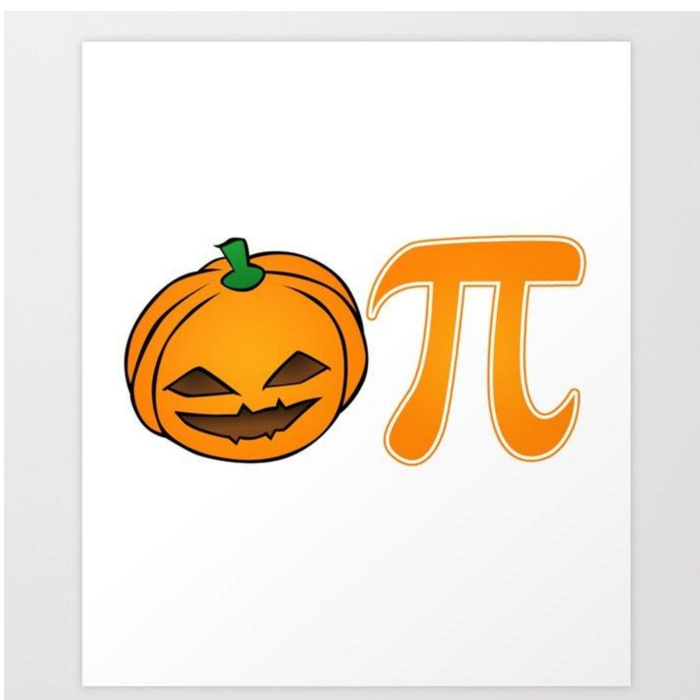
UNIT 4

Classwork Packet

Topics:

Solving Equations with Rational Coefficients
Solving Two-Step Equations
Writing Equations
More Two-Step Equations
Solving Equations with Variables on Both Sides
Inequalities
Solving Inequalities
Solving Multi-Step Equations and Inequalities

Sequences
Properties of Operations
Adding & Subtracting Expressions
Order of Operations (complex)
Exponents
Simplifying Algebraic Expressions
Distributive Property



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Lesson 1 Reteach

Solving Equations with Rational Coefficients

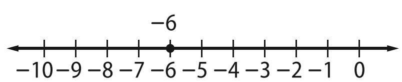
Multiplication Property of Equality	**Division Property of Equality**
If you multiply each side of an equation by the same nonzero number, the two sides remain equal.	If you divide each side of an equation by the same nonzero number, the two sides remain equal.

Example **Solve $-7.1x = 42.6$. Check your solution and graph it on a number line.**

$-7.1x = 42.6$	Write the equation.
$\frac{-7.1x}{-7.1} = \frac{42.6}{-7.1}$	Division Property of Equality
$1x = -6$	$-7.1 \div -7.1 = 1$, $42.6 \div -7.1 = -6$
$x = -6$	Identity Property; $1x = x$
Check $-7.1x = 42.6$	Write the equation.
$-7.1(-6) \stackrel{?}{=} 42.6$	Replace x with -6 and check to see if the sentence is true.
$42.6 = 42.6$ ✓	The sentence is true.

The solution is -6.

To graph -6, draw a dot at -6 on the number line.



Exercises

Solve each equation. Check your solutions.

1. $-\frac{1}{2}a = -4$

2. $5.7d = 6.84$

3. $\frac{2}{3}m = -18$

4. $4d = -34$

5. $-9.3 = -6.2p$

6. $-\frac{1}{4}k = -\frac{3}{5}$

7. $-\frac{2}{3}g = 30$

8. $-16.8y = -67.2$

9. $\frac{3}{8}w = -\frac{1}{16}$

10. $0.4m = 20.4$

11. $-\frac{7}{10}y = \frac{2}{5}$

12. $0.9t = 0.63$

13. $-\frac{1}{5}b = -\frac{1}{15}$

14. $-2.5p = -65$

15. $47 = -5j$

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Lesson 2 Reteach

Solving Two-Step Equations

A two-step equation contains two operations. To solve two-step equations, use inverse operations to undo each operation in reverse order of the order of operations. First, undo addition/subtraction. Then, undo multiplication/division.

Example 1 **Solve $\frac{1}{2}c - 13 = 7$. Check your solution.**

$\frac{1}{2}c - 13 = 7$	Write the equation.
$\frac{1}{2}c - 13 + 13 = 7 + 13$	Addition Property of Equality
$\frac{1}{2}c = 20$	Simplify.
$2 \cdot \frac{1}{2}c = 2 \cdot 20$	Multiplication Property of Equality
$c = 40$	Simplify. Check your solution.

Check $\frac{1}{2}c - 13 = 7$

$$\frac{1}{2}(40) - 13 \stackrel{?}{=} 7$$
$$20 - 13 \stackrel{?}{=} 7$$
$$7 = 7 \checkmark$$

Example 2 **Solve $7y - 2y + 4 = 29$. Check your solution.**

$7y - 2y + 4 = 29$	Write the equation.
$5y + 4 = 29$	Combine like terms.
$\underline{-4 = -4}$	Subtraction Property of Equality
$5y = 25$	Simplify.
$\frac{5y}{5} = \frac{25}{5}$	Division Property of Equality
$y = 5$	Simplify. Check your solution.

Check $7y - 2y + 4 = 29$

$$7(5) - 2(5) + 4 \stackrel{?}{=} 29$$
$$35 - 10 + 4 \stackrel{?}{=} 29$$
$$25 + 4 \stackrel{?}{=} 29$$
$$29 = 29 \checkmark$$

Exercises

Solve each equation. Check your solutions.

1. $5t + 2 = 7$

2. $2x + 5 = 9$

3. $6.2u - 8 = 29.2$

4. $8m - 7 = 17$

5. $\frac{1}{7}m - 9 = 5$

6. $\frac{1}{9}k - 3 = -11$

7. $13 + \frac{1}{4}a = -3$

8. $-3 + \frac{1}{2}c = 12$

9. $7 - h = 209$

10. $-g + 18 = -32$

11. $16.4 - p = 3.5$

12. $-\frac{2}{5}c - 8 = 32$

13. $\frac{3}{8}q + 12 = 36$

14. $3 - \frac{3}{4}n = 9$

15. $\frac{7}{9}v + 2 = 23$

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Lesson 3 Reteach

Writing Equations

Just as phrases can be represented as expressions, sentences can be represented as equations.

Phrase: two more than three times a number

Expression: $2 + 3n$

Sentence: Two more than three times a number is 11.

