Cumulative Review Exercises

[3.2] **85. Internet Plans** An Internet service offers two plans for its customers. One plan includes 5 hours of use and costs $7.95 per month. Each additional minute after the 5 hours costs $0.15. The second plan costs $19.95 per month and provides unlimited Internet access. How many hours would Jake LaRue have to use the Internet monthly to make the second plan the less expensive?

86. Filling a Hot Tub How long will it take to fill a 600-gallon hot tub if water is flowing into the hot tub at a rate of 4 gallons a minute?

[3.3] **87. Supplementary Angles** Two angles are supplementary angles if the sum of their measures is 180°. Find the two supplementary angles if the smaller angle is 30° less than half the larger angle.

© Mcinich\Dreamstime LLC-Royalty Free

See Exercise 86.

[4.6] **88.** Multiply $(3.4 \times 10^{-5})(2 \times 10^{13})$.

6.7 Rational Equations: Applications and Problem Solving

1. Set up and solve applications containing rational expressions.
2. Set up and solve motion problems.
3. Set up and solve work problems.

1 Set Up and Solve Applications Containing Rational Expressions

Many applications of algebra involve rational equations. After we represent the application as an equation, we solve the rational equation as we did in Section 6.6.

The first type of application we will consider is a *geometry problem*.

EXAMPLE 1 A New Rug Mary and Larry Armstrong are interested in purchasing a carpet whose area is 60 square feet. Determine the length and width if the width is 5 feet less than $\frac{3}{5}$ of the length. See **Figure 6.1**.

FIGURE 6.1

Solution

Understand and Translate

$$\text{Let } x = \text{length.}$$

$$\text{Then } \frac{3}{5}x - 5 = \text{width.}$$

$$\text{area} = \text{length} \cdot \text{width}$$

$$60 = x\left(\frac{3}{5}x - 5\right)$$

Carry Out

$$60 = \frac{3}{5}x^2 - 5x$$

$$5\,(60) = 5\left(\frac{3}{5}x^2 - 5x\right) \quad \text{Multiply both sides by 5.}$$

$$300 = 3x^2 - 25x \quad \text{Distributive property was used.}$$

$$0 = 3x^2 - 25x - 300 \quad \text{Subtracted 300 from both sides.}$$

$$\text{or} \quad 3x^2 - 25x - 300 = 0$$

$$(3x + 20)(x - 15) = 0 \quad \text{Factored.}$$

$$3x + 20 = 0 \quad \text{or} \quad x - 15 = 0 \quad \text{Zero-factor property}$$

$$3x = -20 \qquad x = 15$$

$$x = -\frac{20}{3}$$

Check and Answer Since the length of a rectangle cannot be negative, we can eliminate $-\frac{20}{3}$ as an answer to our problem.

$$\text{length} = x = 15 \text{ feet}$$

$$\text{width} = \frac{3}{5}(15) - 5 = 4 \text{ feet}$$

Check

$$a = lw$$
$$60 \stackrel{?}{=} 15(4)$$
$$60 = 60 \quad \text{True}$$

Therefore, the length is 15 feet and the width is 4 feet.

Now Try Exercise 5

Now we will work with a problem that expresses the relationship between two numbers. Problems like this are sometimes referred to as *number problems*.

EXAMPLE 2 Reciprocals One number is 4 times another number. The sum of their reciprocals is $\frac{5}{2}$. Determine the numbers.

Solution **Understand and Translate**

$$\text{Let } x = \text{first number.}$$
$$\text{Then } 4x = \text{second number.}$$

The reciprocal of the first number is $\frac{1}{x}$ and the reciprocal of the second number is $\frac{1}{4x}$. The sum of their reciprocals is $\frac{5}{2}$, thus, $\frac{1}{x} + \frac{1}{4x} = \frac{5}{2}$.

Carry Out

$$\frac{1}{x} + \frac{1}{4x} = \frac{5}{2}$$
$$4x\left(\frac{1}{x} + \frac{1}{4x}\right) = 4x\left(\frac{5}{2}\right) \quad \text{Multiply both sides by the LCD, } 4x.$$
$$4x\left(\frac{1}{x}\right) + 4x\left(\frac{1}{4x}\right) = 10x \quad \text{Distributive property}$$
$$4 + 1 = 10x$$
$$5 = 10x$$
$$\frac{5}{10} = x$$
$$\frac{1}{2} = x$$

Check The first number is $\frac{1}{2}$. The second number is therefore $4x = 4\left(\frac{1}{2}\right) = 2$. Let's now check if the sum of the reciprocals is $\frac{5}{2}$. The reciprocal of $\frac{1}{2}$ is 2. The reciprocal of 2 is $\frac{1}{2}$. The sum of the reciprocals is

$$2 + \frac{1}{2} = \frac{4}{2} + \frac{1}{2} = \frac{5}{2}$$

Answer Since the sum of the reciprocals is $\frac{5}{2}$, the two numbers are 2 and $\frac{1}{2}$.

