SHOW SOMEONE YOU CARE—SEND FLOWERS!

Introduction to Ratios and Rates

Learning Goals
In this lesson, you will:
- Identify ratios, rates, and unit rates.
- Use ratios, rates, and unit rates to analyze problems.

Key Terms
- ratio
- rate
- proportion
- equivalent ratios
- unit rate
- scaling up
- scaling down

You probably don't think about flowers on a daily basis, but there are some people who do! Florists routinely think about different types of flowers, arrangements of those flowers, ordering flowers, plants, balloons, baskets, and vases, and—phew! There's a lot to floristry! But make no mistake, the business of floristry is more than just flowers—it's dollars and cents and mathematics. For example, there are certain days of the years when there is a huge demand for roses, vases, and baby's breath. When this occurs, florists must accurately order roses and baby's breath in comparison to other flowers to make sure they can fulfill the demand, but not have a lot of these flowers left over. What certain days do you think might have a higher demand for roses or vases? How do you think mathematics can help florists order and arrange flowers?
Problem 1 Representing Ratios

Pat’s Flower Shop specializes in growing and selling large daisies. On a typical summer day, you may hear a florist say one of these statements:

- In the Daisy Smile Bouquet, there are 2 white daisies for every 3 orange daisies.
- In the Daisy Smile Bouquet, 2 out of every 5 daisies are white.
- Five daisies cost $7.50.
- There are 10 daisies in a small vase.

In each statement, the florist is comparing two different quantities. In mathematics, we use ratios to make comparisons. A ratio is a comparison of two quantities using division.

Let’s consider the statement:

“In the Daisy Smile Bouquet, there are 2 white daisies for every 3 orange daisies.”

The relationship between the two different types of daisies can be represented in several ways. One way to represent the relationship is to draw a picture, or model.

From the model, you can make comparisons about the different quantities.

- White daisies to orange daisies
- Orange daisies to white daisies
- White daisies to total daisies
- Orange daisies to total daisies

Each comparison is ratio. The first two comparisons are part-to-part ratios. The last two comparisons are part-to-whole ratios because you are comparing one of the parts (either white or orange) to the total number of parts.

The table shows three different ways to represent the part-to-part ratios.
### Part-to-Part Ratios

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<td>2 white daisies : 3 orange daisies</td>
<td>2 white daisies ( \frac{2}{3} ) orange daisies</td>
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<td>3 orange daisies to every 2 white daisies</td>
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</tbody>
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You can also write a part-to-whole ratio to show the number of each daisy compared to the total number of daisies. The table shows two different ways to represent part-to-whole ratios.

### Part-to-Whole Ratios

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<tr>
<td>2 white daisies to every 5 total daisies</td>
<td>2 white daisies : 5 total daisies</td>
<td>2 white daisies ( \frac{2}{5} ) total daisies</td>
</tr>
<tr>
<td>3 orange daisies to every 5 total daisies</td>
<td>3 orange daisies : 5 total daisies</td>
<td>3 orange daisies ( \frac{3}{5} ) total daisies</td>
</tr>
</tbody>
</table>

Notice that when you write a ratio using the total number of parts, you are also writing a fraction. A fraction is a ratio that shows a part-to-whole relationship.

So you are never in doubt what a number represents... label all quantities with the units of measure!
So far, you have seen ratios with the same unit of measure—in this case, daisies. However, remember ratios are comparison of two quantities. Sometimes, ratios can be a comparison of two different quantities with two different units of measure. When this occurs, we call this type of ratio a rate. A rate is a ratio that compares two quantities that are measured in different units. The two shown statements represent rates.

- Five daisies cost $7.50.
- There are 10 daisies in one small vase.

1. Write each statement as a rate using colons and in fractional form.
   a. Five daisies cost $7.50.

      With a colon: ___________________________

      In fractional form: _______________________

   b. There are 10 daisies in one small vase.

      With a colon: ___________________________

      In fractional form: _______________________

A unit rate is a comparison of two measurements in which the denominator has a value of one unit.

2. Which statement from Question 1 represents a unit rate?
Problem 2  Selling Daisies

In any size of the Daisy Smile Bouquet, 2 out of every 5 daisies are white.

