Example 1  Write \( \frac{3}{4} \) as a decimal.

\( \frac{3}{4} \) means \( 3 \div 4 \).

The fraction \( \frac{3}{4} \) can be written as 0.75, since \( 3 \div 4 = 0.75 \).

Example 2  Write \( -0.16 \) as a fraction.

\[
-0.16 = -\frac{16}{100} \quad 0.16 \text{ is 16 hundredths.}
\]

\[
= -\frac{4}{25} \quad \text{Simplify.}
\]

The decimal \( -0.16 \) can be written as \( -\frac{4}{25} \).

Example 3  Write \( 8.\overline{2} \) as a mixed number.

Let \( N = 8.\overline{2} \) or 8.222….

Then \( 10N = 82.222… \).

Subtract.

\[
10N = 82.222...
\]

\[
-1N = 8.222...
\]

\[
9N = 74
\]

\[
9N = 74
\]

\[
\frac{9N}{9} = \frac{74}{9}
\]

\[
N = 8\frac{2}{9}
\]

Simplify.

The decimal \( 8.\overline{2} \) can be written as \( 8\frac{2}{9} \).

Exercises  Write each fraction or mixed number as a decimal.

1. \( \frac{2}{5} \)
2. \( \frac{3}{10} \)
3. \( \frac{7}{8} \)
4. \( \frac{216}{25} \)
5. \( -\frac{2}{3} \)
6. \( -1 \frac{2}{9} \)
7. \( 6\frac{2}{3} \)
8. \( -4\frac{3}{11} \)

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

9. \( 0.8 \)
10. \( -0.15 \)
11. \( 0.\overline{1} \)
12. \( 1.\overline{7} \)
Skills Practice

Rational Numbers

Write each fraction or mixed number as a decimal.

1. $\frac{1}{10}$  
2. $\frac{1}{8}$

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

5. $\frac{21}{50}$  
6. $-3\frac{9}{20}$

7. $4\frac{9}{25}$  
8. $\frac{7}{9}$

9. $1\frac{1}{6}$  
10. $-2\frac{4}{15}$

11. $\frac{5}{33}$  
12. $7\frac{3}{11}$

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

13. 0.9  
14. 0.7

15. 0.84  
16. 0.92

17. $-1.12$  
18. $-5.05$

19. 2.35  
20. 8.85

21. $-0.\overline{1}$  
22. $4.\overline{8}$

23. $6.\overline{7}$  
24. $-8.\overline{4}$
### Practice

**Rational Numbers**

Write each fraction or mixed number as a decimal.

1. \( \frac{3}{5} \)
2. \( \frac{5}{8} \)
3. \( \frac{9}{20} \)
4. \( \frac{37}{50} \)
5. \( -\frac{11}{16} \)
6. \( -\frac{9}{32} \)
7. \( 3\frac{1}{5} \)
8. \( 4\frac{3}{8} \)
9. \( \frac{5}{33} \)
10. \( -\frac{7}{9} \)
11. \( -8\frac{11}{18} \)
12. \( -9\frac{11}{30} \)

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

13. \(-0.8\)
14. \(0.44\)
15. \(1.35\)
16. \(0.\overline{8}\)
17. \(-1.\overline{5}\)
18. \(4.\overline{4}\)

**POPULATION** For Exercises 19–21, refer to the table at the right.

19. Express the fraction for Asian as a decimal.
20. Find the decimal equivalent for the fraction of the population that is African American.
21. Write the fraction for Hispanic as a decimal. Round to the nearest thousandth.

<table>
<thead>
<tr>
<th>Race</th>
<th>Fraction of Total Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asian</td>
<td>( \frac{1}{10} )</td>
</tr>
<tr>
<td>African American</td>
<td>( \frac{1}{16} )</td>
</tr>
<tr>
<td>Hispanic</td>
<td>( \frac{1}{3} )</td>
</tr>
</tbody>
</table>

**MEASUREMENTS** For Exercises 22 and 23, use the figure at the right.

22. Write the width of the jellybean as a fraction.

23. Write the width of the jellybean as a decimal.
<table>
<thead>
<tr>
<th></th>
<th><strong>Word Problem Practice</strong></th>
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<tbody>
<tr>
<td><strong>Rational Numbers</strong></td>
<td></td>
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</tbody>
</table>

<p>| | | |</p>
<table>
<thead>
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<tbody>
<tr>
<td><strong>1. ASTRONOMY</strong></td>
<td>The pull of gravity on the surface of Mars is 0.38 that of Earth. Write 0.38 as a fraction in simplest form.</td>
<td><strong>2. ENERGY</strong></td>
</tr>
<tr>
<td><strong>3. WEIGHTS AND MEASURES</strong></td>
<td>One pint is about 0.55 liter. Write 0.55 liter as a fraction in simplest form.</td>
<td><strong>4. WEIGHTS AND MEASURES</strong></td>
</tr>
<tr>
<td><strong>5. EDUCATION</strong></td>
<td>A local middle school has 47 computers and 174 students. What is the number of students per computer at the school? Write your answer as both a mixed number in simplest form and a decimal rounded to the nearest tenth.</td>
<td><strong>6. BASEBALL</strong></td>
</tr>
<tr>
<td><strong>7. COLLEGES AND UNIVERSITIES</strong></td>
<td>Recently, a small college had an enrollment of 1,342 students and a total of 215 faculty. What was the student-faculty ratio for this college? Write your answer as both a mixed number in simplest form and a decimal rounded to the nearest hundredth.</td>
<td><strong>8. BASKETBALL</strong></td>
</tr>
</tbody>
</table>
A Triangular Line Design

Connect each pair of equivalent rational numbers with a straight line segment. Although you will draw only straight lines, the finished design will appear curved!
Get Ready for the Lesson

Read the introduction at the top of page 91 in your textbook. Write your answers below.

1. Do more or less than half of the students prefer buttered popcorn? Explain how you know.

2. Which category is preferred by more students: caramel or plain? Explain.

3. Which category of popcorn is preferred by about one fourth of the class? Explain.

4. Using estimation, order the fractions from least to greatest.

Read the Lesson

5. Read Example 4 on page 93. Explain how to use a number line to determine which of two rational numbers is the lesser number.

For Exercises 6 and 7, graph each pair of rational numbers on a number line. Then identify the lesser number.

6. \(\frac{1}{5}, \frac{1}{3}\)

7. \(\frac{4}{5}, \frac{9}{10}\)

Remember What You Learned

8. Order the numbers \(\frac{3}{7}, \frac{3}{5}, \frac{3}{8}, \frac{3}{4}\), and \(\frac{3}{11}\) from least to greatest. Then write a rule that helps you compare two positive fractions with the same numerator.
When comparing two or more rational numbers, either write the numbers as fractions with the same denominator or write the numbers as decimals.

**Example 1** Replace □ with <, >, or = to make \(\frac{4}{5} \square \frac{7}{10}\) a true sentence.

Write as fractions with the same denominator. The least common denominator is 10.

\[
\frac{4}{5} = \frac{4 \cdot 2}{5 \cdot 2} = \frac{8}{10} \\
\frac{7}{10} = \frac{7 \cdot 1}{10 \cdot 1} = \frac{7}{10}
\]

Since \(\frac{8}{10} > \frac{7}{10}\), \(\frac{4}{5} > \frac{7}{10}\).

**Example 2** Order the set of rational numbers \(-3.25, -3\frac{1}{3}, -3\frac{2}{5}, \text{ and } -3.25\) from least to greatest.

Write \(-3\frac{1}{3}\) and \(-3\frac{2}{5}\) as decimals.

\[
\frac{1}{3} = 0.\overline{3}, \text{ so } -3\frac{1}{3} = -3.\overline{3}.
\]

\[
\frac{2}{5} = 0.4, \text{ so } -3\frac{2}{5} = -3.4.
\]

Since \(-3.4 < -3.\overline{3} < -3.25 < -3.25\), the numbers from least to greatest are \(-3\frac{2}{5}, -3\frac{1}{3}, -3.25, \text{ and } -3.25\).

**Exercises**

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

1. \(\frac{5}{6} \square \frac{2}{3}\)  
2. \(\frac{4}{5} \square \frac{13}{15}\)  
3. \(\frac{1}{9} \square \frac{1}{8}\)

4. \(-\frac{2}{3} \square -\frac{7}{10}\)  
5. \(3\frac{7}{10} \square 3\frac{4}{5}\)  
6. \(-2\frac{3}{7} \square -2\frac{4}{9}\)

7. \(2.6 \square 2\frac{5}{8}\)  
8. \(4\frac{1}{6} \square 4.16\)  
9. \(-4.58 \square -4.\overline{58}\)

Order each set of rational numbers from least to greatest.

10. \(0.5, 0.1, \frac{1}{4}, \frac{2}{3}\)  
11. \(2.4, 2\frac{4}{7}, 2.13, \frac{9}{10}\)

12. \(\frac{1}{5}, -0.7, 0.25, -\frac{3}{5}\)  
13. \(1\frac{2}{9}, 1\frac{2}{3}, 1.45, 1.67\)

14. \(-2\frac{1}{4}, -2.28, -2.7, -2\frac{4}{5}\)  
15. \(4\frac{2}{3}, 4\frac{5}{6}, 4.6, 5.3\)
Replace each \( \bullet \) with <, >, or = to make a true sentence.

1. \( \frac{1}{2} \bullet \frac{3}{4} \)
2. \( \frac{1}{3} \bullet \frac{1}{6} \)
3. \( \frac{2}{5} \bullet \frac{3}{10} \)

4. \( \frac{2}{9} \bullet \frac{1}{3} \)
5. \( \frac{3}{4} \bullet \frac{9}{12} \)
6. \( \frac{3}{8} \bullet \frac{2}{5} \)

7. \( -\frac{5}{6} \bullet -\frac{6}{7} \)
8. \( -\frac{4}{9} \bullet -\frac{5}{11} \)
9. \( \frac{5}{9} \bullet 0.55 \)

10. \( 4.72 \bullet 4\frac{10}{13} \)
11. \( -2\frac{7}{15} \bullet -2.45 \)
12. \( 5.25 \bullet 5.25 \)

13. \( -1.62 \bullet -1\frac{5}{8} \)
14. \( 11\frac{4}{9} \bullet 11.4 \)
15. \( -1.27 \bullet -1.27 \)

Order each set of rational numbers from least to greatest.

16. \( 0.3, 0.2, \frac{1}{3}, \frac{2}{9} \)
17. \( 1\frac{2}{5}, 1\frac{2}{3}, 1.55, 1.67 \)

18. \( 2.7, 2\frac{1}{7}, 3.13, 1\frac{9}{10} \)
19. \( \frac{1}{4}, -1.7, 0.2, -1\frac{3}{4} \)

20. \( -2.21, -2.09, -2\frac{1}{9}, -1\frac{10}{11} \)
21. \( -3.1, 2.75, 1\frac{7}{8}, -\frac{2}{3} \)

22. \( 6\frac{7}{8}, 6\frac{15}{16}, 6.9, 5.3 \)
23. \( -4\frac{1}{6}, -4.19, -5.3, -5\frac{1}{3} \)

24. \( 5\frac{9}{11}, 5.93, 5\frac{7}{20}, 5.81 \)
25. \( -3\frac{1}{4}, -4\frac{1}{8}, -3.65, -3\frac{4}{11}, -4.05 \)
Replace each \( \bullet \) with \(<\), \(>,\) or \(=\) to make a true sentence.