Now Try Exercise 11

Understanding Algebra

The distance formula is usually written as:

$$\text{distance} = \text{rate} \cdot \text{time}$$

However, it is sometimes convenient to solve the formula for *time*:

$$\frac{\text{distance}}{\text{rate}} = \frac{\text{rate} \cdot \text{time}}{\text{rate}}$$

$$\frac{\text{distance}}{\text{rate}} = \text{time}$$

or $$\text{time} = \frac{\text{distance}}{\text{rate}}$$

2 Set Up and Solve Motion Problems

In Chapter 3 we discussed *motion problems*. Recall that

$$\text{distance} = \text{rate} \cdot \text{time}$$

If we solve this equation for time, we obtain

$$\text{time} = \frac{\text{distance}}{\text{rate}} \quad \text{or} \quad t = \frac{d}{r}$$

This equation is useful in solving motion problems when the total time of travel for two objects or the time of travel between two points is known.

EXAMPLE 3 Canoeing Cindy Kilborn went canoeing in the Colorado River. The current in the river was 2 miles per hour. If it took Cindy the same amount of time to travel 10 miles downstream as 2 miles upstream, determine the speed at which Cindy's canoe would travel in still water.

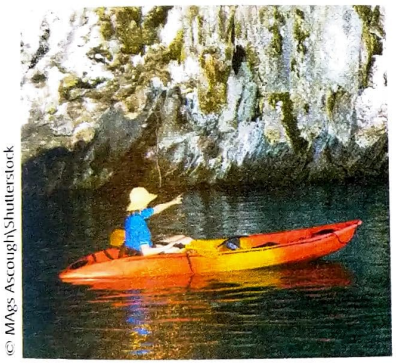
Solution Understand and Translate

Let r = the canoe's speed in still water.

Then $r + 2$ = the canoe's speed traveling downstream (with current)

and $r - 2$ = the canoe's speed traveling upstream (against current.)

Direction	Distance	Rate	Time
Downstream	10	$r + 2$	$\frac{10}{r+2}$
Upstream	2	$r - 2$	$\frac{2}{r-2}$



© MMgs Ascough\Shutterstock

Since the time it takes to travel 10 miles downstream is the same as the time to travel 2 miles upstream, we set the times equal to each other and then solve the resulting equation.

$$\text{time downstream} = \text{time upstream}$$

$$\frac{10}{r+2} = \frac{2}{r-2}$$

Carry Out

$$10(r-2) = 2(r+2) \quad \text{Cross-multiplied.}$$

$$10r - 20 = 2r + 4$$

$$8r = 24$$

$$r = 3$$

Check and Answer A check will show that 3 satisfies the equation. Thus, the canoe would travel at 3 miles per hour in still water.

Now Try Exercise 1

EXAMPLE 4 Scenic Route Shelby Kaylor drives along Route 72 in Oahu, Hawai Because of the beautiful scenery she drives an average of 20 miles per hour. Then sh drives inland and averages 65 miles per hour. If the total distance she drove was 10 miles and the total time she drove was 3.5 hours, how long did she drive at each speed

Solution Understand and Translate

Let d = distance traveled at 20 miles per hour.

Then $100 - d$ = distance traveled at 65 miles per hour.

Direction	Distance	Rate	Time
Shoreline	d	20	$\frac{d}{20}$
Inland	$100 - d$	65	$\frac{100-d}{65}$

© Lee Prince\Shutterstock

Since the total time spent driving is 3.5 hours, we write

$$\text{time along shoreline} + \text{time inland} = 3.5 \text{ hours}$$

$$\frac{d}{20} + \frac{100 - d}{65} = 3.5$$

Carry Out

$$260\left(\frac{d}{20} + \frac{100 - d}{65}\right) = 260(3.5)$$ Multiply both sides by the LCD, 260.

$$260\left(\frac{d}{20}\right) + 260\left(\frac{100 - d}{65}\right) = 910$$ Distributive property

$$13d + 4(100 - d) = 910$$

$$13d + 400 - 4d = 910$$

$$9d + 400 = 910$$

$$9d = 510$$

$$d = \frac{510}{9}$$

$$d \approx 57$$

Answer Remember that the question asked us to find the *time* spent traveling at each speed. The variable d represents the distance traveled at 20 miles per hour. To find the time traveled and to answer the question asked, we need to evaluate $\frac{d}{20}$ and $\frac{100 - d}{65}$ for $d = 57$.

