



CHAPTER

2

Algebra: Rational Numbers



BIG Ideas

- **Standard 7NS1.0** Know the properties of, and compute with, rational numbers expressed in a variety of forms.
- **Standard 7MG1.0** Choose appropriate units of measure and use ratios to convert within and between measurement systems to solve problems.

Key Vocabulary

exponent (p. 126)

rational number (p. 84)

reciprocals (p. 102)

scientific notation (p. 130)



Real-World Link

Astronomy Measurements used in astronomy are frequently expressed as powers of 10. For example, the distance from Earth to the Sun can be written as 9.3×10^7 miles.



FOLDABLES

Study Organizer

Algebra: Rational Numbers Make this Foldable to help you organize your notes. Begin with five sheets of $8\frac{1}{2}'' \times 11''$ paper.

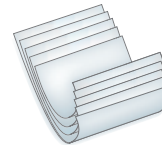
- 1** Place 5 sheets of paper $\frac{3}{4}$ inch apart.



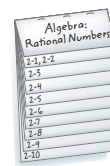
- 3** Staple along the fold.



- 2** Roll up the bottom edges. All tabs should be the same size.



- 4** Label the tabs with the lesson numbers.



GET READY for Chapter 2

Diagnose Readiness You have two options for checking Prerequisite Skills.

Option 2



Take the Online Readiness Quiz at ca.gr7math.com.

Option 1

Take the Quick Check below. Refer to the Quick Review for help.

QUICK Check

Add or subtract. (Lessons 1-4 and 1-5)

1. $-13 + 4$
2. $28 + (-9)$
3. $-8 - 6$
4. $23 - (-15)$

5. **TEMPERATURE** The high temperature for Saturday was 13°F , and the low temperature was -4°F . What was the difference between the high and low temperatures? (Lesson 1-5)

Multiply or divide. (Lesson 1-6)

6. $6(-14)$
7. $36 \div (-4)$
8. $-86 \div (-2)$
9. $-3(-9)$

Solve each equation. (Lessons 1-9 and 1-10)

10. $-12x = 144$
11. $a + 9 = 37$
12. $-18 = y - 42$
13. $25 = \frac{n}{5}$

Find the least common multiple (LCM) of each set of numbers.

(Prior Grade)

14. 12, 16
15. 24, 9
16. 10, 5, 6
17. 3, 7, 9

QUICK Review

Example 1

Find $-27 + 13$.

$$-27 + 13 = -14$$

$|-27| - |13| = |14|$
The sum is negative
because $|-27| > |13|$.

Example 2

Find $-11 - 8$.

$$-11 - 8 = -11 + (-8)$$

To subtract 8,
add -8 .

$$-11 + (-8) = -19$$

$|-11| + |-8| = 19$
Both numbers are
negative so the sum
is negative.

Example 3

Find $-12(7)$.

$$-12(7) = -84$$

The factors have different
signs. The product is
negative.

Example 4

Solve $-8x = 64$.

$$-8x = 64$$

Write the equation.

$$\frac{-8x}{-8} = \frac{64}{-8}$$

Divide each side of the equation
by -8 .

$$x = -8$$

Simplify.

Example 5

Find the LCM of 9, 12, and 18.

- multiples of 9: 0, 9, 18, 27, **36**, 45, ...
multiples of 12: 0, 12, 24, **36**, 48, ...
multiples of 18: 0, 18, **36**, 54, ...

The LCM of 9, 12, and 18 is 36.

Main IDEA

Express rational numbers as decimals and decimals as fractions.



Standard 7NS1.3 Convert fractions to decimals and percents and use these representations in estimations, computations, and applications.

Standard 7NS1.5 Know that every rational number is either a terminating or repeating decimal and be able to convert terminating decimals into reduced fractions.

NEW Vocabulary

rational number
terminating decimal
repeating decimal
bar notation

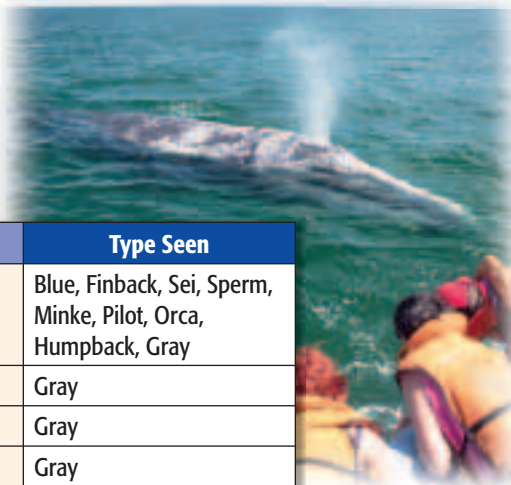
READING in the Content Area

For strategies in reading this lesson, visit ca.gr7math.com.

GET READY for the Lesson

WHALE WATCHING The top ten places in the Northern Hemisphere to watch whales are listed below.

Viewing Site	Location	Type Seen
Sea of Cortez	Baja California, Mexico	Blue, Finback, Sei, Sperm, Minke, Pilot, Orca, Humpback, Gray
Dana Point	California	Gray
Monterey	California	Gray
San Ignacio Lagoon	Baja California, Mexico	Gray
Churchill River Estuary	Manitoba, Canada	Beluga
Stellwagen Bank National Marine Sanctuary	Massachusetts	Humpback, Finback, Minke
Lahaina	Hawaii	Humpback
Silver Bank	Dominican Republic	Humpback
Mingan Island	Quebec, Canada	Blue
Friday Harbor	Washington	Orca, Minke



1. What fraction of the sites are in the United States?
2. What fraction of the sites are in Canada?
3. At what fraction of the sites might you see gray whales?
4. What fraction of the humpback viewing sites are in Mexico?

Numbers that can be written as fractions are called **rational numbers**. Since -7 can be written as $-\frac{7}{1}$ and $2\frac{2}{3}$ can be written as $\frac{8}{3}$, -7 and $2\frac{2}{3}$ are rational numbers. All integers, fractions, and mixed numbers are rational numbers.

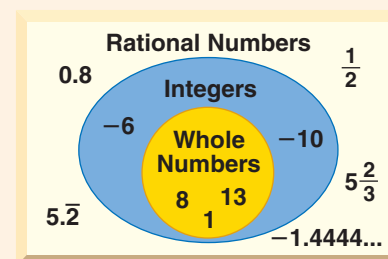
KEY CONCEPT

Rational Numbers

Words Rational numbers are numbers that can be written as fractions.

Algebra $\frac{a}{b}$, where a and b are integers and $b \neq 0$.

Model





Any fraction, positive or negative, can be expressed as a decimal by dividing the numerator by the denominator.

EXAMPLE

Write a Fraction as a Decimal

1 Write $\frac{5}{8}$ as a decimal.

$\frac{5}{8}$ means $5 \div 8$.

$$\begin{array}{r} 0.625 \\ 8 \overline{)5.000} \quad \text{Divide 5 by 8.} \\ \underline{-48} \\ 20 \\ \underline{-16} \\ 40 \\ \underline{-40} \\ 0 \end{array}$$



CHECK Your Progress

Write each fraction or mixed number as a decimal.

a. $\frac{3}{4}$

b. $\frac{-3}{5}$

c. $4\frac{13}{25}$



Vocabulary Link

Terminating

Everyday Use bringing to an end

Math Use a decimal that ends

- Every rational number can be written as either a terminating or repeating decimal. A decimal like 0.625 is called a **terminating decimal** because the division ends, or terminates, when the remainder is 0.

If the division does not end, a pattern of digits repeats.

Repeating decimals have a pattern in their digits that repeats without end. Instead of the three dots at the end of the decimal, **bar notation** is often used to indicate that a digit or group of digits repeats.

$$0.333\ldots = 0.\overline{3}$$

$$-0.282828\ldots = -0.\overline{28}$$

$$60.7151515\ldots = 60.7\overline{15}$$

EXAMPLE

Write a Repeating Decimal

2 Write $-1\frac{2}{3}$ as a decimal.

$-1\frac{2}{3}$ can be rewritten as $\frac{-5}{3}$.

Divide 5 by 3 and add a negative sign.

The mixed number $-1\frac{2}{3}$ can be written as $-1.\overline{6}$.

$$\begin{array}{r} 1.6\ldots \\ 3 \overline{)5.0} \\ \underline{-3} \\ 20 \\ \underline{-18} \\ 2 \end{array}$$



CHECK Your Progress

Write each fraction as a decimal.

d. $\frac{7}{12}$

e. $-\frac{2}{9}$

f. $3\frac{1}{11}$

g. $-2\frac{14}{15}$

STUDY TIP

Common Error

The bar is placed above the repeating part. To write 8.636363... in bar notation, write $8.\overline{63}$, not $8.\overline{6}$ or $8.6\overline{36}$. To write 0.3444... in bar notation, write $0.3\overline{4}$, not $0.3\overline{44}$.

Repeating decimals often occur in real-world situations. However, they are usually rounded to a certain place-value position.



Real-World Career ...

How Does a Sports Statistician Use Math?

A baseball statistician uses decimal equivalents to determine batting averages and winning averages. A batting average is the number of hits divided by the number of times at bat.



For more information, go to ca.gr7math.com.

Real-World EXAMPLE

- 3 BASEBALL** Kansas City pitcher Kris Wilson won 6 of the 11 games he started. To the nearest thousandth, find his winning average.

To find his winning average, divide the number of wins, 6, by the number of games, 11.

Look at the digit to the right of the thousandths place. Round down since $4 < 5$.

Kris Wilson's winning average was 0.545.

$$\begin{array}{r} 0.5454... \\ 11 \overline{)6.0000} \\ \underline{-55} \\ 50 \\ \underline{-44} \\ 60 \\ \underline{-55} \\ 50 \end{array}$$

CHECK Your Progress

- h. AUTO RACING** In a recent season, NASCAR driver Jimmie Johnson won 8 of the 36 total races held. To the nearest thousandth, find the fraction of races he won.

Terminating and repeating decimals are also rational numbers because you can write them as fractions.

EXAMPLES Write Decimals as Fractions

- 4** Write 0.45 as a fraction.

$$\begin{aligned} 0.45 &= \frac{45}{100} && 0.45 \text{ is 45 hundredths.} \\ &= \frac{9}{20} && \text{Simplify.} \end{aligned}$$

- 5 ALGEBRA** Write $0.\overline{5}$ as a fraction in simplest form.

Assign a variable to the value $0.\overline{5}$. Let $N = 0.555\ldots$. Then perform operations on N to determine its fractional value.

$$N = 0.555\ldots$$

$$10(N) = 10(0.555\ldots) \quad \text{Multiply each side by 10 because 1 digit repeats.}$$

$$10N = 5.555\ldots \quad \text{Multiplying by 10 moves the decimal point 1 place to the right.}$$

$$\begin{array}{r} -N = 0.555\ldots \\ \hline \end{array} \quad \text{Subtract } N = 0.555\ldots \text{ to eliminate the repeating part.}$$

$$9N = 5 \quad \text{Simplify.}$$

$$N = \frac{5}{9} \quad \text{Divide each side by 9.}$$

The decimal $0.\overline{5}$ can be written as $\frac{5}{9}$.

CHECK Your Progress

Write each decimal as a fraction or mixed number in simplest form.

i. -0.14

j. 8.75

k. $0.\overline{27}$

l. $-1.\overline{4}$



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STUDY TIP

Repeating Decimals

If 2 digits repeat, multiply each side by 100.

CHECK Your Understanding

Examples 1, 2
(p. 85)

Write each fraction or mixed number as a decimal.

1. $\frac{4}{5}$

2. $\frac{9}{16}$

3. $-1\frac{29}{40}$

4. $\frac{5}{9}$

5. $4\frac{5}{6}$

6. $-7\frac{5}{33}$

Example 3
(p. 86)

7. **BASEBALL** In a recent season, Ichiro Suzuki of the Seattle Mariners had 262 hits during his 704 at-bats. What was Ichiro Suzuki's batting average? Round to the nearest thousandth.

Examples 4, 5
(p. 86)

Write each decimal as a fraction or mixed number in simplest form.

8. 0.6

9. 0.32

10. -1.55

11. $-0.\overline{5}$

12. $-3.\overline{8}$

13. $2.\overline{15}$

Exercises

HOMEWORK HELP

For Exercises	See Examples
14–19	1
20–25	2
26–29	3
30–33	4
34–37	5

Write each fraction or mixed number as a decimal.

14. $\frac{3}{4}$

15. $\frac{2}{5}$

16. $\frac{7}{80}$

17. $\frac{33}{40}$

18. $-\frac{7}{16}$

19. $-\frac{5}{32}$

20. $2\frac{1}{8}$

21. $5\frac{5}{16}$

22. $\frac{4}{33}$

23. $-\frac{6}{11}$

24. $-6\frac{13}{15}$

25. $-7\frac{8}{45}$

ENVIRONMENT For Exercises 26–29, refer to the table at the right.

26. Express the fraction of students with no siblings as a decimal.
27. Find the decimal equivalent for the number of students with three siblings.
28. Write the fraction of students with one sibling as a decimal. Round to the nearest thousandth.
29. Write the fraction of students with two siblings as a decimal. Round to the nearest thousandth.

Students at Carter Junior High	
Number of Siblings	Fraction of Students
None	$\frac{1}{15}$
One	$\frac{1}{3}$
Two	$\frac{5}{12}$
Three	$\frac{1}{6}$
Four or More	$\frac{1}{60}$

Write each decimal as a fraction or mixed number in simplest form.

30. -0.4

31. 0.5

32. 5.55

33. -7.32

34. $0.\overline{2}$

35. $-0.\overline{45}$

36. $-3.\overline{09}$

37. $2.\overline{7}$

38. **ELECTRONICS** A computer manufacturer produces circuit chips that are 0.00032 inch thick. Write this measure as a fraction in simplest form.

39.  **FIND THE DATA** Refer to the California Data File on pages 16–19. Choose some data and write a real-world problem in which you would express a fraction as a decimal.



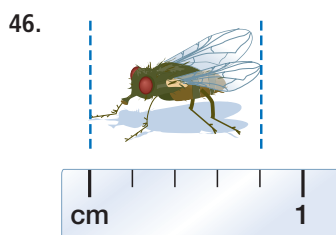
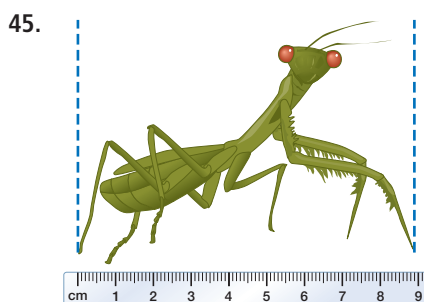
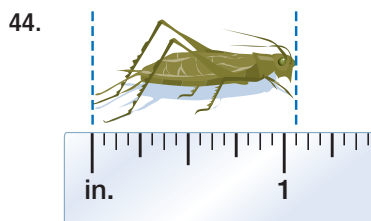
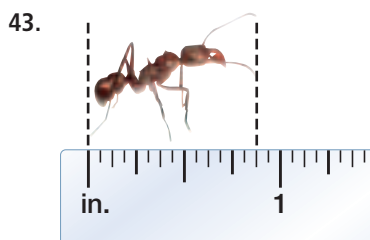
BIOLOGY For Exercises 40–42, write the weight of each animal as a fraction or mixed number.

- 40. queen bee
- 41. hummingbird
- 42. hamster

Animal	Weight (ounces)
Queen Bee	0.004
Hummingbird	0.11
Hamster	3.5

Source: *Animals as Our Companions*

MEASUREMENT For Exercises 43–46, write the length of each insect as a fraction and as a decimal.



47. **WEATHER** Carla recorded the rainfall totals for several months and compared them to the average monthly totals for her town. Her results are shown in the table. Write each decimal as a fraction or mixed number in simplest form. (*Hint: -1 means 1 inch less than the average monthly total.*)

Month	Above/Below Average (in.)
May	1.06
June	0.24
July	-2.72
August	-3.40

EXTRAPRACTICE

See pages 679, 709.

Math online

Self-Check Quiz at
ca.gr7math.com

48. **FROZEN YOGURT** The table shows five popular flavors according to the results of a survey. What is the decimal value of those who liked vanilla, chocolate, or strawberry? Round to the nearest hundredth.

Flavor	Fraction
Vanilla	$\frac{3}{10}$
Chocolate	$\frac{1}{11}$
Strawberry	$\frac{1}{18}$
Cookies and Cream	$\frac{2}{55}$
Rocky Road	$\frac{1}{66}$

H.O.T. Problems

49. **OPEN ENDED** Give an example of a repeating decimal where two digits repeat. Explain why your number is a rational number.
50. **Which One Doesn't Belong?** Identify the fraction that does not belong with the other three. Explain your reasoning.

$$\frac{4}{11}$$

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

$$\frac{1}{9}$$

$$\frac{1}{3}$$



51. **CHALLENGE** Explain why any rational number is either a terminating or repeating decimal.
52. **WRITING IN MATH** Compare 0.1 and $0.\overline{1}$, 0.13 and $0.\overline{13}$, and 0.157 and $0.\overline{157}$ when written as fractions. Make a conjecture about expressing repeating decimals like these as fractions.



STANDARDS PRACTICE

53. Which of the following is equivalent to $\frac{13}{5}$?
- A 2.4 C 2.55
- B 2.45 D 2.6
54. Felisa made 0.9 of her free throws in her last basketball game. Write this decimal as a fraction in simplest form.
- F $\frac{4}{5}$ H $\frac{8}{9}$
- G $\frac{9}{10}$ J $\frac{3}{5}$
55. Janet wants to buy a pair of jeans that cost \$29.99. The sign on the display says that the jeans are $\frac{1}{3}$ off. Which expression can be used to estimate the discount?
- A $0.033 \times \$30$
- B $0.33 \times \$30$
- C $1.3 \times \$30$
- D $33.3 \times \$30$

Spiral Review

56. The product of two integers is 72. If one integer is -18 , what is the other integer? (Lesson 1-10)

ALGEBRA Solve each equation. Check your solution. (Lesson 1-9)

57. $t + 17 = -5$ 58. $a - 5 = 14$ 59. $5 = 9 + x$ 60. $m - 5 = -14$

61. **TIME** The time zones of the world are sometimes expressed in relation to *Greenwich Mean Time GMT*. If Eastern Standard Time is expressed as GMT $-5:00$ and Pacific Standard Time is expressed as GMT $-8:00$, what is the difference between Eastern and Pacific Standard Time? (Lesson 1-5)

62. Graph the set of integers $\{-2, 5, -3, 0, -5, 1\}$ on a number line. Order the integers from least to greatest. (Lesson 1-3)



GET READY for the Next Lesson

PREREQUISITE SKILL Find the least common multiple for each pair of numbers. (Page 667)

63. 15, 5 64. 6, 9 65. 8, 6 66. 3, 5



READING Word Problems

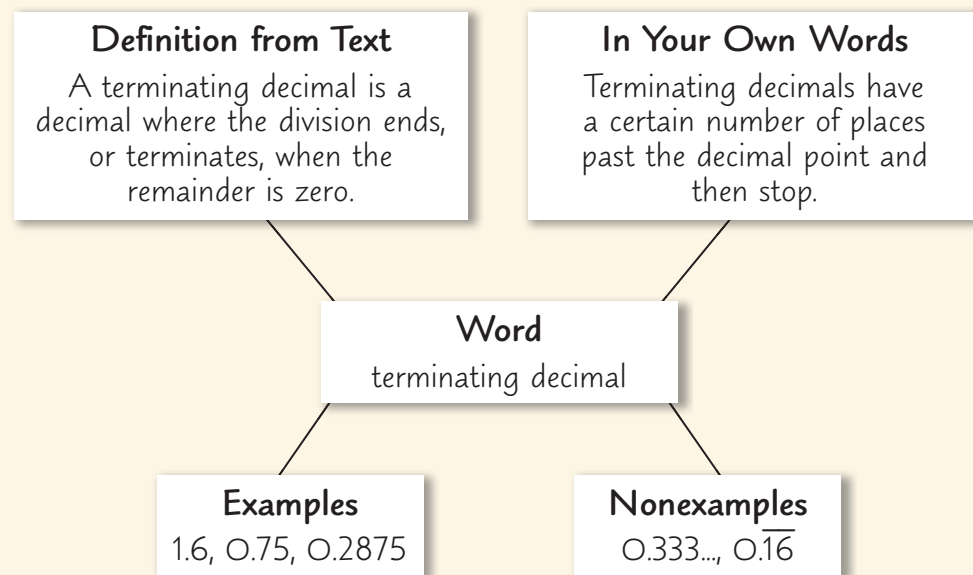
New Vocabulary

New vocabulary terms are clues about important concepts and the key to understanding word problems. Your textbook helps you find those clues by highlighting them in yellow, as **terminating decimal** is highlighted on page 85.