Equation: $2 + 3n = 11$

Example **Clint has 95 trading cards. This is 17 more than three times the number of cards his brother Wyatt has.**

Words	Three times the number of Wyatt's cards plus 17 equals the number of Clint's cards.
Symbols	Let w = the number of Wyatt's cards.
Equation	$3w + 17 = 95$

Exercises

Translate each sentence into an equation.

1. Nine more than half of a number is 21.

2. Six fewer than $\frac{1}{3}$ of a number is 27.

3. Eleven more than three times a number is 101.

4. The quotient of a number and three tenths decreased by 2 is 6.

5. Julie has 66 stuffed animals which is 8 fewer than twice the number of stuffed animals that Carly has.

6. The \$22 Mara spent at a museum gift shop was \$4 more than twice the admission to the museum.

7. A hamburger costs \$7 which is \$2 more than one-third the cost of a pizza.

8. Riley lives 62 miles from his grandma's house which is 22 miles farther than one-quarter the distance to his aunt's house.

9. Angie is 11, which is 3 years younger than 4 times her sister's age.

10. A puppy weighs 14 pounds which is 6 more than one-fifth the mother dog's weight.

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Lesson 4 Reteach

More Two-Step Equations

Solving equations of the form $p(x + q) = r$, can be accomplished in one of two ways:

1. When p is a factor of the constant term, r, then:

- use the Division Property of Equality when p is a whole number or decimal.
- use the Multiplication Property of Equality when p is a fraction.

2. Regardless if p is or is not a factor of the constant term, r, you can use the Distributive Property.

Example 1 Solve the equation $-3(x + 4) = 27$.

$-3(x + 4) = 27$	Write the equation.
$\frac{-3(x+4)}{-3} = \frac{27}{-3}$	Division Property of Equality
$x + 4 = -9$	Simplify.
$x + 4 - 4 = -9 - 4$	Subtraction Property of Equality
$x = -13$	Simplify.

Example 2 Solve $2(d - 10) = -6$.

$2(d - 10) = -6$	Write the equation.
$2d - 20 = -6$	Distributive Property
$2d - 20 + 20 = -6 + 20$	Addition Property of Equality
$2d = 14$	Simplify.
$\frac{2d}{2} = \frac{14}{2}$	Division Property of Equality
$d = 7$	Simplify.

Exercises Solve each equation.

1. $2(y + 7) = 20$

2. $-4(v - 1) = 16$

3. $39 = 13(x - 8)$

4. $99 = 11(q + 4)$

5. $\frac{3}{4}(n - 3) = 18$

6. $\frac{4}{9}(p + 8) = -20$

7. $36 = \frac{3}{8}(k - 5)$

8. $\frac{1}{2}(c + 2) = 5$

9. $0.2(g + 12) = 50$

10. $-2.7(a + 9) = 13.5$

11. $2(b - 13) = 15$

12. $-6(d + 14) = -57$

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Lesson 5 Reteach

Solving Equations with Variables on Each Side

To solve equations with variables on each side, use the Addition or Subtraction Property of Equality to write an equivalent equation with the variable on one side. Then solve the equation.

Example **Solve $12x - 3 = 4x + 13$.**

$12x - 3 = 4x + 13$	Write the equation.
$12x - 4x - 3 = 4x - 4x + 13$	Subtraction Property of Equality
$8x - 3 = 13$	Simplify.
$8x - 3 + 3 = 13 + 3$	Addition Property of Equality
$8x = 16$	Simplify.
$\frac{8x}{8} = \frac{16}{8}$	Division Property of Equality
$x = 2$	Simplify.

To check your solution, replace x with 2 in the original equation.

Check

$12x - 3 = 4x + 13$	Write the equation.
$12(2) - 3 \stackrel{?}{=} 4(2) + 13$	Replace x with 2.
$24 - 3 \stackrel{?}{=} 8 + 13$	Simplify.
$21 = 21$ ✓	The statement is true.

Exercises

Solve each equation. Check your solutions.

1. $2x + 1 = x + 11$

2. $a + 2 = 5 + 4a$

3. $7y + 25 = 2y$

4. $n + 11 = 2n$

5. $7 - \frac{1}{2}c = \frac{1}{4}c - 7$

6. $4 - 3b = 6b - 5$

7. $9d - 9 = 3d - 1.8$

8. $f - 4 = 6f + 26$

9. $-2s + 3 = 5s + 24$

10. $\frac{2}{3}a - 3 = \frac{1}{3}a + 6$

11. $8n - 12 = -12n + 8$

12. $7y + 8 = -2y - 64$

13. $1 + 3x = 7x - 9$

14. $6a - 3 = 4 + 7a$

15. $3b - 1 = 14 + 2b$

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Lesson 6 Reteach

Inequalities

A mathematical sentence that contains any of the symbols listed below is an **inequality**. The chart below will help you write inequalities.

$<$	$>$	$\leq$	$\geq$
• is less than • is fewer than	• is greater than • is more than • exceeds	• is less than or equal to • is no more than • is at most	• is greater than or equal to • is no less than • is at least

Inequalities can be graphed on a number line. This helps you see which values make the inequality true.

The direction of the line indicates whether numbers *greater than* or *less than* the number marked make the sentence true.

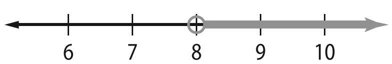
Example 1 **Write an inequality for the sentence.**

Fewer than 70 students attended the last dance.

Words	*Fewer than* 70 students attended the last dance.
Symbols	Let s = the number of students.
Inequality	$s < 70$

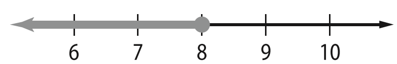
Example 2 **Graph each inequality on a number line.**

a. $x > 8$



The **open dot** means 8 *does not* make the sentence true. The line means that numbers greater than 8 make the sentence true.

b. $x \leq 8$



The **closed dot** means 8 *does* make the sentence true. The line means that numbers less than 8 make the sentence true.

Exercises

Write an inequality for each sentence.

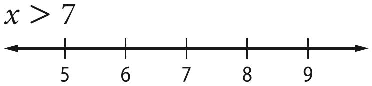
1. The maximum diving depth is no more than 45 feet below sea level.

2. The maximum fee for any student is $15.

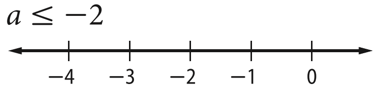
3. You must be at least 38 inches tall to ride the roller coaster.

Graph each inequality on a number line.

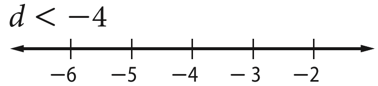
4. $x > 7$



5. $a \leq -2$



6. $d < -4$



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Lesson 7 Reteach

Solving Inequalities

Use the Addition and Subtraction Properties of Inequalities to solve inequalities. When you add or subtract a number from each side of an inequality, the inequality remains true.