Time at 20 mph

$$\frac{d}{20} = \frac{57}{20} \approx 2.9$$

Time at 65 mph

$$\frac{100 - d}{65} = \frac{100 - 57}{65} = \frac{43}{65} \approx 0.6$$

Thus, Shelby drove about 2.9 hours along the shoreline and about 0.6 hours inland. The total time was 2.9 + 0.6 or 3.5 hours.

Now Try Exercise 17

EXAMPLE 5 Distance of a Race At a fund-raising race participants can either bike, walk, or run. Kim Clark, who rode a bike, completed the entire distance of the race with an average speed of 16 kilometers per hour (kph). Steve Schwartz, who jogged, completed the entire distance with an average speed of 5 kph. If Kim completed the race in 2.75 hours less time than Steve did, determine the distance the race covered.

Solution **Understand and Translate** Let d = the distance from the start to the finish of the race. Then we can construct the following table. To determine the time, we divide the distance by the rate.

Person	Distance	Rate	Time
Kim	d	16	$\frac{d}{16}$
Steve	d	5	$\frac{d}{5}$

We are given that Kim completed the race in 2.75 hours less time than Steve did. Therefore, to make Kim's and Steve's times equal, we need to subtract 2.75 hours from Steve's time (or add 2.75 hours to Kim's time).

$$\text{Time for Kim} = \text{Time for Steve} - 2.75 \text{ hours}$$

$$\frac{d}{16} = \frac{d}{5} - 2.75$$

Carry Out

$$80\left(\frac{d}{16}\right) = 80\left(\frac{d}{5} - 2.75\right)$$ Multiply both sides by the LCD, 80.

$$5d = 80\left(\frac{d}{5}\right) - 80(2.75)$$ Distributive property was used.

$$5d = 16d - 220$$

$$-11d = -220$$

$$d = 20$$

Check and Answer To check this answer we will determine the times it took Kim and Steve to complete the race and see if the difference between the times is 2.75 hours. To determine the times, divide the distance, 20 kilometers, by the rate.

$$\text{Kim's time} = \frac{d}{16} = \frac{20}{16} = 1.25 \text{ hours}$$

$$\text{Steve's time} = \frac{d}{5} = \frac{20}{5} = 4 \text{ hours}$$

Since $4 - 1.25 = 2.75$ hours, the answer checks. Therefore the distance the race covered is 20 kilometers.

Now Try Exercise 25

3 Set Up and Solve Work Problems

When two machines or two people work together to get a job done, the situation leads to solving a *work problem.* To solve work problems, we use the fact summarized in the following diagram:

$$\begin{pmatrix}\text{part of task done}\\ \text{by one person}\\ \text{or machine}\end{pmatrix} + \begin{pmatrix}\text{part of task done}\\ \text{by second person}\\ \text{or machine}\end{pmatrix} = \begin{pmatrix}1\\ (\text{one completed})\\ \text{task}\end{pmatrix}$$

To determine the part of the task done by each person or machine, we use the following formula:

rate of work · time worked = part of task completed

An important step in solving these problems is determining the *rate* of work.

Consider the following examples:

- If Joe can do a task by himself in 5 hours, his *rate* is $\frac{1}{5}$ of the task per hour.
- If Yoko can do a task by herself in 4 hours, her *rate* is $\frac{1}{4}$ of the task per hour.
- If a pump can empty a 10-gallon tank in 1 hour, its *rate* is $\frac{1}{10}$ of a gallon per hour.

In general, if a task can get done in x hours, then the *rate* for completing that task is $\frac{1}{x}$ of the task per hour.

Understanding Algebra

Problems where two or more people or machines work together to complete a task are referred to as *work problems*

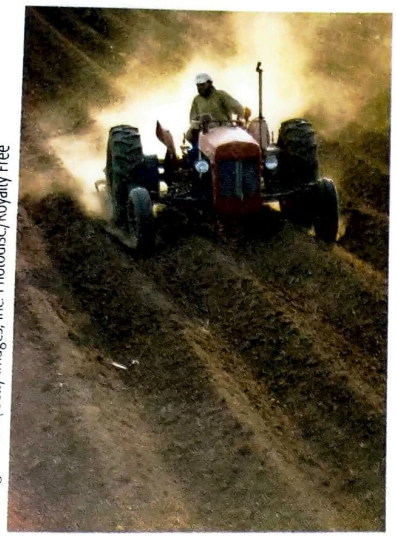
Understanding Algebra

If JoAnn can perform a task in 6 hours, then her *rate* of work is $\frac{1}{6}$ task per hour.