1. \( \frac{3}{5} \bullet \frac{5}{7} \)
2. \( \frac{4}{9} \bullet \frac{5}{11} \)
3. \( \frac{3}{11} \bullet \frac{3}{9} \)
4. \( \frac{5}{15} \bullet \frac{8}{17} \)
5. \( 0.2 \bullet \frac{2}{11} \)
6. \( 0.25 \bullet \frac{5}{21} \)
7. \( \frac{8}{27} \bullet 8.3 \)
8. \( \frac{4}{30} \bullet 4.3 \)
9. \( \frac{8}{13} \bullet \frac{5}{13} \)
10. \( \frac{3}{8} \bullet \frac{7}{8} \)
11. \( \frac{2}{5} \bullet \frac{6}{7} \)
12. \( \frac{2}{9} \bullet \frac{9}{11} \)
13. \( -4.5 \bullet -4.55 \)
14. \( -6.14 \bullet -6.15 \)
15. \( -3.57 \bullet -3.5 \)
16. \( -1.9 \bullet -1.99 \)
17. Which is least: \( \frac{3}{8}, 0.4, \frac{4}{11}, 0.035 \), or \( \frac{5}{13} \)?
18. Which is greatest: \( \frac{7}{9}, 0.778, 0.78, \frac{11}{13} \), or 0.787?

Order each set of rational numbers from least to greatest.

19. \(-5.81, -5\frac{3}{4}, -5\frac{3}{5}, -5.69\)
20. \(-1.01, -1.1, -1\frac{1}{9}, -1\frac{1}{11}\)

21. Which point on the number line is the graph of 0.875?

22. **STATISTICS** If you order a set of numbers from least to greatest, the middle number is the **median**. Find the median of 43.7, 41.3, 44.5, \(42\frac{4}{5}\), and \(43\frac{3}{4}\).
### Word Problem Practice

#### Comparing and Ordering Rational Numbers

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<table>
<thead>
<tr>
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<tbody>
<tr>
<td><strong>1. BASKETBALL</strong></td>
<td><strong>2. SPORTS</strong></td>
</tr>
<tr>
<td>In the last ten games, Percy made (\frac{7}{12}) of his free throws. For the same period, Tariq made (\frac{4}{7}) of his free throws. Which player has the better free throw record?</td>
<td>Central's baseball team won (\frac{53}{78}) of its games last year, while Southern’s team won (\frac{55}{81}) of its games. Which team had the better record?</td>
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</tbody>
</table>

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<tbody>
<tr>
<td><strong>3. MEASUREMENT</strong></td>
<td><strong>4. NATURE</strong></td>
</tr>
<tr>
<td>Beaker A contains (\frac{4}{3}) fluid ounces of water, while beaker B contains (\frac{4}{3}) (\frac{3}{10}) fluid ounces of water. Which beaker has the smaller amount of water?</td>
<td>The two trees in Opal's backyard have circumferences of (12\frac{5}{8}) inches and (12\frac{3}{5}) inches. Which circumference is larger?</td>
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<tbody>
<tr>
<td><strong>5. EXERCISE</strong></td>
<td><strong>6. FOOD</strong></td>
</tr>
<tr>
<td>On Monday, Rob averaged 3.75 laps per minute. On Tuesday, he averaged (\frac{3}{5}) (\frac{4}{5}) laps per minute. On which day did Rob run faster?</td>
<td>Hector and Carla both gave apples to their teacher. Hector's apple weighed (6\frac{7}{12}) ounces, while Carla's apple weighed 6.65 ounces. Which apple weighed more?</td>
</tr>
</tbody>
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<tbody>
<tr>
<td><strong>7. SPORTS</strong></td>
<td><strong>8. STATISTICS</strong></td>
</tr>
<tr>
<td>Christina ran one lap in 83.86 seconds, while Della's time for one lap was (83\frac{7}{8}) seconds. Which runner had the faster time?</td>
<td>The median of a set of numbers can be found by first putting the numbers in order from least to greatest, then choosing the middle number. Find the median of 5.79, (5\frac{3}{4}), (5\frac{7}{8}), 5.9, and (5\frac{4}{5}).</td>
</tr>
</tbody>
</table>
A Famous Line-Up

A number line can be used to graph a mixed number or an improper fraction.

The number line above shows the graph of two points. Point $G$ is at $\frac{1}{2}$ and point $H$ is at $\frac{3}{2}$.

Graph each set of points on the number line. When you are finished, the letters will spell the last names of some famous people.

1. point $R$ at $\frac{10}{3}$, point $A$ at $1\frac{1}{3}$, point $N$ at $4\frac{2}{3}$, point $G$ at $\frac{6}{3}$, point $G$ at $\frac{1}{3}$, point $I$ at $\frac{13}{3}$, and point $A$ at $2\frac{2}{3}$

2. point $R$ at 1, point $E$ at $\frac{-3}{4}$, point $S$ at $-2$, point $D$ at $\frac{3}{2}$, point $A$ at $\frac{1}{2}$, point $H$ at $\frac{-5}{4}$, and point $P$ at $\frac{-1}{4}$

3. point $G$ at $-2\frac{1}{6}$, point $M$ at $\frac{-1}{6}$, point $S$ at $\frac{-5}{6}$, point $S$ at $-1\frac{1}{3}$, point $R$ at $\frac{-11}{6}$, point $O$ at $\frac{-1}{3}$, and point $I$ at $\frac{-5}{3}$

4. Why are these three people famous?
2-3  Lesson Reading Guide

Multiplying Positive and Negative Fractions

Get Ready for the Lesson

Complete the Mini Lab at the top of page 96 in your textbook. Write your answers below.

1. What is the product of \( \frac{1}{3} \) and \( \frac{2}{5} \)?

2. Use an area model to find each product.
   a. \( \frac{3}{4} \cdot \frac{1}{2} \)
   b. \( \frac{2}{5} \cdot \frac{2}{3} \)
   c. \( \frac{1}{4} \cdot \frac{3}{5} \)
   d. \( \frac{2}{3} \cdot \frac{4}{5} \)

3. What is the relationship between the numerators of the factors and the numerator of the product?

4. What is the relationship between the denominators of the factors and the denominator of the product?

Read the Lesson

5. What is the greatest common factor of two numbers?

6. How is the greatest common factor used when multiplying fractions?

7. How is dimensional analysis defined on page 98 in your textbook?

8. How is dimensional analysis used in Example 5 on page 98 in your textbook?

Remember What You Learned

9. If you were to visit Europe, you may need to exchange some of your money for Euros. The exchange rate tells you how many dollars equals how many Euros. How would you use dimensional analysis to compute the number of Euros you would get from $50?
Study Guide and Intervention

Multiplying Positive and Negative Fractions

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

Example 1

Find \( \frac{3}{8} \cdot \frac{4}{11} \). Write in simplest form.

\[
\frac{3}{8} \cdot \frac{4}{11} = \frac{3}{8} \cdot \frac{4}{11} \\
= \frac{3 \cdot 1}{2 \cdot 11} \\
= \frac{3}{22}
\]

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

Example 2

Find \( -2\frac{1}{3} \cdot 3\frac{3}{5} \). Write in simplest form.

\[
-2\frac{1}{3} \cdot 3\frac{3}{5} = -\frac{7}{3} \cdot \frac{18}{5} \\
= -\frac{7 \cdot 6}{1 \cdot 5} \\
= -\frac{42}{5} \\
= -8\frac{2}{5}
\]

Exercises

Multiply. Write in simplest form.

1. \( \frac{2}{3} \cdot \frac{3}{5} \)
2. \( \frac{4}{7} \cdot \frac{3}{4} \)
3. \( -\frac{1}{2} \cdot \frac{7}{9} \)

4. \( \frac{9}{10} \cdot \frac{2}{3} \)
5. \( \frac{5}{8} \cdot \left( -\frac{4}{9} \right) \)
6. \( -\frac{4}{7} \cdot \left( -\frac{2}{3} \right) \)

7. \( 2\frac{2}{5} \cdot \frac{1}{6} \)
8. \( -3\frac{1}{3} \cdot \frac{11}{2} \)
9. \( 3\frac{3}{7} \cdot 2\frac{5}{8} \)

10. \( -1\frac{7}{8} \cdot \left( -2\frac{2}{5} \right) \)
11. \( -1\frac{3}{4} \cdot \frac{21}{5} \)
12. \( 2\frac{2}{3} \cdot 2\frac{3}{7} \)
Skills Practice

Multiplying Positive and Negative Fractions

Multiply. Write in simplest form.

1. \( \frac{1}{8} \cdot \frac{2}{3} \)
2. \( \frac{2}{9} \cdot \frac{7}{8} \)
3. \( \frac{5}{6} \cdot \frac{3}{11} \)

4. \( -\frac{4}{7} \cdot \frac{3}{10} \)
5. \( \frac{2}{9} \cdot \left( -\frac{3}{8} \right) \)
6. \( \frac{3}{5} \cdot \left( -\frac{5}{9} \right) \)

7. \( 1\frac{3}{4} \cdot \frac{2}{3} \)
8. \( \frac{4}{5} \cdot \frac{4\frac{3}{8}}{8} \)
9. \( -\frac{2}{15} \cdot \frac{5\frac{5}{6}}{6} \)

10. \( -1\frac{3}{7} \cdot 1\frac{1}{5} \)
11. \( -2\frac{1}{4} \cdot 1\frac{2}{3} \)
12. \( 1\frac{9}{16} \cdot 2\frac{4}{5} \)

13. \( -3\frac{1}{7} \cdot \left( -1\frac{2}{11} \right) \)
14. \( 2\frac{2}{3} \cdot \left( -2\frac{1}{4} \right) \)
15. \( \left( -\frac{4}{5} \right) \left( -\frac{4}{5} \right) \)

ALGEBRA Evaluate each expression if \( r = \frac{5}{6}, s = -\frac{1}{3}, t = \frac{4}{5}, \) and \( v = -\frac{3}{4} \).

16. \( rv \)
17. \( st \)
18. \( rs \)

19. \( stv \)
20. \( rst \)
21. \( rtv \)

ALGEBRA Evaluate each expression if \( a = -\frac{5}{9}, b = -\frac{1}{5}, c = \frac{2}{3}, \) and \( d = \frac{3}{4} \).

22. \( ad \)
23. \( bc \)
24. \( abc \)
Practice

Multiplying Positive and Negative Fractions

Find each product. Write in simplest form.

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

2. $\frac{6}{7} \cdot \frac{1}{2}$

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

4. $-\frac{15}{16} \cdot \frac{4}{5}$

5. $\left(-\frac{8}{25}\right) \cdot \frac{15}{16}$

6. $\left(-\frac{7}{8}\right) \cdot \left(-\frac{1}{7}\right)$

7. $1\frac{1}{4} \cdot \frac{1}{5}$

8. $1\frac{1}{4} \cdot 1\frac{1}{5}$

9. $-2\frac{2}{3} \cdot \left(-\frac{1}{4}\right)$

10. $\frac{1}{4} \cdot \left(-\frac{4}{15}\right) \cdot \frac{5}{7}$

11. $2\frac{2}{5} \cdot 2\frac{1}{3} \cdot 2$

12. $10 \cdot 8.56 \cdot \frac{1}{2}$

ALGEBRA Evaluate each expression if $a = -\frac{1}{5}$, $b = \frac{2}{3}$, $c = \frac{7}{8}$, and $d = -\frac{3}{4}$.

13. $bc$

14. $ab$

15. $abc$

16. $abd$

17. COOKING A recipe calls for $2\frac{1}{4}$ cups of flour. How much flour would you need to make $\frac{1}{3}$ of the recipe?

18. FARMING A farmer has $6\frac{1}{2}$ acres of land for growing crops. If she plants corn on $\frac{3}{5}$ of the land, how many acres of corn will she have?

ALGEBRA Evaluate each expression if $e = -\frac{1}{4}$, $f = \frac{2}{3}$, $g = -\frac{1}{6}$, and $h = 1\frac{1}{5}$.