1. Complete the model for each question using the ratio given. Then, calculate your answer from your model and explain your reasoning.
   a. How many total daisies are there if 8 daisies are white?

   b. How many daisies are white if there are a total of 25 daisies?

   c. How many daisies are white if there are a total of 35 daisies?

Do you see any patterns?
Pat’s Flower Shop is having a one-day sale. Two daisies cost $1.50.

2. Complete the model for each question using the ratio given. Then, calculate your answer from your model and explain your reasoning.

a. How much would 7 daisies cost?

$1.50

b. How many daisies could you buy for $8.25?

$1.50
Problem 3  Equivalent Ratios and Rates

Previously, you used models to determine whether ratios and rates were equivalent. To determine when two ratios or rates are equivalent to each other, you can write them as a proportion to determine if they are equal. A proportion is an equation that states that two ratios are equal. You can write a proportion by placing an equals sign between the two equivalent ratios. Equivalent ratios are ratios that represent the same part-to-part relationship or the same part-to-whole relationship.

For example, from Pat’s Daisy Smile Bouquet problem situation, you know that 2 out of every 5 daisies are white. So, you can determine how many total daisies there are when 8 daisies are white.

\[
\frac{2}{5} = \frac{8}{20}
\]

There are 8 white daisies out of 20 total daisies in a Daisy Smile Bouquet.

When you rewrite a ratio to an equivalent ratio with greater numbers, you are scaling up the ratio. Scaling up means to multiply the numerator and the denominator by the same factor.

It is important to remember to write the values representing the same quantity in both numerators and in both denominators. It doesn’t matter which quantity is represented in the numerator; it matters that the unit of measure is consistent among the ratios.

Another way you can write equivalent ratios to determine the total number of daisies if 8 are white is shown.

\[
\frac{5}{2} = \frac{20}{8}
\]
1. The Daisy Smile Bouquets are sold in a ratio of 2 white daisies for every 3 orange daisies. Scale up each ratio to determine the unknown quantity of daisies. Explain how you calculated your answer.

   a. \[
   \frac{2 \text{ white daisies}}{3 \text{ orange daisies}} = \frac{？ \text{ white daisies}}{21 \text{ orange daisies}}
   \]

   b. \[
   \frac{2 \text{ white daisies}}{3 \text{ orange daisies}} = \frac{？ \text{ white daisies}}{33 \text{ orange daisies}}
   \]

   c. \[
   \frac{2 \text{ white daisies}}{3 \text{ orange daisies}} = \frac{12 \text{ white daisies}}{？ \text{ orange daisies}}
   \]

   d. \[
   \frac{2 \text{ white daisies}}{3 \text{ orange daisies}} = \frac{24 \text{ white daisies}}{？ \text{ orange daisies}}
   \]
When you rewrite a ratio to an equivalent ratio with lesser numbers, you are scaling down the ratio. Scaling down means you divide the numerator and the denominator by the same factor.

For example you know that 5 daisies cost $7.50. So, you can determine the cost of 1 daisy.

\[
\begin{align*}
\frac{\text{cost}}{\text{daisies}} & \rightarrow \frac{7.50}{5} \\
\frac{\text{cost}}{\text{daisies}} & \rightarrow \frac{1.50}{1} \\
\end{align*}
\]

It costs $1.50 for 1 daisy.

The unit rate \( \frac{1.50}{1} \) daisy is also a rate because the two quantities being compared are different. Recall that any rate can be rewritten as a unit rate with a denominator of 1.

2. Scale down each rate to determine the unit rate.

a. \( \frac{60 \text{ telephone poles}}{3 \text{ miles}} \)  

d. \( \frac{3000 \text{ sheets of paper}}{5 \text{ reams}} \)

b. \( \frac{10,000 \text{ people}}{5 \text{ rallies}} \)  

e. \( \frac{15 \text{ dollars}}{2 \text{ T-shirts}} \)

c. \( \frac{45 \text{ yard of fabric}}{5 \text{ dresses}} \)  

f. \( \frac{10 \text{ km}}{60 \text{ min}} \)
1. Identify each as a ratio that is either part-to-part, part-to-whole, a rate, or a unit rate.

a. 25 bricks on each pallet

b. 5 inches
   2 worms

c. 5 small dolls
   1 large doll

d. 33 girls
   100 total students

e. 5 tons
   1 railway car
2. Scale each ratio or rate up or down to determine the unknown term.