If she then works t hours, the *amount* of work she has completed is represented as $\frac{1}{6} \cdot t$ or $\frac{t}{6}$ of the task.

EXAMPLE 6 Plowing a Field Bob can plow a field by himself in 20 hours. His wife, Mary, can plow the same field by herself in 30 hours. How long will it take them to plow the field if they work together?

Solution **Understand and Translate** Let t = the time, in hours, for Bob and Mary working together to plow the field. We will construct a table to help us in finding the part of the task completed by Bob and Mary in t hours.



Person	Rate of Work (part of the task completed per hour)	Time Worked	Part of Task
Bob	$\frac{1}{20}$	t	$\frac{t}{20}$
Mary	$\frac{1}{30}$	t	$\frac{t}{30}$

$$\left(\begin{array}{c}\text{part of the field plowed}\\ \text{by Bob in } t \text{ hours}\end{array}\right) + \left(\begin{array}{c}\text{part of the field plowed}\\ \text{by Mary in } t \text{ hours}\end{array}\right) = 1(\text{entire field plowed})$$

$$\frac{t}{20} + \frac{t}{30} = 1$$

Carry Out Now multiply both sides of the equation by the LCD, 60.

$$60\left(\frac{t}{20} + \frac{t}{30}\right) = 60 \cdot 1$$

$$\overset{3}{\cancel{60}}\left(\frac{t}{\cancel{20}}\right) + \overset{2}{\cancel{60}}\left(\frac{t}{\cancel{30}}\right) = 60 \qquad \text{Distributive property}$$

$$3t + 2t = 60$$

$$5t = 60$$

$$t = 12$$

Answer Thus, Bob and Mary working together can plow the field in 12 hours. We leave the check for you.

Now Try Exercise 27

Helpful Hint

In Example 6, Bob could plow the field by himself in 20 hours, and Mary could plow the field by herself in 30 hours. We determined that together they could plow the field in 12 hours. Does this answer make sense? Since you would expect the time to plow the field together to be less than the time either of them could plow it alone, the answer makes sense.

EXAMPLE 7 Storing Wine At a winery in Napa Valley, California, one pipe can fill a tank with wine in 3 hours and another pipe can empty the tank in 5 hours. If the valves to both pipes are open, how long will it take to fill the empty tank?

Solution **Understand and Translate** Let t = amount of time to fill the tank with the values to both pipes open.

Pipe	Rate of Work	Time	Part of Task
Pipe filling tank	$\frac{1}{3}$	t	$\frac{t}{3}$
Pipe emptying tank	$\frac{1}{5}$	t	$\frac{t}{5}$

As one pipe is filling, the other is emptying the tank. Therefore, instead of adding the parts of the task, we will subtract the parts of the task.

$$\left(\begin{array}{c}\text{part of tank}\\ \text{filled in } t \text{ hours}\end{array}\right) - \left(\begin{array}{c}\text{part of tank}\\ \text{emptied in } t \text{ hours}\end{array}\right) = 1(\text{total tank filled})$$

$$\frac{t}{3} - \frac{t}{5} = 1$$

Carry Out

$$15\left(\frac{t}{3}-\frac{t}{5}\right) = 15 \cdot 1$$ Multiply both sides by the LCD, 15.

$$\overset{5}{\cancel{15}}\left(\frac{t}{\cancel{3}}\right) - \overset{3}{\cancel{15}}\left(\frac{t}{\cancel{5}}\right) = 15$$ Distributive property was used.

$$5t - 3t = 15$$

$$2t = 15$$

$$t = 7\frac{1}{2}$$

Check and Answer The tank will be filled in $7\frac{1}{2}$ hours. This answer is reasonable because we expect it to take longer than 3 hours when the tank is being drained at the same time.

Now Try Exercise 35

EXAMPLE 8 Cleaning Service Linda and John Franco own a house cleaning service. When Linda cleans Damon's house by herself, it takes 7 hours. When Linda and John work together, they can clean the house in 4 hours. How long will it take John to clean the house by himself?

Solution Let t = time for John to clean the house by himself. Then John's rate is $\frac{1}{t}$. Since Linda can clean the house by herself in 7 hours, her rate is $\frac{1}{7}$ of the job per hour. In the table below, we use the fact that together they can clean the house in 4 hours.