Learning new vocabulary is more than just memorizing the definition. Whenever you see a highlighted word, stop and ask yourself these questions.

- How does this fit with what I already know?
- How is this alike or different from something I learned earlier?

Organize your answers in a word map like the one below.



PRACTICE

Make a word map for each term. The term is defined on the given page.

1. rational number (p. 84)
2. integer (p. 35)
3. greatest common factor (p. 665)
4. least common multiple (p. 667)



Standard 7AF1.4

Use algebraic terminology (e.g. variable, equation, term, coefficient, inequality, expression, constant) correctly.

2-2

Comparing and Ordering Rational Numbers

Main IDEA

Compare and order rational numbers.



Standard 7NS1.1

Read, write, and compare rational numbers in scientific notation (positive and negative powers of 10), **compare rational numbers in general.**

GET READY for the Lesson

RECYCLING The table shows the portion of some common materials and products that are recycled.

1. Do we recycle more or less than half of the paper we produce? Explain.
2. Do we recycle more or less than half of the aluminum cans? Explain.
3. Which items have a recycle rate less than one half?
4. Which items have a recycle rate greater than one half?
5. Using this estimation method, can you order the rates from least to greatest?

Material	Fraction Recycled
Paper	$\frac{5}{11}$
Aluminum Cans	$\frac{5}{8}$
Glass	$\frac{2}{5}$
Scrap Tires	$\frac{3}{4}$

Source: envirosystemsinc.com

REVIEW Vocabulary

least common denominator (LCD) the least common multiple (LCM) of the denominators; *Example:* The LCD of $\frac{1}{3}$ and $\frac{1}{4}$ is 12. (page 667)

Sometimes you can use estimation to compare rational numbers. Another method is to rename each fraction using the least common denominator and then compare the numerators.

EXAMPLE

Compare Positive Rational Numbers

- 1** Replace $\bullet$ with $<$, $>$, or $=$ to make $\frac{5}{8} \bullet \frac{3}{4}$ a true sentence.

Rename the fractions using the least common denominator.

For $\frac{5}{8}$ and $\frac{3}{4}$, the least common denominator is 8.

$$\frac{5}{8} = \frac{5 \cdot 1}{8 \cdot 1} \text{ or } \frac{5}{8}$$

$$\frac{3}{4} = \frac{3 \cdot 2}{4 \cdot 2} \text{ or } \frac{6}{8}$$

$$\text{Since } \frac{5}{8} < \frac{6}{8}, \frac{5}{8} < \frac{3}{4}.$$

CHECK Your Progress

Replace each $\bullet$ with $<$, $>$, or $=$ to make a true sentence.

a. $\frac{3}{4} \bullet \frac{7}{12}$

b. $\frac{5}{6} \bullet \frac{7}{8}$

c. $1\frac{4}{9} \bullet 1\frac{2}{5}$



You can also compare and order rational numbers by expressing them as decimals.

EXAMPLE Compare Using Decimals

2 Replace $\bullet$ with $<$, $>$, or $=$ to make $\frac{8}{9} \bullet 0.8$ a true sentence.

$$\frac{8}{9} \bullet 0.8$$

$$0.8\overline{8} \bullet 0.80$$

Express $\frac{8}{9}$ as a decimal. In the hundredths place, $8 > 0$.

$$\text{So, } \frac{8}{9} > 0.8.$$

CHECK Your Progress

Replace each $\bullet$ with $<$, $>$, or $=$ to make a true sentence.

d. $\frac{1}{3} \bullet 0.3$

e. $0.22 \bullet \frac{11}{50}$

f. $2\frac{5}{12} \bullet 2.42$



Real-World Link

American males born after 1990 have an average life expectancy of about 74 years.

Source: www.cdc.gov

Real-World EXAMPLE Order Rational Numbers

3 HEALTH The average life expectancies of males for several countries are shown in the table. Order the countries from least to greatest male life expectancy.

Express each number as a decimal.

$$\text{Australia : } 76.9 = 76.90$$

$$\text{France : } 74\frac{4}{5} = 74.80$$

$$\text{Spain : } 75\frac{1}{3} = 75.\overline{3}$$

$$\text{United Kingdom : } 75 = 75.00$$

$$\text{United States : } 74\frac{1}{4} = 74.25$$

Life Expectancy of Males	
Country	Approximate Age (years)
Australia	76.9
France	$74\frac{4}{5}$
Spain	$75\frac{1}{3}$
United Kingdom	75
United States	$74\frac{1}{4}$

Source: mapquest.com/atlas

From least to greatest life expectancy, the countries are United States, France, United Kingdom, Spain, and Australia.

CHECK Your Progress

g. **ELECTRONICS** The overall width in inches of several widescreen televisions are 38.3 , $38\frac{3}{5}$, $38\frac{2}{3}$, $38.\overline{4}$, and $38\frac{9}{16}$. Order the widths from least to greatest.

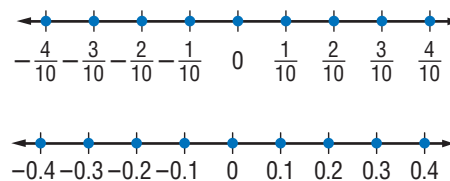
h. **TOOLS** Sophia has five wrenches measuring $\frac{3}{8}$ inch, $\frac{1}{4}$ inch, $\frac{5}{16}$ inch, $\frac{1}{2}$ inch, and $\frac{3}{4}$ inch. What is the order of the measures from least to greatest?



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Just as positive and negative integers can be represented on a number line, so can positive and negative rational numbers.



You can use a number line to help you compare and order negative rational numbers.

EXAMPLES

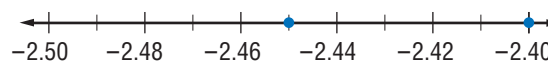
Compare Negative Rational Numbers

STUDY TIP

Number Line On a number line, a number to the left is always less than a number to the right.

4 $-2.4 \bullet -2.45$

Graph the decimals on a number line.



Since -2.4 is to the right of -2.45 , $-2.4 > -2.45$.

5 $-\frac{7}{8} \bullet -\frac{6}{8}$

Since the denominators are the same, compare the numerators.

$-7 < -6$, so $-\frac{7}{8} < -\frac{6}{8}$.

CHECK Your Progress

Replace each $\bullet$ with $<$, $>$, or $=$ to make a true sentence.

i. $-\frac{9}{16} \bullet -\frac{12}{16}$

j. $-3.15 \bullet -3.17$

k. $-\frac{7}{10} \bullet -\frac{4}{5}$

CHECK Your Understanding

Examples 1–4
(pp. 91–93)

Replace each $\bullet$ with $<$, $>$, or $=$ to make a true sentence.

1. $\frac{1}{2} \bullet \frac{5}{12}$

2. $\frac{9}{25} \bullet \frac{3}{10}$

3. $\frac{3}{11} \bullet 0.25$

4. $3\frac{5}{8} \bullet 3.625$

5. $-\frac{10}{18} \bullet -\frac{16}{18}$

6. $-\frac{4}{5} \bullet -\frac{7}{10}$

7. $-0.\overline{6} \bullet -0.\overline{67}$

8. $-2.\overline{4} \bullet -2.42$

Example 5
(p. 93)

9. **OCEANOGRAPHY** The tide heights for several cities are shown in the table. Order the cities from least tide height to greatest.

City	Tide Height (ft)	City	Tide Height (ft)
Baltimore, MD	$1\overline{6}$	Key West, FL	$1.8\overline{3}$
Galveston, TX	$1\frac{5}{12}$	Mobile, AL	1.5
Gulfport, MS	$1\frac{1}{6}$	Washington, DC	$1\frac{17}{20}$

Exercises

HOMEWORK HELP

For Exercises	See Examples
10, 11	1
12–15	2
16, 17	3
18–23	4
24–29	5

Replace each ● with $<$, $>$, or $=$ to make a true sentence.

10. $\frac{2}{3}$ ● $\frac{7}{9}$ 11. $\frac{3}{5}$ ● $\frac{5}{8}$ 12. 0.5 ● $\frac{7}{12}$
 13. 0.75 ● $\frac{11}{15}$ 14. $6\frac{15}{32}$ ● 6.5 15. $2\frac{21}{30}$ ● 2.7

16. **CARPENTRY** Rondell has some drill bits marked $\frac{7}{16}$, $\frac{3}{8}$, $\frac{5}{32}$, $\frac{9}{16}$, and $\frac{1}{4}$. If these are all measurements in inches, how should he arrange them if he wants them from least to greatest?

17. **PHOTOGRAPHY** Cameras often have multiple shutter speeds. Some common shutter speeds in seconds are $\frac{1}{125}$, $0.0\overline{6}$, $\frac{1}{60}$, 0.125 , 0.004 , and $\frac{1}{4}$. List these speeds in order from the fastest to the slowest.

Replace each ● with $<$, $>$, or $=$ to make a true sentence.

18. -4.8 ● -4.6 19. -5.25 ● -5.24 20. -22.9 ● -22.09
 21. -2.07 ● -2.6 22. -4.3 ● -4.37 23. -2.8 ● -2.86
 24. $-\frac{3}{11}$ ● $-\frac{1}{11}$ 25. $-\frac{4}{10}$ ● $-\frac{7}{10}$ 26. $-\frac{1}{6}$ ● $-\frac{1}{12}$
 27. $-\frac{3}{5}$ ● $-\frac{7}{15}$ 28. $-1\frac{3}{8}$ ● $-1\frac{2}{3}$ 29. $-5\frac{4}{7}$ ● $-5\frac{3}{5}$

Graph the following numbers on a number line.

30. $-3\frac{2}{5}$, -3.68 , -3.97 , $-4\frac{3}{4}$ 31. -2.9 , -2.95 , $-2\frac{1}{4}$, $-2\frac{1}{2}$
 32. -5.25 , $-5\frac{1}{3}$, $-4\frac{7}{8}$, -4.6 33. 3.7 , 2.9 , $-4\frac{1}{8}$, $1\frac{1}{5}$

34. **STATISTICS** If you order a set of numbers from least to greatest, the middle number is the *median*. Find the median of -18.5°C , -18°C , and 20.2°C .

35. **ANALYZE TABLES** The table shows the regular season records of five college baseball teams during a recent season. Which team had the best record? (*Hint*: Divide the number of games won by the number of games played.)

Team	Games Won	Games Played
University of Alabama	29	55
University of Notre Dame	51	63
University of Southern California	24	56
Florida State University	45	68
Rice University	46	60

36. **ATTENDANCE** The school play was attended by $\frac{5}{6}$ of the 6th grade, $\frac{3}{4}$ of the 7th grade, and $\frac{4}{5}$ of the 8th grade. Which grade has the greatest part of its class attend the play?

EXTRA PRACTICE

See pages 679, 709.

Math online

Self-Check Quiz at
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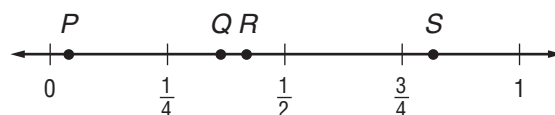
**H.O.T. Problems**

37. **NUMBER SENSE** Are the fractions $\frac{5}{11}$, $\frac{5}{12}$, $\frac{5}{13}$, and $\frac{5}{14}$ arranged in order from least to greatest or from greatest to least? Explain.
38. **OPEN ENDED** Name two fractions that are less than $\frac{1}{2}$ and two fractions that are greater than $\frac{1}{2}$.
39. **CHALLENGE** Are there any rational numbers between $0.\overline{2}$ and $\frac{2}{9}$? Explain.
40. **WRITING IN MATH** Explain why 0.28 is less than $0.\overline{28}$.

**STANDARDS PRACTICE**

41. Which fraction is between $-\frac{3}{4}$ and $-\frac{2}{3}$?
- A $-\frac{1}{2}$
- B $-\frac{3}{5}$
- C $-\frac{5}{7}$
- D $-\frac{7}{8}$

42. Which point on the number line below is the coordinate of 0.425?



- F Point P
- G Point Q
- H Point R
- J Point S

Spiral Review

43. **MEASUREMENT** The sheet of ice for a hockey rink is created in two layers. First an $\frac{1}{8}$ -inch layer of ice is made for the lines to be painted on. Then a $\frac{6}{8}$ -inch layer of ice is added on top of the painted layer, for a total thickness of $\frac{7}{8}$ inch. Write the total thickness of the ice as a decimal. (Lesson 2-1)

ALGEBRA Solve each equation. Check your solution. (Lesson 1-10)

44. $\frac{y}{7} = 22$
45. $4p = -60$
46. $20 = \frac{t}{15}$
47. $81 = -3d$
48. $\frac{a}{6} = -108$
49. $-4n = -96$
50. **WEATHER** After the temperature had fallen 10°F , the temperature was -8°F . Write and solve a subtraction equation to find the starting temperature. (Lesson 1-9)

**GET READY for the Next Lesson**

PREREQUISITE SKILL Multiply. (Lesson 1-6)

51. $-4(-7)$
52. $8(-12)$
53. $(-3)17$
54. $23(-5)$

2-3

Multiplying Positive and Negative Fractions

Main IDEA

Multiply positive and negative fractions.



Standard

7NS1.2 Add, subtract, multiply, and divide rational numbers (integers, fractions, and terminating decimals) and take positive rational numbers to whole-number powers.

Standard 7MG1.3 Use measures expressed as rates (e.g. speed, density) and measures expressed as products (e.g. person-days) to solve problems; check the units of the solutions; and use dimensional analysis to check the reasonableness of the answer.

NEW Vocabulary

dimensional analysis

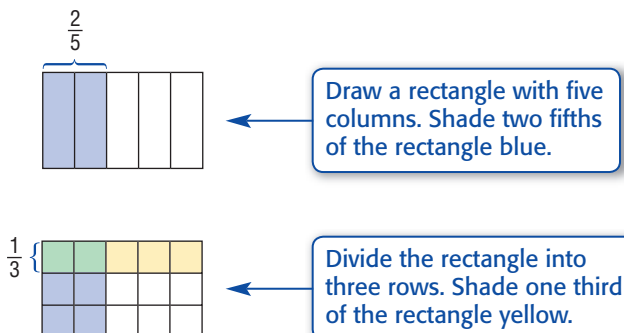
MINI Lab

Concepts in Motion

Animation ca.gr7math.com



To multiply $\frac{1}{3}$ and $\frac{2}{5}$, you can use an area model to find $\frac{1}{3}$ of $\frac{2}{5}$.



The green shaded area represents $\frac{1}{3}$ of $\frac{2}{5}$.

- What is the product of $\frac{1}{3}$ and $\frac{2}{5}$?
- Use an area model to find each product.
 - $\frac{3}{4} \cdot \frac{1}{2}$
 - $\frac{2}{5} \cdot \frac{2}{3}$
 - $\frac{1}{4} \cdot \frac{3}{5}$
 - $\frac{2}{3} \cdot \frac{4}{5}$
- What is the relationship between the numerators of the factors and the numerator of the product?
- What is the relationship between the denominators of the factors and the denominator of the product?

The Mini Lab suggests the rule for multiplying fractions.

KEY CONCEPT

Multiply Fractions

Words To multiply fractions, multiply the numerators and multiply the denominators.

Examples

Numbers

$$\frac{2}{3} \cdot \frac{4}{5} = \frac{8}{15}$$

Algebra

$$\frac{a}{b} \cdot \frac{c}{d} = \frac{ac}{bd} \text{ where } b \text{ and } d \neq 0$$

You can use the rules for multiplying integers to determine the sign of the product of any two signed numbers.

REVIEW Vocabulary

greatest common factor (GCF) the greatest of the common factors of two or more numbers; *Example:* the GCF of 8 and 12 is 4. (page 665)

EXAMPLE

Multiply Positive Fractions

1 Find $\frac{4}{9} \cdot \frac{3}{5}$. Write in simplest form.

$$\begin{aligned}\frac{4}{9} \cdot \frac{3}{5} &= \frac{4}{\cancel{9}^3} \cdot \frac{\cancel{3}^1}{5} \\ &= \frac{4 \cdot 1}{3 \cdot 5} \\ &= \frac{4}{15}\end{aligned}$$

Divide 9 and 3 by their GCF, 3.

← Multiply the numerators.

← Multiply the denominators.

Simplify.



CHECK Your Progress

Multiply. Write in simplest form.

a. $\frac{1}{4} \cdot \frac{2}{3}$

b. $\frac{5}{12} \cdot \frac{3}{20}$

c. $\frac{7}{10} \cdot \frac{7}{16}$

STUDY TIP

Negative Fractions

$-\frac{5}{6}$, $\frac{-5}{6}$, and $\frac{5}{-6}$ are all equivalent fractions.

EXAMPLE

Multiply Negative Fractions

2 Find $-\frac{5}{6} \cdot \frac{3}{8}$. Write in simplest form.

$$\begin{aligned}-\frac{5}{6} \cdot \frac{3}{8} &= \frac{-5}{\cancel{6}^2} \cdot \frac{\cancel{3}^1}{8} \\ &= \frac{-5 \cdot 1}{2 \cdot 8} \\ &= -\frac{5}{16}\end{aligned}$$

Divide 6 and 3 by their GCF, 3.

← Multiply the numerators.

← Multiply the denominators.

The fractions have different signs, so the product is negative.



CHECK Your Progress

Multiply. Write in simplest form.

d. $\frac{8}{9} \cdot -\frac{3}{4}$

e. $-\frac{3}{5} \cdot \frac{7}{9}$

f. $\left(-\frac{1}{2}\right)\left(-\frac{6}{7}\right)$

To multiply mixed numbers, first rename them as improper fractions.

EXAMPLE

Multiply Mixed Numbers

3 Find $4\frac{1}{2} \cdot 2\frac{2}{3}$. Write in simplest form. **Estimate** $4 \times 3 = 12$

$$\begin{aligned}4\frac{1}{2} \cdot 2\frac{2}{3} &= \frac{9}{2} \cdot \frac{8}{3} \\ &= \frac{\cancel{9}^3}{\cancel{2}^1} \cdot \frac{\cancel{8}^4}{\cancel{3}^1} \\ &= \frac{3 \cdot 4}{1 \cdot 1} \\ &= \frac{12}{1} \text{ or } 12\end{aligned}$$

$$4\frac{1}{2} = \frac{9}{2}, 2\frac{2}{3} = \frac{8}{3}$$

Divide out common factors.

← Multiply the numerators.

← Multiply the denominators.

Simplify. Compare to the estimate.



CHECK Your Progress

Multiply. Write in simplest form.

g. $1\frac{1}{2} \cdot 1\frac{2}{3}$

h. $\frac{5}{7} \cdot 1\frac{3}{5}$

i. $\left(-2\frac{1}{6}\right)\left(-1\frac{1}{5}\right)$



Real-World EXAMPLE

- 4 ROLLER COASTERS** A roller coaster at an amusement park is 160 feet high. If a new roller coaster is built that is $2\frac{3}{5}$ times the height of the existing coaster, what is the height of the new roller coaster?

The new coaster is $2\frac{3}{5}$ times higher than the current coaster.

$$\begin{aligned} 2\frac{3}{5} \cdot 160 &= \frac{13}{5} \cdot \frac{160}{1} & 2\frac{3}{5} &= \frac{13}{5}, 160 = \frac{160}{1} \\ &= \frac{2,080}{5} \text{ or } 416 \end{aligned}$$

The new roller coaster will be 416 feet high.