Example 1 **Solve $12 + y > 20$. Check your solution.**

$12 + y > 20$	Write the inequality.
$12 - 12 + y > 20 - 12$	Subtraction Property of Inequality
$y > 8$	Simplify.

The solution is $y > 8$. You can check this solution by substituting a number greater than 8 into the inequality.

Use the Multiplication and Division Properties of Inequalities to solve inequalities.

- When you multiply or divide each side of an inequality by a positive number, the inequality remains true. The direction of the inequality sign does not change.
- For an inequality to remain true when multiplying or dividing each side of the inequality by a negative number, however, you must reverse the direction of the inequality symbol.

Example 2 **Solve $\frac{y}{-12} < 4$. Check your solution.**

$\frac{y}{-12} < 4$	Write the inequality.
$-12\left(\frac{y}{-12}\right) > -12(4)$	Multiplication Property of Inequality
$y > -48$	Simplify.

The solution is $y > -48$. You can check this solution by substituting a number greater than -48 into the inequality.

Exercises

Solve each inequality. Check your solutions.

1. $-12 < 8 + b$

2. $t - 5 > -4$

3. $p + 5 < -13$

4. $14 > w + (-2)$

5. $j + 6 \geq -4$

6. $z + (-4) < -2.5$

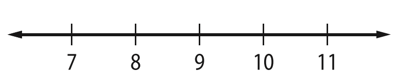
7. $b - \frac{1}{4} < 2\frac{1}{4}$

8. $g - 2\frac{1}{3} \geq 3\frac{1}{6}$

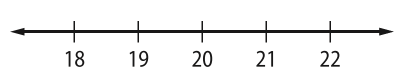
9. $-2 + z < 5$

Solve each inequality. Graph each solution on a number line.

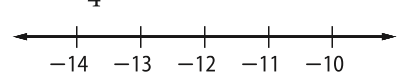
10. $81 < 9d$



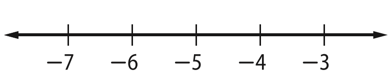
11. $-8 < \frac{c}{-2.5}$



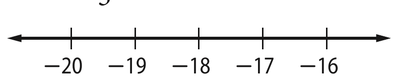
12. $\frac{h}{-4} \geq 3$



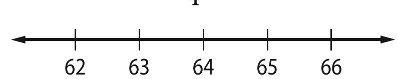
13. $-20t \leq 100$



14. $-\frac{2}{3}x > 12$



15. $-16 \leq -\frac{1}{4}b$



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Lesson 8 Reteach

Solving Multi-Step Equations and Inequalities

Equations with grouping symbols can be solved by first using the Distributive Property to remove the grouping symbols.

Example 1 Solve $2(6m - 1) = 8m$. Check your solution.

$2(6m - 1) = 8m$	Write the equation.
$12m - 2 = 8m$	Distributive Property
$12m - 12m - 2 = 8m - 12m$	Subtraction Property of Equality
$-2 = -4m$	Simplify.
$\frac{-2}{-4} = \frac{-4m}{-4}$	Division Property of Equality
$\frac{1}{2} = m$	Simplify.

Check

$2(6m - 1) = 8m$	Write the equation.
$2\left[6\left(\frac{1}{2}\right) - 1\right] \stackrel{?}{=} 8\left(\frac{1}{2}\right)$	Replace m with $\frac{1}{2}$.
$2(3 - 1) \stackrel{?}{=} 4$	Simplify.
$4 = 4 \checkmark$	The solution checks.

Some equations have no solution. The solution set is the **null** or **empty set,** which is represented by Ø. Other equations have every number as a solution. Such an equation is called an **identity.**

Example 2 Solve each equation.

a. $\mathbf{2(x - 1) = 4 + 2x}$

$$2x - 2 = 4 + 2x$$
$$2x - 2x - 2 = 4 + 2x - 2x$$
$$-2 = 4$$

The statement $-2 = 4$ is *never* true. The equation has no solutions and the solution set is Ø.

b. $\mathbf{-2(x - 1) = 2 - 2x}$

$$-2x + 2 = 2 - 2x$$
$$-2x + 2 - 2 = 2 - 2 - 2x$$
$$-2x = -2x$$
$$x = x$$

The statement $x = x$ is *always* true. The equation is an identity and the solution set is all numbers.

Exercises

Solve. Check your solutions.

1. $8(g - 3) = 24$

2. $5(x + 3) = 25$

3. $2(3d + 7) = 5 + 6d$

4. $2(s + 11) = 5(s + 2)$

5. $7y - 1 = 2(y + 3) - 2$

6. $2(f + 3) - 2 = 8 + 2f$

7. $2(x - 2) + 3 = 2x - 1$

8. $1 + 2(b + 6) = 5(b - 1)$

9. $2x - 5 = 3(x + 3)$

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Lesson 1 Reteach

Ratios

A **ratio** is a way to compare two quantities using division. Ratios can be written in a number of ways. The ratio representing 7 out of 12 can be written as: 7 to 12, 7:12, and $\frac{7}{12}$.
Ratios are usually written as fractions in simplest form when the first number being compared is less than the second number being compared.

Example 1 **Express the ratio *16 correct answers out of 20 questions* as a fraction in simplest form. Explain its meaning.**

$$\frac{\text{correct answers}}{\text{number of questions}} = \frac{16}{20} \overset{\div 4}{=} \frac{4}{5}$$ Divide the numerator and denominator by the GCF, 4.

The ratio of correct answers to questions is 4 to 5. This means that for every 5 questions, 4 were answered correctly. Also, $\frac{4}{5}$ of the questions were answered correctly.

When a ratio involves measurements, both quantities should have the same unit of measure. When the quantities have different units of measure, you must convert one unit to the other. It is usually easiest to convert the larger unit to the smaller unit.

Example 2 **Express the ratio *6 feet to 15 inches* as a fraction in simplest form.**

$\frac{6 \text{ feet}}{15 \text{ inches}}$ Write the ratio as a fraction.

$= \frac{72 \text{ inches}}{15 \text{ inches}}$ Convert 6 feet to 72 inches.

$= \frac{24}{5}$ Divide the numerator and denominator by the GCF, 3.

Written in simplest form, the ratio is 24 to 5.

Exercises

Express each ratio as a fraction in simplest form.