Worker	Rate of Work	Time	Part of Task
Linda	$\frac{1}{7}$	4	$\frac{4}{7}$
John	$\frac{1}{t}$	4	$\frac{4}{t}$

$$\begin{pmatrix}\text{part of house}\\ \text{cleaned by Linda}\end{pmatrix} + \begin{pmatrix}\text{part of house}\\ \text{cleaned by John}\end{pmatrix} = 1$$

$$\frac{4}{7} + \frac{4}{t} = 1$$

Carry Out

$$7t\left(\frac{4}{7}+\frac{4}{t}\right) = 7t \cdot 1$$ Multiply both sides by the LCD, $7t$.

$$\cancel{7t}\left(\frac{4}{\cancel{7}}\right) + 7\cancel{t}\left(\frac{4}{\cancel{t}}\right) = 7t$$ Distributive property was used.

$$4t + 28 = 7t$$

$$28 = 3t$$

$$\frac{28}{3} = t$$

$$9\frac{1}{3} = t$$

Check and Answer Thus, it takes John $9\frac{1}{3}$ hours, or 9 hours 20 minutes, to clean the house by himself. This answer is reasonable because we expect it to take longer for John to clean the house by himself than it would for Linda and John working together.

Now Try Exercise 39

Understanding Algebra

In Example 8, notice that if two people were to work at Linda's rate, they would clean the house in $\frac{1}{2} \times 7 = \frac{7}{2}$, or $3\frac{1}{2}$, hours.

Since Linda and John together clean the house in 4 hours, we know that John cleans at a slower rate than Linda!

This is one way to determine that our answer makes sense.

EXAMPLE 9 Thank-You Notes Peter and Kaitlyn Kewin are handwriting thank-you notes to guests who attended their 20th wedding anniversary party. Kaitlyn by herself could write all the notes in 6 hours and Peter could write all the notes by himself in 10 hours. After Kaitlyn has been writing thank-you notes for 4 hours by herself, she must leave town on business. Peter then continues the task of writing the thank-you notes. How long will it take Peter to finish writing the remaining notes?

Solution **Understand and Translate** Let t = time it will take Peter to finish writing the notes.

Person	Rate of Work	Time	Part of Task
Kaitlyn	$\frac{1}{6}$	4	$\frac{4}{6} = \frac{2}{3}$
Peter	$\frac{1}{10}$	t	$\frac{t}{10}$

$$\left(\begin{array}{c}\text{part of notes written}\\ \text{by Kaitlyn}\end{array}\right) + \left(\begin{array}{c}\text{part of notes written}\\ \text{by Peter}\end{array}\right) = 1$$

$$\frac{2}{3} + \frac{t}{10} = 1$$

Carry Out

$$30\left(\frac{2}{3} + \frac{t}{10}\right) = 30 \cdot 1 \quad \text{Multiply both sides by the LCD, 30.}$$

$$\overset{10}{\cancel{30}}\left(\frac{2}{\cancel{3}_{1}}\right) + \overset{3}{\cancel{30}}\left(\frac{t}{\cancel{10}_{1}}\right) = 30 \quad \text{Distributive property}$$

$$20 + 3t = 30$$

$$3t = 10$$

$$t = \frac{10}{3} \quad \text{or} \quad 3\frac{1}{3}$$

Answer Thus, it will take Peter $3\frac{1}{3}$ hours to complete the notes.

Now Try Exercise 37

EXERCISE SET 6.7

MathXL® MyMathLab

Warm-Up Exercises

Fill in the blanks with the appropriate word, phrase, or symbol(s) from the following list.

1 hour $\frac{1}{5}$ $\frac{1}{3}$ $\frac{\text{distance}}{\text{rate}}$ $\frac{\text{rate}}{\text{distance}}$ 3 1 complete task

1. In most work problems, one side of the equation is 1. The 1 represents _____.
2. If Harlan Bricker can paint a room in 3 hours by himself, then his rate of work is _____ of the task per hour.
3. If Michelle Slocum can complete a task in 5 hours, then _____ represents the part of the task completed by her in one hour.
4. If we solve the equation distance = rate · time for time, we get, time = _____.

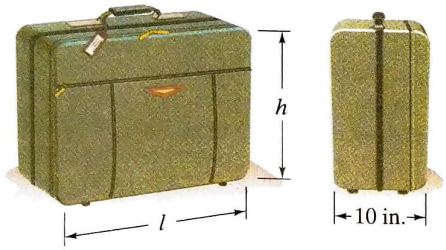
Practice the Skills/Problem Solving

In Exercises 5–36, solve the problem and answer the question.