CHECK Your Progress

- j. **CARPENTRY** A piece of lumber is $4\frac{1}{4}$ feet long. If you need a piece of lumber that is $\frac{2}{3}$ this size, how long a piece do you need?

Dimensional analysis is the process of including units of measurement when you compute. You can use dimensional analysis to check whether your answers are reasonable.

EXAMPLE

Use Dimensional Analysis

- 5 AIRCRAFT** Refer to the information at the left. Suppose a 757 aircraft is traveling at its cruising speed. How far will it travel in $1\frac{1}{3}$ hours?

Words

Distance equals the rate multiplied by the time.

Variable

Let d represent the distance.

Equation

$$d = 540 \text{ miles per hour} \cdot 1\frac{1}{3} \text{ hours}$$

$$d = \frac{540 \text{ miles}}{1 \text{ hour}} \cdot 1\frac{1}{3} \text{ hours} \quad \text{Write the equation.}$$

$$d = \frac{540 \text{ miles}}{1 \text{ hour}} \cdot \frac{4}{3} \cdot \frac{\text{hours}}{1} \quad 1\frac{1}{3} = \frac{4}{3}$$

$$d = \frac{180}{1} \text{ miles} \cdot \frac{4}{3} \cdot \frac{\text{hours}}{1} \quad \text{Divide by common factors and units.}$$

$$d = 720 \text{ miles}$$

At its cruising speed, a 757 will travel 720 miles in $1\frac{1}{3}$ hours.

Check for Reasonableness The problem asks for the distance. When you divide the common units, the answer is expressed in miles.



CHECK Your Progress

- k. **AIRCRAFT** Refer to the information about the 757 aircraft. What is its wingspan in yards?



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Real-World Link

A 757 aircraft has an average cruising speed of 540 miles per hour, a capacity of 242 passengers, and a wingspan of $165\frac{1}{3}$ feet.

Source: Continental Traveler

STUDY TIP

Mental Math

$\frac{1}{3}$ of 540 is 180.

Using the Distributive Property, $1\frac{1}{3}$ of 540 should equal $540 + 180$, or 720.



CHECK Your Understanding

Examples 1–3
(p. 97)

Multiply. Write in simplest form.

1. $\frac{3}{5} \cdot \frac{5}{7}$

2. $\frac{4}{5} \cdot \frac{3}{8}$

3. $\frac{6}{7} \cdot \frac{7}{6}$

4. $-\frac{1}{8} \cdot \frac{4}{9}$

5. $-\frac{2}{9} \cdot \left(\frac{3}{8}\right)$

6. $\left(-\frac{12}{13}\right)\left(-\frac{2}{3}\right)$

7. $1\frac{1}{3} \cdot 5\frac{1}{2}$

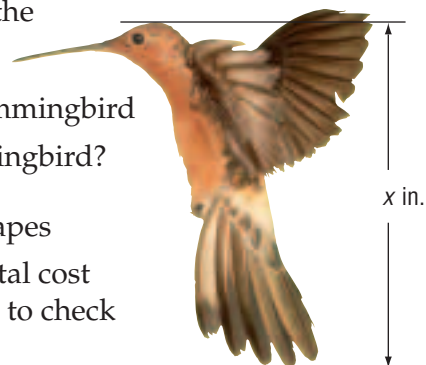
8. $2\frac{1}{2} \cdot 1\frac{2}{5}$

9. $-6\frac{3}{4} \cdot 1\frac{7}{9}$

Example 4
(p. 98)

10. **BIOLOGY** The giant hummingbird of South America is the largest hummingbird in the world. It is $4\frac{1}{8}$ times larger than the bee hummingbird. If the length of a bee hummingbird is 2 inches, how long is the giant hummingbird?

Giant Hummingbird



Example 5
(p. 98)

11. **FRUIT** Terrence bought $2\frac{5}{8}$ pounds of grapes that cost \$2 per pound. What was the total cost of the grapes? Use dimensional analysis to check the reasonableness of the answer.

Exercises

HOMEWORK HELP

For Exercises	See Examples
12–15	1
16–19	2
20–23	3
24, 25	4
26–27	5

Multiply. Write in simplest form.

12. $\frac{1}{12} \cdot \frac{4}{7}$

13. $\frac{3}{16} \cdot \frac{1}{9}$

14. $\frac{5}{8} \cdot \frac{4}{5}$

15. $\frac{9}{10} \cdot \frac{2}{3}$

16. $-\frac{9}{10} \cdot \frac{2}{3}$

17. $\left(-\frac{12}{25}\right)\frac{15}{32}$

18. $\left(-\frac{3}{5}\right)\left(-\frac{1}{3}\right)$

19. $\left(-\frac{4}{7}\right)\left(-\frac{1}{20}\right)$

20. $3\frac{1}{3} \cdot \frac{1}{4}$

21. $4\frac{1}{4} \cdot 3\frac{1}{3}$

22. $-3\frac{3}{8} \cdot \left(-\frac{2}{3}\right)$

23. $-\frac{5}{6} \cdot \left(-1\frac{4}{5}\right)$

24. **FOOD** There are $3\frac{1}{2}$ servings of green beans in a certain can. Each serving is $\frac{1}{2}$ cup of beans. How many cups of green beans does the can contain?

25. **MEASUREMENT** Minh-Thu has a square photograph of the volleyball team that measures $3\frac{1}{2}$ inches on each side. She reduces each dimension to $\frac{2}{3}$ its size. What is the length of a side of the new photograph?

Solve each problem. Use dimensional analysis to check the reasonableness of the answer.

26. **BAKING** A recipe calls for $\frac{3}{4}$ cup of sugar per batch of cookies. If Gabe wants to make 6 batches of cookies, how many cups of sugar does he need?
27. **POPULATION** The population density measures how many people live within a certain area. In a certain city, there are about 150,000 people per square mile. How many people live in an area of 2.25 square miles?

ALGEBRA Evaluate each expression if $r = -\frac{1}{4}$, $s = \frac{2}{5}$, $t = \frac{8}{9}$, and $v = -\frac{2}{3}$.

28. rs

29. rt

30. stv

31. rtv

Find each product. Write in simplest form.

32. $\frac{1}{3} \cdot \left(-\frac{3}{8}\right) \cdot \frac{4}{5}$

33. $\frac{1}{2} \cdot \frac{2}{5} \cdot \frac{3}{4}$

34. $\left(-\frac{2}{5}\right) \cdot \frac{1}{6} \cdot \left(-\frac{5}{2}\right)$

35. $2\frac{2}{7} \cdot 1\frac{5}{9} \cdot 2\frac{2}{5}$

36. $3\frac{1}{3} \cdot 1\frac{1}{2} \cdot 5$

37. $10 \cdot 3.78 \cdot \frac{1}{5}$

38. $\frac{1}{5} \cdot 0.25$

39. $-\frac{2}{9} \cdot 0.\bar{3}$

40. $-\frac{7}{16} \cdot (-2.375)$

GEOGRAPHY For Exercises 41–43, refer to the table and the information below. Round answers to the nearest whole number.

There are about 57 million square miles of land on Earth covering seven continents.

41. What is the approximate land area of Europe?
42. What is the approximate land area of Asia?
43. Only about $\frac{3}{10}$ of Australia's land area is able to support agriculture. What fraction of the Earth's land is this?

Continent	Approximate Fraction of Earth's Landmass
Africa	$\frac{1}{5}$
Antarctica	$\frac{9}{100}$
Asia	$\frac{3}{10}$
Australia	$\frac{11}{200}$
Europe	$\frac{7}{100}$
North America	$\frac{33}{200}$
South America	$\frac{3}{25}$

ALGEBRA Evaluate each expression if $a = -1\frac{1}{5}$, $b = 2\frac{7}{9}$, $c = -2\frac{1}{4}$, and $d = 4\frac{1}{2}$. Express in simplest form.

44. abd^2

45. b^2c^2

46. $\frac{1}{2}a^2d$

47. $-3ac(-bd)$

48. **RESEARCH** Use the Internet or other resource to find a recipe for spaghetti sauce. Change the recipe to make $\frac{2}{3}$ of the amount. Then change the recipe to make $1\frac{1}{2}$ of the amount.

EXTRAPRACTICE
See pages 680, 709.
Math online
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H.O.T. Problems

49. **FIND THE ERROR** Matt and Enrique are multiplying $2\frac{1}{2}$ and $3\frac{1}{4}$. Who is correct? Explain your reasoning.



Matt

$2\frac{1}{2} \cdot 3\frac{1}{4} = 2 \cdot 3 + \frac{1}{2} \cdot \frac{1}{4}$
 $= 6 + \frac{1}{8}$
 $= 6\frac{1}{8}$



Enrique

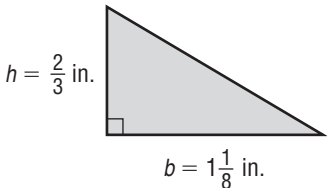
$2\frac{1}{2} \cdot 3\frac{1}{4} = \frac{5}{2} \cdot \frac{13}{4}$
 $= \frac{65}{8}$
 $= 8\frac{1}{8}$



50. **OPEN ENDED** Select two fractions with a product greater than $\frac{1}{2}$ and less than 1. Use a number line to justify your answer.
51. **CHALLENGE** Find the missing fraction. $\frac{3}{4} \cdot \square = \frac{9}{14}$
52. **WRITING IN MATH** Explain why the product of $\frac{1}{2}$ and $\frac{7}{8}$ is less than $\frac{1}{2}$.



STANDARDS PRACTICE

53. What number will make $\frac{3}{4} \cdot \frac{7}{8} = \frac{7}{8} \cdot n$ true?
 A $\frac{4}{8}$
 B $\frac{3}{4}$
 C $\frac{10}{12}$
 D $\frac{7}{8}$
54. Find the area of the triangle. Use the formula $A = \frac{1}{2}bh$.
- 
- F $\frac{3}{4} \text{ in}^2$ H $\frac{3}{8} \text{ in}^2$
 G $\frac{5}{8} \text{ in}^2$ J $\frac{1}{6} \text{ in}^2$

Spiral Review

Replace each $\bullet$ with $<$, $>$, or $=$ to make a true sentence. (Lesson 2-2)

55. $\frac{1}{2} \bullet \frac{4}{7}$ 56. $\frac{2}{7} \bullet 0.\overline{28}$ 57. $-\frac{4}{9} \bullet -0.\overline{4}$

58. **HISTORY** In 1864, Abraham Lincoln won the presidential election with about 0.55 of the popular vote. Write this as a fraction in simplest form. (Lesson 2-1)
59. **GOLF** After four rounds of golf, Lazaro's score was 5 under par or -5 . Lazaro had improved his overall score during the fourth round by decreasing it by 6 strokes. Write and solve a subtraction equation to find Lazaro's score after the third round. (Lesson 1-9)

Write an equation to model the relationship between the quantities in each table. (Lesson 1-7)

60.

Servings, s	Total Calories, C
2	300
5	750
7	1,050
s	C

61.

Regular Price, p	Sale Price, s
\$8	\$6
\$12	\$9
\$16	\$12
p	s

GET READY for the Next Lesson

PREREQUISITE SKILL Divide. (Lesson 1-6)

62. $51 \div (-17)$ 63. $-81 \div (-3)$ 64. $-92 \div 4$ 65. $-105 \div (-7)$

2-4

Dividing Positive and Negative Fractions



Main IDEA

Divide positive and negative fractions.



Standard 7NS1.2 Add, subtract, multiply, and divide rational numbers (integers, fractions, and terminating decimals) and take positive rational numbers to whole-number powers.

Standard 7MG1.3 Use measures expressed as rates (e.g. speed, density) and measures expressed as products (e.g. person-days) to solve problems; check the units of the solutions; and use dimensional analysis to check the reasonableness of the answer.

NEW Vocabulary

multiplicative inverses
reciprocals

Concepts in Motion

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GET READY for the Lesson

ANIMALS The world's longest snake is the reticulated python. It is approximately one-fourth the length of the blue whale.

- Find the value of $110 \div 4$.
- Find the value of $110 \times \frac{1}{4}$.
- Compare the values of $110 \div 4$ and $110 \times \frac{1}{4}$.
- What can you conclude about the relationship between dividing by 4 and multiplying by $\frac{1}{4}$?

World's Largest Animals		
Largest Animal	Blue Whale	110 feet long
Largest Reptile	Saltwater Crocodile	16 feet long
Largest Bird	Ostrich	9 feet tall
Largest Insect	Stick Insect	15 inches long

Source: *The World Almanac for Kids*

Two numbers whose product is 1 are **multiplicative inverses**, or **reciprocals**, of each other. For example, 4 and $\frac{1}{4}$ are multiplicative inverses because $4 \cdot \frac{1}{4} = 1$.

KEY CONCEPT

Inverse Property of Multiplication

Words The product of a number and its multiplicative inverse is 1.

Examples

Numbers

$$\frac{3}{4} \cdot \frac{4}{3} = 1$$

Algebra

$$\frac{a}{b} \cdot \frac{b}{a} = 1, \text{ where } a \text{ and } b \neq 0$$

EXAMPLE Find a Multiplicative Inverse

- 1** Write the multiplicative inverse of $-5\frac{2}{3}$.

$$-5\frac{2}{3} = -\frac{17}{3} \quad \text{Write } -5\frac{2}{3} \text{ as an improper fraction.}$$

Since $-\frac{17}{3} \left(-\frac{3}{17} \right) = 1$, the multiplicative inverse of $-5\frac{2}{3}$ is $-\frac{3}{17}$.

CHECK Your Progress

Write the multiplicative inverse of each number.

a. $-2\frac{1}{3}$

b. $-\frac{5}{8}$

c. 7



STUDY TIP

Complex Fractions

Recall that a fraction bar represents division. So,

$$\frac{a}{b} \div \frac{c}{d} = \frac{\frac{a}{b}}{\frac{c}{d}}$$

Multiplicative inverses are used in division. Consider $\frac{a}{b} \div \frac{c}{d}$, which can be written as a fraction.

$$\frac{\frac{a}{b}}{\frac{c}{d}} = \frac{\frac{a}{b} \cdot \frac{d}{c}}{\frac{c}{d} \cdot \frac{d}{c}}$$

$$= \frac{\frac{a}{b} \cdot \frac{d}{c}}{1}$$

$$= \frac{a}{b} \cdot \frac{d}{c} \quad \frac{c}{d} \cdot \frac{d}{c} = 1$$

Multiply the numerator and denominator by $\frac{d}{c}$, the multiplicative inverse of $\frac{c}{d}$.

KEY CONCEPT

Divide Fractions

Words To divide by a fraction, multiply by its multiplicative inverse.

Examples

Numbers

$$\frac{2}{5} \div \frac{3}{4} = \frac{2}{5} \cdot \frac{4}{3}$$

Algebra

$$\frac{a}{b} \div \frac{c}{d} = \frac{a}{b} \cdot \frac{d}{c}, \text{ where } b, c, \text{ and } d \neq 0$$

EXAMPLES

Divide Fractions and Mixed Numbers

Divide. Write in simplest form.

2 $-\frac{4}{5} \div \frac{6}{7}$

$$-\frac{4}{5} \div \frac{6}{7} = -\frac{4}{5} \cdot \frac{7}{6}$$

Multiply by the multiplicative inverse of $\frac{6}{7}$, which is $\frac{7}{6}$.

$$= -\frac{\overset{2}{\cancel{4}}}{5} \cdot \frac{7}{\underset{3}{\cancel{6}}}$$

Divide -4 and 6 by their GCF, 2 .

$$= -\frac{14}{15}$$

Multiply.

3 $4\frac{2}{3} \div (-3\frac{1}{2})$

$$4\frac{2}{3} \div (-3\frac{1}{2}) = \frac{14}{3} \div \left(-\frac{7}{2}\right)$$

$$4\frac{2}{3} = 1\frac{4}{3}, -3\frac{1}{2} = -\frac{7}{2}$$

$$= \frac{14}{3} \cdot \left(-\frac{2}{7}\right)$$

The multiplicative inverse of $-\frac{7}{2}$ is $-\frac{2}{7}$.

$$= \frac{\overset{2}{\cancel{14}}}{3} \cdot \left(-\frac{2}{\underset{1}{\cancel{7}}}\right)$$

Divide 14 and 7 by their GCF, 7 .

$$= -\frac{4}{3} \text{ or } -1\frac{1}{3}$$

Multiply.

STUDY TIP

Dividing By a Whole Number

When dividing by a whole number, rename it as an improper fraction first. Then multiply by its reciprocal.



CHECK Your Progress

Divide. Write in simplest form.

d. $\frac{3}{4} \div \frac{1}{2}$

e. $-\frac{1}{4} \div \frac{7}{8}$

f. $-\frac{2}{3} \div \left(-\frac{3}{5}\right)$

g. $2\frac{3}{4} \div \left(-2\frac{1}{5}\right)$

h. $1\frac{1}{2} \div 2\frac{1}{3}$

i. $-1\frac{1}{2} \div 12$



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Real-World Link . . .

The first Flag Day was celebrated in 1877. It was the 100th anniversary of the day the Continental Congress adopted the Stars and Stripes as the official flag.

Source: *World Book*



Real-World EXAMPLE

- 4 HOLIDAYS** Isabel and her friends are making ribbons to give to other campers at their day camp on Flag Day. They have a roll with 20 feet of ribbon. How many Flag Day ribbons as shown at the right can they make?



Since 4 inches equals $\frac{4}{12}$ or $\frac{1}{3}$ foot, divide 20 by $\frac{1}{3}$.

$$\begin{aligned} 20 \div \frac{1}{3} &= \frac{20}{1} \div \frac{1}{3} \\ &= \frac{20}{1} \cdot \frac{3}{1} \\ &= \frac{60}{1} \text{ or } 60 \end{aligned}$$

Write 20 as $\frac{20}{1}$.

Multiply by the multiplicative inverse of $\frac{1}{3}$, which is 3.

Simplify.

Isabel and her friends can make 60 Flag Day ribbons.

CHECK Your Progress

- j. **LUMBER** Some boards are cut to a thickness of $1\frac{1}{2}$ inches. The shelf that holds the boards is 36 inches deep. How many boards can be stacked on the shelf?

Real-World EXAMPLE

- 5 HOME IMPROVEMENT** There were 4 persons working on a remodeling project. It took them $6\frac{1}{2}$ days to finish the job. How long would it take 6 persons to finish a similar project?

If 4 persons each worked $6\frac{1}{2}$ days, the project required $4 \times 6\frac{1}{2}$ person-days of work. Divide this number by 6 persons to find the number of days it will take to complete the other project.

$$4 \times 6\frac{1}{2} \text{ person-days} \div 6 \text{ persons}$$

$$\begin{aligned} &= \frac{4 \times 6\frac{1}{2} \text{ person-days}}{1} \times \frac{1}{6 \text{ persons}} \\ &= \frac{26}{6} \text{ or } 4\frac{1}{3} \text{ days} \end{aligned}$$

Multiply by the multiplicative inverse of 6, which is $\frac{1}{6}$.

Simplify.

Check for Reasonableness The problem asks for the number of days. When you divide the common units, the answer is expressed in days.

CHECK Your Progress

- k. **TRAVEL** Geoff plans to travel 480 miles. If his car gets an average of 32 miles per gallon of gasoline, approximately how much gasoline will he use? Use dimensional analysis to check the reasonableness of the answer.

STUDY TIP

Dimensional Analysis

You can also use dimensional analysis to check the reasonableness of the answer.



CHECK Your Understanding

Example 1
(p. 102)

Write the multiplicative inverse of each number.

1. $\frac{5}{7}$

2. -12

3. $-2\frac{3}{4}$

Example 2
(p. 103)

Divide. Write in simplest form.