19. $efh^2$

20. $e^2h^2$

21. $\frac{1}{8}f^2g$

22. $-2ef(-gh)$
### Word Problem Practice

#### Multiplying Positive and Negative Fractions

| **1. NUTRITION** Maria’s favorite granola bar has 230 Calories. The nutrition label states that $\frac{7}{8}$ of the Calories come from fat. How many Calories in the granola bar come from fat? |
| **2. ELECTIONS** In the last election, $\frac{3}{8}$ of the voters in Afton voted for the incumbent mayor. If 424 people voted in Afton in the last election, how many voted for the incumbent mayor? |
| **3. HOBBIES** Jerry is building a $\frac{1}{9}$ scale model of a race car. If the tires on the actual car are 33 inches in diameter, what is the diameter of the tires on the model? |
| **4. COOKING** Enola’s recipe for cookies calls for $2\frac{1}{2}$ cups of flour. If she wants to make $\frac{3}{4}$ of a batch of cookies, how much flour should she use? |
| **5. TRANSPORTATION** Hana’s car used $\frac{3}{4}$ of a tank of gas to cross Arizona. The gas tank on her car holds $15\frac{1}{2}$ gallons. How many gallons of gas did it take to cross Arizona? |
| **6. GEOMETRY** The area of a rectangle is found by multiplying its length times its width. What is the area of a rectangle with a length of $2\frac{1}{4}$ inches and a width of $1\frac{5}{9}$ inches? |
| **7. COOKING** A recipe for ice cream calls for $3\frac{1}{3}$ cups of heavy cream. If Steve wants to make $2\frac{1}{2}$ times the normal amount, how much heavy cream should he use? |
| **8. ADVERTISING** A jewelry advertisement shows a bracelet at 6 times its actual size. If the actual length of the bracelet is $5\frac{3}{10}$ inches, what is the length of the bracelet in the photograph? |
Rational Numbers as Ordered Pairs

If you think of a rational number as an ordered pair, it can be located on a coordinate system. The example graph shows the number \( \frac{1}{3} \). The horizontal axis is used for the numerator and the vertical axis for the denominator.

Graph the rational numbers as ordered pairs.

1. \( \frac{1}{2}, \frac{2}{4}, \frac{3}{6}, \frac{4}{8} \)

2. \( \frac{4}{3}, \frac{8}{6}, \frac{12}{9}, \frac{16}{12}, \frac{20}{15} \)

3. \( \frac{-3}{2}, \frac{-6}{4}, \frac{3}{-2}, \frac{6}{-4} \)

4. \( \frac{-5}{2}, \frac{-10}{4}, \frac{5}{-2}, \frac{10}{-4}, \frac{15}{-6} \)

5. Complete this generalization: A rational number \( \frac{a}{b} \) is shown on a coordinate system using the ordered pair \((a, b)\). Using this model, equivalent rational numbers will ________________.

6. Show that this generalization is false: A rational number \( \frac{a}{b} \) is shown on a coordinate system using the ordered pair \((a, b)\). All ordered pairs on the same line stand for equivalent rational numbers.
2-4 Lesson Reading Guide

Dividing Positive and Negative Fractions

Get Ready for the Lesson

Read the introduction at the top of page 102 in your textbook. Write your answers below.

1. Find the value of $60 \div 5$.

2. Find the value of $60 \times \frac{1}{5}$.

3. Compare the values of $60 \div 5$ and $60 \times \frac{1}{5}$.

4. What can you conclude about the relationship between dividing by 5 and multiplying by $\frac{1}{5}$?

Read the Lesson

5. Describe the process for finding the multiplicative inverse of a mixed number.

For Exercises 6–9, write the multiplicative inverse of each mixed number.

6. $2 \frac{1}{5}$

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

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

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

10. Explain how to divide by a fraction.

11. Look at your answers for Exercises 6 and 10 above. How do you divide a number by $2 \frac{1}{5}$?

Remember What You Learned

12. Look up the word *invert* in the dictionary. Draw a simple picture and then invert it. Explain how this helps you remember how to divide fractions.
**Example 1**

Write the multiplicative inverse of \(-2\frac{3}{4}\).

\[-2\frac{3}{4} = -\frac{11}{4}\]

Write \(-2\frac{3}{4}\) as an improper fraction.

Since \(-\frac{11}{4}\left(-\frac{4}{11}\right) = 1\), the multiplicative inverse of \(-2\frac{3}{4}\) is \(-\frac{4}{11}\).

To divide by a fraction or mixed number, multiply by its multiplicative inverse.

**Example 2**

Find \(\frac{3}{8} \div \frac{6}{7}\). Write in simplest form.

\[\frac{3}{8} \div \frac{6}{7} = \frac{3}{8} \cdot \frac{7}{6}\]

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

\[= \frac{3}{8} \cdot \frac{7}{6}\]

Divide 6 and 3 by their GCF, 3.

\[= \frac{7}{16}\]

Simplify.

**Exercises**

Write the multiplicative inverse of each number.

1. \(\frac{3}{5}\)  
2. \(-\frac{8}{9}\)  
3. \(\frac{1}{10}\)  
4. \(-\frac{1}{6}\)

5. \(2\frac{3}{5}\)  
6. \(-1\frac{2}{3}\)  
7. \(-5\frac{2}{5}\)  
8. \(7\frac{1}{4}\)

Divide. Write in simplest form.

9. \(\frac{1}{3} \div \frac{1}{6}\)  
10. \(\frac{2}{5} \div \frac{4}{7}\)

11. \(\frac{5}{6} \div \frac{3}{4}\)  
12. \(1\frac{1}{5} \div 2\frac{1}{4}\)

13. \(3\frac{1}{7} \div (-3\frac{2}{3})\)  
14. \(-\frac{4}{9} \div 2\)

15. \(\frac{6}{11} \div (-4)\)  
16. \(5 \div 2\frac{1}{3}\)

Two numbers whose product is 1 are multiplicative inverses, or reciprocals, of each other.

To divide by a fraction or mixed number, multiply by its multiplicative inverse.

To divide by a fraction or mixed number, multiply by its multiplicative inverse.
Write the multiplicative inverse of each number.

1. \(\frac{2}{3}\)  
2. \(-\frac{4}{7}\)  
3. \(-\frac{1}{12}\)  

4. 22  
5. \(\frac{9}{35}\)  
6. \(-\frac{14}{17}\)  

7. \(1\frac{5}{7}\)  
8. \(-1\frac{3}{13}\)  
9. \(2\frac{3}{7}\)  

10. \(-3\frac{6}{11}\)  
11. \(4\frac{8}{15}\)  
12. \(5\frac{3}{5}\)  

Divide. Write in simplest form.

13. \(\frac{3}{7} \div \frac{3}{5}\)  
14. \(\frac{2}{7} \div \frac{6}{7}\)  

15. \(-\frac{5}{8} \div \frac{3}{4}\)  
16. \(\frac{7}{9} \div \left(-\frac{14}{15}\right)\)  

17. \(-\frac{4}{5} \div \frac{8}{9}\)  
18. \(\frac{2}{11} \div \frac{4}{9}\)  

19. \(1\frac{3}{4} \div 2\frac{1}{2}\)  
20. \(-2\frac{3}{5} \div 1\frac{3}{10}\)  

21. \(-3\frac{4}{7} \div \left(-1\frac{1}{14}\right)\)  
22. \(\frac{10}{11} \div 5\)  

23. \(-4 \div \frac{3}{5}\)  
24. \(3\frac{4}{15} \div 4\frac{2}{3}\)  

25. \(9\frac{1}{3} \div 5\frac{3}{5}\)  
26. \(-12\frac{3}{4} \div \left(-2\frac{5}{6}\right)\)  

27. \(2\frac{4}{9} \div \left(-6\frac{2}{7}\right)\)  
28. \(-11\frac{1}{5} \div 3\frac{1}{9}\)
Practice

Dividing Positive and Negative Fractions

Write the multiplicative inverse of each number.

1. \(\frac{4}{5}\)  
2. \(\frac{7}{12}\)  
3. \(-20\)  
4. \(-5\frac{3}{8}\)

Find each quotient. Write in simplest form.

5. \(\frac{1}{5} \div \frac{1}{4}\)  
6. \(\frac{2}{5} \div \frac{5}{6}\)  
7. \(\frac{3}{7} \div \frac{6}{11}\)  
8. \(\frac{3}{10} \div \frac{4}{5}\)  
9. \(\frac{3}{8} \div 6\)  
10. \(\frac{6}{7} \div 3\)  
11. \(\frac{4}{5} \div 10\)  
12. \(\frac{6}{11} \div 8\)  
13. \(-\frac{4}{5} \div \frac{5}{6}\)

14. \(\frac{5}{12} \div -\frac{3}{5}\)  
15. \(-\frac{3}{10} \div -\frac{2}{5}\)  
16. \(-\frac{13}{18} \div -\frac{8}{9}\)  
17. \(\frac{4}{5} \div \frac{1}{4}\)  
18. \(\frac{8}{3} \div \frac{3}{4}\)  
19. \(-10\frac{1}{2} \div 2\frac{1}{3}\)

20. OFFICE SUPPLIES A regular paper clip is \(1\frac{1}{4}\) inches long, and a jumbo paper clip is \(1\frac{7}{8}\) inches long. How many times longer is the jumbo paper clip than the regular paper clip?

21. STORAGE The ceiling in a storage unit is \(7\frac{2}{3}\) feet high. How many boxes may be stacked in a single stack if each box is \(\frac{3}{4}\) foot tall?

ALGEBRA Evaluate each expression for the given values.

22. \(\frac{r}{s}\) if \(r = -\frac{7}{20}\) and \(s = \frac{7}{15}\)  
23. \(\frac{m}{n}\) if \(m = \frac{4}{9}\) and \(n = \frac{11}{12}\)
### 2-4 Word Problem Practice

**Dividing Positive and Negative Fractions**

<table>
<thead>
<tr>
<th>Question</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. CONTAINER GARDENING</strong></td>
<td>One bag of potting soil contains $8\frac{1}{4}$ quarts of soil. How many clay pots can be filled from one bag of potting soil if each pot holds $\frac{3}{4}$ quart?</td>
</tr>
<tr>
<td><strong>2. MUSIC</strong></td>
<td>Doug has a shelf $9\frac{3}{4}$ inches long for storing CDs. Each CD is $\frac{3}{8}$ inch wide. How many CDs will fit on one shelf?</td>
</tr>
<tr>
<td><strong>3. SERVING SIZE</strong></td>
<td>A box of cereal contains $15\frac{3}{5}$ ounces of cereal. If a bowl holds $2\frac{2}{5}$ ounces of cereal, how many bowls of cereal are in one box?</td>
</tr>
<tr>
<td><strong>4. HOME IMPROVEMENT</strong></td>
<td>Lori is building a path in her backyard using square paving stones that are $1\frac{3}{4}$ feet on each side. How many paving stones placed end-to-end are needed to make a path that is 21 feet long?</td>
</tr>
<tr>
<td><strong>5. GEOMETRY</strong></td>
<td>Given the length of a rectangle and its area, you can find the width by dividing the area by the length. A rectangle has an area of $6\frac{2}{3}$ square inches and a length of $2\frac{1}{2}$ inches. What is the width of the rectangle?</td>
</tr>
<tr>
<td><strong>6. GEOMETRY</strong></td>
<td>Given the length of a rectangle and its area, you can find the width by dividing the area by the length. A rectangle has an area of $4\frac{5}{7}$ square feet and a length of $3\frac{2}{3}$ feet. What is the width of the rectangle?</td>
</tr>
<tr>
<td><strong>7. HOBBIES</strong></td>
<td>Dena has a picture frame that is $13\frac{1}{2}$ inches wide. How many pictures that are $3\frac{3}{8}$ inches wide can be placed beside each other within the frame?</td>
</tr>
<tr>
<td><strong>8. YARD WORK</strong></td>
<td>Leon is mowing his yard, which is $21\frac{2}{3}$ feet wide. His lawn mower makes a cut that is $1\frac{2}{3}$ feet wide on each pass. How many passes will Leon need to finish the lawn?</td>
</tr>
</tbody>
</table>
Continued Fractions

The expression at the right is an example of a continued fraction. The example shows how to change an improper fraction into a continued fraction.