Geometry Problems; see Example 1.

5. **Packaging Computers** The Phillips Paper Company makes rectangular pieces of cardboard for packing computers. The sheets of cardboard are to have an area of 99 square inches, and the length of a sheet is to be 5 inches more than $\frac{2}{3}$ its width. Determine the length and width of the cardboard to be manufactured. Use $A = l \cdot w$.

6. **Carry-on Luggage** On most airlines carry-on luggage can have a maximum width of 10 inches with a maximum volume of 3840 cubic inches (see the figure). If the height of the luggage is $\frac{2}{3}$ the length, determine the dimensions of the largest piece of carry-on luggage. Use $V = lwh$.



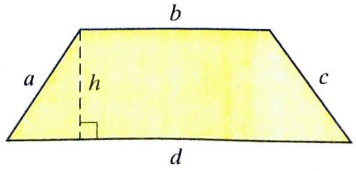
7. **Triangles of Dough** Pillsbury Crescent Rolls are packaged in tubes that contain perforated triangles of dough. The base of the triangular piece of dough is about 5 centimeters more than its height. Determine the base and height of a piece of dough if the area is about 42 square centimeters. Use $A = \frac{1}{2}bh$.


© Nikola Spasenoski/Shutterstock

8. **Yield Sign** Yield right of way signs used in the United States are triangles. The area of the sign is about 558 square inches. The height of the sign is about 5 inches less than its base. Determine the length of the base of a yield right of way sign.

9. **Triangular Garden** A triangular area is 20 square feet. Find the base of the triangular area if the height is 1 foot more than $\frac{1}{2}$ the base. Use $A = \frac{1}{2}bh$.

10. **Roofing** One side of the roof of Shelby Kaylor's house is in the shape of a trapezoid and has an area of 200 square feet. If the height of the trapezoid is $\frac{1}{4}$ the sum of the 2 bases, determine the height of the trapezoid. Use $A = \frac{1}{2}h(b + d)$.



Number Problems; see Example 2.

11. **Difference of Numbers** One number is 9 times larger than another. The difference of their reciprocals is 1. Determine the two numbers.

12. **Sum of Numbers** One number is 3 times larger than another. The sum of their reciprocals is $\frac{4}{3}$. Determine the two numbers.

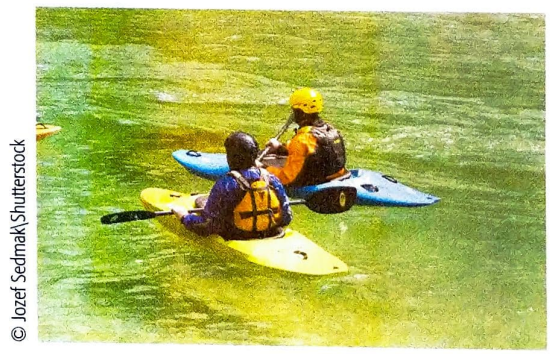
13. **Increased Numerator** The numerator of the fraction $\frac{3}{4}$ is increased by an amount so that the value of the resulting fraction is $\frac{5}{2}$. Determine the amount by which the numerator was increased.

14. **Decreased Denominator** The denominator of the fraction $\frac{8}{21}$ is decreased by an amount so that the value of the resulting fraction is $\frac{1}{2}$. Determine the amount by which the denominator was decreased.

Motion Problems; see Examples 3–5.

15. **Paddleboat Ride** In the Mississippi River near New Orleans, the Creole Queen paddleboat travels 6 miles upstream (against the current) in the same amount of time it travels 12 miles downstream (with the current). If the current of the river is 3 miles per hour, determine the speed of the Creole Queen in still water.

16. **Kayak Ride** Kathy Boothby-Sestak can paddle her kayak 6 miles per hour in still water. It takes her as long to paddle 5 miles upstream as 10 miles downstream in the Wabash River near Lafayette, Indiana. Determine the river's current.


© Jozef Sedmak/Shutterstock

17. **Trolley Ride** A trolley travels in one direction at an average of 12 miles per hour, then turns around and travels on the same track in the opposite direction at 12 miles per hour. If the total time traveling on the trolley is $2\frac{1}{2}$ hours, how far did the trolley travel in one direction?