4. $\frac{2}{3} \div \frac{3}{4}$

5. $\frac{5}{8} \div \frac{1}{2}$

6. $\frac{3}{8} \div \left(-\frac{9}{10}\right)$

7. $-\frac{7}{16} \div \left(-\frac{7}{8}\right)$

Example 3
(p. 103)

8. $\frac{4}{5} \div 8$

9. $\frac{9}{10} \div 3$

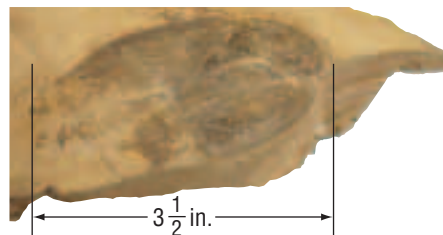
10. $-5\frac{5}{6} \div \left(-4\frac{2}{3}\right)$

11. $-3\frac{7}{12} \div 6\frac{5}{6}$

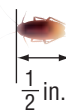
Examples 4, 5
(p. 104)

12. **BIOLOGY** The 300 million-year-old fossil of a cockroach was recently found in eastern Ohio. The ancient cockroach is shown next to the common German cockroach found today.

300-Million-Year-Old Cockroach



Common German Cockroach



How many times longer is the ancient cockroach than the German cockroach?

Exercises

HOMEWORK HELP

For Exercises	See Examples
13–18	1
19–26	2
27–34	3
35, 36	4
37, 38	5

Write the multiplicative inverse of each number.

13. $-\frac{7}{9}$

14. $-\frac{5}{8}$

15. 15

16. 18

17. $3\frac{2}{5}$

18. $4\frac{1}{8}$

Divide. Write in simplest form.

19. $\frac{2}{5} \div \frac{3}{4}$

20. $\frac{3}{8} \div \frac{2}{3}$

21. $\frac{2}{3} \div \frac{5}{6}$

22. $\frac{2}{5} \div \frac{1}{10}$

23. $-\frac{4}{5} \div \frac{3}{4}$

24. $\frac{3}{10} \div \left(-\frac{2}{3}\right)$

25. $-\frac{5}{9} \div \left(-\frac{2}{3}\right)$

26. $-\frac{7}{12} \div \left(-\frac{5}{6}\right)$

27. $\frac{2}{5} \div 4$

28. $\frac{9}{16} \div 3$

29. $\frac{4}{5} \div 6$

30. $\frac{6}{7} \div 4$

31. $3\frac{3}{4} \div 2\frac{1}{2}$

32. $7\frac{1}{2} \div 2\frac{1}{10}$

33. $-12\frac{1}{4} \div 4\frac{2}{3}$

34. $10\frac{1}{5} \div \left(-\frac{3}{15}\right)$



••**HUMAN BODY** For Exercises 35 and 36, use the information below and at the right.

The table shows the composition of a healthy adult male's body. Examples of body cell mass are muscle, body organs, and blood. Examples of supporting tissue are blood plasma and bones.

Composition of Human Body	
Component	Fraction of Body Weight
Body Cell Mass	$\frac{11}{20}$
Supporting Tissue	$\frac{3}{10}$
Body Fat	$\frac{3}{20}$

Source: about.com

35. How many times more of a healthy adult male's body weight is made up of body cell mass than body fat?
36. How many times more of a healthy adult male's body weight is made up of body cell mass than supporting tissue?

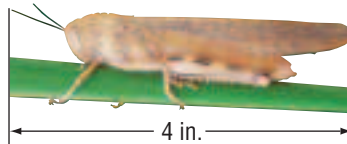
For Exercises 37 and 38, use dimensional analysis to check the reasonableness of each answer.

37. **PAINTING** It took 3 persons $2\frac{1}{2}$ hours to paint a large room. How long would it take 5 persons to paint a similar room?
38. **VACATION** The Sumner family is planning a vacation. The destination is 350 miles away. If they drive at an average speed of 62 miles per hour, approximately how long will it take to get there?
39. **BIOLOGY** Use the information below. How many of the smallest grasshoppers need to be laid end-to-end to have the same length as one of the largest grasshoppers?

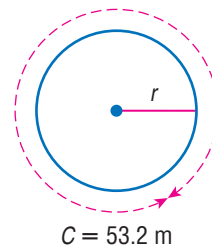
Smallest grasshopper



Largest grasshopper



40. **LIBRARIES** Pilar is storing a set of art books on a shelf that has $11\frac{1}{4}$ inches of shelf space. If each book is $\frac{3}{4}$ inch wide, how many books can be stored on the shelf?
41. **GEOMETRY** The circumference C , or distance around a circle, can be approximated using the formula $C = \frac{44}{7}r$, where r is the radius of the circle. What is the radius of the circle at the right? Round to the nearest tenth.



42. **BAKING** Emily is baking chocolate cupcakes. Each batch of 20 cupcakes requires $\frac{2}{3}$ cups of cocoa. If Emily has $3\frac{1}{4}$ cups of cocoa, how many full batches of cupcakes will she be able to make and how much cocoa will she have left over?
43. **OPEN ENDED** Select a fraction between 0 and 1. Identify both its additive and multiplicative inverses. Explain your reasoning.
44. **CHALLENGE** Give a counterexample to the statement *The quotient of two fractions between 0 and 1 is never a whole number.*



Real-World Link

99% of the mass of the human body is made up of six elements: oxygen, carbon, hydrogen, nitrogen, calcium, and phosphorus.

Source: about.com

EXTRAPRACTICE

See pages 680, 709.

Math online

Self-Check Quiz at
ca.gr7math.com

H.O.T. Problems



45. **NUMBER SENSE** Which is greater: $30 \cdot \frac{3}{4}$ or $30 \div \frac{3}{4}$? Explain.

CHALLENGE Use mental math to find each value.

46. $\frac{43}{594} \cdot \frac{641}{76} \div \frac{641}{594}$

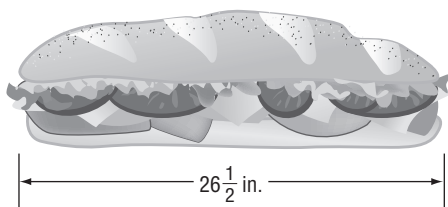
47. $\frac{783}{241} \cdot \frac{241}{783} \div \frac{72}{53}$

48. **WRITING IN MATH** Write a real-world problem that can be solved by dividing fractions or mixed numbers. Solve the problem.



STANDARDS PRACTICE

49. A submarine sandwich that is $26\frac{1}{2}$ inches long is cut into $4\frac{5}{12}$ -inch mini-sub. How many mini-sub are there?



- A 4 C 6
B 5 D 7

50. Mr. Jones is doing a science experiment with his class of 20 students. Each student needs $\frac{3}{4}$ cup of vinegar. If he currently has 15 cups of vinegar, which equation could Mr. Jones use to determine if he has enough vinegar for his entire class?

F $x = 15 \div 20$

G $x = 15 \div \frac{3}{4}$

H $x = 20 - (15)$

J $x = 15(20)$

Spiral Review

Multiply. Write in simplest form. (Lesson 2-3)

51. $\frac{1}{2} \cdot \frac{3}{4}$

52. $\frac{7}{12} \cdot \frac{4}{7}$

53. $1\frac{2}{3} \cdot 4\frac{1}{5}$

54. $\frac{2}{3} \cdot 3\frac{1}{4}$

55. **SCHOOL** In a survey of students at Centerburg Middle School, $\frac{13}{20}$ of the boys and $\frac{17}{25}$ of the girls said they ride the bus to school. Of those surveyed, do a greater fraction of boys or girls ride the bus? (Lesson 2-2)
56. **ALGEBRA** Write an equation using two variables that could be used to determine the population of Asia if it is about three million less than five times the population of Africa. (Lesson 1-7)

Write an integer to describe each situation. (Lesson 1-3)

57. 10 candy bars short of his goal

58. 7 bonus points



GET READY for the Next Lesson

PREREQUISITE SKILL Add or subtract. (Lessons 1-4 and 1-5)

59. $-7 + 15$

60. $-9 + (-4)$

61. $-3 - 15$

62. $12 - (-17)$

2-5

Adding and Subtracting Like Fractions

Main IDEA

Add and subtract fractions with like denominators.



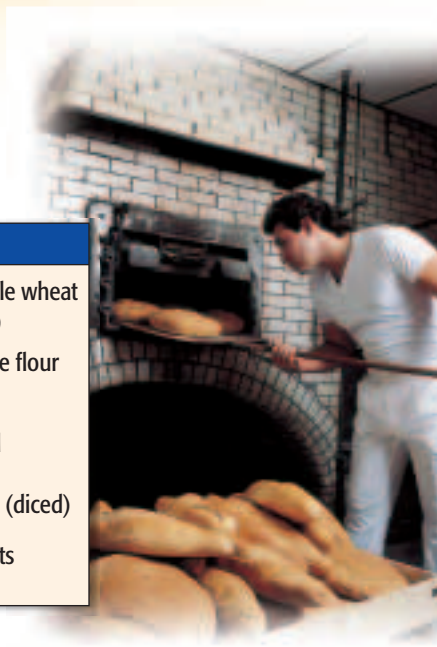
Standard 7NS1.2 Add, subtract, multiply and divide **rational numbers** (integers, **fractions**, and terminating decimals) and take positive rational numbers to whole-number powers.

GET READY for the Lesson

BAKING A bread recipe calls for the ingredients at the right together with small amounts of sugar, oil, yeast, and salt.

1. What is the sum of the whole-number parts of the amounts?
2. How many $\frac{1}{3}$ cups are there?
3. Can you combine these ingredients in a 4-cup mixing bowl? Explain.

Bread	
$1\frac{1}{3}$	cups of whole wheat flour (sifted)
$2\frac{1}{3}$	cups of white flour (sifted)
$\frac{1}{3}$	cup oatmeal
$\frac{1}{3}$	cup apricots (diced)
$\frac{1}{3}$	cup hazelnuts (chopped)



NEW Vocabulary

like fractions

Fractions that have the same denominators are called **like fractions**.

KEY CONCEPT

Add and Subtract Like Fractions

Words

To add or subtract like fractions, add or subtract the numerators and write the result over the denominator.

Examples

Numbers

$$\frac{1}{5} + \frac{3}{5} = \frac{4}{5}$$

$$\frac{7}{8} - \frac{3}{8} = \frac{4}{8} \text{ or } \frac{1}{2}$$

Algebra

$$\frac{a}{c} + \frac{b}{c} = \frac{a+b}{c}, \text{ where } c \neq 0$$

$$\frac{a}{c} - \frac{b}{c} = \frac{a-b}{c}, \text{ where } c \neq 0$$

You can use the rules for adding integers to determine the sign of the sum of any two signed numbers.

EXAMPLE

Add Like Fractions

- 1 Find $\frac{5}{8} + \left(-\frac{7}{8}\right)$. Write in simplest form.

$$\begin{aligned} \frac{5}{8} + \left(-\frac{7}{8}\right) &= \frac{5 + (-7)}{8} \\ &= \frac{-2}{8} \text{ or } -\frac{1}{4} \end{aligned}$$

←Add the numerators.
←The denominators are the same.
Simplify.



CHECK Your Progress

Add. Write in simplest form.

a. $\frac{5}{9} + \frac{7}{9}$

b. $-\frac{5}{9} + \frac{1}{9}$

c. $-\frac{1}{6} + \left(-\frac{5}{6}\right)$

STUDY TIP

Look Back You can review **adding integers** in Lesson 1-4.

EXAMPLE**Subtract Like Fractions**

- 2** Find $-\frac{8}{9} - \frac{7}{9}$. Write in simplest form.

$$\begin{aligned} -\frac{8}{9} - \frac{7}{9} &= -\frac{8}{9} + \left(-\frac{7}{9}\right) \\ &= \frac{-8 + (-7)}{9} \\ &= \frac{-15}{9} \text{ or } -1\frac{2}{3} \end{aligned}$$

Subtract the numerators by adding the opposite of 7.

Rename $\frac{-15}{9}$ as $-1\frac{6}{9}$ or $-1\frac{2}{3}$.

**CHECK Your Progress**

Subtract. Write in simplest form.

d. $-\frac{4}{5} - \frac{3}{5}$

e. $\frac{3}{8} - \frac{5}{8}$

f. $\frac{5}{7} - \left(-\frac{4}{7}\right)$

To add or subtract mixed numbers, add or subtract the whole numbers and the fractions separately. Then simplify.

EXAMPLE**Add Mixed Numbers**

- 3** Find $5\frac{7}{9} + 8\frac{4}{9}$. Write in simplest form.

$$\begin{aligned} 5\frac{7}{9} + 8\frac{4}{9} &= (5 + 8) + \left(\frac{7}{9} + \frac{4}{9}\right) \\ &= 13 + \frac{7+4}{9} \\ &= 13\frac{11}{9} \text{ or } 14\frac{2}{9} \end{aligned}$$

Add the whole numbers and fractions separately.

Add the numerators.

$$\frac{11}{9} = 1\frac{2}{9}$$

**CHECK Your Progress**

Add or subtract. Write in simplest form.

g. $9\frac{5}{8} - 3\frac{3}{8}$

h. $8 - 6\frac{2}{9}$

i. $-8\frac{5}{9} + \left(-6\frac{2}{9}\right)$

Another way to add or subtract mixed numbers is to write the mixed numbers as improper fractions.

**Real-World EXAMPLE****Subtract Mixed Numbers**

- 4 HEIGHTS** Jasmine is $60\frac{1}{4}$ inches tall. Amber is $58\frac{3}{4}$ inches tall. How much taller is Jasmine than Amber? **Estimate** $60 - 59 = 1$

$$\begin{aligned} 60\frac{1}{4} - 58\frac{3}{4} &= \frac{241}{4} - \frac{235}{4} \\ &= \frac{241 - 235}{4} \\ &= \frac{6}{4} \text{ or } 1\frac{1}{2} \end{aligned}$$

Write the mixed numbers as improper fractions.

← Subtract the numerators.

← The denominators are the same.

Jasmine is $1\frac{1}{2}$ inches taller than Amber.

**CHECK Your Progress**

- j. **BAKING** A recipe for chocolate cookies calls for $2\frac{3}{4}$ cups of flour. If Alexis has $1\frac{1}{4}$ cups of flour, how much more will she need?

STUDY TIP

Alternative Method
You can also add the mixed numbers vertically.

$$\begin{array}{r} 5\frac{7}{9} \\ + 8\frac{4}{9} \\ \hline 13\frac{11}{9} \text{ or } 14\frac{2}{9} \end{array}$$



Personal Tutor at ca.gr7math.com

CHECK Your Understanding

Examples 1–3
(pp. 108–109)

Add or subtract. Write in simplest form.

1. $\frac{2}{5} + \left(-\frac{4}{5}\right)$

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

3. $-\frac{4}{9} + \left(-\frac{7}{9}\right)$

4. $-\frac{7}{10} - \frac{9}{10}$

5. $\frac{3}{8} - \frac{7}{8}$

6. $-\frac{5}{6} - \left(-\frac{2}{6}\right)$

7. $5\frac{4}{9} - 2\frac{2}{9}$

8. $-1\frac{3}{7} + \left(-2\frac{2}{7}\right)$

9. $10 - 3\frac{5}{16}$

Example 4
(p. 109)

10. **CLOTHING** Hat sizes are determined by the distance across a person's head. How much wider is a person's head who wears a hat size of $7\frac{3}{4}$ inches than someone who wears a hat size of $6\frac{1}{4}$ inches?

Exercises

HOMEWORK HELP

For Exercises	See Examples
11–14	1
15–18	2
19–26	3
27, 28	4

Add or subtract. Write in simplest form.

11. $-\frac{1}{9} + \frac{4}{9}$

12. $-\frac{3}{7} + \left(-\frac{2}{7}\right)$

13. $-\frac{5}{12} + \frac{7}{12}$

14. $\frac{8}{9} + \left(-\frac{5}{9}\right)$

15. $-\frac{4}{5} - \frac{3}{5}$

16. $\frac{15}{16} - \frac{9}{16}$

17. $\frac{1}{12} - \frac{7}{12}$

18. $\frac{2}{9} - \frac{8}{9}$

19. $3\frac{5}{8} + 7\frac{5}{8}$

20. $9\frac{5}{9} + 4\frac{7}{9}$

21. $8\frac{1}{10} + \left(-2\frac{9}{10}\right)$

22. $8\frac{5}{12} + \left(-5\frac{11}{12}\right)$

23. $-1\frac{5}{6} - 3\frac{5}{6}$

24. $-3\frac{3}{4} - 7\frac{3}{4}$

25. $7 - 5\frac{2}{5}$

26. $9 - 6\frac{3}{7}$

27. **HOME IMPROVEMENT** Andrew has $42\frac{1}{3}$ feet of molding to use as borders around the windows of his house. If he uses $23\frac{2}{3}$ feet of the molding on the front windows, how much remains for the back windows?

28. **WEATHER** One year, Brady's hometown of Powell received about $42\frac{6}{10}$ inches of snow. The following year only $14\frac{3}{10}$ inches of snow fell. What is the difference in the amount of snow between the two years?

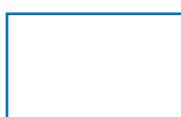
Simplify each expression.

29. $-7\frac{4}{5} + 3\frac{1}{5} - \left(2\frac{3}{5}\right)$

30. $-8\frac{1}{8} - \left(-3\frac{5}{8}\right) + 6\frac{3}{8}$

MEASUREMENT Find the perimeter of each rectangle.

31. 
12 $\frac{1}{4}$ in. 25 $\frac{3}{4}$ in.

32. 
6 $\frac{5}{8}$ ft 10 $\frac{7}{8}$ ft

ALGEBRA Evaluate each expression for the given values.

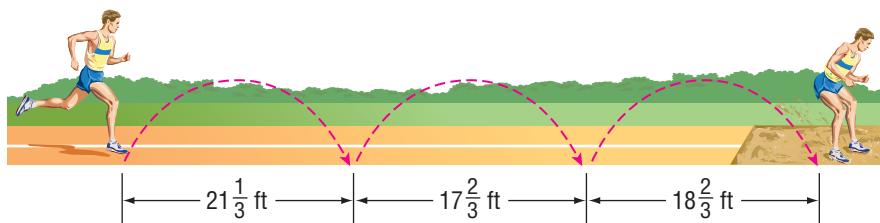
33. $a - b$ if $a = 5\frac{1}{3}$ and $b = -2\frac{1}{3}$

34. $x + y$ if $x = -\frac{5}{12}$ and $y = -\frac{1}{12}$

35. $n - m$ if $m = 5\frac{2}{3}$ and $n = -2\frac{2}{3}$

36. $s - t$ if $s = -\frac{1}{2}$ and $t = -2\frac{1}{2}$

37. **SPORTS** One of the track and field events is the triple jump. In this event, the athlete takes a running start and makes three jumps without stopping. Find the total length of the 3 jumps for the athlete below.



38. **HOMEWORK** Rob recorded the amount of time he spent on homework last week. Express his total time for the week in terms of hours and minutes.

Day	Time
Mon	$2\frac{1}{6}$ h
Tue	$2\frac{1}{2}$ h
Wed	$1\frac{3}{4}$ h
Thu	$2\frac{5}{12}$ h
Fri	$1\frac{1}{4}$ h

EXTRAPRACTICE
See pages 680, 709.
Math online
Self-Check Quiz at
ca.gr7math.com

39. **PLUMBING** A plumber has a pipe that is $64\frac{5}{8}$ inches long. The plumber cuts $2\frac{7}{8}$ inches off the end of the pipe, then cuts off an additional $1\frac{3}{8}$ inches. How long is the remaining pipe after the last cut is made?

H.O.T. Problems

40. **OPEN ENDED** Write a subtraction problem with a difference of $\frac{2}{9}$.
41. **FIND THE ERROR** Allison and Wesley are adding $\frac{1}{7}$ and $\frac{3}{7}$. Who is correct? Explain your reasoning.

Allison: $\frac{1}{7} + \frac{3}{7} = \frac{1+3}{7} = \frac{4}{7}$

Wesley: $\frac{1}{7} + \frac{3}{7} = \frac{1+3}{7+7} = \frac{4}{14} \text{ or } \frac{2}{7}$

42. **CHALLENGE** Explain how you could use mental math to find the following sum. Then find the sum.

$$3\frac{2}{3} + 4\frac{2}{5} + 2\frac{1}{6} + 2\frac{5}{6} + 1\frac{1}{3} + \frac{3}{5}$$

43. **WRITING IN MATH** Write a real-world situation that can be solved by adding or subtracting mixed numbers. Then solve the problem.