1. 4 weeks to plan 2 events

2. 9 children to 24 adults

3. 8 teaspoons to 12 forks

4. 16 cups to 10 servings

5. 7 shelves to 84 books

6. 6 teachers to 165 students

7. 14 inches to 3 feet

8. 20 inches to 2 yards

9. 9 feet to 12 inches

10. 4 gallons to 2 quarts

11. 3 pints to 2 quarts

12. 22 ounces to 5 pounds

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Lesson 2 Reteach

Unit Rates

A **rate** is a ratio of two quantities having different kinds of units.

$$\frac{30 \text{ miles}}{2 \text{ hours}}$$

different kinds of units

A **unit rate** is a rate with a denominator of 1.
To change a rate to a unit rate, divide the numerator by the denominator.

$$\frac{30 \text{ miles}}{2 \text{ hours}} \overset{\div 2}{\underset{\div 2}{=}} \frac{15 \text{ miles}}{1 \text{ hour}}$$

Example **Express the rate *$10 for 8 fish* as a unit rate.**

$\frac{10 \text{ dollars}}{8 \text{ fish}}$ Write the ratio as a fraction.

$\frac{10 \text{ dollars}}{8 \text{ fish}} \overset{\div 8}{\underset{\div 8}{=}} \frac{1.25 \text{ dollars}}{1 \text{ fish}}$ Divide the numerator and denominator by 8 to get a denominator of 1.

The unit rate is $1.25 per fish.

Exercises

Express each rate as a unit rate. Round to the nearest tenth or nearest cent, if necessary.

1. $58 for 5 tickets

2. $4.19 for 4 cans of soup

3. $274.90 for 6 people

4. 565 miles in 12 hours

5. 237 pages in 8 days

6. $102 dollars over 12 hours

7. 180 words in 5 minutes

8. $6.99 for 5 cans

9. Shawna strung 5 necklaces in 2 hours. How many necklaces could she string in 7 hours?

10. At Funtimes Gym, eight 1-hour classes cost $96. At Fitness Place, twelve 1-hour classes cost $132. Which gym offers the best rate per hour?

11. Jamie downloaded 8 songs in 3 minutes. At this rate, how many songs could he download in 30 minutes?

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Lesson 3 Reteach

Complex Fractions and Unit Rates

Complex fractions are fractions with a numerator that is a fraction, a denominator that is a fraction, or both that are fractions.

Example **Simplify $\dfrac{2}{\frac{3}{4}}$.**

$\dfrac{2}{\frac{3}{4}} = 2 \div \dfrac{3}{4}$ Write the complex fraction as a division problem.

$= \dfrac{2}{1} \times \dfrac{4}{3}$ Multiply by the reciprocal of $\frac{3}{4}$, which is $\frac{4}{3}$.

$= \dfrac{8}{3}$ or $2\dfrac{2}{3}$ Simplify.

So, $\dfrac{2}{\frac{3}{4}}$ is equal to $2\frac{2}{3}$.

Exercises

Simplify.

1. $\dfrac{3}{\frac{1}{3}}$

2. $\dfrac{5}{\frac{3}{7}}$

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

4. $\dfrac{2}{\frac{4}{9}}$

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

6. $\dfrac{10}{\frac{7}{8}}$

7. $\dfrac{\frac{3}{5}}{\frac{3}{7}}$

8. $\dfrac{\frac{1}{6}}{\frac{5}{6}}$

9. $\dfrac{\frac{4}{5}}{\frac{9}{10}}$

10. $\dfrac{\frac{3}{5}}{\frac{3}{10}}$

Lesson 4 Reteach

Converting Rates

Dimensional analysis is the process of including units of measurement as factors when you compute.

Example 1 **A cheetah can run short distances at a speed of up to 75 miles per hour. How many feet per second is this?**

You need to convert miles per hour to feet per second.

Use 1 mile = 5280 feet and 1 hour = 3600 seconds.

$$\frac{75\text{ mi}}{1\text{ h}} = \frac{75\text{ mi}}{1\text{ h}} \cdot \frac{5280\text{ ft}}{1\text{ mi}} \cdot \frac{1\text{ h}}{3600\text{ s}}$$ Multiply by $\frac{5280\text{ ft}}{1\text{ mi}}$ and $\frac{1\text{ h}}{3600\text{ s}}$.

$$= \frac{\overset{5}{\cancel{75}}\ \cancel{\text{mi}}}{1\ \cancel{\text{h}}} \cdot \frac{\overset{22}{\cancel{5280}}\text{ ft}}{1\ \cancel{\text{mi}}} \cdot \frac{1\ \cancel{\text{h}}}{\underset{\underset{1}{\cancel{15}}}{\cancel{3600}}\text{ s}}$$ Divide the common factors and units.

$$= \frac{110\text{ ft}}{1\text{ s}}$$ Simplify.

So, 75 miles per hour is equivalent to 110 feet per second.

Example 2 **Convert 2 gallons to liters. Round to the nearest hundredth.**

Use 1 liter ≈ 0.264 gallons.

$$2\text{ gal} \approx 2\text{ gal} \cdot \frac{1\text{ L}}{0.264\text{ gal}}$$ Multiply by $\frac{1\text{ L}}{0.264\text{ gal}}$.

$$\approx 2\ \cancel{\text{gal}} \cdot \frac{1\text{ L}}{0.264\ \cancel{\text{gal}}}$$ Divide out the common units, leaving the desired unit, liter.

$$\approx \frac{2\text{ L}}{0.264}\text{ or }7.58\text{ L}$$ Simplify.

So, 2 gallons is approximately 7.58 liters.

Exercises

1. Jake was in a bicycle race. His average speed was 22 miles per hour. At this rate, how many feet per hour did Jake travel?

2. Giant pandas can spend up to 16 hours a day eating bamboo. How many minutes per day is this?

3. Karin discovered that her leaky faucet was leaking 1.25 cups of water an hour. At this rate, how many gallons a day were leaking?

Complete each conversion. Round to the nearest hundredth.

4. 8 L ≈ ■ qt **5.** 6 pt ≈ ■ mL **6.** 22 kg ≈ ■ lb **7.** 3 m ≈ ■ in.

8. The average American uses about 90 gallons of water per day. How many liters per year is this?

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Lesson 5 Reteach

Proportional and Nonproportional Relationships

Two quantities are **proportional** if they have a constant ratio or rate. If they do not have the same ratio or rate, they are said to be **nonproportional**.

Example 1 **Determine whether the distance traveled is proportional to the time. Explain your reasoning.**

Time (min)	1	2	3	4
Distance (yd)	300	600	900	1200

Write the rate of distance to time for each column. Simplify each fraction.