18. **Motorcycle Trip** Brandy Dawson and Jason Dodge start a motorcycle trip at the same point north of Fort Worth, Texas. Both are traveling to San Antonio, Texas, a distance of about 400 kilometers. Brandy rides 30 kilometers per hour faster than Jason does. When Brandy reaches her destination, Jason has only traveled to Austin, Texas, a distance of about 250 kilometers. Determine the approximate speed of each motorcycle.

19. **Jet Flight** Elenore Morales traveled 1600 miles by commercial jet from Kansas City, Missouri, to Spokane, Washington. She then traveled an additional 500 miles on a private

propeller plane from Spokane to Billings, Montana. If the speed of the jet was 4 times the speed of the propeller plane and the total time in the air was 6 hours, determine the speed of each plane.

20. **Exercise Regimen** Chris Barker walks a distance of 2 miles on an indoor track and then jogs at twice his walking speed for another 2 miles. If the total time spent on the track was one hour, determine the speeds at which he walks and jogs.

21. **No Wake Zone** Alisha is traveling by motorboat from her dock to Paradise Island. While she is in a no wake zone, her average speed is 4 miles per hour. Once she leaves the no wake zone, her average speed is 28 miles per hour. If the total distance traveled from her dock to the island is 36.6 miles and the total time of the trip is 1.7 hours, determine the distance from her dock to the end of the no wake zone and the distance from the end of the no wake zone to Paradise Island.

22. **The Tail of the Dragon** US 129 in Tennessee is a very popular road for motorcyclists because one stretch of that road has 318 curves and is called The Tail of the Dragon. Larry Gilligan rode his motorcycle in one direction and averaged 22 miles per hour. On the return trip it was raining and he only averaged 11 miles per hour. If the round trip took 1.5 hours, what is the length of The Tail of the Dragon?

23. **Headwind and Tailwind** A Boeing 747 flew from San Francisco to Honolulu, a distance of 2900 miles. Flying with the wind, it averaged 600 miles per hour. When the wind changed from a tailwind to a headwind, the plane's speed dropped to 550 miles per hour. If the total time of the trip was 5 hours, determine the length of time it flew at each speed.

24. **Thalys Train** The Thalys train in Europe has been known to travel an average 240 kilometers per hour (kph). Prior to using the Thalys trains in Europe, trains traveled an average speed of 120 kph. If a Thalys train traveling from Brussels to Amsterdam can complete its trip in 0.88 hour less time than an older train, determine the distance from Brussels to Amsterdam.

© Allen R. Angel

Thalys train

25. **Water Skiers** At a water show a boat pulls a water skier at a speed of 30 feet per second. When it reaches the end of the lake, more skiers are added to be pulled by the boat, so the boat's speed drops to 25 feet per second. If the boat traveled the same distance on both trips and the trip back with the additional skiers took 8 seconds longer than the trip with the single skier, how far, in feet, in one direction, had the boat traveled?

© Allen R. Angel

26. **Cross-Country Skiing** Alana Bradley and her father Tim begin skiing the same cross-country ski trail in Elmwood Park in Sioux Falls, South Dakota, at the same time. If Alana, who averages 9 miles per hour, finishes the trail 0.25 hours sooner than her father, who averages 6 miles per hour, determine the length of the trail.

Work Problems; see Examples 6–9.

27. **Wallpaper** Reynaldo and Felicia Fernandez decide to wallpaper their family room. Felicia, who has wallpapering experience, can wallpaper the room in 6 hours. Reynaldo can wallpaper the same room in 8 hours. How long will it take them to wallpaper the family room if they work together?

28. **Conveyor Belt** At a salt mine, one conveyor belt requires 20 minutes to fill a large truck with ore. A second conveyor belt requires 30 minutes to fill the same truck with ore. How long would it take if both conveyor belts were working together to fill the truck with ore?

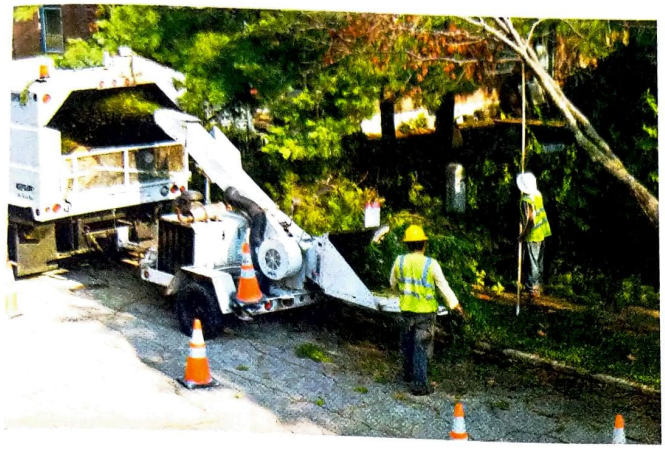
29. **Picking Peaches** In a peach orchard in Williamson, New York, Gary Rominger can load his truck with peaches in 6 hours. His friend, Alex Taurke, takes twice as long to load Gary's truck with peaches. How long will it take them working together to load the truck with peaches?