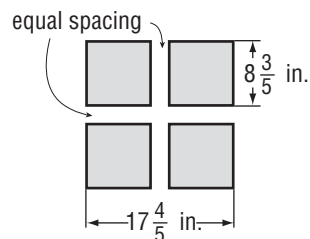


STANDARDS PRACTICE

44. Esteban is $63\frac{1}{8}$ inches tall. Haley is $59\frac{5}{8}$ inches tall. How much taller is Esteban than Haley? Write in simplest form.

A $4\frac{1}{2}$ in.
 B $4\frac{1}{4}$ in.
 C $3\frac{3}{4}$ in.
 D $3\frac{1}{2}$ in.

45. The equal-sized square tiles on a bathroom floor are set as shown.



What is the width of the space between the tiles?

F $\frac{3}{5}$ in. H $\frac{3}{10}$ in.
 G $\frac{1}{5}$ in. J $\frac{2}{5}$ in.

Spiral Review

Divide. Write in simplest form. (Lesson 2-4)

46. $\frac{3}{5} \div \frac{6}{7}$

47. $\frac{7}{8} \div 2\frac{4}{5}$

48. $-3\frac{1}{4} \div 2\frac{1}{2}$

49. Find the product of $-\frac{7}{8}$ and $-\frac{6}{7}$. (Lesson 2-3)

50. **NUTRITION** There is 2.3 times the recommended daily allowance of vitamin C in a 5.5-ounce serving of kiwifruit. Write an equation to represent the amount of vitamin C recommended for each day. (Lesson 1-7)

Fruit	Vitamin C (mg in 5.5 oz)
Orange	52
Strawberries	63
Kiwifruit	103.5

Source: Food and Drug Administration

Evaluate each expression. (Lesson 1-3)

51. $|-20| - |17|$

52. $|31| - |-10|$

53. $|5 + 9|$

54. $|8 - 17|$

55. **FOOD** On a typical day, 2 million gallons of ice cream are produced in the United States. About how many gallons of ice cream are produced each year? (Lesson 1-1)

GET READY for the Next Lesson

PREREQUISITE SKILL Find the least common multiple (LCM) of each set of numbers. (page 667)

56. 14, 21

57. 18, 9, 6

58. 6, 4, 9

59. 5, 10, 20

Mid-Chapter Quiz

Lessons 2-1 through 2-5

- MEASUREMENT** One centimeter is about 0.392 inch. What fraction of an inch is this? (Lesson 2-1)
- Write $1\frac{7}{16}$ as a decimal. (Lesson 2-1)
- Write $0.\overline{4}$ as a fraction in simplest form. (Lesson 2-1)

Replace each $\bullet$ with $<$, $>$, or $=$ to make a true sentence. (Lesson 2-2)

- $\frac{1}{3} \bullet \frac{1}{4}$
- $0.\overline{12} \bullet \frac{4}{33}$
- $-\frac{2}{5} \bullet -\frac{3}{10}$
- $-7.833... \bullet -7.8$

-  **STANDARDS PRACTICE** The table gives the durations, in hours, of several human spaceflights.

Mission	Year	Duration (h)
Challenger (41-B)	1984	$191\frac{4}{15}$
Discovery (51-A)	1984	$191\frac{3}{4}$
Endeavour (STS-57)	1992	$190\frac{1}{2}$
Discovery (STS-103)	1999	$191\frac{1}{6}$

Which of the following correctly orders these durations from least to greatest?

(Lesson 2-2)

- $190\frac{1}{2}, 191\frac{1}{6}, 191\frac{3}{4}, 191\frac{4}{15}$
- $191\frac{3}{4}, 191\frac{1}{6}, 191\frac{4}{15}, 190\frac{1}{2}$
- $190\frac{1}{2}, 191\frac{1}{6}, 191\frac{4}{15}, 191\frac{3}{4}$
- $191\frac{1}{6}, 191\frac{4}{15}, 190\frac{1}{2}, 191\frac{3}{4}$

Multiply. Write in simplest form.

(Lesson 2-3)

- $\left(-\frac{1}{3}\right) \cdot \frac{7}{8}$
- $\left(-2\frac{3}{4}\right) \cdot \left(-\frac{1}{5}\right)$

- WEATHER** The table shows the approximate number of sunny days each year for certain cities. Oklahoma City has about $\frac{3}{5}$ as many sunny days as Phoenix. About how many sunny days each year are there in Oklahoma City? (Lesson 2-3)

Sunny Days Per Year	
City	Days
Austin, TX	120
Denver, CO	115
Phoenix, AZ	215
Sacramento, CA	195
Santa Fe, NM	175

Source: National Oceanic and Atmospheric Administration

Divide. Write in simplest form.

(Lesson 2-4)

- $\frac{1}{2} \div \left(-\frac{3}{4}\right)$
- $\left(-1\frac{1}{3}\right) \div \left(-\frac{1}{4}\right)$

-  **STANDARDS PRACTICE** A board that is $25\frac{1}{2}$ feet long is cut into pieces that are each $1\frac{1}{2}$ feet long. Which of the steps below would give the number of pieces into which the board is cut? (Lesson 2-4)

F Multiply $1\frac{1}{2}$ by $25\frac{1}{2}$.

G Divide $25\frac{1}{2}$ by $1\frac{1}{2}$.

H Add $25\frac{1}{2}$ to $1\frac{1}{2}$.

J Subtract $1\frac{1}{2}$ from $25\frac{1}{2}$.

Add or subtract. Write in simplest form.

(Lesson 2-5)

- $\frac{1}{5} + \left(-\frac{4}{5}\right)$
- $-3\frac{4}{7} - 3\frac{6}{7}$

Adding and Subtracting Unlike Fractions

Main IDEA

Add and subtract fractions with unlike denominators.



Standard 7NS1.2 Add, subtract, multiply, and divide rational numbers (integers, fractions and terminating decimals) and take positive rational numbers to whole-number powers.

Standard 7NS2.2 Add and subtract fractions by using factoring to find common denominators.

GET READY for the Lesson

FOOD Marta and Brooke are sharing a pizza. Marta eats $\frac{1}{4}$ of the pizza, and Brooke eats $\frac{3}{8}$ of the pizza.



1. What are the denominators of the fractions?
2. What is the least common multiple of the denominators?
3. Find the missing value in $\frac{1}{4} = \frac{?}{8}$.

NEW Vocabulary

unlike fractions

Fractions with unlike denominators are called **unlike fractions**. To add or subtract unlike fractions, rename the fractions using prime factors to find the least common denominator. Then add or subtract as with like fractions.

REVIEW Vocabulary

least common denominator (LCD) the least common multiple (LCM) of the denominators (page 667)

EXAMPLES Add and Subtract Unlike Fractions

Add or subtract. Write in simplest form.

1 $\frac{1}{4} + \left(-\frac{2}{3}\right)$

$$\begin{aligned}\frac{1}{4} + \left(-\frac{2}{3}\right) &= \frac{1}{4} \cdot \frac{3}{3} + \left(-\frac{2}{3}\right) \cdot \frac{4}{4} \\ &= \frac{3}{12} + \left(-\frac{8}{12}\right) \\ &= \frac{3 + (-8)}{12} \text{ or } -\frac{5}{12}\end{aligned}$$

The LCD is $3 \cdot 4$ or 12.

Rename using the LCD.

Add the numerators. Then simplify.

2 $-\frac{8}{63} - \left(-\frac{7}{99}\right)$

$$\begin{aligned}-\frac{8}{63} + \frac{7}{99} &= -\frac{8}{63} \cdot \frac{11}{11} + \frac{7}{99} \cdot \frac{7}{7} \\ &= -\frac{88}{693} + \frac{49}{693} \\ &= \frac{-88 + 49}{693} \\ &= -\frac{39}{693} \text{ or } -\frac{13}{231}\end{aligned}$$

$63 = 3 \cdot 3 \cdot 7$, $99 = 3 \cdot 3 \cdot 11$
The LCD is $3 \cdot 3 \cdot 7 \cdot 11$ or 693.

Rename using the LCD.

Add the numerators.

Simplify.

CHECK Your Progress

Add or subtract. Write in simplest form.

a. $-\frac{5}{6} + \left(-\frac{1}{2}\right)$

b. $\frac{1}{14} + \frac{3}{49}$

c. $-\frac{5}{16} + \frac{3}{10}$

STUDY TIP

Estimation Think:

$-6\frac{2}{9}$ is about -6 and

$4\frac{5}{6}$ is about 5 . Since

$-6 + 5$ is about -1 , the answer is about -1 . The answer seems reasonable.

EXAMPLE

Add and Subtract Mixed Numbers

- 3 Find $-6\frac{2}{9} + 4\frac{5}{6}$. Write in simplest form.

$$-6\frac{2}{9} + 4\frac{5}{6} = -\frac{56}{9} + \frac{29}{6}$$

Write as improper fractions.

$$= -\frac{112}{18} + \frac{87}{18}$$

$$\frac{-56}{9} \cdot \frac{2}{2} = -\frac{112}{18} \text{ and } \frac{29}{6} \cdot \frac{3}{3} = \frac{87}{18}$$

$$= \frac{-112 + 87}{18}$$

Add the numerators.

$$= \frac{-25}{18} \text{ or } -1\frac{7}{18}$$

Simplify.

CHECK Your Progress

Add or subtract. Write in simplest form.

d. $-\frac{5}{12} + \left(-\frac{1}{8}\right)$ e. $-3\frac{1}{2} + 8\frac{1}{3}$ f. $2\frac{3}{4} - 6\frac{1}{3}$ g. $-1\frac{2}{5} + \left(-3\frac{1}{3}\right)$

STANDARDS EXAMPLE

- 4 Four telephone books are $2\frac{1}{8}$, $1\frac{15}{16}$, $1\frac{3}{4}$, and $2\frac{3}{8}$ inches thick. If these books were stacked one on top of another, what is the total height of the books?

A $5\frac{3}{16}$ in.

C $11\frac{3}{16}$ in.

B $8\frac{3}{16}$ in.

D $15\frac{3}{16}$ in.

Test-Taking Tip

Use Estimation If a test question would take an excessive amount of time to work, try estimating the answer. Then look for the appropriate answer choice.

Read the Item

You need to find the sum of four mixed numbers.

Solve the Item

It would take some time to change each of the fractions to ones with a common denominator. However, notice that all four of the numbers have a value of about 2. Since 2×4 equals 8, the answer will be about 8. Notice that only one of the choices is close to 8. The answer is B.

CHECK Your Progress

- h. Amanda is planning a rectangular vegetable garden using a roll of border fencing that is $45\frac{3}{4}$ feet long. If she makes the width of the garden $10\frac{1}{2}$ feet, what must the length be?

F $12\frac{3}{8}$ ft

H $24\frac{3}{4}$ ft

G $17\frac{1}{2}$ ft

J $35\frac{1}{4}$ ft



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CHECK Your Understanding

Examples 1–3
(pp. 114–115)

Add or subtract. Write in simplest form.

1. $\frac{3}{4} + \left(-\frac{1}{6}\right)$

2. $-\frac{5}{8} + \frac{1}{2}$

3. $-\frac{4}{9} + \left(-\frac{2}{3}\right)$

4. $\frac{7}{8} - \frac{3}{4}$

5. $\frac{7}{13} - \frac{2}{9}$

6. $\frac{14}{15} - \left(-\frac{12}{21}\right)$

7. $-3\frac{2}{5} + 1\frac{5}{6}$

8. $3\frac{5}{8} - 1\frac{1}{3}$

9. $-4\frac{7}{12} - \left(-3\frac{7}{72}\right)$

Example 4
(p. 115)

10.  **STANDARDS PRACTICE** Tamera played a computer game for $1\frac{1}{4}$ hours, studied for $2\frac{1}{4}$ hours, and did some chores for $\frac{1}{2}$ hour. How much time did Tamera spend on all of these tasks?

A $2\frac{1}{2}$ h

B $3\frac{1}{4}$ h

C 4 h

D $4\frac{1}{2}$ h

Exercises

HOMEWORK HELP

For Exercises	See Examples
11–14	1
15–18	2
19–26	3
42, 43	4

Add or subtract. Write in simplest form.

11. $\frac{1}{4} + \left(-\frac{7}{12}\right)$

12. $-\frac{3}{8} + \frac{5}{6}$

13. $-\frac{6}{7} + \left(-\frac{1}{2}\right)$

14. $-\frac{5}{9} + \left(-\frac{3}{8}\right)$

15. $\frac{1}{3} - \frac{7}{8}$

16. $\frac{4}{5} - \left(-\frac{2}{15}\right)$

17. $-\frac{2}{9} - \left(-\frac{3}{11}\right)$

18. $-\frac{7}{15} - \left(-\frac{12}{25}\right)$

19. $3\frac{1}{5} + \left(-8\frac{1}{2}\right)$

20. $1\frac{1}{6} + \left(-6\frac{2}{3}\right)$

21. $8\frac{3}{7} - \left(-6\frac{1}{2}\right)$

22. $7\frac{3}{4} - \left(-1\frac{1}{8}\right)$

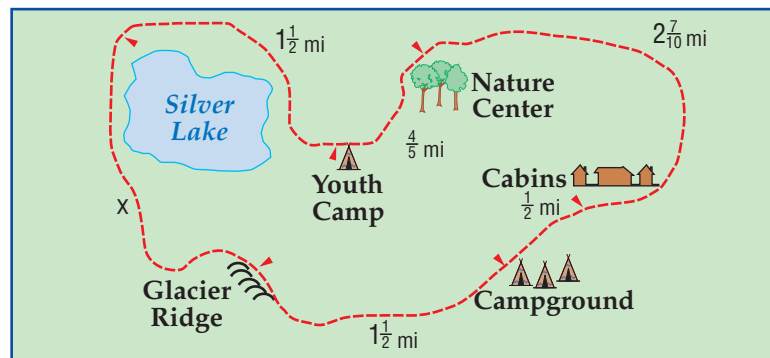
23. $-4\frac{3}{4} - 5\frac{5}{8}$

24. $-8\frac{1}{3} - 4\frac{5}{6}$

25. $-15\frac{5}{8} + 11\frac{2}{3}$

26. $-22\frac{2}{5} + 15\frac{5}{6}$

27. **HIKING** The map shows a hiking trail at a campground. If the distance along the trail from the campground to Silver Lake is $4\frac{1}{10}$ miles, how far is it from Glacier Ridge to Silver Lake?



ALGEBRA Evaluate each expression for the given values.

28. $c - d$ if $c = -\frac{3}{4}$ and $d = -12\frac{7}{8}$

29. $r - s$ if $r = -\frac{5}{8}$ and $s = 2\frac{5}{6}$

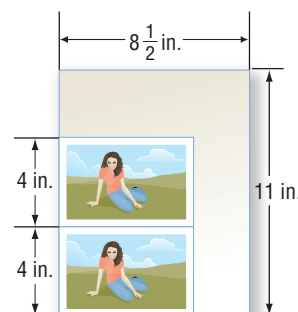


30. **HISTORY** In the 1824 presidential election, Andrew Jackson, John Quincy Adams, Henry Clay, and William H. Crawford received electoral votes. Use the information at the right to determine what fraction of the votes William H. Crawford received.

Candidate	Fraction of Vote
Andrew Jackson	$\frac{3}{8}$
John Quincy Adams	$\frac{1}{3}$
Henry Clay	$\frac{1}{7}$

Source: *The World Almanac*

31. **PHOTOGRAPHY** Two 4-inch by 6-inch digital photographs are printed on an $8\frac{1}{2}$ -inch by 11-inch sheet of photo paper. After the photos are printed, Aaron cuts them from the sheet. What is the area of the remaining photo paper?



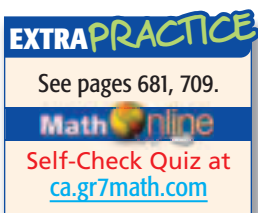
MEASUREMENT Find the missing measure for each figure.

32.

 $6\frac{3}{4}$ ft
 $4\frac{1}{3}$ ft
 x ft
 $4\frac{1}{3}$ ft
 perimeter = $17\frac{11}{12}$ ft

33.

 x in.
 $9\frac{1}{2}$ in.
 $11\frac{7}{8}$ in.
 $13\frac{1}{4}$ in.
 perimeter = $40\frac{3}{4}$ in.



34. **FIND THE DATA** Refer to the California Data File on pages 16–19. Choose some data and write a real-world problem in which you would add or subtract unlike fractions or mixed numbers.

H.O.T. Problems

35. **OPEN ENDED** Write a subtraction problem using unlike fractions with a least common denominator of 12. Find the difference.
36. **NUMBER SENSE** Without doing the computation, determine whether $\frac{4}{7} + \frac{5}{9}$ is greater than, less than, or equal to 1. Explain.
37. **CHALLENGE** Suppose a bucket is placed under two faucets. If one faucet is turned on alone, the bucket will be filled in 5 minutes. If the other faucet is turned on alone, the bucket will be filled in 3 minutes. Write the fraction of the bucket that will be filled in 1 minute if both faucets are turned on.

WRITING IN MATH For Exercises 38–41, write an expression for each statement. Then find the answer.

38. $\frac{3}{4}$ of $\frac{2}{3}$
39. $\frac{3}{4}$ more than $\frac{2}{3}$
40. $\frac{3}{4}$ less than $\frac{2}{3}$
41. $\frac{3}{4}$ divided into $\frac{2}{3}$



STANDARDS PRACTICE

42. A recipe for snack mix contains $2\frac{1}{3}$ cups of mixed nuts, $3\frac{1}{2}$ cups of granola, and $\frac{3}{4}$ cup raisins. What is the total amount of snack mix?
- A $5\frac{2}{3}$ c
B $5\frac{7}{12}$ c
C $6\frac{2}{3}$ c
D $6\frac{7}{12}$ c
43. Which of the following shows the next step using the least common denominator to simplify $\frac{3}{4} - \frac{2}{3}$?
- F $\left(\frac{3}{4} \times \frac{5}{5}\right) - \left(\frac{2}{3} \times \frac{6}{6}\right)$
G $\left(\frac{3}{4} \times \frac{6}{6}\right) - \left(\frac{2}{3} \times \frac{5}{5}\right)$
H $\left(\frac{3}{4} \times \frac{3}{3}\right) - \left(\frac{2}{3} \times \frac{4}{4}\right)$
J $\left(\frac{3}{4} \times \frac{4}{4}\right) - \left(\frac{2}{3} \times \frac{3}{3}\right)$

Spiral Review

Add or subtract. Write in simplest form. (Lesson 2-5)

44. $-\frac{7}{11} + \frac{5}{11}$

45. $-\frac{7}{15} - \frac{4}{15}$

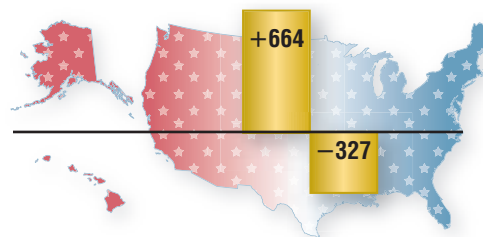
46. $5\frac{4}{5} - 7\frac{1}{5}$

47. **ALGEBRA** Find $a \div b$ if $a = 3\frac{1}{2}$ and $b = -\frac{7}{8}$. (Lesson 2-4)

POPULATION For Exercises 48 and 49, use the graphic at the right. (Lesson 1-7)

48. Write and solve a multiplication equation to determine the number of hours it would take for the population of the United States to increase by 1 million.
49. Write and solve a multiplication equation to determine the number of days it would take for the U.S. population to increase by 1 million.

Population Hourly Change



Source: U.S. Census Bureau

50. **INVESTMENTS** Mr. Coffey purchased stock for \$50 per share. The next day the value of the stock dropped \$12. On the second and third days, the value dropped another \$16, then rose \$25. What was the value of the stock at the end of the third day? (Lesson 1-4)

GET READY for the Next Lesson

PREREQUISITE SKILL Solve each equation. Check your solution. (Lessons 1-9 and 1-10)

51. $d - 13 = -44$

52. $-18t = 270$

53. $-34 = y + 22$

54. $-5 = \frac{a}{16}$

2-7

Solving Equations with Rational Numbers

Main IDEA

Solve equations involving rational numbers.