$\frac{300}{1} = \frac{300}{1}$ $\frac{600}{2} = \frac{300}{1}$ $\frac{900}{3} = \frac{300}{1}$ $\frac{1200}{4} = \frac{300}{1}$

Since all of the rates equal $\frac{300}{1}$, the distance traveled is proportional to the time.

Proportional relationships can be described using equations of the form $y = kx$, where k is the constant ratio. The constant ratio is the **constant of proportionality.**

Example 2 **The perimeter of a square with a side of 3 inches is 12 inches. A square's perimeter is proportional to the length of one of its sides. Find the constant of proportionality. Then write an equation relating the perimeter of a square to the length of one of its sides. What would be the perimeter of a square with 9-inch sides?**

Find the constant of proportionality between perimeter and side length.

$\frac{\text{perimeter}}{\text{length of sides}} = \frac{12}{3}$ or 4

Words: The perimeter is 4 times the length of a side.
Variable: Let P = perimeter and s = the length of a side.
Equation: $P = 4s$

$P = 4s$ Write the equation.
$P = 4(9)$ Replace s with the length of a side.
$P = 36$ Multiply.

The perimeter of a square with a side of 9 inches is 36 inches.

Exercises

Determine whether the set of numbers in each table is proportional. If the relationship is proportional, identify the constant of proportionality. Explain your reasoning.

1.

Cookies	6	9	12	15
Cupcakes	4	6	8	10

2.

Population (100,000)	1.3	2.1	3.3	5.2
Years	1	2	3	4

3. Gloria earned \$26 for babysitting 4 hours. Find the constant of proportionality. Then write an equation relating money earned to the number of hours. How much would Gloria earn after babysitting 25 hours?

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Lesson 6 Reteach

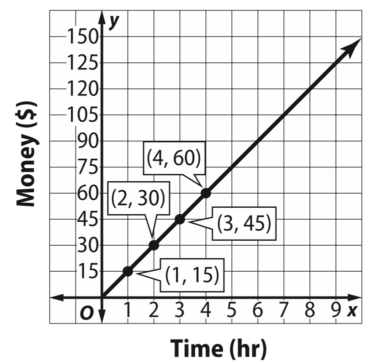
Graphing Proportional Relationships

If two quantities are proportional, the graph of the two quantities is a straight line through the origin. You can use a graph of the quantities to find the constant ratio between the quantities, or the **constant of proportionality**.

Example **Miranda earns $15 per hour for babysitting. Is the amount of money she earns proportional to the number of hours she spends babysitting?**

Time (hr)	0	1	2	3	4
Money ($)	0	15	30	45	60

Graph the ordered pairs on the coordinate plane. Then connect the ordered pairs.



The graph passes through the origin and is a straight line. So, the amount of money Miranda earns babysitting is proportional to the number of hours she spends babysitting.

Check Write the ratio of money to time for each ordered pair in simplest form.

$\frac{15}{1}$ $\quad \frac{30}{2} = \frac{15}{1}$ $\quad \frac{45}{3} = \frac{15}{1}$ $\quad \frac{60}{4} = \frac{15}{1}$

The ratios are all the same. The relationship is proportional.

Exercises

Determine whether each relationship is proportional by graphing on the coordinate plane. Explain your reasoning.

1.

Radius	1	2	3	4	5
Circumference	2π	4π	6π	8π	10π

2.

Teachers	1	2	3	4	5
Students	15	28	40	55	75

3. A recipe for chocolate chip cookies uses 3 cups flour and 2 sticks of butter. Is the amount of butter used proportional to the number of cups of flour used? Explain your reasoning.

4. What is the constant of proportionality between the perimeter of a square to its side length, s? Explain what it means.

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Lesson 7 Reteach

Solving Proportions

A **proportion** is an equation stating that two ratios or rates are equal.

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

An important property of proportions is that their cross products are equal. You can use this property to solve problems involving proportions.

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

$$ad = bc$$

Example

Solve the proportion $\frac{14.1}{c} = \frac{3}{4}$.

$\frac{14.1}{c} = \frac{3}{4}$

$14.1 \cdot 4 = c \cdot 3$ Cross products

$56.4 = 3c$ Multiply.

$\frac{56.4}{3} = \frac{3c}{3}$ Divide.

$18.8 = c$ Simplify.

The solution is 18.8.

Exercises

Solve each proportion.

1. $\frac{x}{9} = \frac{16}{12}$

2. $\frac{32}{28} = \frac{w}{7}$

3. $\frac{5}{u} = \frac{60}{132}$

4. $\frac{36}{21} = \frac{24}{s}$

5. $\frac{a}{64} = \frac{225}{480}$

6. $\frac{42}{w} = \frac{56}{8}$

7. $\frac{1}{10} = \frac{m}{12}$

8. $\frac{5}{3} = \frac{85}{h}$

9. $\frac{24}{g} = \frac{2}{30}$

10. $\frac{f}{21} = \frac{57}{63}$

11. $\frac{22}{z} = \frac{121}{16.5}$

12. $\frac{2}{3} = \frac{k}{12.6}$

13. $\frac{r}{9} = \frac{5}{20}$

14. $\frac{d}{21} = \frac{1.5}{3.5}$

15. $\frac{46}{57.5} = \frac{360}{q}$

16. $\frac{4.2}{4.8} = \frac{d}{80}$

17. $\frac{1}{c} = \frac{4.5}{11.7}$

18. $\frac{0.3}{n} = \frac{4.75}{14.25}$

19. $\frac{9.1}{14.7} = \frac{1.3}{p}$

20. $\frac{0.4}{3} = \frac{y}{98.25}$

21. $\frac{v}{33.44} = \frac{1}{3.2}$

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Lesson 8 Reteach

Scale Drawings and Models

Scale drawings or **scale models** represent objects that are either too large or too small to be drawn or built at actual size. The lengths and widths of objects on a scale drawing or model are proportional to the corresponding lengths and widths on the actual object.

The **scale** of a drawing or model is the ratio of a given measure on the drawing or model and the corresponding measure on the actual object. If the measurements are in the same unit, the scale can be written without units. In this case, it is called the **scale factor**.

Example 1 **A map shows a scale of 1 inch = 6 miles. The distance between two places on the map is 4.25 inches. What is the actual distance?**

Let x represent the actual distance. Write and solve a proportion.

$$\begin{array}{rcl} \text{map width} \rightarrow & \dfrac{1 \text{ inch}}{6 \text{ miles}} = \dfrac{4.25 \text{ inches}}{x \text{ miles}} & \leftarrow \text{map width} \\ \text{actual width} \rightarrow & & \leftarrow \text{actual width} \end{array}$$

$1 \cdot x = 6 \cdot 4.25$ Find the cross products.