© Tomas Smolek\Shutterstock

30. **Watering Plants** In a small nursery, Becky Hailey can water all the plants in 30 minutes. Her co-worker, Karen Grizzaffi, can water all the plants in 20 minutes. How long will it take them working together to water the plants?

31. **Painting a Room** Eric Kweeder can paint a room in 60 minutes. His brother, Jessup, can paint the same room in 40 minutes. How long will it take them working together to paint the room?

32. Tree Chipping The ClearCut Tree Service has two models of chippers, the "Pirate" and the "Ninja." The Pirate can chip a 20-ton load of trees in 2 hours while the Ninja can chip a 20-ton load of trees in 4 hours. How long will it take the two chippers working simultaneously to chip the 20-ton load of trees?



© Susan Law Cain\Shutterstock

33. Hot Tub Pam and Loren Fornieri know that their hot tub can be filled in 40 minutes and drained completely in 60 minutes. If the water is turned on and the drain is left open, how long would it take the tub to fill completely?

34. Filling a Tank During a rainstorm, the rain is flowing into a large holding tank. At the rate the rain is falling, the empty tank would fill in 8 hours. At the bottom of the tank is a spigot to dispense water. Typically, it takes about 12 hours with the spigot wide open to empty the water in a full tank. If the tank is empty and the spigot has been accidentally left open, and the rain falls at the constant rate, how long would it take for the tank to fill completely?

35. Payroll Checks At the Community Savings Bank, it takes a computer 40 minutes to process and print payroll checks. When a second computer is used and the two computers work together, the checks can be processed and printed in 24 minutes. How long would it take the second computer by itself to process and print the payroll checks?

36. Flowing Water When the water is turned on and passes through a small hose, a pool can be filled in 6 hours. When the water is turned on at two spigots and passes through both the small hose and a large hose, the pool can be filled in 2 hours. How long would it take to fill the pool using only the large hose?

37. Digging a Trench A construction company with two backhoes has contracted to dig a long trench for drainage pipes. The larger backhoe can dig the entire trench by itself in 12 days. The smaller backhoe can dig the entire trench by itself in 15 days. The large backhoe begins working on the trench by itself, but after 5 days it is transferred to a different job and the smaller backhoe begins working on the trench. How long will it take for the smaller backhoe to complete the job?

38. Delivery of Food Ian and Nicole Murphy deliver food to various restaurants. If Ian drove the entire trip, the trip would take about 10 hours. If Nicole drove the entire trip, the trip would take about 8 hours. After Nicole had been driving for 4 hours, Ian takes over the driving. About how much longer will Ian drive before they reach their final destination?

39. Snowstorm Following a snowstorm, Ken and Bettina Reeves must clear their driveway and sidewalk. Ken can clear the snow by himself in 4 hours, and Bettina can clear the snow by herself in 6 hours. After Bettina has been working for 3 hours, Ken is able to join her. How much longer will it take them working together to remove the rest of the snow?

© Julien\Shutterstock

40. Photocopying The College of Applied Science just added two new photocopier machines to its business office and retained one older machine. The older machine, working alone, can copy a full set of diplomas in 3 hours. Each of the two new machines, working alone, can copy a full set of diplomas in 2 hours.

a) How long would it take the three copiers working together to copy a full set of diplomas?

b) How long would it take the three copiers working together to copy 100 full sets of diplomas?

41. Skimming Oil A boat designed to skim oil off the surface of the water has two skimmers. One skimmer can fill the boat's holding tank in 60 hours while the second skimmer can fill the boat's holding tank in 50 hours. There is also a valve in the holding tank that is used to transfer the oil to a larger vessel. If no new oil is coming into the holding tank, a full holding tank of skimmed oil can be transferred to a larger tank in 30 hours. If both skimmers begin skimming and the valve on the holding tank is opened, how long will it take for the empty holding tank on the boat to fill?

42. Flower Garden Bob can plant a flower garden by himself in 8 hours. Mary can plant the same garden by herself in 10 hours, and Gloria can plant the same garden by herself in 12 hours. How long would it take them working together to plant the garden?

© Doug Menuez\Getty Images, Inc.-Photodisc/Royalty Free