**Example**

Write \( \frac{72}{17} \) as a continued fraction.

\[
\frac{72}{17} = 4 + \frac{4}{17} = 4 + \frac{1}{\frac{17}{4}} = 4 + \frac{1}{4 + \frac{1}{4}}
\]

Notice that each fraction must have a numerator of 1 before the process is complete.

**Exercises**

Change each improper fraction to a continued fraction.

1. \( \frac{13}{10} \)
2. \( \frac{17}{11} \)
3. \( \frac{25}{13} \)
4. \( \frac{17}{6} \)

Write each continued fraction as an improper fraction.

5. \( 1 + \frac{1}{1 + \frac{1}{1 + \frac{1}{2}}} \)
6. \( 1 + \frac{1}{1 + \frac{1}{1 + \frac{1}{3}}} \)
7. \( 1 + \frac{1}{1 + \frac{1}{1 + \frac{1}{5}}} \)
Lesson Reading Guide
Adding and Subtracting Like Fractions

Get Ready for the Lesson
Read the introduction at the top of page 108 in your textbook.
Write your answers below.

1. What is the sum of the whole-number parts of the baskets of apples?
2. How many \(\frac{1}{4}\) baskets are there?
3. Can you combine all of the apples into a bushel that holds five baskets? Explain.

Read the Lesson
4. Define like fractions.

For Exercises 5–8, determine whether each pair of fractions are like fractions.

5. \(\frac{3}{5}, \frac{3}{7}\)
6. \(\frac{5}{8}, \frac{7}{8}\)
7. \(\frac{4}{7}, -\frac{5}{7}\)
8. \(\frac{5}{9}, -\frac{2}{3}\)

9. Explain how to add like fractions. Then simplify if necessary.

10. Explain how to subtract like fractions. Then simplify if necessary.

Add or subtract. Write in simplest form.

11. \(\frac{3}{5} + \frac{1}{5}\)
12. \(\frac{5}{8} + \frac{7}{8}\)
13. \(\frac{5}{9} - \frac{2}{9}\)
14. \(\frac{4}{7} - \frac{5}{7}\)

Remember What You Learned
15. Talk with a partner about the word like. What does it usually mean? How is this different from the way it is used in the lesson?
Fractions that have the same denominator are called **like fractions**. To add like fractions, add the numerators of the fractions and write the sum over the denominator.

**Example 1**

Find \( \frac{1}{5} + \left( -\frac{4}{5} \right) \). Write in simplest form.

\[
\frac{1}{5} + \left( -\frac{4}{5} \right) = \frac{1 + (-4)}{5} = \frac{-3}{5} \text{ or } -\frac{3}{5}
\]

Add the numerators. The denominators are the same.

Simplify.

To subtract like fractions, subtract the numerators of the fractions and write the difference over the denominator.

**Example 2**

Find \( \frac{-4}{9} - \frac{7}{9} \). Write in simplest form.

\[
\frac{-4}{9} - \frac{7}{9} = \frac{-4 - 7}{9} = \frac{-11}{9} \text{ or } -\frac{11}{9}
\]

Subtract the numerators. The denominators are the same.

Rename \(-\frac{11}{9}\) as \(-\frac{11}{9}\).

To add or subtract mixed numbers, first write the mixed numbers as improper fractions. Then add or subtract the improper fractions and simplify the result.

**Example 3**

Find \( 2\frac{2}{7} + 6\frac{5}{7} \). Write in simplest form.

\[
2\frac{2}{7} + 6\frac{5}{7} = \frac{17}{7} + \frac{47}{7} = \frac{64}{7} \text{ or } 9\frac{1}{7}
\]

Write the mixed numbers as improper fractions.

Add the numerators. The denominators are the same.

Rewrite \(\frac{64}{7}\) as \(9\frac{1}{7}\).

**Exercises**

Add or subtract. Write in simplest form.

1. \( \frac{4}{7} + \frac{2}{7} \)
2. \( \frac{1}{10} + \frac{5}{10} \)
3. \( \frac{5}{9} + \left( -\frac{1}{9} \right) \)
4. \( \frac{1}{6} + \frac{-5}{6} \)
5. \( \frac{-3}{8} + \frac{7}{8} \)
6. \( \frac{5}{11} - \left( -\frac{4}{11} \right) \)
7. \( \frac{-4}{5} - \frac{3}{5} \)
8. \( \frac{-9}{13} + \left( -\frac{6}{13} \right) \)
9. \( 2\frac{1}{4} + 1\frac{1}{4} \)
10. \( 3\frac{5}{7} + 2\frac{3}{7} \)
11. \( 3\frac{5}{8} - 1\frac{3}{8} \)
12. \( 4\frac{2}{5} - 2\frac{4}{5} \)
Add or subtract. Write in simplest form.

1. \( \frac{1}{5} + \frac{3}{5} \) 
2. \( \frac{2}{9} + \frac{5}{9} \) 
3. \( \frac{7}{11} + \frac{3}{11} \) 

4. \( -\frac{1}{4} + \frac{3}{4} \) 
5. \( -\frac{4}{9} + \frac{8}{9} \) 
6. \( -\frac{5}{7} + \frac{2}{7} \) 

7. \( \frac{7}{12} + \frac{5}{12} \) 
8. \( \frac{1}{9} + \left( -\frac{4}{9} \right) \) 
9. \( -\frac{5}{7} + \left( -\frac{3}{7} \right) \) 

10. \( -\frac{9}{16} + \left( -\frac{3}{16} \right) \) 
11. \( \frac{5}{8} - \frac{3}{8} \) 
12. \( \frac{13}{19} - \frac{6}{19} \) 

13. \( \frac{2}{7} - \frac{6}{7} \) 
14. \( \frac{4}{15} - \frac{7}{15} \) 
15. \( \frac{1}{9} - \left( -\frac{4}{9} \right) \) 

16. \( \frac{3}{13} - \left( -\frac{11}{13} \right) \) 
17. \( 2\frac{3}{7} + 1\frac{2}{7} \) 
18. \( 1\frac{4}{15} + 4\frac{8}{15} \) 

19. \( 5\frac{6}{7} - 3\frac{2}{7} \) 
20. \( 6\frac{7}{12} - 3\frac{1}{12} \) 
21. \( -2\frac{5}{11} - 7\frac{1}{11} \) 

22. \( -4\frac{3}{8} - 2\frac{7}{8} \) 
23. \( 5\frac{2}{9} - 2\frac{4}{9} \) 
24. \( 8\frac{1}{5} - 4\frac{2}{5} \)
Practice

Adding and Subtracting Like Fractions

Add or subtract. Write in simplest form.

1. \(-\frac{1}{4} + \frac{3}{4}\)  
   2. \(-\frac{3}{8} + \left(-\frac{1}{8}\right)\)  
   3. \(-\frac{8}{11} + \frac{10}{11}\)  

4. \(-\frac{5}{7} - \frac{4}{7}\)  
   5. \(\frac{11}{12} - \frac{7}{12}\)  
   6. \(\frac{2}{15} - \frac{7}{15}\)

7. \(\frac{4}{4} + \frac{6}{4}\)  
   8. \(\frac{5}{10} + \frac{9}{10}\)  
   9. \(\frac{7}{9} + \left(-\frac{5}{9}\right)\)

10. \(-\frac{1}{9} - \frac{4}{9}\)  
   11. \(-\frac{4}{5} - \frac{5}{5}\)  
   12. \(\frac{5}{6} - \frac{3}{6}\)

13. SEWING  Naomi needs \(2\frac{3}{4}\) yards of fabric to make a banner for a football game. The fabric store has \(6\frac{1}{4}\) yards of the fabric she wants. How much of the fabric will remain at the store after Naomi buys her fabric?

14. GEOMETRY  Find the perimeter of the triangle.

Simplify each expression.

15. \(-\frac{5}{7} + \frac{2}{7} - \left(\frac{5}{7}\right)\)  
   16. \(-\frac{7}{12} - \left(-\frac{11}{12}\right) + \frac{7}{12}\)

ALGEBRA  Evaluate each expressions for the given values.

17. \(r + s\) if \(r = 8\frac{4}{5}\) and \(s = -3\frac{2}{5}\)  
   18. \(b - c\) if \(b = -2\frac{7}{9}\) and \(c = -9\frac{5}{9}\)
1. **GEOMETRY** Find the perimeter of a rectangle with a length of $4\frac{2}{3}$ inches and a width of $3\frac{1}{3}$ inches.

2. **PETS** Pat wants to find out how much her dog Hunter weighs. Pat steps on the scale and reads her weight as $126\frac{3}{8}$ pounds. The combined weight of Pat and Hunter is $137\frac{7}{8}$ pounds. How much does Hunter weigh?

3. **MEASUREMENTS** Tate fills a $13\frac{1}{3}$ ounce glass from a $21\frac{2}{3}$ ounce bottle of juice. How much juice is left in the bottle?

4. **DECORATING** Jeri has two posters. One is $4\frac{1}{7}$ feet wide and the other is $5\frac{1}{10}$ feet wide. Will the two posters fit beside each other on a wall that is 10 feet wide? Explain.

5. **AGE** Nida is $11\frac{11}{12}$ years old, while her sister Yoki is $8\frac{5}{12}$ years old. What is the sum of the ages of the sisters?

6. **GEOMETRY** A triangle has sides of $1\frac{1}{8}$ inches, $1\frac{3}{8}$ inches, and $1\frac{5}{8}$ inches. What is the perimeter of the triangle?

7. **HUMAN BODY** Tom’s right foot measures $10\frac{2}{5}$ inches, while Randy’s right foot measures $9\frac{4}{5}$ inches. How much longer is Tom’s foot than Randy’s?

8. **COMPUTERS** Trey has two data files on his computer that he is going to combine. One file is $1\frac{4}{9}$ megabytes, while the other file is $3\frac{8}{9}$ megabytes. What will be the size of the resulting file?
Extending Problems

When examining the solution of a problem, good problem solvers look for ways to extend the problem. The questions on this page show you a way to examine and extend the following pattern.