$x = 25.5$ Simplify.

The actual distance is 25.5 miles.

Example 2 **Sam made a model car that is 9 inches long. The actual car that the model is based on is 13.5 feet long. Find the scale and the scale factor of the model.**

Write the ratio of the model's length to the length of the actual car. Then solve a proportion in which the model's length is 1 inch and the length of the actual car is x feet.

$$\begin{array}{rcl} \text{model length} \rightarrow & \dfrac{9 \text{ in.}}{13.5 \text{ ft}} = \dfrac{1 \text{ in.}}{x \text{ ft}} & \leftarrow \text{model length} \\ \text{actual length} \rightarrow & & \leftarrow \text{actual length} \end{array}$$

$9 \cdot x = 13.5 \cdot 1$ Find the cross products.

$9x = 13.5$ Simplify.

$x = 1.5$ Divide each side by 9. Simplify.

So, the scale is 1 inch = 1.5 feet.

To change this to a scale factor with the same units, first write as a ratio.

$\boxed{\text{scale}} \longrightarrow 1 \text{ inch} = 1.5 \text{ feet} \longrightarrow \dfrac{1 \text{ in.}}{1.5 \text{ ft}} \longrightarrow \dfrac{1 \text{ in.}}{18 \text{ in.}} \longrightarrow 1{:}18 \; \boxed{\text{scale factor}}$

Exercises

1. Joanna knows the distance to her grandmother's house is 21 miles. On a map, the distance is 5.25 inches. What is the scale of the map?

2. Kevin drew a scale drawing of his living room. The actual room is 16 feet long. If the room is 12 inches long in the drawing, what is the scale of the drawing?

3. Cindy's dad made her a dollhouse that is a scale model of their house. If their house is 45 feet tall and the model is 15 inches tall, what is the scale of the model?

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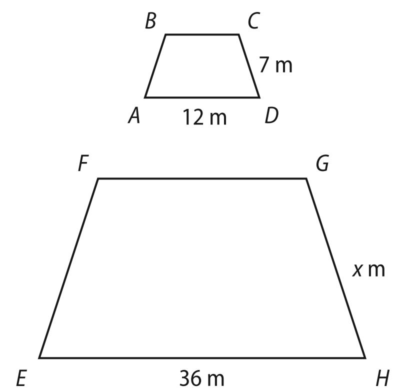
Lesson 9 Reteach

Similar Figures

Similar figures are figures that have the same shape but not necessarily the same size. If two figures are similar, then the corresponding angles have the same measure, and the corresponding sides are proportional. Because corresponding sides are proportional, you can use proportions or the scale factor to find the measures of the sides of similar figures when some measures are known. The scale factor is the ratio of a length on a scale drawing to the corresponding length on the real object. It is also the ratio of corresponding sides in similar figures.

Example

If the polygons *ABCD* and *EFGH* are similar, what is the value of *x*?

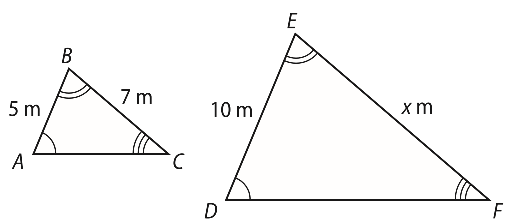


$\frac{AD}{EH} = \frac{CD}{GH}$	The corresponding sides are proportional. Write a proportion.
$\frac{12}{36} = \frac{7}{x}$	Replace *AD* with 12, *EH* with 36, *CD* with 7, and *GH* with *x*.
$12 \cdot x = 36 \cdot 7$	Find the cross products.
$12x = 252$	Simplify.
$x = 21$	Division Property of Equality

Exercises

The figures are similar. Find each missing measure.

1.



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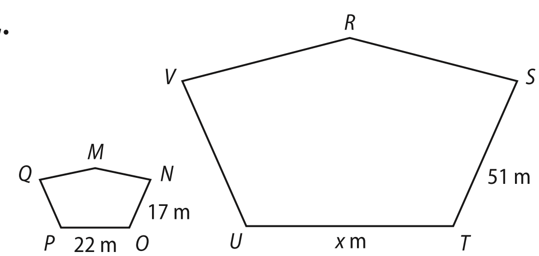

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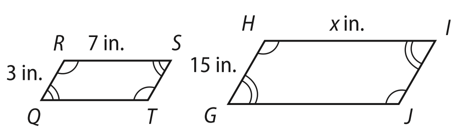

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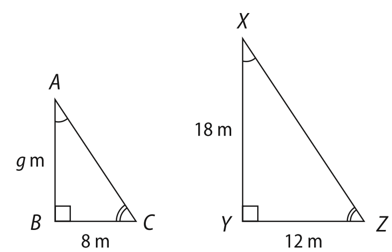
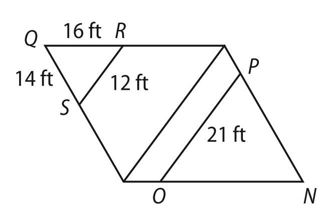


5. The art club is painting the mural shown at the right on a wall. Triangle *QRS* and triangle *NOP* are similar.



a. Find the length of $\overline{NO}$.

b. Find the length of $\overline{PN}$.

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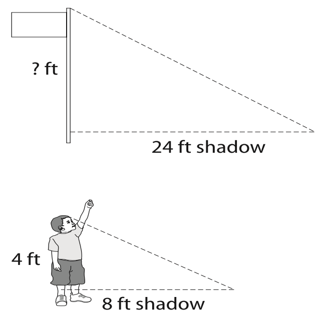
Lesson 10 Reteach

Indirect Measurement

The properties of similar triangles can be use to find measurements that are difficult to measure directly. This is called **indirect measurement.**

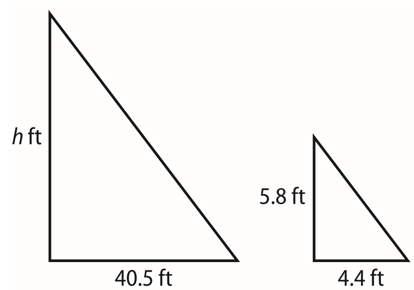
One type of indirect measurement is *shadow reckoning*. The diagram at the right shows how two objects and their shadows form two sides of similar triangles. You can use a proportion to find measures such as the height of the flag pole.



Example **A school building casts a 40.5-foot shadow at the same time a 5.8-foot student casts a 4.4-foot shadow. How tall is the school building to the nearest tenth?**

Understand You know the lengths of the shadows and the height of the student. You need to find the building's height.