a. \[
\frac{3 \text{ people}}{9 \text{ granola bars}} = \frac{?}{3 \text{ granola bars}}
\]

b. \[
\frac{2 \text{ sandwiches}}{6 \text{ people}} = \frac{1 \text{ sandwich}}{?}
\]

c. \[
\frac{4 \text{ pencils}}{1 \text{ person}} = \frac{?}{25 \text{ people}}
\]

d. \[
\frac{8 \text{ songs}}{1 \text{ CD}} = \frac{?}{5 \text{ CDs}}
\]

e. \[
\frac{3 \text{ tickets}}{\$26.25} = \frac{1 \text{ ticket}}{?}
\]

f. \[
\frac{10 \text{ hours of work}}{\$120} = \frac{1 \text{ hour of work}}{?}
\]

g. \[
\frac{2 \text{ hours}}{120 \text{ miles}} = \frac{12 \text{ hours}}{?}
\]

h. \[
\frac{6 \text{ gallons of red paint}}{4 \text{ gallons of yellow paint}} = \frac{?}{1 \text{ gallon of yellow paint}}
\]

Be prepared to share your solutions and methods.
1.1 Introduction to Ratios and Rates

Learning Goals
In this lesson, you will:
- Identify ratios, rates, and unit rates.
- Use ratios, rates, and unit rates to analyze problems.

Key Terms
- ratio
- rate
- proportion
- equivalent ratios
- unit rate
- scaling up
- scaling down

Essential Ideas
- A ratio is a comparison of two quantities using division.
- A rate is a ratio that compares two quantities that are measured in different units.
- A unit rate is a comparison of two measurements in which the denominator has a value of one unit.
- A proportion is an equation that states that two ratios are equal.
- Scaling up means to multiply the numerator and the denominator by the same factor.
- Scaling down means to divide the numerator and the denominator by the same factor.

Common Core State Standards for Mathematics
6.RP Ratios and Proportional Relationships
Understand ratio concepts and use ratio reasoning to solve problems.
1. Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities.
7.RP Ratios and Proportional Relationships
Analyze proportional relationships and use them to solve real-world and mathematical problems.
1. Compute unit rates associated with ratios of fractions, including ratios of lengths, areas and other quantities measured in like or different units.
Overview
Students review various key terms that relate to ratio, rates, and proportions. They express ratios using words, a colon, and by writing a fraction. Students will then draw models to represent ratios in a situation and solve for unknown quantities using the models. Equivalent ratios are explored and students create proportions to solve for unknown quantities. Finally, students conclude the lesson by distinguishing between part-to-part ratios, part-to-whole ratios, and rates.
Warm Up

Rewrite each statement using a fraction.

1. Five days out of every seven days I go to school.
   I go to school $\frac{5}{7}$ of the week.

2. Four months out of every year it snows.
   It snows $\frac{4}{12}$, or $\frac{1}{3}$ of the year.

3. It rained fifteen days in March.
   It rained $\frac{15}{31}$ of the days this month.

4. I have bandages on two of my fingers.
   $\frac{2}{10}$, or $\frac{1}{5}$ of my fingers have bandages on them.

5. Two of the dozen eggs were already cracked when I opened the box of eggs.
   $\frac{2}{12}$, or $\frac{1}{6}$ of the dozen eggs were cracked when I opened the box of eggs.
SHOW SOMEONE YOU CARE—SEND FLOWERS!
Teacher Implementation Guide
CONT’D
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You probably don’t think about flowers on a daily basis, but there are some people who do! Florists routinely think about different types of flowers, arrangements of those flowers, ordering flowers, plants, balloons, baskets, and vases, and—phew! There’s a lot to floristry! But make no mistake, the business of floristry is more than just flowers—it’s dollars and cents and mathematics. For example, there are certain days of the years when there is a huge demand for roses, vases, and baby’s breath. When this occurs, florists must accurately order roses and baby’s breath in comparison to other flowers to make sure they can fulfill the demand, but not have a lot of these flowers left over. What certain days do you think might have a higher demand for roses or vases? How do you think mathematics can help florists order and arrange flowers?