Row 1: \[ \frac{1}{2} = \quad \frac{1}{2} = \quad \frac{1}{2} \]
Row 2: \[ \frac{1}{2} + \frac{1}{4} = \quad \frac{2}{4} + \frac{1}{4} = \quad \frac{3}{4} \]
Row 3: \[ \frac{1}{2} + \frac{1}{4} + \frac{1}{8} = \quad \frac{4}{8} + \frac{2}{8} + \frac{1}{8} = \quad \frac{7}{8} \]
Row 4: \[ \frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \frac{1}{16} = \quad \frac{8}{16} + \frac{4}{16} + \frac{2}{16} + \frac{1}{16} = \quad \frac{15}{16} \]

1. What is the relationship between the denominators of the fractions in the first column?

2. What is the relationship between the numerators of the fractions in the second column?

3. In the space below, write Row 5 of the pattern.

4. What would be the fraction at the end of Row 6? Row 9?

5. Now complete the following pattern.

   Row 1: \[ \frac{1}{3} = \quad \frac{1}{3} = \quad \frac{1}{3} \]
   Row 2: \[ \frac{1}{3} + \frac{1}{9} = \quad \frac{3}{9} + \frac{1}{9} = \quad \frac{4}{9} \]
   Row 3: \[ \frac{1}{3} + \frac{1}{9} + \frac{1}{27} = \quad \frac{3}{27} + \frac{1}{27} + \frac{1}{27} = \quad \frac{5}{27} \]
   Row 4: \[ \frac{1}{3} + \frac{1}{9} + \frac{1}{27} + \frac{1}{81} = \quad \frac{3}{81} + \frac{1}{81} + \frac{1}{81} + \frac{1}{81} = \quad \frac{10}{81} \]
   Row 5: \[ \frac{1}{3} + \frac{1}{9} + \frac{1}{27} + \frac{1}{81} + \frac{1}{243} = \quad \frac{3}{243} + \frac{1}{243} + \frac{1}{243} + \frac{1}{243} + \frac{1}{243} = \quad \frac{16}{243} \]

6. CHALLENGE Find this sum: \[ \frac{1}{4} + \frac{1}{16} + \frac{1}{64} + \frac{1}{256} + \frac{1}{1,024} + \frac{1}{4,096} \].
Get Ready for the Lesson

Read the introduction at the top of page 114 in your textbook. Write your answers below.

1. What are the denominators of the fractions?

2. What is the least common multiple of the denominators?

3. Find the missing value in \( \frac{1}{2} = \frac{?}{6} \).

Read the Lesson

4. What do LCM and LCD stand for? Give a definition for each.

Find the LCM of each pair of numbers.

5. 2, 3  
6. 4, 6  
7. 5, 10  
8. 9, 12

Find the LCD of each pair of fractions.

9. \( \frac{3}{5}, \frac{3}{7} \)  
10. \( \frac{5}{8}, \frac{7}{12} \)  
11. \( \frac{4}{7}, \frac{5}{7} \)  
12. \( \frac{5}{9}, \frac{2}{3} \)

13. Explain how to add or subtract unlike fractions.

Rewrite each sum or difference in terms of like fractions. Then add or subtract. Write in simplest form.

14. \( \frac{3}{5} + \frac{1}{2} \)  
15. \( \frac{3}{4} + \frac{7}{8} \)  
16. \( \frac{5}{9} - \frac{2}{3} \)

17. \( \frac{4}{7} - \frac{1}{2} \)  
18. \( \frac{3}{5} + \frac{3}{7} \)  
19. \( \frac{5}{8} - \frac{7}{12} \)

Remember What You Learned

20. Describe what the prefix \( un- \) usually means when it appears in front of a word. How does this meaning relate to unlike fractions?
Fractions with unlike denominators are called **unlike fractions**. To add or subtract unlike fractions, rename the fractions using the least common denominator. Then add or subtract as with like fractions.

**Example 1** Find $\frac{3}{5} + \frac{2}{3}$. Write in simplest form.

\[
\frac{3}{5} + \frac{2}{3} = \frac{3 \cdot 3}{5 \cdot 3} + \frac{2 \cdot 5}{3 \cdot 5}
\]
\[
= \frac{9}{15} + \frac{10}{15}
\]
\[
= \frac{19}{15}
\]

The LCD is $5 \cdot 3$ or $15$.

Rename each fraction using the LCD.

Add the numerators. The denominators are the same.

Simplify.

**Example 2** Find $-3\frac{1}{2} - 1\frac{5}{6}$. Write in simplest form.

\[
-3\frac{1}{2} - 1\frac{5}{6} = -\frac{7}{2} - \frac{11}{6}
\]

Write the mixed numbers as improper fractions.

\[
= -\frac{7 \cdot 3}{2 \cdot 3} - \frac{11}{6}
\]
\[
= -\frac{21}{6} - \frac{11}{6}
\]
\[
= -\frac{21 - 11}{6}
\]
\[
= -\frac{32}{6} \text{ or } -\frac{16}{3} \text{ or } -5\frac{1}{3}
\]

The LCD is $2 \cdot 3$ or $6$.

Rename $\frac{7}{2}$ using the LCD.

Subtract the numerators.

Simplify.

**Exercises**

Add or subtract. Write in simplest form.

1. $\frac{2}{5} + \frac{3}{10}$

2. $\frac{1}{3} + \frac{2}{9}$

3. $\frac{5}{9} + \left( -\frac{1}{6} \right)$

4. $-\frac{3}{4} - \frac{5}{6}$

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

6. $1\frac{2}{3} - \left( -\frac{4}{9} \right)$

7. $-\frac{7}{10} - \left( -\frac{1}{2} \right)$

8. $2\frac{1}{4} + 1\frac{3}{8}$

9. $3\frac{3}{4} - 1\frac{1}{3}$

10. $-1\frac{1}{5} - 2\frac{1}{4}$

11. $-2\frac{4}{9} - \left( -1\frac{1}{3} \right)$

12. $3\frac{3}{5} - 2\frac{2}{3}$
Skills Practice
Adding and Subtracting Unlike Fractions

Add or subtract. Write in simplest form.

1. \( \frac{1}{6} + \frac{1}{2} \)
2. \( \frac{4}{9} + \frac{1}{3} \)

3. \( \frac{7}{8} + \frac{1}{4} \)
4. \( \frac{3}{4} + \frac{2}{3} \)

5. \( \frac{6}{7} - \frac{3}{14} \)
6. \( \frac{4}{5} - \frac{1}{3} \)

7. \( \frac{1}{4} - \frac{5}{6} \)
8. \( -\frac{3}{5} + \frac{1}{4} \)

9. \( -\frac{3}{7} - \frac{2}{3} \)
10. \( \frac{4}{7} - \left( -\frac{1}{2} \right) \)

11. \( 3\frac{2}{5} + 2\frac{1}{3} \)
12. \( 5\frac{5}{7} + 3\frac{1}{2} \)

13. \( 3\frac{1}{6} + 4\frac{1}{4} \)
14. \( 1\frac{1}{2} + \left( -1\frac{1}{5} \right) \)

15. \( 2\frac{3}{4} + \left( -6\frac{3}{8} \right) \)
16. \( 5\frac{1}{4} + \left( -2\frac{2}{3} \right) \)

17. \( -5\frac{1}{12} - 3\frac{2}{3} \)
18. \( -3\frac{3}{5} - \frac{9}{10} \)

19. \( -2\frac{1}{5} - 3\frac{3}{4} \)
20. \( 2\frac{1}{3} - \left( -4\frac{5}{6} \right) \)

21. \( 3\frac{2}{7} - \left( -4\frac{2}{3} \right) \)
22. \( 5\frac{7}{9} - \left( -2\frac{1}{3} \right) \)

23. \( 10\frac{2}{9} - \left( -3\frac{1}{3} \right) \)
24. \( -2\frac{1}{3} - \left( -5\frac{4}{5} \right) \)
Add or subtract. Write in simplest form.

1. $\frac{1}{2} + \frac{7}{10}$
2. $\frac{5}{6} + \left(-\frac{5}{9}\right)$
3. $-\frac{4}{5} + \left(-\frac{1}{3}\right)$

4. $\frac{7}{9} - \frac{2}{5}$
5. $\frac{3}{4} - \left(-\frac{1}{12}\right)$
6. $\frac{7}{8} - \left(-\frac{2}{3}\right)$

7. $4\frac{1}{5} + 6\frac{3}{4}$
8. $1\frac{7}{10} + \left(-\frac{5\frac{3}{5}}{5}\right)$
9. $\frac{7\frac{3}{5}}{5} - \left(-\frac{5\frac{1}{3}}{3}\right)$

10. $-3\frac{2}{3} - 4\frac{5}{9}$
11. $-4\frac{3}{5} - 5\frac{9}{10}$
12. $-18\frac{5}{12} + 14\frac{3}{4}$

13. POPULATION About $\frac{1}{5}$ of the world’s population lives in China, and $\frac{1}{6}$ of the world’s population lives in India. What fraction of the world’s population lives in other countries?

ALGEBRA For Exercises 14 and 15, evaluate each expression using the given information.

14. $m - n$ if $m = -\frac{3}{5}$ and $n = -10\frac{7}{10}$
15. $j - k$ if $j = -\frac{5}{9}$ and $k = 4\frac{5}{6}$

GEOMETRY Find the missing measure for each figure.

16. perimeter = $12\frac{23}{24}$ in.

17. perimeter = $59\frac{1}{4}$ in.
## 2-6 Word Problems Practice
### Adding and Subtracting Unlike Fractions

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. GEOMETRY Two line segments have lengths of $3\frac{3}{4}$ inches and $1\frac{1}{3}$ inches. What is the sum of the lengths of the two line segments?</td>
<td>2. COMPUTERS The biology class has created two data files on the computer. One file is $2\frac{1}{9}$ megabytes, while the other file is $4\frac{1}{2}$ megabytes. How much larger is the second file than the first?</td>
</tr>
<tr>
<td>3. HUMAN BODY The index finger on Pablo’s right hand measures $3\frac{5}{8}$ inches, while the index finger on his left hand measures $3\frac{5}{16}$ inches. Which hand has the longer index finger? How much longer is it?</td>
<td>4. DECORATING Sugi has two pictures that she wants to put beside each other in a frame. One is $3\frac{1}{2}$ inches wide and the other is $5\frac{1}{8}$ inches wide. How wide must the frame be to fit both pictures?</td>
</tr>
<tr>
<td>5. PETS Laura purchased two puppies from a litter. One of the puppies weighs $4\frac{5}{6}$ pounds and the other puppy weighs $5\frac{1}{2}$ pounds. How much more does the second puppy weigh than the first?</td>
<td>6. AGE Alma is $6\frac{3}{4}$ years old, while her brother David is $3\frac{5}{6}$ years old. What is the sum of the ages of Alma and David?</td>
</tr>
<tr>
<td>7. MEASUREMENT Ned pours $7\frac{2}{5}$ ounces of water from a beaker containing $10\frac{1}{4}$ ounces. How much water is left in the beaker?</td>
<td>8. GEOMETRY A triangle has sides of $1\frac{1}{6}$ inches, $1\frac{1}{3}$ inches, and $1\frac{2}{3}$ inches. What is the perimeter of the triangle?</td>
</tr>
</tbody>
</table>
Magic Squares

A magic square is an arrangement of numbers such that the rows, columns, and diagonals all have the same sum. In this magic square, the magic sum is 15.

Find the magic sum for each square in Exercises 1–5. Then fill in the empty cells.

1. 2. 3.

4. 5.

6. Arrange these numbers to make a magic square.

\[
\begin{array}{cccc}
\frac{1}{2} & 1 & 2 & \frac{1}{3} \\
2 & 3 & 3 & \frac{1}{4} \\
\frac{1}{6} & 1 & \frac{5}{12} & \frac{7}{12} \\
\end{array}
\]
Get Ready for the Lesson

Read the introduction at the top of page 119 in your textbook. Write your answers below.

1. Multiply each side of the equation by 3. Then divide each side by 2. Write the result.

2. Multiply each side of the original equation by the multiplicative inverse of \( \frac{2}{3} \). Write the result.

3. What was Kenseth’s average life speed in Michigan?

4. Which method of solving the equation seems most efficient?

Read the Lesson

5. Match the method of solving with the appropriate equation.

- \( 1.25a = 3.75 \) _____  
  a. Subtract \( \frac{3}{5} \) from each side.

- \( x + 1.25 = 5.25 \) _____  
  b. Multiply each by \( \frac{5}{3} \).

- \( \frac{3}{5}m = \frac{7}{10} \) _____  
  c. Add 1.25 to each side.

- \( r - 1.25 = 4.5 \) _____  
  d. Divide each side by 1.25.

- \( \frac{3}{5} + f = \frac{1}{2} \) _____  
  e. Subtract 1.25 from each side.