Standard 7AF1.1

Use variables and appropriate operations to write an expression, an equation, an inequality, or a system of equations or inequalities that represents a verbal descriptor (e.g. three less than a number, half as large as an area A).

Standard 7NS1.2 Add, subtract, multiply, and divide rational numbers (integers, fractions, and terminating decimals) and take positive rational numbers to whole-number powers.

REVIEW Vocabulary

equation a mathematical sentence that contains an equals sign (Lesson 1-8)

GET READY for the Lesson

BIOLOGY An elephant, which can run at a speed of 25 miles per hour, runs $\frac{5}{6}$ as fast as a grizzly bear. If s represents the speed of a grizzly bear, you can write the equation $25 = \frac{5}{6}s$.



1. Multiply each side of the equation by 6. Then divide each side by 5. Write the result.
2. Multiply each side of the original equation by the multiplicative inverse of $\frac{5}{6}$. Write the result.
3. What is the speed of a grizzly bear?
4. Which method of solving the equation seems most efficient?

You have used properties of equality to solve equations with integers. The same properties can also be used to solve equations with rational numbers.

EXAMPLES

Solve by Using Addition or Subtraction

1 Solve $p - 7.36 = 2.84$.

$$p - 7.36 = 2.84$$

Write the equation.

$$p - 7.36 + 7.36 = 2.84 + 7.36$$

Add 7.36 to each side.

$$p = 10.2$$

Simplify.

2 Solve $\frac{1}{2} = t + \frac{3}{4}$.

$$\frac{1}{2} = t + \frac{3}{4}$$

Write the equation.

$$\frac{1}{2} - \frac{3}{4} = t + \frac{3}{4} - \frac{3}{4}$$

Subtract $\frac{3}{4}$ from each side.

$$\frac{1}{2} - \frac{3}{4} = t$$

Simplify.

$$\frac{2}{4} - \frac{3}{4} = t$$

Rename $\frac{1}{2}$.

$$-\frac{1}{4} = t$$

Simplify.



CHECK Your Progress

Solve each equation. Check your solution.

a. $t - 7.81 = 4.32$

b. $y + \frac{2}{5} = -\frac{1}{2}$

c. $1\frac{5}{6} = 2\frac{1}{3} + a$

EXAMPLES

Solve by Using Multiplication or Division

- 3** Solve $\frac{4}{7}b = 16$. Check your solution.

$$\frac{4}{7}b = 16$$

Write the equation.

$$\frac{7}{4}\left(\frac{4}{7}b\right) = \frac{7}{4}(16)$$

Multiply each side by $\frac{7}{4}$, the reciprocal of $\frac{4}{7}$.

$$b = 28$$

Simplify. Check the solution.

- 4** Solve $58.4 = -7.3m$. Check your solution.

$$58.4 = -7.3m$$

Write the equation.

$$\frac{58.4}{-7.3} = \frac{-7.3m}{-7.3}$$

Divide each side by -7.3 .

$$-8 = m$$

Simplify. Check the solution.



CHECK Your Progress

Solve each equation. Check your solution.

d. $-12 = \frac{4}{5}r$

e. $-\frac{2}{3}n = -\frac{3}{5}$

f. $7.2v = -36$



Real-World EXAMPLE

- 5 BASKETBALL** Suppose that during her last game, Sue Bird made 12 field goals, which were $\frac{3}{4}$ of her field goal attempts. Write and solve an equation to determine her number of field goal attempts that game.

Words

$\frac{3}{4}$ of field goal attempts is 12.

Variable

Let g represent field goal attempts.

Equation

$$\frac{3}{4}g = 12$$

$$\frac{3}{4}g = 12$$

Write the equation.

$$\frac{4}{3}\left(\frac{3}{4}g\right) = \frac{4}{3}(12)$$

Multiply each side by $\frac{4}{3}$, the reciprocal of $\frac{3}{4}$.

$$g = 16$$

Simplify.

Sue Bird had 16 field goal attempts.



CHECK Your Progress

- g. **COMMUNICATION** Larissa pays \$0.25 per minute for long distance calls on her cell phone. Her long distance charge last month was \$5. Write and solve an equation that could be used to determine the number of minutes she used to make long distance calls.



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CHECK Your Understanding

Solve each equation. Check your solution.

Examples 1, 2
(p. 119)

1. $t + 0.25 = -4.12$

2. $v - 8.34 = -3.77$

3. $a - \frac{3}{4} = -\frac{3}{8}$

4. $c + \frac{5}{8} = -1\frac{9}{16}$

Examples 3, 4
(p. 120)

5. $-45 = \frac{5}{6}d$

6. $-\frac{7}{10}n = 18$

7. $-26.5 = -5.3w$

8. $2.6x = 22.75$

Example 5
(p. 120)

9. **SPACE** The planet Jupiter takes 11.9 Earth years to make one revolution around the Sun. Write and solve a multiplication equation to determine the number of revolutions Jupiter makes in 59.5 Earth years.

Exercises

HOMEWORK HELP

For Exercises	See Examples
10–15	1, 2
16–21	3, 4
22, 23	5

Solve each equation. Check your solution.

10. $q + 0.45 = 1.29$

11. $a - 1.72 = 5.81$

12. $-\frac{1}{2} = m - \frac{2}{3}$

13. $-\frac{5}{9} = f + \frac{1}{3}$

14. $g - (-1.5) = 2.35$

15. $-1.3 = n - (-6.12)$

16. $-\frac{4}{7}b = 16$

17. $-\frac{2}{9}p = -8$

18. $-1.92 = -0.32s$

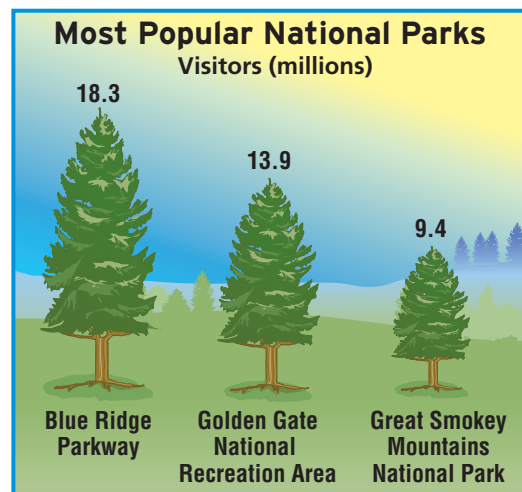
19. $-8.4 = 1.2t$

20. $\frac{t}{3.2} = -4.5$

21. $\frac{h}{-5.75} = -2.2$

22. **MONEY** The currency of Egypt is called a pound. One U.S. dollar is equal to $3\frac{3}{4}$ Egyptian pounds. Write and solve a multiplication equation to find the number of U.S. dollars that would equal 21 Egyptian pounds.

23. **RECREATION** Refer to the graphic. Write and solve an addition equation to determine the number of visitors v that the Golden Gate National Recreation Area needs to equal the number of visitors to the Blue Ridge Parkway.



Solve each equation. Check your solution.

24. $3.5g = -\frac{7}{8}$

25. $-7.5r = -3\frac{1}{3}$

26. $4\frac{1}{6} = -3.\bar{3}c$

27. $-4.2 = \frac{x}{7}$



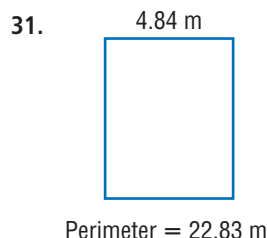
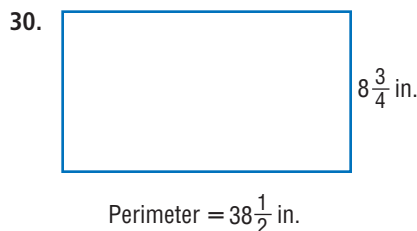
Real-World Link

As of 2006, Ben Roethlisberger held the record as the youngest quarterback to win the Super Bowl.

Source: nfl.com

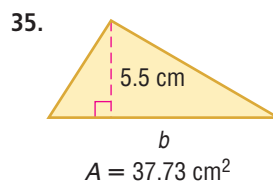
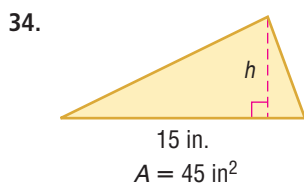
28. **FOOTBALL** In his rookie season, Ben Roethlisberger completed 196 passes with a season pass-completion rate of 0.664. Write and solve an equation to determine the number of passes Ben Roethlisberger attempted during his rookie season.
29. **COMPUTERS** Stephan's CD recorder can write 5.3 megabytes of data per second. If he uses a CD with a 700 megabyte capacity, how long will it take to record the entire CD?

MEASUREMENT Find the area of each rectangle.



32. **TRAVEL** Mr. Harris filled the gas tank of his car. Gasoline cost \$2.95 per gallon, and Mr. Harris spent a total of \$39.53. If his car can travel 32.5 miles per gallon of gasoline, how far can he travel with the gasoline he just purchased?
33. **MEASUREMENT** Andy has a board that he is going to use to make shelves for a craft fair. The board is 108 inches long. If each shelf is $9\frac{5}{8}$ inches long, write and solve an equation to find how many shelves he can make using this board.

MEASUREMENT Find the missing measure in each triangle.



EXTRAPRACTICE

See pages 681, 709.

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H.O.T. Problems

36. **OPEN ENDED** Write an equation with rational numbers that has a solution of $\frac{1}{4}$.
37. **Which One Doesn't Belong?** Identify the expression that does not have the same value as the other three. Explain your reasoning.

$$\frac{4}{3}\left(\frac{3}{4}x\right)$$

$$-\frac{3}{2}\left(-\frac{2}{3}x\right)$$

$$2\left(\frac{1}{2}x\right)$$

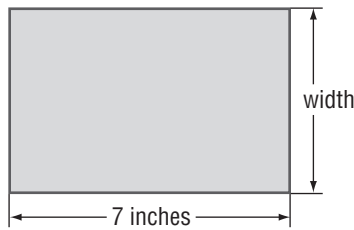
$$-\frac{1}{3}\left(\frac{1}{3}x\right)$$

38. **CHALLENGE** During a clearance sale, sweaters were marked at $\frac{1}{4}$ the original price. Patrice had a coupon for $\frac{1}{3}$ off the marked price of any sweater. If Patrice paid \$24 for a sweater, what was the original price of the sweater?
39. **WRITING IN MATH** Explain how to solve $-\frac{2}{3}x = 14$ using properties of equality. Use the term *multiplicative inverse* in your explanation.



STANDARDS PRACTICE

40. If the area of the rectangle is $22\frac{3}{4}$ square inches, what is the width of the rectangle?



- A $\frac{4}{13}$ in.
 B $2\frac{1}{2}$ in.
 C $3\frac{1}{4}$ in.
 D $3\frac{3}{4}$ in.

41. The difference of a number x and 2.3 is 1.8. Which equation shows this relationship?

F $x + 2.3 = 1.8$

G $x - 2.3 = 1.8$

H $\frac{x}{2.3} = 1.8$

J $x - 1.8 = 2.3$

42. If $a = 6$ and $b = 4$, then $5a - ab =$

A 6

B 24

C 30

D 54

Spiral Review

Add or subtract. Write in simplest form. (Lesson 2-6)

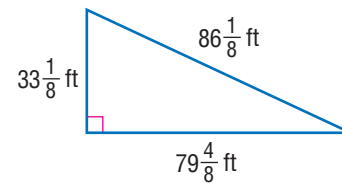
43. $\frac{1}{6} + \frac{1}{7}$

44. $\frac{7}{8} - \frac{1}{6}$

45. $-5\frac{1}{2} - 6\frac{4}{5}$

46. $2\frac{1}{2} + 5\frac{2}{3}$

47. **GEOMETRY** Find the perimeter of the triangle.
 (Lesson 2-5)



48. **VEGETABLES** Hudson purchased $3\frac{2}{5}$ pounds of vegetables that cost \$3 per pound. What was the total cost of the vegetables? (Lesson 2-3)

49. **ALGEBRA** The sum of two integers is 13. One of the integers is -5 . Write and solve an equation to find the other integer. (Lesson 1-9)

Add. (Lesson 1-4)

50. $-48 + 13 + (-16)$

51. $35 + 17 + (-25)$

52. $-50 + (-62) + 3$

53. $27 + (-30) + (-26)$

GET READY for the Next Lesson

54. **PREREQUISITE SKILL** Kishi wants to buy a digital music player that costs \$250 with tax. So far, she has saved \$120. If she saves \$15 each week, in how many weeks will she be able to purchase the digital music player? Use the *four-step plan*. (Lesson 1-1)



2-8

Problem-Solving Investigation

MAIN IDEA: Look for a pattern to solve problems.



Standard 7MR2.4 Make and test conjectures by using both inductive and deductive reasoning.

Standard 7NS1.2 Add, subtract, multiply, and divide rational numbers (integers, fractions, and terminating decimals) and take positive rational numbers to whole-number powers.

P.S.I. TEAM +

e-Mail: LOOK FOR A PATTERN

YOUR MISSION: Look for a pattern to solve the problem.

THE PROBLEM: How many bounces occurred before Terry's ball reached a height less than 1 inch?

TERRY: In science class, I dropped a ball from 48 inches above the ground. After the first, second, third, and fourth bounces, the ball reached heights of 24, 12, 6, and 3 inches, respectively.



EXPLORE	You know the original height of the ball and the heights after the first 4 bounces. You want to know the number of bounces before the ball reached a height less than 1 inch.														
PLAN	Look for a pattern in the heights. Then continue the pattern to find when the ball's height was less than 1 inch.														
SOLVE	<table><tr><td>Bounce</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td></tr><tr><td>Height (in.)</td><td>24</td><td>12</td><td>6</td><td>3</td><td>$1\frac{1}{2}$</td><td>$\frac{3}{4}$</td></tr></table> After the sixth bounce, the ball reached a height less than 1 inch.	Bounce	1	2	3	4	5	6	Height (in.)	24	12	6	3	$1\frac{1}{2}$	$\frac{3}{4}$
Bounce	1	2	3	4	5	6									
Height (in.)	24	12	6	3	$1\frac{1}{2}$	$\frac{3}{4}$									
CHECK	Check your pattern to make sure the answer is correct.														

Analyze The Strategy

- Describe how to continue the pattern in the second row. Find the fraction of the height after 7 bounces.
- WRITING IN MATH** Write a problem that can be solved by finding a pattern. Describe a pattern.

Mixed Problem Solving

For Exercises 3–5, look for a pattern. Then use the pattern to solve the problem.

- MUSIC** The names of musical notes form a pattern. Name the next three notes in the following pattern: whole note, half note, quarter note.
- GEOMETRY** Draw the next two figures in the pattern.



- MUSEUMS** A science museum offers discount passes for group admission. If this pattern continues, how many people would be admitted if a group buys 31 passes?

Passes	People Admitted
2	3
5	7
7	10
12	18

Use any strategy to solve Exercises 6–10. Some strategies are shown below.

PROBLEM-SOLVING STRATEGIES

- Use the four-step plan.
- Look for a pattern.

- GEOMETRY** Find the perimeters of the next two figures in the pattern. The length of each side of a triangle is 4 meters.



- MONEY** To attend the class trip, each student will have to pay \$7.50 for transportation, and \$5.00 for food. If there are 360 students in the class, how much money will need to be collected for the trip?

- TRAVEL** Rafael is taking a vacation. His plane is scheduled to leave at 2:20 P.M. He must arrive at the airport at least 2 hours before his flight. It will take him 45 minutes to drive from his house to the airport. When is the latest he should plan to leave his house for the airport?
- WATER MANAGEMENT** A tank is draining at a rate of 8 gallons every 3 minutes. If there are 70 gallons in the tank, when will the tank have just 22 gallons left?
- THEATER** A theater is designed with 12 seats in the first row, 17 seats in the second row, 22 seats in the third row, and so on. How many seats are in the ninth row?

Select the Operation

For Exercises 11–13, select the appropriate operation(s) to solve the problem. Justify your selection(s) and solve the problem.

- INSECTS** The longest insect in the world is the stick insect whose length reaches 15 inches. The smallest insect is the fairy fly whose length is only 0.01 inch. How many times longer is the stick insect than the fairy fly?
- ANALYZE TABLES** In computer terminology, a bit is the smallest unit of data. A byte is equal to 8 bits. The table below gives the equivalences for several units of data.

Unit of Data	Equivalence
1 byte	8 bits
1 kilobyte (kB)	1,024 bytes
1 megabyte (MB)	1,024 kilobytes
1 gigabyte (GB)	1,024 megabytes

How many bits are in 1 MB?

- PIZZA** Lola is planning a party. She plans to order 4 pizzas, which cost \$12.75 each. If she has a coupon for \$1.50 off each pizza, find the total cost of the pizzas.

Main IDEA

Use powers and exponents in expressions.



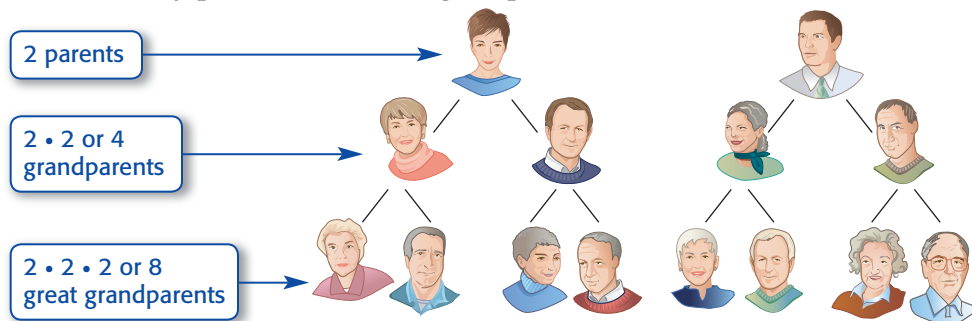
Standard 7NS1.2 Add, subtract, multiply, and divide rational numbers (integers, fractions, and terminating decimals) and **take positive rational numbers to whole-number powers.**

Standard 7NS2.1 Understand negative whole-number exponents. Multiply and divide expressions involving exponents with a common base.

Standard 7AF2.1 Interpret positive whole-number powers as repeated multiplication and negative whole-number powers as repeated division or multiplication by the multiplicative inverse. Simplify and evaluate expressions that include exponents.

GET READY for the Lesson

FAMILY Every person has 2 biological parents.



1. How many 2s are multiplied to determine the number of great grandparents? great-great grandparents?

A product of repeated factors can be expressed as a **power**, that is, using an exponent and a base.

4 common factors

$$2 \cdot 2 \cdot 2 \cdot 2 = 2^4$$

The **base** is the common factor.

The **exponent** tells how many times the base is used as a factor.

NEW Vocabulary

power
base
exponent

EXAMPLES

Write Expressions Using Powers

Write each expression using exponents.

- 1 $\frac{1}{2} \cdot \frac{1}{2} \cdot \frac{1}{2} \cdot 3 \cdot 3 \cdot 3 \cdot 3$
 $\frac{1}{2} \cdot \frac{1}{2} \cdot \frac{1}{2} \cdot 3 \cdot 3 \cdot 3 \cdot 3 = \left(\frac{1}{2} \cdot \frac{1}{2} \cdot \frac{1}{2}\right) \cdot (3 \cdot 3 \cdot 3 \cdot 3)$ Associative Property
 $= \left(\frac{1}{2}\right)^3 \cdot 3^4$ Definition of exponents
- 2 $a \cdot b \cdot b \cdot a \cdot b$
 $a \cdot b \cdot b \cdot a \cdot b = a \cdot a \cdot b \cdot b \cdot b$ Commutative Property
 $= (a \cdot a) \cdot (b \cdot b \cdot b)$ Associative Property
 $= a^2 \cdot b^3$ Definition of exponents

CHECK Your Progress

Write each expression using exponents.

- a. $\frac{2}{3} \cdot 7 \cdot \frac{2}{3} \cdot \frac{2}{3} \cdot 7 \cdot \frac{2}{3}$ b. $m \cdot m \cdot n \cdot n \cdot n \cdot m$ c. $3 \cdot a \cdot b \cdot 2 \cdot 3 \cdot a$



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STUDY TIP

Negative Exponents

Remember that 10^{-2} equals $\frac{1}{10^2}$,
not -100 or -20 .