Key Terms
- Baby’s breath are plants that have tiny white flowers and buds. They are usually with roses in flower arrangements.
Problem 1
Two out of every five daisies in a bouquet are white. Examples of part-to-part and part-to-whole ratios are given in word form, using a colon, and in fractional form. The terms ratio, rate and unit rate are introduced. Students answer questions about ratios and rewrite ratio statements in various ways.

Grouping
Ask a student to read the definition of ratio and information in Problem 1 aloud. Then complete Problem 1 as a class.

Problem 1 Representing Ratios
Pat’s Flower Shop specializes in growing and selling large daisies. On a typical summer day, you may hear a florist say one of these statements:
- In the Daisy Smile Bouquet, there are 2 white daisies for every 3 orange daisies.
- In the Daisy Smile Bouquet, 2 out of every 5 daisies are white.
- Five daisies cost $7.50.
- There are 10 daisies in a small vase.

In each statement, the florist is comparing two different quantities. In mathematics, we use ratios to make comparisons. A ratio is a comparison of two quantities using division.

Let’s consider the statement: “In the Daisy Smile Bouquet, there are 2 white daisies for every 3 orange daisies.”

The relationship between the two different types of daisies can be represented in several ways. One way to represent the relationship is to draw picture, or model.

From the model, you can make comparisons about the different quantities.
- White daisies to orange daisies
- Orange daisies to white daisies
- White daisies to total daisies
- Orange daisies to total daisies

Each comparison is ratio. The first two comparisons are part-to-part ratios. The last two comparisons are part-to-whole ratios because you are comparing one of the parts (either white or orange) to the total number of parts.

The table shows three different ways to represent the part-to-part ratios.
Discuss Phase, Problem 1

- Are all fractions considered ratios?
- Are all ratios considered fractions?
- What is the difference between a part-to-part ratio and a part-to-whole ratio?

### Part-to-Part Ratios

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You can also write a part-to-whole ratio to show the number of each daisy compared to the total number of daisies. The table shows two different ways to represent part-to-whole ratios.

### Part-to-Whole Ratios

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Notice that when you write a ratio using the total number of parts, you are also writing a fraction. A fraction is a ratio that shows a part-to-whole relationship.

So you are never in doubt what a number represents... label all quantities with the units of measure!
Grouping
Have students complete Questions 1 and 2 with partner. Then share the responses as a class.

Share Phase, Questions 1 and 2
- What is the difference between a rate and a ratio?
- How is a unit rate different from other rates?
- How is a unit rate similar to other rates?

So far, you have seen ratios with the same unit of measure—in this case, daisies. However, remember ratios are comparison of two quantities. Sometimes, ratios can be a comparison of two different quantities with two different units of measure. When this occurs, we call this type of ratio a rate. A rate is a ratio that compares two quantities that are measured in different units. The two shown statements represent rates.

- Five daisies cost $7.50.
- There are 10 daisies in one small vase.

1. Write each statement as a rate using colons and in fractional form.
   a. Five daisies cost $7.50.
      With a colon: 5 daisies : $7.50
      In fractional form: \[
      \frac{5 \text{ daisies}}{1} = \frac{7.50}{1.00}
      \]
   b. There are 10 daisies in one small vase.
      With a colon: 10 daisies : 1 small vase
      In fractional form: \[
      \frac{10 \text{ daisies}}{1 \text{ small vase}} = \frac{10}{1}
      \]

A unit rate is a comparison of two measurements in which the denominator has a value of one unit.

2. Which statement from Question 1 represents a unit rate?
   There are 10 daisies in one small vase.
Problem 2
Two out of every five daisies in bouquet are white. Students use the information given to complete models to represent different numbers of daisy bouquets.

Grouping
Have students complete Questions 1 and 2 with a partner. Then share the responses as a class.

Share Phase, Question 1
• For every daisy in a bouquet that is white, how many daisies are not white?
• If 8 daisies are white, how many daisies are not white?
• If there a total of 25 daisies, how many daisies are not white?
• If there a total of 35 daisies, how many daisies are not white?

Problem 2
Selling Daisies
In any size of the Daisy Smile Bouquet, 2 out of every 5 daisies are white.
1. Complete the model for each question using the ratio given. Then, calculate your answer from your model and explain your reasoning.
   a. How many total daisies are there if 8 daisies are white?