Explain in words how to solve each equation.

6. \( \frac{y}{3.2} = 1.1 \)

7. \( \frac{3}{8} + v = \frac{7}{12} \)

Remember What You Learned

8. The description of a problem often has more information than you need to design an equation and solve it. Describe the process of writing an equation to solve a problem.
The Addition, Subtraction, Multiplication, and Division Properties of Equality can be used to solve equations with rational numbers.

Example 1 Solve \( x - 2.73 = 1.31 \). Check your solution.

\[
\begin{align*}
x - 2.73 &= 1.31 & \text{Write the equation.} \\
x - 2.73 + 2.73 &= 1.31 + 2.73 & \text{Add 2.73 to each side.} \\
x &= 4.04 & \text{Simplify.}
\end{align*}
\]

Check 
\[
\begin{align*}
x - 2.73 &= 1.31 & \text{Write the original equation.} \\
4.04 - 2.73 & \neq 1.31 & \text{Replace } x \text{ with } 4.04. \\
1.31 & \neq 1.31 & \text{Simplify.}
\end{align*}
\]

Example 2 Solve \( \frac{4}{5}y = \frac{2}{3} \). Check your solution.

\[
\begin{align*}
\frac{4}{5}y &= \frac{2}{3} & \text{Write the equation.} \\
\frac{5}{4}\left(\frac{4}{5}y\right) &= \frac{5}{4}\left(\frac{2}{3}\right) & \text{Multiply each side by } \frac{5}{4}. \\
y &= \frac{5}{6} & \text{Simplify.}
\end{align*}
\]

Check 
\[
\begin{align*}
\frac{4}{5}y &= \frac{2}{3} & \text{Write the original equation.} \\
\frac{4}{5}\left(\frac{5}{6}\right) & \neq \frac{2}{3} & \text{Replace } y \text{ with } \frac{5}{6}. \\
\frac{2}{3} & \neq \frac{2}{3} & \text{Simplify.}
\end{align*}
\]

Exercises

Solve each equation. Check your solution.

1. \( t + 1.32 = 3.48 \) 
2. \( b - 4.22 = 7.08 \) 
3. \( -8.07 = r - 4.48 \)

4. \( h + \frac{4}{9} = \frac{7}{9} \) 
5. \( -\frac{5}{8} = x - \frac{1}{4} \) 
6. \( -\frac{2}{3} + f = \frac{3}{5} \)

7. \( 3.2c = 9.6 \) 
8. \( -5.04 = 1.26d \) 
9. \( \frac{3}{5}x = 6 \)

10. \( -\frac{2}{3} = \frac{3}{4}t \) 
11. \( \frac{w}{2.5} = 4.2 \) 
12. \( 1\frac{3}{4}r = 3\frac{5}{8} \)
Skills Practice
Solving Equations with Rational Numbers

Solve each equation. Check your solution.

1. \(x + 2.62 = 6.37\)
2. \(y - 3.16 = 7.92\)

3. \(-3.38 = r - 9.76\)
4. \(s + \frac{5}{8} = \frac{7}{8}\)

5. \(-\frac{5}{6} = x - \frac{1}{3}\)
6. \(-\frac{4}{5} + z = \frac{1}{10}\)

7. \(3.4c = 6.8\)
8. \(-1.56 = 0.26w\)

9. \(12.8y = 6.4\)
10. \(\frac{3}{4}x = 9\)

11. \(\frac{4}{9} = \frac{8}{11}a\)
12. \(-\frac{2}{5}s = \frac{4}{15}\)

13. \(-\frac{2}{3} = \frac{3}{10}t\)
14. \(-\frac{4}{11}w = -\frac{19}{22}\)

15. \(5.1 = -1.7r\)
16. \(z - (-3.2) = 3.69\)

17. \(-2.11 = w - (-5.81)\)
18. \(\frac{w}{2.6} = 3.5\)

19. \(-\frac{x}{1.8} = 7.2\)
20. \(2\frac{1}{4}y = 3\frac{3}{8}\)

21. \(-2\frac{2}{5}f = -3\frac{1}{5}\)
22. \(1.5d = \frac{3}{8}\)

23. \(-7.5g = -6\frac{2}{3}\)
24. \(-2\frac{1}{5} = c - (-\frac{4}{5})\)
Practice
Solving Equations with Rational Numbers

Solve each equation. Check your solution.

1. \( m + 0.88 = 1.64 \)
2. \( t - 2.89 = 9.15 \)
3. \( -\frac{3}{5} = d - \frac{5}{6} \)

4. \( \frac{-7}{16} = b + \frac{1}{4} \)
5. \( h - (-6.3) = 8.12 \)
6. \( -2.5 = n - (-5.37) \)

7. \( -\frac{5}{8}k = 25 \)
8. \( \frac{-3}{7}v = -27 \)
9. \( -2.94 = -0.42a \)

10. \( -8.4 = 1.4y \)
11. \( \frac{f}{2.4} = -7.5 \)
12. \( \frac{-p}{-6.25} = -3.6 \)

13. \( 2.5x = -\frac{13}{16} \)
14. \( -4.5w = -\frac{81}{3} \)
15. \( 8\frac{2}{3} = -1.3g \)

17. MONEY  The currency in Switzerland is called a franc. On a certain day, one U.S. dollar equaled \( 1\frac{1}{4} \) Swiss francs. Write and solve a multiplication equation to find the number of U.S. dollars that would equal 15 Swiss francs.

FOOTBALL For Exercise 18, refer to the table.

18. Let \( s \) equal the number of additional seats that the Pittsburgh Steelers’ stadium needs to equal the number of seats in Kansas City Chiefs’ stadium. Write and solve an addition equation to determine the number of seats that the Steelers’ stadium needs to equal the number of seats in the Chiefs’ stadium.

<table>
<thead>
<tr>
<th>NFL Stadiums</th>
<th>Seating Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stadium</td>
<td>Seats (thousands)</td>
</tr>
<tr>
<td>Dallas Cowboys</td>
<td>65.7</td>
</tr>
<tr>
<td>Kansas City Chiefs</td>
<td>79.4</td>
</tr>
<tr>
<td>Pittsburgh Steelers</td>
<td>64.5</td>
</tr>
<tr>
<td>San Diego Chargers</td>
<td>71.3</td>
</tr>
</tbody>
</table>
### Word Problem Practice

**Solving Equations with Rational Numbers**

| 1. NATURE  | The height of a certain tree is 12.85 meters. The length \( \ell \) of its longest branch can be found using the equation \( \ell + 3.23 = 12.85 \). Solve the equation. |
| 2. SHOPPING | Kristen went shopping and spent $84.63 on books and CDs. The equation 84.63 = \( b + 43.22 \) can be used to determine the amount \( b \) that she spent on books. Solve the equation. |
| 3. ENERGY PRICES | Suppose regular unleaded gasoline costs $2.40 per gallon. The price \( p \) of premium gasoline can be found using the equation \( \frac{p}{1.2} = 2.40 \). What is the price of the premium gasoline? |
| 4. DRIVING TIME | Sam went for a drive last Sunday. His average speed was 46 miles per hour and he drove 115 miles. The equation 115 = 46\( t \) can be used to find the time \( t \) that he spent driving. Solve the equation. |
| 5. AUTOMOBILES | The bed of Julian’s truck is 2\( \frac{1}{3} \) yards long. The length \( \ell \) of the truck can be found by solving the equation \( \ell - 2\frac{4}{9} = 2\frac{1}{3} \). What is the length of the truck? |
| 6. SPORTS | Leo and Ted both ran in a race. Leo’s time was 9 minutes, which was \( \frac{3}{4} \) of Ted’s time. Using \( t \) for Ted’s time, write a multiplication equation to represent the situation. |
| 7. SPEED | Ella rode the bus to work today. The distance she traveled was 4\( \frac{1}{4} \) miles and the ride took \( \frac{1}{3} \) of an hour. The equation \( \frac{1}{3}s = 4\frac{1}{4} \) can be used to find the average speed \( s \) of the bus. What was the average speed of the bus? |
| 8. GEOMETRY | A rectangle has area \( \frac{6}{3} \) square inches and length \( 2\frac{1}{2} \) inches. The equation \( \frac{6}{3} = 2\frac{1}{2}w \) can be used to find the width \( w \) of the rectangle. Solve the equation. |
Equation Hexa-Maze

To solve the maze, start with the number in the center. This number must be the solution of the equation in the next cell. The number in the new cell will then be the solution to the equation in the next cell. At each move, you may only move to an adjacent cell. Each cell is used only once.
TI-73 Activity

Solving and Checking Equations

Use the Equation Solver feature in the MATH menu to solve equations quickly or to check your solutions.

Example

Solve \(4.9 = \frac{x + (-4)}{7}\). Check your solution.

Step 1

Choose Equation Solver.

Step 2

Enter the equation. (If an equation is already there, press \(\uparrow\) \(\text{CLEAR}\).)

\[
4.9 \ 2\text{nd} \ [\text{TEXT}] = \text{Done} \ \ (\ x \ + \ (-\ 4) \ ) \ \ b_6 \ \ 7 \ \ \text{ENTER}
\]

Step 3

In the Solve row, choose \(x\). (Ignore any current value shown for \(x\).)

\[
\text{ENTER}
\]

Step 4

Read the value of \(x\) in the second row.

\(x = 38.3\)

Step 5

Check the result. Evaluate the right side of the equation with the value 38.3 \(x\) for \(x\).

\[
\text{ENTER}
\]

The calculator displays 4.9, which matches the left side of the equation. So the result is correct.

Exercises

Solve each equation. Check your solution.

1. \(-4x = 24.9\)

2. \(6.9 + c = 2.6\)

3. \(-\frac{4}{3} = 1\frac{1}{4}k\)

4. \(p - (-17.1) = 28.3\)

5. \(-\frac{4}{5} = g + \left(-\frac{3}{8}\right)\)

6. \(9.1 + 1.4t = -18.9\)

7. The volume of a cylinder is given by the formula \(V = \pi r^2h\), where \(r\) is the radius of the base and \(h\) is the height of the cylinder. The volume of a cylinder is 21.21 cubic centimeters. If the cylinder has a height of 27 centimeters, what is its radius? Round to the nearest hundredth.
Three people board the subway train at the first stop. Five people board the train at the second stop. Seven people board the train at the third stop. If this pattern continues and no one gets off the train, how many people are on the subway train when it reaches the seventh and final stop?

**Understand** You know that 3 people boarded the subway train at the first stop. At each subsequent stop, 2 more people board the train than at the previous stop.

**Plan** Look for a pattern and use the pattern to find how many people boarded the train in all.

**Solve** Complete the information for the first, second, and third stops. Continue the pattern to solve the problem.

<table>
<thead>
<tr>
<th>First Stop</th>
<th>Second Stop</th>
<th>Third Stop</th>
<th>Fourth Stop</th>
<th>Fifth Stop</th>
<th>Sixth Stop</th>
<th>Seventh Stop</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>5</td>
<td>7</td>
<td>9</td>
<td>11</td>
<td>13</td>
<td>15</td>
</tr>
<tr>
<td>3 people on the train</td>
<td>3 + 5 = 8 people on the train</td>
<td>8 + 7 = 15 people on the train</td>
<td>15 + 9 = 24 people on the train</td>
<td>24 + 11 = 35 people on the train</td>
<td>35 + 13 = 48 people on the train</td>
<td>48 + 15 = 63 people on the train</td>
</tr>
</tbody>
</table>

At the seventh and final stop there were 63 people on the subway train.

**Check** Check your pattern to make sure the answer is correct.

**Exercises**

Look for a pattern. Then use the pattern to solve each problem.