Plan To find the height of the building, set up a proportion comparing the student's shadow to the building's shadow. Then solve.



Solve

student's height → $\frac{5.8}{h} = \frac{4.4}{40.5}$ ← student's shadow
building's height → ← building's shadow

$5.8 \cdot 40.5 = h \cdot 4.4$ Find the cross products.

$234.9 = 4.4h$ Multiply.

$53.4 \approx h$ Divide each side by 4.4.

The height of the school building is about 53.4 feet.

Exercises

1. Lena's house casts a shadow that is 14 feet long at the same time that Lena casts a shadow that is 3.5 feet long. If Lena is 4.5 feet tall, how tall is her house?

2. Suppose a rocket outside a science museum cast a shadow that was 176 feet. At the same time, a 5.75-foot-tall person standing next to the rocket casts a shadow that is 9.2 feet long. How tall is the rocket?

3. A cell phone tower casts a shadow that is 92 feet. A building next to the tower is 28 feet high and casts a shadow that is 11.2 feet long. How tall is the cell phone tower?

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Lesson 1 Problem-Solving Practice

Solving Equations with Rational Coefficients

1. Cooking time for a turkey is determined using the rate of $\frac{1}{3}$ hour per pound. Mrs. Milton figures she will have at most four hours to cook the turkey. What is the largest turkey she should buy?

2. Josh and his brother will drive from Boston to New York, a distance of 220 miles. If they drive an average speed of 50.5 miles per hour, how long will it take Josh and his brother to arrive in New York? Round to the nearest tenth.

3. A cell phone plan costs $0.20 cents per minute. Lisa has budgeted $35 a month for her cell phone. How many minutes Lisa can use each month?

4. It takes Greg $\frac{1}{6}$ hour to jog one mile. How many miles can Greg jog in 3 hours?

5. Kurt and four friends are eating in the food court at South Center Mall. They will divide the bill equally among the five of them. Two friends order hamburgers and two order pizza. All of them order soda. Kurt has only $3.75 with him. What can Kurt order so that each will pay only $3.75?

Hot dog	Pizza	Hamburger	Soda
$2.50	$1.75	$3.25	$1.25

6. Mr. Paulson plans to make 6 pounds of yams. If one person eats $\frac{1}{2}$ pound of yams, how many people can Mr. Paulson serve with 6 pounds of yams?

Lesson 2 Problem-Solving Practice

Solving Two-Step Equations

1. A plumber charges \$45 plus \$39.75 per hour of service. Miguel's bill was \$164.25. Solve the equation $45 + 39.75x = 164.25$. How many hours of service did the plumber charge?

2. A ranch in Wyoming is approximately 825,000 acres. A total of 8684 fenced-in areas (each with the same size) could fit inside the ranch, with 20 acres of ranch left over. Solve the equation $825{,}000 = 8684x + 20$ to find the number of acres each fenced-in area would cover.

3. Sasha researched the size of zoos in her state. She found that the zoo in the north part of the state is almost twice as large as the zoo in the south. She also found that the zoo in the south part of the state has 200 fewer than twice the number of animals as the northern zoo. How many animals per acre does each zoo have?

Zoo	Acres	Number of Animals
North	64	?
South	35	3800

4. The perimeter of a local dog park measures 158 feet. If the length of the park is 2 feet less than $\frac{1}{2}$ the width, what are the dimensions of the dog park?

5. A high school band needs \$1200 for a trip. So far they have raised \$430. They have 5 more fundraisers planned. The equation $430 + 5f = 1200$ represents how much money they must raise at each of the remaining fundraisers. How much money must they raise at each of the remaining fundraisers?

6. Haley bought a membership to an online photo-sharing site for \$12. After purchasing the membership, she wanted to buy several prints. Prints cost \$0.12 each. She has a total of \$18.00 to spend on both the membership and the prints. Solve the equation $12 + 0.12p = 18$ to find the number of prints Haley can purchase.

Lesson 3 Problem-Solving Practice

Writing Equations

1. Toni spent the day at the mall. At the end of the day, Toni found that she spent a total of \$107.50 on lunch, clothes, and school supplies. Toni spent an equal amount on clothes and school supplies. If Toni spent \$10.50 on lunch, write an equation that can be used to find how much Toni spent on clothes and school supplies.

2. John and Belinda played nine holes of golf. John's score was 10 strokes less than two times Belinda's score. If John's score was 54 strokes, write and solve an equation to find Belinda's score.

3. The New Orleans Saints scored 2 more points than three times the points scored by the Pittsburgh Steelers. If the New Orleans Saints scored 32 points, write and solve an equation to find the number of points scored by the Pittsburgh Steelers.

4. All of the girls in Danielle's cabin at camp are the same age. Their counselor is 3 times their age. Danielle's age and her counselor's ages add up to 28. Write an equation that can be used to find the ages of Danielle and her counselor.

5. Three businesses donated money to charity. The chart shows the pledges made by the businesses.

Business	Amount Pledged (in millions)
Business A	x
Business B	
Business C	

Business B pledged \$20 million less than twice the amount pledged by Business A. Business C pledged \$200 million less than twice the amount pledged by Business B. If x represents the amount pledged by Business A, write expressions to show the amounts pledged by Business B and Business C in terms of x.

6. Refer to the information in Exercise 5. The combined pledges of Business A, Business B, and Business C totaled \$1035 million. Write an equation that can be used to determine how much each business pledged.

Lesson 4 Problem-Solving Practice

More Two-Step Equations

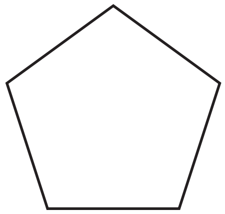
1. Blake and two of his friends are going to an amusement park. The cost of admission to the park is $39.95 per person. Once they are in the park, Blake and his friends ride the race cars, which require an additional fee. If the total amount spent by all three boys is $143.70, then what is the additional fee to ride the race cars?

2. Fatina's Girl Scout troop of 12 members takes a trip to the local bowling alley. Each girl pays a lane fee at the bowling alley and an additional $5 to rent a pair of bowling shoes. The total cost for all 12 members of her Girl Scout troop to use the bowling lanes and rent shoes is $138. What is the lane fee at the bowling alley?

3. Catherine purchases 8 bags of Cyprus mulch. She has a coupon for $0.75 off each bag of mulch. After applying her coupon towards the purchase, the total cost of the mulch is $22. What is the regular price for a bag of mulch?

4. The pentagon shown here is a regular pentagon, so each side has the same length. The perimeter of the pentagon is 7 inches. What is the value of *s*?

(s — 06) in.