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```
There are 20 total daisies if 8 daisies are white. I was able to draw 8 white daisies and using the given ratio, I determined that there are 20 total daisies.

b. How many daisies are white if there are a total of 25 daisies?

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There are 10 white daisies. I was able to draw 25 daisies, and using the ratio, I could determine that there were 10 white daisies.

c. How many daisies are white if there are a total of 35 daisies?

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```
There are 14 white daisies. I was able to draw 35 daisies, and using the ratio, I determined that there were 14 white daisies.

Do you see any patterns?
Pat’s Flower Shop is having a one-day sale. Two daisies cost $1.50.

2. Complete the model for each question using the ratio given. Then, calculate your answer from your model and explain your reasoning.

a. How much would 7 daisies cost?

Seven daisies would cost $5.25.
I was able to draw 7 daisies and given the rate that 2 daisies cost $1.50, I know that 6 daisies cost $4.50. Then, I determined that the cost of 1 daisy must be $0.75. Finally, I added $4.50 and $0.75 to get a total cost of $5.25.

b. How many daisies could you buy for $8.25?

I can buy 11 daisies for $8.25.
I was able to draw 11 daisies and given the rate that 2 daisies cost $1.50, I know that 10 daisies cost $7.50. Then, I determined that the cost of 1 daisy must be $0.75. Finally, I added $7.50 and $0.75 to get a total cost of $8.25.
Problem 3
The terms proportion, scaling up, and scaling down are introduced. Students use proportions to solve for unknown quantities of daisies. Students then use scaling down to determine unit rates.

Grouping
Ask a student to read the information and definitions before Question 1 aloud. Discuss the information as a class.

Problem 3 Equivalent Ratios and Rates
Previously, you used models to determine whether ratios and rates were equivalent. To determine when two ratios or rates are equivalent to each other, you can write them as a proportion to determine if they are equal. A proportion is an equation that states that two ratios are equal. You can write a proportion by placing an equals sign between the two equivalent ratios. Equivalent ratios are ratios that represent the same part-to-part relationship or the same part-to-whole relationship.

For example, from Pat’s Daisy Smile Bouquet problem situation, you know that 2 out of every 5 daisies are white. So, you can determine how many total daisies there are when 8 daisies are white.

\[
\frac{\text{white daisies}}{\text{total daisies}} = \frac{2}{5} \quad \text{and} \quad \frac{8}{x}
\]

There are 8 white daisies out of 20 total daisies in a Daisy Smile Bouquet.

When you rewrite a ratio to an equivalent ratio with greater numbers, you are scaling up the ratio. Scaling up means to multiply the numerator and the denominator by the same factor.

It is important to remember to write the values representing the same quantity in both numerators and in both denominators. It doesn’t matter which quantity is represented in the numerator; it matters that the unit of measure is consistent among the ratios.

Another way you can write equivalent ratios to determine the total number of daisies if 8 are white is shown.

It's important to think about lining up the labels when writing equivalent ratios.

\[
\frac{\text{total daisies}}{\text{white daisies}} = \frac{5}{2} \quad \text{and} \quad \frac{8}{x}
\]
1. The Daisy Smile Bouquets are sold in a ratio of 2 white daisies for every 3 orange daisies. Scale up each ratio to determine the unknown quantity of daisies. Explain how you calculated your answer.
   a. 2 white daisies : 3 orange daisies = ? white daisies : 21 orange daisies
      14 white daisies
      I multiplied the numerator and denominator by 7.
   b. 2 white daisies : 3 orange daisies = ? white daisies : 33 orange daisies
      22 white daisies
      I multiplied the numerator and denominator by 11.
   c. 2 white daisies : 3 orange daisies = 12 white daisies : ? orange daisies
      18 orange daisies
      I multiplied the numerator and denominator by 6.
   d. 2 white daisies : 3 orange daisies = 24 white daisies : ? orange daisies
      36 orange daisies
      I multiplied the numerator and denominator by 12.
1.1 Introduction to Ratios and Rates

Grouping
- Ask a student to read the definition of scaling down aloud. Discuss the worked example as a class.
- Have students complete Question 2 with a partner. Then share the responses as a class.