1. **COOKING** A muffin recipe calls for \(2\frac{1}{2}\) cups of flour for every \(\frac{2}{3}\) cup of sugar. How many cups of flour should be used when 4 cups of sugar are used?

2. **FUNDRAISER** There were 256 people at a fundraiser. When the event was over, half of the people who remained left every 5 minutes. How long after the event ended did the last person leave?
Skills Practice

Problem-Solving Investigation: Look for a Pattern

Look for a pattern. Then use the pattern to solve each problem.

1. **YARN** A knitting shop is having a huge yarn sale. One skein sells for $1.00, 2 skeins sell for $1.50, and 3 skeins sell for $2.00. If this pattern continues, how many skeins of yarn can you buy for $5.00?

2. **BIOLOGY** Biologists place sensors in 8 concentric circles to track the movement of grizzly bears throughout Yellowstone National Park. Four sensors are placed in the inner circle. Eight sensors are placed in the next circle. Sixteen sensors are placed in the third circle, and so on. If the pattern continues, how many sensors are needed in all?

3. **HONOR STUDENTS** A local high school displays pictures of the honor students from each school year on the office wall. The top row has 9 pictures displayed. The next 3 rows have 7, 10, and 8 pictures displayed. The pattern continues to the bottom row, which has 14 pictures in it. How many rows of pictures are there on the office wall?

4. **CHEERLEADING** The football cheerleaders will arrange themselves in rows to form a pattern on the football field at halftime. In the first five rows there are 12, 10, 11, 9, and 10 girls in each row. They will form a total of twelve rows. If the pattern continues, how many girls will be in the back row?

5. **GEOMETRY** Find the perimeters of the next two figures in the pattern. The length of each side of each small square is 3 feet.

6. **HOT TUBS** A hot tub holds 630 gallons of water when it is full. A hose fills the tub at a rate of 6 gallons every five minutes. How long will it take to fill the hot tub?
2-8 Practice

Problem-Solving Investigation: Look for a Pattern

For Exercises 1 and 2, look for a pattern. Then use the pattern to solve the problem.

1. GEOMETRY Draw the next two angles in the pattern.
   a. \(10^\circ\)
   b. \(20^\circ\)
   c. \(30^\circ\)
   d. \(40^\circ\)

2. ANALYZE TABLES A falling object continues to fall faster until it hits the ground. How far will an object fall during the fifth second?

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Distance Fallen</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st second</td>
<td>16 feet</td>
</tr>
<tr>
<td>2nd second</td>
<td>48 feet</td>
</tr>
<tr>
<td>3rd second</td>
<td>80 feet</td>
</tr>
<tr>
<td>4th second</td>
<td>112 feet</td>
</tr>
</tbody>
</table>

Use any strategy to solve Exercises 3–6. Some strategies are shown below.

- Look for a pattern.
- Work backward.

3. YARD WORK Denzel can mow \(\frac{1}{8}\) of his yard every 7 minutes. If he has 40 minutes to mow \(\frac{3}{4}\) of the yard, will he have enough time?

4. READING Ling read 175 pages by 1:00 P.M., 210 pages by 2:00 P.M., and 245 pages by 3:00 P.M. If she continues reading at this rate, how many pages will Ling have read by 4:00 P.M.?

5. MOVIES The land area of Alaska is about 570 thousand square miles. The land area of Washington, D.C., is about 0.06 thousand square miles. How many times larger is Alaska than Washington, D.C.?

6. U.S. PRESIDENTS President Clinton served 5 two-year terms as governor of Arkansas and 2 four-year terms as President of the United States. How many total years did he serve in these two government offices?
2-8 Word Problem Practice

Problem-Solving Investigation: Look for a Pattern

Look for a pattern. Then use the pattern to solve each problem.

ENTERTAINMENT For Exercises 1 and 2, use the information at the right, which shows the ticket prices at a skating rink.

<table>
<thead>
<tr>
<th>Number of People in Group</th>
<th>Total Cost per Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$1.00</td>
</tr>
<tr>
<td>2</td>
<td>$2.00</td>
</tr>
<tr>
<td>3</td>
<td>$2.90</td>
</tr>
<tr>
<td>4</td>
<td>$3.70</td>
</tr>
<tr>
<td>5</td>
<td>$4.40</td>
</tr>
</tbody>
</table>

1. Describe the pattern used to calculate the cost for a group after 2 people.

2. If the pattern continues, what would the cost be for a group of 8 skaters?

3. SAVINGS Jordan saved $1 the first week, $2 the second week, $4 the third week, and $8 the fourth week. If this pattern continues, how much will she save the eighth week?

4. AGRICULTURE In a vegetable garden, the second row is 8 inches from the first row, the third row is 10 inches from the second row, the fourth row is 14 inches from the third row, and the fifth row is 20 inches from the fourth row. If the pattern continues, how far will the eighth row be from the seventh row?

5. GARDENING Marial was planting daisies in her garden. She planted 2 white daisies and 5 yellow daisies in the first row, 4 white daisies and 6 yellow daisies in the second row, and 6 white daisies and 7 yellow daisies in the third row. If she continues the pattern, how many white and yellow daisies will she plant in the sixth row?

6. BIOLOGY A newborn seal pup weighs 4 pounds the first week, 8 pounds the second week, 16 pounds the third week, and 32 pounds the fourth week. If this growth pattern continues, how many weeks old will the seal pup be before it weighs over 100 pounds?
Lesson Reading Guide

Powers and Exponents

Get Ready for the Lesson

Read the introduction at the top of page 126 in your textbook. Write your answers below.

1. How many 2s are multiplied to find his savings at Week 4? Week 5?

2. How much money will Hector save in Week 8?

3. When will he have enough to buy a pair of shoes for $80?

Read the Lesson

4. Define the terms base, exponent, and power.

5. For Exercises 5–7, identify the base, exponent, and power in each expression.

6. $5^4$

7. $7^{-2}$

8. $x^8$

9. Explain in words what $5^4$ means.

Rewrite each expression using multiplication instead of an exponent.

10. $9^5$

11. $c^8$

Evaluate each expression.

12. $5^4$

13. $9^5$

14. $6^3$

15. $2^8$

Remember What You Learned

16. Notice that $4^{-3} = \frac{1}{4^3}$. A power with a negative exponent is not negative.

Write a true sentence using the terms negative exponent, power, positive, and rational.
Expressions containing repeated factors can be written using exponents.

**Example 1**  Write $7 \cdot 7 \cdot 7 \cdot 7$ using exponents.

Since 7 is used as a factor 5 times, $7 \cdot 7 \cdot 7 \cdot 7 \cdot 7 = 7^5$.

**Example 2**  Write $p \cdot p \cdot p \cdot q$ using exponents.

Since $p$ is used as a factor 3 times and $q$ is used as a factor 2 times, $p \cdot p \cdot p \cdot q = p^3 \cdot q^2$.

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

**Example 3**  Evaluate $6^2$.

$6^2 = 6 \cdot 6$  Definition of exponents  
$= 36$  Simplify.

**Example 4**  Evaluate $5^{-3}$.

$5^{-3} = \frac{1}{5^3}$  Definition of negative exponents  
$= \frac{1}{125}$  Simplify.

**Exercises**

Write each expression using exponents.

1. $8 \cdot 8 \cdot 8 \cdot 8 \cdot 8$

2. $4 \cdot 4 \cdot 4 \cdot 4$

3. $a \cdot a \cdot a \cdot a \cdot a \cdot a$

4. $g \cdot g \cdot g \cdot g \cdot g \cdot g \cdot g$

5. $5 \cdot 5 \cdot 9 \cdot 9 \cdot 5 \cdot 9 \cdot 5 \cdot 5$

6. $s \cdot w \cdot w \cdot s \cdot s \cdot s \cdot s$

Evaluate each expression.

7. $4^2$

8. $5^3$

9. $13^2$

10. $2^3 \cdot 3^2$

11. $8^{-2}$

12. $2^4 \cdot 5^2$

13. $3^{-4}$

14. $3^4 \cdot 7^2$
Skills Practice
Powers and Exponents

Write each expression using exponents.

1. \(2 \cdot 2 \cdot 2 \cdot 2\)  
2. \(9 \cdot 9\)

3. \(7 \cdot 7 \cdot 7 \cdot 7 \cdot 7\)  
4. \(x \cdot x \cdot x\)

5. \(c \cdot c \cdot c \cdot c \cdot c\)  
6. \(s \cdot s \cdot s \cdot s \cdot s \cdot s\)

7. \(5 \cdot 5 \cdot 5 \cdot 3 \cdot 3\)  
8. \(4 \cdot 4 \cdot 4 \cdot 6 \cdot 6 \cdot 6\)

9. \(8 \cdot 8 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 8\)  
10. \(a \cdot a \cdot b \cdot a \cdot b \cdot a \cdot a\)

11. \(m \cdot n \cdot n \cdot n \cdot n \cdot m \cdot n\)  
12. \(y \cdot x \cdot x \cdot y \cdot x \cdot y \cdot y\)

Evaluate each expression.

13. \(4^3\)  
14. \(2^5\)

15. \(8^3\)  
16. \(5^4\)

17. \(2^8\)  
18. \(2^3 \cdot 5^2\)

19. \(4^2 \cdot 3^4\)  
20. \(2^6 \cdot 6^2\)

21. \(3^3 \cdot 7^3\)  
22. \(2^{-3}\)

23. \(8^{-2}\)  
24. \(7^{-4}\)
Write each expression using exponents.

1. $3 \cdot 3 \cdot m$
2. $2 \cdot d \cdot 5 \cdot d \cdot d \cdot 5$
3. $p \cdot 9 \cdot 3 \cdot q \cdot p \cdot 9$
4. $g \cdot 7 \cdot 7 \cdot g \cdot h \cdot 7 \cdot h$
5. $2 \cdot 5 \cdot r \cdot 7 \cdot s \cdot r \cdot 5 \cdot r \cdot 7 \cdot r \cdot s$
6. $x \cdot 8 \cdot y \cdot x \cdot 5 \cdot x \cdot 5 \cdot y \cdot 8 \cdot y \cdot y \cdot 5$

Evaluate each expression.

7. $2^4$
8. $5^3$
9. $2^2 \cdot 6^2$
10. $2^3 \cdot 5^2$
11. $3^{-4}$
12. $8^{-3}$
13. $9^{-2}$
14. $5^{-3}$
15. $7 \cdot 2^2 \cdot 5^2$
16. $3^2 \cdot 6 \cdot 10^2$
17. $3^{-2} \cdot 2^{-3}$
18. $7 \cdot 3^3 \cdot 5^{-4}$

ALGEBRA Evaluate each expression.

19. $r^3 \cdot s$, if $r = 5$ and $s = 4$
20. $m^2 \cdot n^3$, if $m = 6$ and $n = 2$
21. $f^4 \cdot g^5$, if $f = 3$ and $g = 1$
22. $x^5 \cdot y$, if $x = 2$ and $y = 8$

23. Complete the following pattern.
   $5^4 = 625$, $5^3 = 125$, $5^2 = 25$, $5^1 = 5$, $5^0 = 1$, $5^{-1} = \frac{1}{5}$, $5^{-2} = \frac{1}{25}$, $5^{-3} = \frac{1}{125}$

24. MONEY Suppose $100 is deposited into an account and the amount doubles every 8 years. How much will be in the account after 40 years?