You can also use powers to name numbers that are less than 1. Consider the pattern in the powers of 10.

Negative powers are the result of repeated division.

Exponential Form	Standard Form
10^3	1,000
10^2	100
10^1	10
10^0	1
10^{-1}	$\frac{1}{10}$
10^{-2}	$\frac{1}{100}$

$$\begin{aligned} 1,000 \div 10 &= 100 \\ 100 \div 10 &= 10 \\ 10 \div 10 &= 1 \\ 1 \div 10 &= \frac{1}{10} \text{ or } \frac{1}{10^1} \\ \frac{1}{10} \div 10 &= \frac{1}{100} \text{ or } \frac{1}{10^2} \end{aligned}$$

The pattern suggests the following definition for zero exponents and negative exponents.

KEY CONCEPT

Zero and Negative Exponents

Words

Any nonzero number to the zero power is 1. Any nonzero number to the negative n power is the multiplicative inverse of the n th power.

Examples

Numbers

$$\begin{aligned} 5^0 &= 1 \\ 7^{-3} &= \frac{1}{7} \cdot \frac{1}{7} \cdot \frac{1}{7} \text{ or } \frac{1}{7^3} \end{aligned}$$

Algebra

$$\begin{aligned} x^0 &= 1, x \neq 0 \\ x^{-n} &= \frac{1}{x^n}, x \neq 0 \end{aligned}$$

REVIEW Vocabulary

evaluate to find the value of an expression (Lesson 1-2)

EXAMPLES

Evaluate Powers

3 Evaluate $\left(\frac{2}{3}\right)^4$.

$$\begin{aligned} \left(\frac{2}{3}\right)^4 &= \frac{2}{3} \cdot \frac{2}{3} \cdot \frac{2}{3} \cdot \frac{2}{3} \\ &= \frac{16}{81} \end{aligned}$$

Write the power as a product.

Multiply.

4 Evaluate 4^{-3} .

$$\begin{aligned} 4^{-3} &= \frac{1}{4^3} \\ &= \frac{1}{64} \end{aligned}$$

Write the power using a positive exponent.

$$4^3 = 4 \cdot 4 \cdot 4 \text{ or } 64$$

5 ALGEBRA Evaluate $a^2 \cdot b^4$ if $a = 3$ and $b = 5$.

$$a^2 \cdot b^4 = 3^2 \cdot 5^4$$

Replace a with 3 and b with 5.

$$= (3 \cdot 3) \cdot (5 \cdot 5 \cdot 5 \cdot 5)$$

Write the powers as products.

$$= 9 \cdot 625 \text{ or } 5,625$$

Multiply.

CHECK Your Progress

Evaluate each expression.

d. $\left(\frac{1}{15}\right)^3$

e. 5^{-4}

f. $c^3 \cdot d^2$ if $c = -4$ and $d = 9$



CHECK Your Understanding

Example 1
(p. 126)

Write each expression using exponents.

1. $2 \cdot 2 \cdot 2 \cdot 3 \cdot 3 \cdot 3$ 2. $r \cdot s \cdot r \cdot r \cdot s \cdot s \cdot r \cdot r$ 3. $\frac{1}{2} \cdot p \cdot k \cdot \frac{1}{2} \cdot p \cdot p \cdot k$

Examples 2, 3
(pp. 126–127)

Evaluate each expression.

4. 2^6 5. $\left(\frac{1}{7}\right)^3$
6. 6^{-3} 7. 3^{-5}

Example 4
(p. 127)

8. **EARTH SCIENCE** There are approximately 10^{21} kilograms of water on Earth. This includes oceans, rivers, lakes, ice caps, and water vapor in the atmosphere. Evaluate 10^{21} .

9. **ALGEBRA** Evaluate $x^2 \cdot y^4$ if $x = 2$ and $y = 10$.

Exercises

HOMEWORK HELP

For Exercises	See Examples
10–15	1
16–23	2–3
24–27	4

Write each expression using exponents.

10. $8 \cdot 8 \cdot a$ 11. $5 \cdot q \cdot 3 \cdot q \cdot q \cdot 3$
12. $m \cdot \frac{1}{4} \cdot p \cdot m \cdot \frac{1}{4}$ 13. $d \cdot 2 \cdot 2 \cdot d \cdot k \cdot d \cdot k$
14. $2 \cdot 7 \cdot a \cdot 9 \cdot b \cdot a \cdot 7 \cdot b \cdot 9 \cdot b \cdot a$ 15. $x \cdot \frac{1}{6} \cdot y \cdot y \cdot \frac{1}{6} \cdot 5 \cdot y \cdot 5 \cdot x \cdot \frac{1}{6} \cdot y \cdot y$

Evaluate each expression.

16. 2^3 17. $\left(\frac{1}{3}\right)^4$ 18. $3^3 \cdot 4^2$ 19. $3^2 \cdot \left(\frac{1}{5}\right)^2$
20. 5^{-4} 21. 9^{-3} 22. 7^{-2} 23. 4^{-3}

ALGEBRA Evaluate each expression.

24. $g^5 \cdot h$, if $g = 2$ and $h = 7$ 25. $x^3 \cdot y^4$, if $x = 1$ and $y = 3$
26. $a^2 \cdot m^6$, if $a = \frac{1}{2}$ and $m = 2$ 27. $k^4 \cdot d$, if $k = 3$ and $d = \frac{5}{6}$

ASTRONOMY For Exercises 28–31, refer to the information at the right.

28. How many stars can be seen with unaided eyes in an urban area?

29. How many stars can be seen with unaided eyes in a rural area?

30. How many stars can be seen with binoculars?

31. How many stars can be seen with a small telescope?

How Many Stars Can You See?

Unaided Eye in Urban Area	$3 \cdot 10^2$ stars
Unaided Eye in Rural Area	$2 \cdot 10^3$ stars
With Binoculars	$3 \cdot 10^4$ stars
With Small Telescope	$2 \cdot 10^6$ stars

Source: Kids Discover

EXTRA PRACTICE

See pages 682, 709.

Math online

Self-Check Quiz at
ca.gr7math.com

Evaluate each expression.

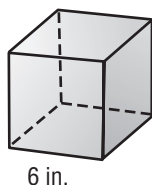
32. $5 \cdot 2^3 \cdot 7^2$ 33. $2^2 \cdot 7 \cdot 10^4$ 34. $2^3 \cdot 7^{-2}$
35. $5^{-2} \cdot 2^{-7}$ 36. $4 \cdot 2^5 \cdot 5^{-3}$ 37. $3^{-2} \cdot 5 \cdot 7^{-3}$
38. $\frac{3^3 \cdot 10^2}{3^2 \cdot 10^4}$ 39. $\frac{4^2 \cdot 3^5 \cdot 2^4}{4^3 \cdot 3^5 \cdot 2^2}$ 40. $(0.2)^3 \cdot \left(\frac{1}{2}\right)^4$

**H.O.T. Problems**

41. **NUMBER SENSE** Without evaluating the powers, order 6^{-3} , 6^2 , and 6^0 from least to greatest. Explain your reasoning.
42. **CHALLENGE** Complete the following pattern.
 $3^4 = 81$, $3^3 = 27$, $3^2 = 9$, $3^1 = 3$, $3^0 = \square$, $3^{-1} = \square$, $3^{-2} = \square$, $3^{-3} = \square$
43. **OPEN ENDED** Write an expression with a negative exponent whose value is between 0 and $\frac{1}{2}$.
44. **CHALLENGE** Select several fractions between 0 and 1. Find the values of each fraction after it is raised to the -1 power. Explain the relationship between the -1 power and the original fraction.
45. **WRITING IN MATH** Explain the difference between the expressions $(-4)^2$ and 4^{-2} .

**STANDARDS PRACTICE**

46. To find the volume of a cube, multiply its length, its width, and its depth.



What is the volume of the cube expressed as a power?

- A 6^2 C 6^4
 B 6^3 D 6^6

47. Which is equivalent to $2^3 \cdot 3^4$?

- F $3 \cdot 3 \cdot 4 \cdot 4 \cdot 4$
 G $2 \cdot 2 \cdot 2 \cdot 3 \cdot 3 \cdot 3 \cdot 3$
 H $2 \cdot 2 \cdot 2 \cdot 3 \cdot 3 \cdot 3$
 J $6 \cdot 12$

48. $\left(\frac{3}{4}\right)^3 =$

- A $\frac{9}{12}$ C $\frac{9}{64}$
 B $\frac{9}{16}$ D $\frac{27}{64}$

Spiral Review

49. **BICYCLING** The table shows the relationship between the time Melody rides her bike and the distance that she rides. If she continues riding at the same rate, how far will she ride in 1 hour? Use the *look for a pattern* strategy. (Lesson 2-8)

Time (min)	Distance (mi)
5	1
15	3
25	5

50. **FOOD** Suppose hamburgers are cut in squares that are $2\frac{1}{2}$ inches on a side. Write and solve a multiplication equation to determine how many hamburgers can fit across a grill that is 30 inches wide. (Lesson 2-7)

GET READY for the Next Lesson

PREREQUISITE SKILL Write each number.

51. two million 52. three hundred twenty 53. twenty-six hundred

Main IDEA

Express numbers in scientific notation.

**Standard 7NS1.1**

Read, write, and compare rational numbers in scientific notation (positive and negative powers of 10), compare rational numbers in general.

MINI Lab

1. Copy and complete each table below.

Expression	Product
$8.7 \times 10^1 = 8.7 \times 10$	87
$8.7 \times 10^2 = 8.7 \times 100$	
$8.7 \times 10^3 = 8.7 \times$	

Expression	Product
$8.7 \times 10^{-1} = 8.7 \times \frac{1}{10}$	0.87
$8.7 \times 10^{-2} = 8.7 \times \frac{1}{100}$	
$8.7 \times 10^{-3} = 8.7 \times$	

2. If 8.7 is multiplied by a positive power of 10, what relationship exists between the decimal point's new position and the exponent?
3. When 8.7 is multiplied by a negative power of 10, how does the new position of the decimal point relate to the negative exponent?

NEW Vocabulary

scientific notation

Scientific notation is a compact way of writing numbers whose absolute value is very large or very small.

factor greater than or equal to 1, but less than 10

$$8.7 \times 10^{-4}$$

power of 10 written in exponential form

If the number is negative, a negative sign precedes it.

KEY CONCEPT**Scientific Notation to Standard Form**

- Multiplying by a positive power of 10 moves the decimal point right.
- Multiplying by a negative power of 10 moves the decimal point left.
- The number of places the decimal point moves is the absolute value of the exponent.

STUDY TIP**Negative Exponents**

Negative exponents represent repeated division. So, multiplying by a negative exponent is the same as dividing.

EXAMPLES**Express Numbers in Standard Form**

- 1 Write 5.34×10^4 in standard form.

$$5.34 \times 10^4 = \underline{53,400.}$$

The decimal point moves 4 places right.

- 2 Write -3.27×10^{-3} in standard form.

$$-3.27 \times 10^{-3} = \underline{-0.00327}$$

The decimal point moves 3 places left.

**CHECK Your Progress**

Write each number in standard form.

a. 7.42×10^5

b. -6.1×10^{-2}

c. 3.714×10^2



KEY CONCEPT

Standard Form to Scientific Notation

To write a number in scientific notation, follow these steps.

1. Move the decimal point to the right of the first nonzero digit.
2. Count the number of places you moved the decimal point.
3. Find the power of 10. If the absolute value of the original number was between 0 and 1, the exponent is negative. Otherwise, the exponent is positive.

EXAMPLES

Write Numbers in Scientific Notation

- 3** Write $-3,725,000$ in scientific notation.

$$\begin{aligned} -3,725,000 &= -3.725 \times 1,000,000 && \text{The decimal point moves 6 places.} \\ &= -3.725 \times 10^6 && \text{Since } 3,725,000 > 1, \text{ the exponent is positive.} \end{aligned}$$

- 4** Write 0.000316 in scientific notation.

$$\begin{aligned} 0.000316 &= 3.16 \times 0.0001 && \text{The decimal point moves 4 places.} \\ &= 3.16 \times 10^{-4} && \text{Since } 0 < 0.000316 < 1, \text{ the exponent is negative.} \end{aligned}$$



CHECK Your Progress

Write each number in scientific notation.

d. $-14,140,000$

e. 0.00876

f. 0.114

Top U.S. Cities Visited by Overseas Travelers	
U.S. City	Number of Arrivals
Boston	7.21×10^5
Las Vegas	1.3×10^6
Los Angeles	2.2×10^6
Metro DC area	9.01×10^5
New York	4.0×10^6
Orlando	1.8×10^6
San Francisco	1.6×10^6



Real-World Link

The table lists seven of the top U.S. cities visited by overseas travelers in a recent year.

Source: infoplease.com



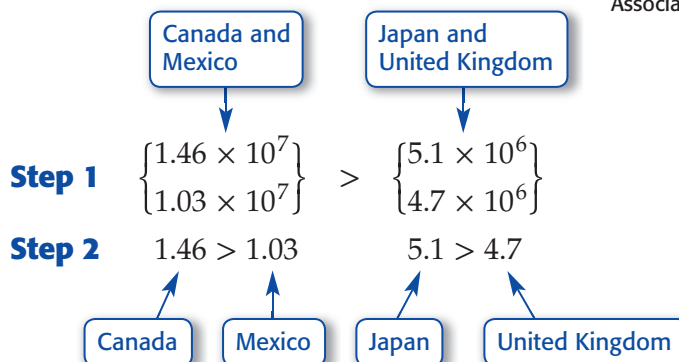
Real-World EXAMPLE

- 5 TRAVEL** Refer to the table at the right. Order the countries according to the number of visitors from greatest to least.

Order the expressions according to their exponents. Then order expressions with the same exponents by comparing their decimal factors.

International Visitors in the U.S.A.	
Country	Number of Visitors
Canada	1.46×10^7
Japan	5.1×10^6
Mexico	1.03×10^7
United Kingdom	4.7×10^6

Source: International Trade Association



CHECK Your Progress

- g. **TRAVEL** Refer to the information at the left. Order the cities according to the number of arrivals from least to greatest.



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CHECK Your Understanding

Examples 1, 2
(p. 130)

Write each number in standard form.

1. 7.32×10^4

2. -9.931×10^5

3. 4.55×10^{-1}

4. 6.02×10^{-4}

Examples 3, 4
(p. 131)

Write each number in scientific notation.

5. 277,000

6. 8,785,000,000

7. -0.00004955

8. 0.524

Example 5
(p. 131)

9. **BASEBALL** The table at the right lists four Major League Ballparks. List the ballparks from least to greatest capacity.

Ballpark	Team	Capacity
H. H. H. Metrodome	Minnesota Twins	4.8×10^4
Network Associates Coliseum	Oakland Athletics	4.7×10^4
The Ballpark in Arlington	Texas Rangers	4.9×10^4
Wrigley Field	Chicago Cubs	3.9×10^4

Source: www.users.bestweb.net

Exercises

HOMEWORK HELP

For Exercises	See Examples
10–13	1
14–17	2
18–21	3
22–25	4
26–29	5

Write each number in standard form.

10. 2.08×10^2

11. 3.16×10^3

12. 7.113×10^7

13. -4.265×10^6

14. 7.8×10^{-3}

15. -1.1×10^{-4}

16. 8.73×10^{-4}

17. 2.52×10^{-5}

Write each number in scientific notation.

18. 6,700

19. 43,000

20. $-52,300,000$

21. 147,000,000

22. 0.037

23. -0.0072

24. 0.00000707

25. 0.0000901

26. **CHEMISTRY** The table shows the mass in grams of one atom of each of several elements. List the elements in order from the least mass to greatest mass per atom.

Element	Mass per Atom
Carbon	1.995×10^{-23} g
Gold	3.272×10^{-22} g
Hydrogen	1.674×10^{-24} g
Oxygen	2.658×10^{-23} g
Silver	1.792×10^{-22} g

Source: Chemistry: Concepts and Applications

27. **GEOGRAPHY** The areas of the Great Lakes are listed in the table. Order the lakes according to their area from least to greatest.

Great Lake	Area (mi ²)
Erie	9.91×10^3
Huron	2.3×10^4
Michigan	2.23×10^4
Ontario	7.32×10^3
Superior	3.17×10^4

Source: World Book

Arrange these numbers in increasing order.

28. 216,000,000, 2.2×10^3 , 3.1×10^7 , 310,000

29. -4.56×10^{-3} , 4.56×10^2 , -4.56×10^2 , 4.56×10^{-2}



EXTRA PRACTICE
See pages 682, 709.
Math Online
Self-Check Quiz at
ca.gr7math.com

H.O.T. Problems

30. **HEALTH** The diameter of a red blood cell is about 7.4×10^{-4} centimeter. Write this number using standard form.
31. **MEASUREMENT** The smallest unit of time is the *yoctosecond*, which equals 0.000000000000000000000001 second. Write this number in scientific notation.
32. **SPACE** The temperature of the Sun varies from $10,900^{\circ}\text{F}$ on the surface to 27 billion $^{\circ}\text{F}$ at its core. Write these temperatures in scientific notation.
33. **DINOSAURS** The *giganotosaurus* weighed about 1.6×10^4 pounds. The *microceratops* weighed about 1.1×10^1 . How many times heavier was the *giganotosaurus* than the *microceratops*? Write your answer in standard form. Round to the nearest tenth.
34. **NUMBER SENSE** Determine whether 1.2×10^5 or 1.2×10^6 is closer to one million. Explain.
35. **CHALLENGE** Compute and express each value in scientific notation.
- a. $\frac{(130,000)(0.0057)}{0.0004}$ b. $\frac{(90,000)(0.0016)}{(200,000)(30,000)(0.00012)}$
36. **WRITING IN MATH** Determine whether a decimal times a power of 10 is *sometimes*, *always*, or *never* expressed in scientific notation. Explain.



STANDARDS PRACTICE

37. Which shows 0.0000035 in scientific notation?
- A 3.5×10^6
B 3.5×10^5
C 3.5×10^{-5}
D 3.5×10^{-6}
38. The average width of a strand of a spider web is 7.0×10^{-6} meter. Which expression represents this number in standard form?
- F 7,000,000 m
G 700,000 m
H 0.00007 m
J 0.000007 m

Spiral Review

39. **ALGEBRA** Evaluate $a^5 \cdot b^2$ if $a = 2$ and $b = 3$. (Lesson 2-9)

ALGEBRA Solve each equation. Check your solution. (Lesson 2-7)

40. $t + 3\frac{1}{3} = 2\frac{1}{2}$ 41. $-\frac{2}{3}y = 14$ 42. $\frac{p}{1.3} = 2.4$ 43. $-1\frac{3}{4} = n - 4\frac{1}{6}$

44. **LANGUAGE** There are about one billion people who speak Mandarin. This is 492 million more than those who speak English. How many speak English? (Lesson 1-1)

Study Guide and Review



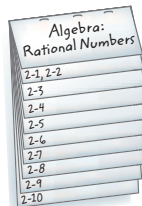
Download Vocabulary Review from ca.gr7math.com

FOLDABLES

Study Organizer

GET READY to Study

Be sure the following Key Concepts are noted in your Foldable.



Key Concepts

Rational Numbers (Lesson 2-1)

- A rational number is any number that can be expressed in the form $\frac{a}{b}$, where a and b are integers and $b \neq 0$.

Multiplying and Dividing Fractions

(Lessons 2-3 and 2-4)

- To multiply fractions, multiply the numerators and multiply the denominators.
- To divide by a fraction, multiply by its multiplicative inverse.

Adding and Subtracting Fractions

(Lessons 2-5 and 2-6)

- To add or subtract fractions, rename the fractions using the least common denominator. Then add or subtract and simplify, if necessary.

Powers and Scientific Notation

(Lessons 2-9 and 2-10)

- A number is expressed in scientific notation when it is written as the product of a factor and a power of 10. The factor must be greater than or equal to 1 and less than 10.