5. Jorge set a personal running goal for to run a total of 120 kilometers. He wants to run the same amount each day for 10 days. If he runs all but 3 kilometers of a nature trail on each day, then how many kilometers is the nature trail?

6. Theresa, Sheila, and Denise spent the day at the beach. Each of them purchased a soda, steak fries, and a personal pizza for lunch. The total cost was $42.45. What was the cost of each personal pizza?

Beach Snack Bar	
Menu Item	**Cost**
Soda	$2.25
Steak fries	$6.95
Funnel Cake	$5.50
Cinnamon Roll	$3.75

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Lesson 5 Problem-Solving Practice

Solving Equations with Variables on Each Side

1. One hot air balloon is 15 meters above the ground, and is rising at a rate of 20 meters per minute. A second balloon is 195 meters above the ground, and is descending at a rate of 16 meters per minute. In how many minutes will the two balloons be at the same height?

2. A commuter train pulling 8 cars had room for another 84 passengers. Halfway through the commute, the train had to be taken out of service. All of the passengers were transferred to another commuter train that had 6 cars with the same capacity as those in the first train. After all of the passengers transferred to the replacement train, there was room for only 10 more passengers. What is the maximum number of passengers that each car can transport?

3. The table below shows what two rental companies charge for an intermediate 4-door sedan. How many miles must a driver drive in one day to make both options the same price?

	First Choice Car	Best Rent-A-Car
Daily charge	$65	$48
Cost per mile	$0.06	$0.10

4. Cindy is saving for a trip to Hawaii. Each week, she puts aside the same amount of money for her airfare. After 9 weeks of saving, she needs $390 more for her airfare. After 14 weeks, Cindy still needs $240. How much is the airfare to Hawaii? How much does Cindy put aside each week for her airfare?

5. Josh has two leaking pipes in his basement. While waiting for the plumber to come, Josh puts a bucket under each leak. The two buckets each hold the same amount of water. The bucket under the first leak fills in 20 minutes. The bucket under the second leak fills in 35 minutes. Josh's brother takes away one of the buckets and places the one bucket under the two leaks. About how long will it take for the one bucket to fill completely?

6. Refer to the information in Exercise 5. Josh wraps a cloth around the first leak, which cuts the rate of that leak in half. At the same time, it doubles the rate of the second leak. How will this affect the time it takes to fill the bucket?

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Lesson 6 Problem-Solving Practice

Inequalities

1. The Texas Transportation Commission can establish a daytime speed limit of 75 miles per hour in counties with a population density of less than 10 persons per square mile. Write an inequality to describe the population density.

2. The front passenger seat of an SUV is equipped with weight sensors that determine the appropriate amount of deployment force of the air bag. If the weight on the front seat is less than 66 pounds, the air bag will not deploy. Write an inequality to show the minimum weight on the passenger seat that would lead to the deployment of the air bag.

3. An amusement park ride cannot safely restrain people under 50 inches tall or over 78 inches tall. Write two different inequalities that shows the safe height limits for riders.

4. One model of a forklift truck can raise a maximum of 1750 kilograms. Write an inequality to describe the maximum number of 40-kilogram boxes that this forklift truck can raise.

5. Agri-Crop sells a system that uses satellites to determine the appropriate amount of fertilizer to dispense on crops. The equipment for the system costs $6000. In addition, there is a yearly fee of $950 for signal reception. How much additional crop revenue would the system have to generate so that the investment is profitable for a farmer over a five-year period?

6. Refer to the information in Exercise 5. A representative from Agri-Corp estimates that the system would yield an additional $100 per acre each year of a certain crop. How large a farm should a farmer have in order to expect to make a profit using the system over a ten-year period?

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Lesson 7 Problem-Solving Practice

Solving Inequalities

1. Gabrielle went to the movie theatre with her friends. She had $20.00 to spend. The movie ticket cost $6.25. Write an inequality to determine how much money she had to spend on snacks.

2. An adult female flea lays more than 25,000 eggs every month. What is the minimum number of eggs laid by an adult female flea in one week.
Let 1 month = 4 weeks.

3. The American Quarter Horse is the most popular riding horse in the world. The average weight of an American Quarter Horse at birth is 85 pounds. They grow to a maximum weight of 1300 pounds. Write and solve an inequality to find how many pounds an American Quarter Horse may gain from birth to adulthood.

4. A big league pitching coach tries to limit his pitchers to 110 pitches per game. If the pitcher has already thrown 52 pitches, write and solve an inequality to find how many more pitches he can throw before reaching the limit.

5. Winona Toy Company makes many kinds of toys. The table shows average production times.

Toy	Average Production Time (hours)
fire truck	2
train	$3\frac{1}{3}$
stuffed bear	$2\frac{1}{4}$
doll	4

Stella is a stuffed bear maker. She works 10 hours a day. Write and solve an inequality to determine the maximum number of bears Stella may make in a day.

6. Refer to the table in Exercise 5. Winona Toy company hopes to sell a lot of trains during the holiday season, so the managers hire another worker to make trains. What is the maximum number of trains that two workers can make in a 40-hour work week?

Lesson 8 Problem-Solving Practice

Solving Multi-Step Equations and Inequalities

1. In September 2010, the average price of gasoline was \$3.81 a gallon. This price represented an increase of \$2.31 less than twice the price the previous year. Use the equation $3.81 = 2x - 2.31$ to determine the price of gasoline in September 2009.

2. The length of one side of a regular hexagon is x. A regular pentagon also has a side length of x. A square is constructed with a side length of x. The total perimeter of all three figures in 105 centimeters. What is the length each side of the figures?

3. An excavation crew is digging a tunnel under a bay. The crew has dug 573 meters of the tunnel, which is 34 meters past the halfway point of the tunnel. What will be the length of the tunnel when the crew has finished digging?

4. A group of friends went on a three-day hike. During the second day of the hike, the group hiked twice as far as they did on the first day. On the third day, they hiked twelve miles farther than the combined distance of the first two days. In all, they hiked 24 miles. How far did they hike on the first day?

5. Nathan is interested in leasing a new car. He collected this information from two leasing companies.

Leasing Company	Monthly Payment	Mileage Limit	Extra Mileage Charge
ABC	\$463	10,000	\$0.25/mi
XYZ	\$473.50	12,000	\$0.10/mi

Nathan's drive to and from work each day is about 45 miles. If he goes to work about 226 days in a given year, what is the minimum amount he would have to pay in excess mileage if he leased from the ABC Leasing Company?

6. Refer to the table in Exercise 5. If Nathan leases a new car from XYZ Company, how many miles can he drive after work or on the weekend without being charged for excess mileage?