25. EPIDEMICS At the beginning of an epidemic, 50 people are sick. If the number of sick people triples every other day, how many people will be sick at the end of 2 weeks?
<table>
<thead>
<tr>
<th><strong>1. SPORTS</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>In the first round of a local tennis tournament there are $2^5$ matches. Find the number of matches.</td>
<td><strong>2. GEOMETRY</strong></td>
</tr>
<tr>
<td></td>
<td>The volume of a box can be found by multiplying the length, width, and height of the box. If the length, width, and height of the box are all 5 inches, write the volume of the box using an exponent.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>3. MONEY</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>An apartment complex has 3 buildings. Each building has 3 apartments. There are 3 people living in each apartment, and each person pays 3 dollars per month for pool maintenance. The expression $3^4$ denotes the amount paid each month for pool maintenance. Find this amount.</td>
<td><strong>4. ACTIVISM</strong></td>
</tr>
<tr>
<td></td>
<td>A petition drive is being held in 10 cities. In each city, 10 people have collected 10 signatures each. The expression $10^3$ denotes the number of signatures that have been collected altogether. Find this number.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>5. MEASUREMENT</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>There are $10^6$ millimeters in a kilometer. Write the number of millimeters in a kilometer.</td>
<td><strong>6. NATURE</strong></td>
</tr>
<tr>
<td></td>
<td>Suppose a certain forest fire doubles in size every 12 hours. If the initial size of the fire was 1 acre, how many acres will the fire cover in 2 days?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>7. BANKING</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Suppose that a dollar placed into an account triples every 12 years. How much will be in the account after 60 years?</td>
<td><strong>8. BIOLOGY</strong></td>
</tr>
<tr>
<td></td>
<td>Suppose a bacterium splits into two bacteria every 15 minutes. How many bacteria will there be in 3 hours?</td>
</tr>
</tbody>
</table>
A-Mazing Exponents

Solve the following puzzle by finding the correct path through the boxes. The solution is a famous quote from United States history.

Starting with Box 1, draw an arrow to the box next or diagonal to Box 1 with the expression of the least value. The arrow cannot go to a box that has already been used. The first arrow has been drawn to get you started.

When you have finished drawing your path through the boxes, write the box numbers on the lines below. Put the numbers in the order in which they are connected. Then use the chart at the right to convert each box number to a letter.

<table>
<thead>
<tr>
<th>Box Number</th>
<th>Letter</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>G</td>
</tr>
<tr>
<td>2</td>
<td>M</td>
</tr>
<tr>
<td>3</td>
<td>E</td>
</tr>
<tr>
<td>4</td>
<td>E</td>
</tr>
<tr>
<td>5</td>
<td>R</td>
</tr>
<tr>
<td>6</td>
<td>E</td>
</tr>
<tr>
<td>7</td>
<td>I</td>
</tr>
<tr>
<td>8</td>
<td>V</td>
</tr>
<tr>
<td>9</td>
<td>B</td>
</tr>
<tr>
<td>10</td>
<td>T</td>
</tr>
<tr>
<td>11</td>
<td>D</td>
</tr>
<tr>
<td>12</td>
<td>L</td>
</tr>
<tr>
<td>13</td>
<td>I</td>
</tr>
<tr>
<td>14</td>
<td>Y</td>
</tr>
<tr>
<td>15</td>
<td>R</td>
</tr>
<tr>
<td>16</td>
<td>E</td>
</tr>
<tr>
<td>17</td>
<td>E</td>
</tr>
<tr>
<td>18</td>
<td>E</td>
</tr>
<tr>
<td>19</td>
<td>O</td>
</tr>
<tr>
<td>20</td>
<td>G</td>
</tr>
<tr>
<td>21</td>
<td>T</td>
</tr>
<tr>
<td>22</td>
<td>A</td>
</tr>
<tr>
<td>23</td>
<td>M</td>
</tr>
<tr>
<td>24</td>
<td>V</td>
</tr>
<tr>
<td>25</td>
<td>I</td>
</tr>
</tbody>
</table>
Scientific Calculator Activity

The Power Key

The power key on many calculators makes it easier to evaluate expressions with exponents. It is usually labeled $y^x$ or $\wedge$.

**Example 1**
Evaluate $5^4$.

Enter: $5 \ 4 \ \text{ENTER}$

Therefore, $5^4 = 625$.

**Example 2**
Evaluate $2^5 \cdot 4^3$.

Enter: $2 \ 5 \ \times \ 4 \ \text{ENTER}$

Therefore, $2^5 \cdot 4^3 = 2,048$.

**Exercises**

Evaluate each expression.

1. $3^8$
2. $52^4$
3. $2 \cdot 6^3$
4. $4^3 \cdot 2^7$
5. $3 \cdot 2^5 \cdot 4^5$
6. $5^3 \cdot 4^2 \cdot 2^5$
7. $5^4 - 3^3$
8. $2 \cdot 4^3 + 3^4$
9. $3 \cdot 5^3 + 4 \cdot 2^7$
10. $5 \cdot 2^3 - 3 \cdot 2^3$
11. $(4 + 5)^2 + 6^3 \cdot 2^5$
12. $(3^5 - 2^5) \cdot 5^5$
13. **CHALLENGE** $10 \cdot 7^3 + 6 \cdot 2^3 \cdot 3^4 - 5 \cdot 4^3$
Get Ready for the Lesson

Read the introduction at the top of page 130 in your textbook. Write your answers below.

1. | Expression          | Product |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$8.7 \times 10^1 = 8.7 \times 10$</td>
<td>87</td>
</tr>
<tr>
<td>$8.7 \times 10^2 = 8.7 \times 100$</td>
<td></td>
</tr>
<tr>
<td>$8.7 \times 10^3 = 8.7 \times$</td>
<td></td>
</tr>
</tbody>
</table>

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?

Read the Lesson

4. How can you tell that a number is in standard form?

Identify each positive number as either very large or very small.

5. 9,245,000
6. 0.00083986
7. 0.0000003
8. 1,000,000,000

For each pair of numbers, determine how many places the decimal has moved and whether the exponent of the original would be positive or negative in scientific notation.

9. $0.00037 \rightarrow 3.7$
10. $185,000 \rightarrow 1.85$

Write each number in scientific notation.

11. 8,790,000
12. 0.0000125
13. 0.00899
14. 402,500,000

Remember What You Learned

15. Work with a partner. One person should explain how to write a very large number in scientific notation. The other person should explain how to write a very small number in scientific notation.
2-10
Study Guide and Intervention
Scientific Notation

A number in scientific notation is written as the product of a factor that is at least one but less than ten and a power of ten.

**Example 1**
Write $8.65 \times 10^7$ in standard form.

$$8.65 \times 10^7 = 8.65 \times 10,000,000 \quad 10^7 = 10 \cdot 10 \cdot 10 \cdot 10 \cdot 10 \cdot 10 \cdot 10 \text{ or } 10,000,000$$

Move the decimal point 7 places to the right.

**Example 2**
Write $9.2 \times 10^{-3}$ in standard form.

$$9.2 \times 10^{-3} = 9.2 \times \frac{1}{10^3} \quad 10^{-3} = \frac{1}{10^3} = \frac{1}{1,000} \text{ or } 0.001$$

$$= 9.2 \times 0.001$$

$$= 0.0092$$

Move the decimal point 3 places to the left.

**Example 3**
Write 76,250 in scientific notation.

$$76,250 = 7.625 \times 10,000$$

The decimal point moves 4 places.

$$= 7.625 \times 10^4$$

The exponent is positive.

**Example 4**
Write 0.00157 in scientific notation.

$$0.00157 = 1.57 \times 0.001$$

The decimal point moves 3 places.

$$= 1.57 \times 10^{-3}$$

The exponent is negative.

**Exercises**

Write each number in standard form.

1. $5.3 \times 10^1$
2. $9.4 \times 10^3$
3. $7.07 \times 10^5$
4. $2.6 \times 10^{-3}$
5. $8.651 \times 10^{-2}$
6. $6.7 \times 10^{-6}$

Write each number in scientific notation.

7. 561
8. 14
9. 56,400,000
10. 0.752
11. 0.0064
12. 0.000581
Write each number in standard form.

1. \(6.7 \times 10^1\)
2. \(6.1 \times 10^4\)

3. \(1.6 \times 10^3\)
4. \(3.46 \times 10^2\)

5. \(2.91 \times 10^5\)
6. \(8.651 \times 10^7\)

7. \(3.35 \times 10^{-1}\)
8. \(7.3 \times 10^{-6}\)

9. \(1.49 \times 10^{-7}\)
10. \(4.0027 \times 10^{-4}\)

11. \(5.2277 \times 10^{-3}\)
12. \(8.50284 \times 10^{-2}\)

Write each number in scientific notation.

13. 34
14. 273

15. 79,700
16. 6,590

17. 4,733,800
18. 2,204,000,000

19. 0.00916
20. 0.29

21. 0.00000571
22. 0.0008331

23. 0.0121
24. 0.00000018
2-10 Practice

Scientific Notation

Write each number in standard form.

1. \(9.03 \times 10^2\)  
2. \(7.89 \times 10^3\)  
3. \(4.115 \times 10^5\)  
4. \(3.201 \times 10^6\)  
5. \(5.1 \times 10^{-2}\)  
6. \(7.7 \times 10^{-5}\)  
7. \(3.85 \times 10^{-4}\)  
8. \(1.04 \times 10^{-3}\)

Write each number in scientific notation.

9. \(4,400\)  
10. \(75,000\)  
11. \(69,900,000\)  
12. \(575,000,000\)  
13. \(0.084\)  
14. \(0.0099\)  
15. \(0.000000515\)  
16. \(0.0000307\)

17. Which number is greater: \(3.5 \times 10^4\) or \(2.1 \times 10^6\)?

18. Which number is less: \(7.2 \times 10^7\) or \(9.9 \times 10^5\)?

19. POPULATION The table lists the populations of five countries. List the countries from least to greatest population.

<table>
<thead>
<tr>
<th>Country</th>
<th>Population</th>
</tr>
</thead>
</table>
| Australia    | \(2.0 \times 10^7\)  
| Brazil       | \(1.9 \times 10^8\)  
| Egypt        | \(7.7 \times 10^7\)  
| Luxembourg   | \(4.7 \times 10^5\)  
| Singapore    | \(4.4 \times 10^8\)  

Source: The World Factbook

20. SOLAR SYSTEM Pluto is \(3.67 \times 10^9\) miles from the Sun. Write this number in standard form.

21. MEASUREMENT One centimeter is equal to about \(0.0000062\) mile. Write this number in scientific notation.

22. DISASTERS In 2005, Hurricane Katrina caused over \(125\) billion in damage in the southern United States. Write \$125 billion in scientific notation.
### Word Problem Practice

**Scientific Notation**

<table>
<thead>
<tr>
<th>1. MEASUREMENT</th>
<th>There are about 25.4 millimeters in one inch. Write this number in scientific notation.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. POPULATION</td>
<td>In the year 2000, the population of Rahway, New Jersey, was 26,500. Write this number in scientific notation.</td>
</tr>
<tr>
<td>3. MEASUREMENT</td>
<td>There are 5,280 feet in one mile. Write this number in scientific notation.</td>
</tr>
<tr>
<td>4. PHYSICS</td>
<td>The speed of light is about $1.86 \times 10^5$ miles per second. Write this number in standard notation.</td>
</tr>
<tr>
<td>5. COMPUTERS</td>
<td>A CD can store about 650,000,000 bytes of data. Write this number in scientific notation.</td>
</tr>
<tr>
<td>6. SPACE</td>
<td>The diameter of the Sun is about $1.39 \times 10^9$ meters. Write this number in standard notation.</td>
</tr>
<tr>
<td>7. ECONOMICS</td>
<td>The U.S. Gross Domestic Product in the year 2004 was $1.17 \times 10^{13}$ dollars. Write this number in standard notation.</td>
</tr>
<tr>
<td>8. MASS</td>
<td>The mass of planet Earth is about $5.98 \times 10^{24}$ kilograms. Write this number in standard notation.</td>
</tr>
</tbody>
</table>