Key Vocabulary

bar notation (p. 85)	power (p. 126)
base (p. 126)	rational number (p. 84)
dimensional analysis (p. 98)	reciprocals (p. 102)
exponent (p. 126)	repeating decimal (p. 85)
like fraction (p. 108)	scientific notation (p. 130)
multiplicative inverses (p. 102)	terminating decimal (p. 85)
	unlike fraction (p. 114)

Vocabulary Check

State whether each sentence is *true* or *false*. If *false*, replace the underlined word or number to make a true sentence.

- Like fractions have the same denominator.
- The number that is expressed using an exponent is a rational number.
- Dimensional analysis is the process of including units of measurement in computation.
- The number $0.\overline{3}$ is a repeating decimal.
- Numbers that can be written as fractions are called reciprocals.
- The number 4.05×10^8 is written in bar notation.
- The number 2.75 is a terminating decimal.
- The base tells how many times a number is used as a factor.
- Two numbers whose product is 1 are multiplicative inverses of each other.
- The number 5^4 is a power.

Lesson-by-Lesson Review

2-1 Rational Numbers (pp. 84–89)

Write each fraction or mixed number as a decimal.

11. $1\frac{1}{3}$

12. $-\frac{5}{8}$

13. $-2\frac{3}{10}$

14. $\frac{5}{9}$

Write each decimal as a fraction or mixed number in simplest form.

15. 0.3

16. -7.14

17. $4.\overline{3}$

18. $-5.\overline{7}$

19. **HISTORY** Thirteen of the 50 states in the United States were the original colonies. Write this fraction as a decimal.

20. **BIOLOGY** The average rate of human hair growth is about 0.4 inch per month. Write this decimal as a fraction in simplest form.

Example 1 Write $\frac{3}{5}$ as a decimal.

$\frac{3}{5}$ means $3 \div 5$.

$$\begin{array}{r} 0.6 \\ 5 \overline{)3.0} \\ \underline{-3\ 0} \\ 0 \end{array}$$

The fraction $\frac{3}{5}$ can be written as 0.6.

Example 2 Write 0.28 as a fraction in simplest form.

$$\begin{aligned} 0.28 &= \frac{28}{100} && \text{0.28 is 28 hundredths.} \\ &= \frac{7}{25} && \text{Simplify.} \end{aligned}$$

The decimal 0.28 can be written as $\frac{7}{25}$.

2-2 Comparing and Ordering Rational Numbers (pp. 91–95)

Replace each $\bullet$ with $<$, $>$, or $=$ to make a true sentence.

21. $\frac{2}{3} \bullet \frac{8}{9}$

22. $-0.\overline{24} \bullet -\frac{8}{33}$

23. $-\frac{1}{2} \bullet -\frac{55}{110}$

24. $\frac{5}{6} \bullet \frac{3}{4}$

25. Order $-\frac{1}{2}$, 0.75, $-\frac{3}{4}$, 0 from least to greatest.

26. **BOOKS** The heights of Olivia's books are $4\frac{9}{16}$ inches, $6\frac{5}{8}$ inches, $\frac{15}{2}$ inches, and $\frac{19}{4}$ inches. What would be the order of the books if Olivia places them on a shelf in order from least to greatest height?

Example 3 Replace $\bullet$ with $<$, $>$, or $=$ to make $\frac{2}{5} \bullet 0.34$ a true sentence.

$$\frac{2}{5} = 0.4$$

Since $0.4 > 0.34$, $\frac{2}{5} > 0.34$.

Example 4 Replace $\bullet$ with $<$, $>$, or $=$ to make $-\frac{3}{4} \bullet -\frac{7}{12}$ a true sentence.

For $-\frac{3}{4}$ and $-\frac{7}{12}$, the least common denominator is 12.

$$-\frac{3}{4} = -\frac{3 \cdot 3}{4 \cdot 3} \text{ or } -\frac{9}{12}$$

Since $-9 < -7$, $-\frac{9}{12} < -\frac{7}{12}$.

So, $-\frac{3}{4} < -\frac{7}{12}$.

2-3

Multiplying Positive and Negative Fractions (pp. 96–101)

Multiply. Write in simplest form.

27. $\frac{3}{5} \cdot 1\frac{2}{3}$

28. $-\frac{2}{3} \cdot \left(-\frac{2}{3}\right)$

29. $\frac{5}{6} \cdot \frac{3}{5}$

30. $\frac{1}{2} \cdot \frac{10}{11}$

31. **COOKING** Crystal is making $1\frac{1}{2}$ times a recipe. The original recipe calls for $3\frac{1}{2}$ cups of milk. How many cups of milk does she need?

Example 5 Find $\frac{2}{3} \cdot \frac{5}{7}$. Write in simplest form.

$$\frac{2}{3} \cdot \frac{5}{7} = \frac{2 \cdot 5}{3 \cdot 7} \quad \begin{array}{l} \leftarrow \text{Multiply the numerators.} \\ \leftarrow \text{Multiply the denominators.} \end{array}$$

$$= \frac{10}{21} \quad \text{Simplify.}$$

2-4

Dividing Positive and Negative Fractions (pp. 102–107)

Divide. Write in simplest form.

32. $\frac{7}{9} \div \frac{1}{3}$

33. $\frac{7}{12} \div \left(-\frac{2}{3}\right)$

34. $-4\frac{2}{5} \div (-2)$

35. $6\frac{1}{6} \div \left(-1\frac{2}{3}\right)$

36. **DESIGN** Marcus wishes to space letters equally across the top of a page. If each letter is 1.7 inches wide, and the paper is $8\frac{1}{2}$ inches wide, what is the maximum number of letters that he can fit across the top of the page?

Example 6 Find $-\frac{5}{6} \div \frac{3}{5}$. Write in simplest form.

$$-\frac{5}{6} \div \frac{3}{5} = -\frac{5}{6} \cdot \frac{5}{3} \quad \text{Multiply by the multiplicative inverse.}$$

$$= -\frac{25}{18} \quad \text{Simplify.}$$

$$= -1\frac{7}{18} \quad \text{Write as a mixed number.}$$

2-5

Adding and Subtracting Like Fractions (pp. 108–112)

Add or subtract. Write in simplest form.

37. $\frac{5}{11} + \frac{6}{11}$

38. $\frac{1}{28} + \left(-\frac{3}{28}\right)$

39. $\frac{1}{8} - \frac{7}{8}$

40. $12\frac{4}{5} - 5\frac{3}{5}$

41. **JOBS** Jeremy worked $5\frac{3}{20}$ hours on Monday. On Tuesday, he worked $2\frac{13}{20}$ hours. How much longer did Jeremy work on Monday than on Tuesday?

Example 7 Find $\frac{1}{5} - \frac{3}{5}$. Write in simplest form.

$$\frac{1}{5} - \frac{3}{5} = \frac{1-3}{5} \quad \begin{array}{l} \leftarrow \text{Subtract the numerators.} \\ \leftarrow \text{The denominators are the same.} \end{array}$$

$$= \frac{-2}{5} \quad \text{Simplify.}$$

$$= -\frac{2}{5}$$

Lesson-by-Lesson Review

2-6

Adding and Subtracting Unlike Fractions (pp. 114–118)

Add or subtract. Write in simplest form.

42. $-\frac{2}{3} + \frac{3}{5}$

43. $\frac{5}{12} - \left(-\frac{7}{15}\right)$

44. $-4\frac{1}{2} - 6\frac{2}{3}$

45. $5 - 1\frac{2}{5}$

46. $7\frac{3}{4} + 3\frac{4}{5}$

47. $5\frac{3}{5} - 12\frac{1}{2}$

48. **PIZZA** A pizza has 3 toppings with no toppings overlapping. Pepperoni tops $\frac{1}{3}$ of the pizza and mushrooms top $\frac{2}{5}$. The remainder is topped with sausage. What fraction is topped with sausage?

Example 8 Find $\frac{3}{4} + \frac{1}{3}$. Write in simplest form.

$$\frac{3}{4} + \frac{1}{3} = \frac{9}{12} + \frac{4}{12}$$

Rename the fractions.

$$= \frac{9+4}{12}$$

Add the numerators.

$$= \frac{13}{12}$$

Simplify.

$$= 1\frac{1}{12}$$

2-7

Solving Equations with Rational Numbers (pp. 119–123)

Solve each equation.

49. $d - (-0.8) = 4$

50. $\frac{x}{4} = -2.2$

51. $\frac{3}{4}n = \frac{7}{8}$

52. $-7.2 = \frac{r}{1.6}$

53. **AGE** Trevor is $\frac{3}{8}$ of Maria's age. Trevor is 15. Write and solve a multiplication equation to find Maria's age.

Example 9 Solve $t + \frac{1}{3} = \frac{5}{6}$.

$$t + \frac{1}{3} = \frac{5}{6}$$

Write the equation.

$$t + \frac{1}{3} - \frac{1}{3} = \frac{5}{6} - \frac{1}{3}$$

Subtract $\frac{1}{3}$ from each side.

$$t = \frac{1}{2}$$

Simplify.

2-8

PSI: Look for a Pattern (pp. 124–125)

Solve. Use the *look for a pattern* strategy.

54. **ALGEBRA** Find the next two numbers in the sequence 3, 6, 9, 12,
55. **RUNNING** Marcy can run one lap in 65 seconds. Each additional lap takes her 2 seconds longer to run than the previous lap. How many minutes will it take her to run three miles? (1 mile = 4 laps)
56. **GEOMETRY** What is the total number of rectangles, of any size, in the figure below?



Example 10 Raul's phone plan charges a flat monthly rate of \$4.95 and \$0.06 per minute. If Raul spent a total of \$7.35 last month, how many minutes did he use?

Look for a pattern.

Minutes	Charges	Total
0	$4.95 + 0(0.06)$	\$4.95
10	$4.95 + 10(0.06)$	\$5.55
20	$4.95 + 20(0.06)$	\$6.15
30	$4.95 + 30(0.06)$	\$6.75
40	$4.95 + 40(0.06)$	\$7.35

So, Raul used 40 minutes last month.

2-9

Powers and Exponents (pp. 126–129)

Write each expression using exponents.

57. $3 \cdot 3 \cdot 3 \cdot 3 \cdot 3$

58. $2 \cdot 2 \cdot 5 \cdot 5 \cdot 5$

59. $x \cdot x \cdot x \cdot x \cdot y$

60. $4 \cdot 4 \cdot 9 \cdot 9$

Evaluate each expression.

61. 5^4

62. $\left(\frac{1}{3}\right)^2 \cdot \left(\frac{2}{5}\right)^2$

63. 5^{-3}

64. $\left(\frac{3}{4}\right)^2 \cdot \left(\frac{1}{2}\right)^3$

65. **PHONE TREES** To close school for the day, the principal calls six parents, who in turn call six more parents. If each of those parents calls six more parents, how many calls will be made by the parents in this last group?

Example 11Write $3 \cdot 3 \cdot 3 \cdot 7 \cdot 7$ using exponents.

$$3 \cdot 3 \cdot 3 \cdot 7 \cdot 7 = 3^3 \cdot 7^2$$

Example 12Evaluate 7^3 .

$$7^3 = 7 \cdot 7 \cdot 7 \text{ or } 343$$

Example 13Evaluate 3^{-6} .

$$3^{-6} = \frac{1}{3^6}$$

Write the power using a positive exponent

$$= \frac{1}{729}$$

$$3^6 = 3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 \text{ or } 729$$

2-10

Scientific Notation (pp. 130–133)

Write each number in standard form.

66. 3.2×10^{-3}

67. 6.71×10^4

68. 1.72×10^5

69. 1.5×10^{-2}

70. **ANIMALS** The smallest mammal is the Kitti's hog-nosed bat weighing about 4.375×10^{-3} pound. Write this weight in standard form.

Write each number in scientific notation.

71. 0.000064

72. 0.000351

73. 87,500,000

74. 7,410,000

75. **SPACE** The distance from Earth to the Sun is approximately 93 million miles. Write this distance in standard form and in scientific notation.

Example 14Write 3.21×10^{-6} in standard form.

$$3.21 \times 10^{-6} = 0.00000321$$
 Move the decimal point 6 places to the left.

Example 15Write 7.25×10^5 in standard form.

$$7.25 \times 10^5 = 725000$$

Move the decimal point 5 places to the right.

Example 16

Write 0.004 in scientific notation.

$$0.004 = 4 \times 0.001$$

$$= 4 \times 10^{-3}$$

The decimal point moves 3 places.

Since $0 < 0.004 < 1$, the exponent is negative.

Practice Test

Write each fraction or mixed number as a decimal.

1. $4\frac{5}{6}$

2. $-\frac{7}{20}$

3. **FROGS** The Gold Frog grows to only 0.375 inch. Write this length as a fraction in simplest form.

4. **ENERGY** The United States produces about $\frac{9}{50}$ of the world's energy and consumes about $\frac{6}{25}$ of the world's energy. Does the United States produce more energy than it uses or vice versa? Explain your reasoning.

5.  **STANDARDS PRACTICE** A recipe for two dozen cookies calls for $1\frac{3}{4}$ cups of flour. In order to make eight dozen cookies, how many cups of flour should be used?
- A $16\frac{1}{2}$
B 14
C $9\frac{1}{4}$
D 7

Add, subtract, multiply, or divide. Write in simplest form.

6. $-5\frac{1}{4} \cdot (-2\frac{1}{3})$

7. $-6 \div \frac{1}{8}$

8. $-\frac{3}{8} + \frac{4}{9}$

9. $(-1\frac{7}{8}) - (-3\frac{1}{4})$

10. **ANALYZE TABLES** The table shows the time of the back and forth swing of a pendulum and its length. How long is a pendulum with a swing of 5 seconds?

Time of Swing	Length of Pendulum
1 second	1 unit
2 seconds	4 units
3 seconds	9 units
4 seconds	16 units

11. **BAKING** Madison needs $2\frac{2}{3}$ cups of flour, but she can only find her $\frac{1}{3}$ measuring cup. How many times will she need to fill the measuring cup with flour to get the amount she needs?

Solve each equation. Check your solution.

12. $x - \frac{5}{6} = \frac{1}{3}$

13. $16 = \frac{2}{3}y$

14. Write the expression $4 \cdot 4 \cdot a \cdot a \cdot b \cdot 3 \cdot 4 \cdot 3 \cdot a$ using exponents.

Evaluate each expression.

15. 6^{-4}

16. $k^3 \cdot g^{-2}$ if $k = 4$ and $g = 8$

17. **EXTREME SPORTS** In 2003, San Antonio, Texas, hosted the first ever summer Global X Games while Whistler, British Columbia, in Canada hosted the winter games. Team USA won the gold medal with a total of $7^2 \cdot 2^2$ points. Evaluate the number of points won by Team USA.

18. Write 8.83×10^{-7} in standard form.

19. Write 25,000 in scientific notation.

20.  **STANDARDS PRACTICE** The following table gives the approximate diameter, in miles, for several planets.

Planet	Diameter
Mercury	3.032×10^3
Saturn	7.4975×10^4
Neptune	3.0603×10^4
Earth	7.926×10^3

Which list below correctly orders these planets from least to greatest diameters?

- F Mercury, Neptune, Saturn, Earth
G Mercury, Earth, Neptune, Saturn
H Mercury, Neptune, Earth, Saturn
J Neptune, Mercury, Earth, Saturn

California Standards Practice

Cumulative, Chapters 1–2



Read each question. Then fill in the correct answer on the answer document provided by your teacher or on a sheet of paper.

- 1 A carpenter estimates that it will take one person 54 hours to complete a job. He plans to have three people work on the job for two days. How many hours each day will the workers need to work to complete the job?
A 8 hours C 12 hours
B 9 hours D 18 hours
- 2 The weight of a paper clip is 9.0×10^{-4} kilograms. Which of the following represents this weight in standard notation?
F 0.00000009
G 0.000009
H 0.00009
J 0.0009
- 3 After reading the salon prices listed below, Alex chose Special No. 1. She wanted to find her total savings. Her first step was to find the sum of \$19 plus 2 times \$4. What should Alex do next to find her total savings?

Hair Salon Prices		
Trim	\$12	Special #1
Haircut	\$19	Haircut, style, and shampoo \$25
Shampoo	\$4	
Style	\$4	Special #2
Highlights	\$55	Haircut, style, shampoo, and highlights \$75
Perm	\$50	

- A Subtract \$75 from the sum.
- B Divide the sum by 3.
- C Subtract \$25 from the sum.
- D Add \$4 to the sum.

- 4 Which number equals $(3)^{-3}$?

F $-\frac{1}{27}$
G -9
H $\frac{1}{27}$
J 9

- 5 Which fraction is equivalent to $\frac{3}{5} + \frac{3}{10}$?

A $\frac{6}{15}$ C $\frac{9}{50}$
B $\frac{9}{10}$ D $\frac{9}{15}$

- 6 A jar of mixed nuts contains $2\frac{1}{2}$ pounds of peanuts, $1\frac{1}{3}$ pounds of cashews and $1\frac{5}{6}$ pounds of walnuts. What is the total weight of the contents of the jar?

F $4\frac{1}{6}$ pounds
G $4\frac{1}{2}$ pounds
H $5\frac{2}{3}$ pounds
J $6\frac{1}{3}$ pounds

TEST-TAKING TIP

Question 6 If the test question would take an excessive amount of time to work, try estimating the answer. Then look for the appropriate answer choice.

- 7 The distance from Earth to the Sun is 92,900,000 miles. Which expression represents this number in scientific notation?

A 92.9×10^6 C 9.29×10^6
B 9.29×10^7 D 929×10^5

- 8 The table shows the atomic weights of certain elements.

Element	Atomic Weight (amu)
Argon	39.948
Zinc	65.39
Lead	207.2
Oxygen	15.9994
Titanium	47.867
Mercury	200.59

Which element has an atomic weight that is exactly 160.642 less than the atomic weight of Mercury?

- F argon H oxygen
G titanium J zinc
- 9 A pizzeria sells large pizzas for \$11.50, medium pizzas for \$8.75, and small pizzas for \$6.50. Suppose a scout group orders 3 large pizzas, 2 medium pizzas, and 2 small pizzas. Which equation can be used to find the total cost of the pizzas?
- A $t = (3 + 2 + 2)(11.50 + 8.75 + 6.50)$
B $t = (3)(11.50) + 2(8.75) + 2(6.50)$
C $t = (3 + 2 + 2)\left(\frac{11.50 + 8.75 + 6.50}{3}\right)$
D $t = (3)(11.50) + 8.75 + 2(6.50)$

- 10 What does y^3 equal when $y = -4$?
- F -64
G -12
H $\frac{1}{64}$
J $\frac{1}{12}$

- 11 Mr. Carr wants to buy a new computer. He will finance the total cost of \$1,350 by making 24 equal monthly payments to pay back this amount plus interest. What other information is needed to determine the amount of Mr. Carr's monthly payment?
- A the brand of the computer
B the amount of money Mr. Carr has in his savings account
C the interest rate being charged
D the amount of Mr. Carr's weekly income
- 12 Cindy has 55 minutes before she has to leave to go to school. She spends 15 minutes reading the newspaper. Then she spends 4 minutes brushing her teeth and another 15 minutes watching television. Which expression can you use to find the amount of time she has left before she has to leave?
- F $55 - 15 + 4 - 15$ H $55 - 2(15) - 4$
G $55 + 2(15) - 4$ J $55 + (-2)(15) + 4$

Pre-AP

**Record your answers on a sheet of paper.
Show your work.**

- 13 The container for a child's set of blocks is 9 inches by 9 inches by 9 inches. The blocks measure 3 inches by 3 inches by 3 inches.
- Describe how to determine the number of blocks needed to fill the container.
 - Write and simplify an expression to solve the problem.
 - How many blocks will it take?

NEED EXTRA HELP?													
If You Missed Question...	1	2	3	4	5	6	7	8	9	10	11	12	13
Go to Lesson...	2-2	2-10	1-1	1-5	1-7	2-6	2-10	2-1	1-7	2-10	1-1	1-1	2-9
For Help with Standard...	MG1.3	NS1.1	MR1.1	NS2.1	NS2.2	NS2.2	NS1.1	NS1.2	AF1.1	AF2.1	MR1.1	AF1.1	AF2.1