 is greater than -8.7.

24

GRADE 6 • UNIT 7 • SECTION A | LESSON 3

Problem 1

Decide whether each inequality statement is true or false. Explain your reasoning.

a. -5 > 2

False

Sample reasoning: -5 is to the left of 2 on the number line.

b. 3 > -8

True

Sample reasoning: 3 is to the right of -8 on the number line.

c. -12 > -15

True

Sample reasoning: -12 is to the right of -15 on the number line.

d. -12.5 > -12

False

Sample reasoning: -12.5 is to the left of -12 on the number line.

Problem 2

Here is a true statement: -8.7 < -8.4. Select **all** the statements that are equivalent to -8.7 < -8.4.

A. -8.7 is further to the right on the number line than -8.4

B. -8.7 is further to the left on the number line than -8.4

C. -8.7 is less than -8.4

D. -8.7 is greater than -8.4

E. -8.4 is less than -8.7

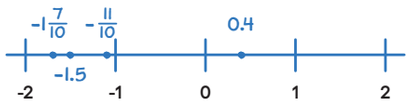
F. -8.4 is greater than -8.7

Problem 3

from Unit 7, Lesson 2

Plot each of the following numbers on the number line. Label each point with its numeric value.

0.4, -1.5, $-1\frac{7}{10}$, $-\frac{11}{10}$



Problem 4

from Unit 6, Lesson 7

Each lap around the track is 400 meters.

a. How many meters does someone run if they run:

2 laps?

800 meters

400 · 2 = 800

5 laps?

2,000 meters

400 · 5 = 2,000

x laps?

400x meters (or equivalent)

b. If Noah ran 14 laps, how many meters did he run?

5,600 meters

400 · 14 = 5,600

c. If Noah ran 7,600 meters, how many laps did he run?

19 laps

7600 ÷ 400 = 19

Problem 5

from Unit 3, Lesson 16

A stadium can 16,000 people at full capacity.

a. If there are 13,920 people in the stadium, what percentage of the capacity is filled? Explain or show your reasoning.

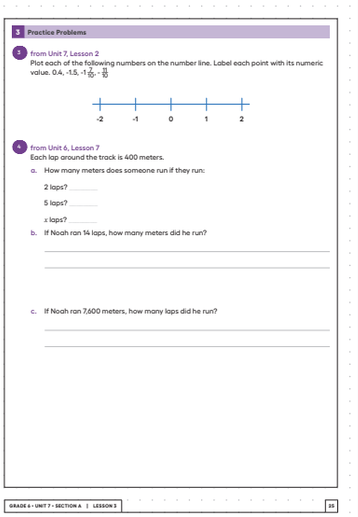
87%

Sample reasoning: 13,920 ÷ 16,000 = 0.87.

b. How many more people are needed for the stadium to be at full capacity?

2,080 people

Student Workbook


3 Practice Problems

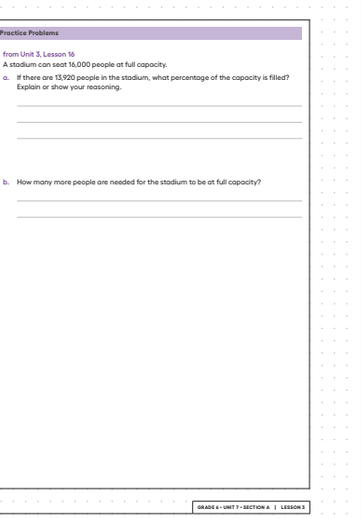
3 from Unit 7, Lesson 2
Plot each of the following numbers on the number line. Label each point with its numeric value. 0.4, -1.5, $-1\frac{7}{10}$, $-\frac{11}{10}$

-2 -1 0 1 2

4 from Unit 6, Lesson 7
Each lap around the track is 400 meters.
a. How many meters does someone run if they run:
2 laps?
5 laps?
x laps?
b. If Noah ran 14 laps, how many meters did he run?
c. If Noah ran 7,600 meters, how many laps did he run?

GRADE 6 • UNIT 7 • SECTION A | LESSON 3 35

Student Workbook


3 Practice Problems

5 from Unit 3, Lesson 16
A stadium can seat 16,000 people at full capacity.
a. If there are 13,920 people in the stadium, what percentage of the capacity is filled? Explain or show your reasoning.
b. How many more people are needed for the stadium to be at full capacity?

36 GRADE 6 • UNIT 7 • SECTION A | LESSON 3