Share Phase, Question 2
- How many threes are in sixty?
- How many fives are in ten-thousand?
- How many fives are in forty-five?
- How many fives are in three-thousand?
- How many twos are in fifteen?
- How many tens are in sixty?

When you rewrite a ratio to an equivalent ratio with lesser numbers, you are scaling down the ratio. Scaling down means you divide the numerator and the denominator by the same factor.

For example you know that 5 daisies cost $7.50. So, you can determine the cost of 1 daisy.

\[
\text{cost} \quad \frac{5 \text{ daisies}}{7.50} \quad \frac{1 \text{ daisy}}{1.50}
\]

It costs $1.50 for 1 daisy.

The unit rate $1.50 : 1, $1.50 \frac{\text{daisies}}{1 \text{ daisy}}$ is also a rate because the two quantities being compared are different. Recall that any rate can be rewritten as a unit rate with a denominator of 1.

2. Scale down each rate to determine the unit rate.
   a. \[\frac{60 \text{ telephone poles}}{3 \text{ miles}} = \frac{20 \text{ poles}}{1 \text{ mile}}\]
   b. \[\frac{10,000 \text{ people}}{5 \text{ rallies}} = \frac{2000 \text{ people}}{1 \text{ rally}}\]
   c. \[\frac{45 \text{ yard of fabric}}{5 \text{ dresses}} = \frac{9 \text{ yards}}{1 \text{ dress}}\]
   d. \[\frac{3000 \text{ sheets of paper}}{5 \text{ reams}} = \frac{600 \text{ sheets}}{1 \text{ ream}}\]
   e. \[\frac{15 \text{ dollars}}{2 \text{ T-shirts}} = \frac{7.50}{1 \text{ T-shirt}}\]
   f. \[\frac{10 \text{ km}}{60 \text{ min}} = \frac{0.166}{1 \text{ min}}\]
Talk the Talk

Students identify several ratios as part-to-part, part-to-whole, or a rate. Students will solve proportions for the unknown quantities by either scaling up or scaling down.

Grouping

• Have students analyze the flow chart independently. Then discuss the chart as a class.
• Have students complete Questions 1 and 2 with a partner. Then share the responses as a class.

Share Phase, Question 1

Does this ratio compare the same quantities or different quantities?

1. Identify each as a ratio that is either part-to-part, part-to-whole, a rate, or a unit rate.
   a. 25 bricks on each pallet
      rate
   b. 5 inches
      2 worms
      rate
   c. 5 small dolls
      1 large doll
      part-to-part ratio
   d. 33 girls
      100 total students
      part-to-whole ratio
   e. 5 tons
      1 railway car
      unit rate
Share Phase, Question 2

- Did you solve the proportion by scaling up or scaling down? Explain.
- How do you know when it is necessary to scale up to solve the proportion?
- How do you know when it is necessary to scale down to solve the proportion?
- Nine divided by what number is equal to three?
- Two divided by what number is equal to one?
- One times what number is equal to twenty-five?
- One times what number is equal to five?
- Three divided by what number is equal to one?
- Ten divided by what number is equal to one?
- Two times what number is equal to twelve?
- Four divided by what number is equal to one?

2. Scale each ratio or rate up or down to determine the unknown term.

a. 3 people = 9 granola bars
   1 person = 3 granola bars

b. 2 sandwiches = 1 sandwich
   6 people = ?

Note: The equation is not balanced, as there should be a number equal to 6 people.

Be prepared to share your solutions and methods.
Follow Up

Assignment
Use the Assignment for Lesson 1.1 in the Student Assignments book. See the Teacher’s Resources and Assessments book for answers.

Skills Practice
Refer to the Skills Practice worksheet for Lesson 1.1 in the Student Assignments book for additional resources. See the Teacher’s Resources and Assessments book for answers.

Assessment
See the Assessments provided in the Teacher’s Resources and Assessments book for Chapter 1.

Check for Students’ Understanding
Consider the following facts:

• An average page in a novel contains 350 words.
• An average novel contains 450 pages.
• An average number of pages per chapter in a novel is 25 pages.

Solve for each unknown quantity and explain what it represents in terms of the situation.

1. \[
\frac{450}{25} = ?
\]
   18 chapters per novel

2. \[
\frac{\frac{1}{350}}{25} = ?
\]
   8750 represents the average number of words on 25 pages