## Contents

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**Additional Practice**

**Answers to Check Your Work**

Student Activity Sheets
Tim wants to rearrange the furniture in his room. He decides to make a scale drawing of his room, called a *floor plan*. He can use the floor plan to try out different room arrangements. This will save him the work of moving the actual furniture. He can move the paper furniture on his scale drawing.

Tim’s actual room dimensions are 2.6 m wide and 3 m long.

Tim decides to use graph paper. His first idea is to draw a floor plan with dimensions 26 cm by 30 cm.

1. **a.** Explain why you think Tim decided on these floor plan dimensions.

   **b.** What are some advantages and disadvantages of making a plan with dimensions 26 cm by 30 cm?
Tim decides to use dimensions of 13 cm by 15 cm for his floor plan.

2. a. Why do you think Tim decided to use these dimensions?
   b. Use Student Activity Sheet 1 to draw the same floor plan Tim will draw of his room. Indicate the location for the door to his room on the floor plan.
A double number line is a useful tool to show the relationship between the dimensions in a drawing and the actual room dimensions. Here is a double number line that belongs to the scale drawing of Tim's room.

\[\begin{array}{c|c}
0 & 1 \quad 5 \quad 10 \\
\hline
0 & 15 \quad 300 \\
\end{array}\]

3. Copy this double number line under your own scale drawing on Student Activity Sheet 1 and fill in the missing numbers on the bottom of the line.

Here is the furniture for Tim's room.

- **dressing**
  - \(w = 80\ cm\)
  - \(d = 30\ cm\)
  - \(h = 170\ cm\)

- **chair**
  - \(w = 50\ cm\)
  - \(d = 50\ cm\)
  - \(h = 100\ cm\)

- **bed**
  - \(w = 100\ cm\)
  - \(d = 170\ cm\)
  - \(h = 100\ cm\)

On a separate piece of graph paper, draw each piece of furniture to the same scale as the floor plan. Each miniature piece of furniture should represent the space the actual furniture takes up on the floor of Tim’s room. Cut out these pieces and move them around on your floor plan until you have an arrangement you like.

4. Draw your favorite arrangement for Tim’s room on your floor plan on Student Activity Sheet 1.
The double number line used for Tim’s floor plan indicates a **scale ratio** of 1:20.

5. **Reflect**  
Look back at the double number line for Tim’s floor plan. Describe how you would explain to someone what it means that Tim’s floor plan has a scale ratio of 1:20.

Tim’s older sister, Jenna, wants to rent an apartment. Below is a floor plan of an apartment she likes a lot. She wants to use the floor plan to find the dimensions of the living room.

6. a. Use this ratio table to help Jenna find the length of the living room.

<table>
<thead>
<tr>
<th>Length in Drawing (in cm)</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual Length (in cm)</td>
<td>75</td>
</tr>
</tbody>
</table>

b. What is the actual width of the living room? Show your calculations.
Tim and his friends want to build a sand volleyball court. They use the scale drawing below to begin to figure out the actual dimensions. Tim says, “One centimeter in the drawing is actually 3 meters.”

7. a. Do you agree or disagree with Tim’s statement? Explain.

   b. What are the actual dimensions of the court? Of the total volleyball space (including the part around the actual court)?

A scale drawing represents objects that are too large or too small to draw at actual size.

A scale ratio shows the relationship between the dimensions in the drawing and the actual dimensions of the object. A scale ratio of 1:100 on a floor plan can mean:

  - 1 centimeter represents 100 centimeters or
  - 1 meter represents 100 meters or
  - 1 millimeter represents 100 millimeters or
  - 1 inch represents 100 inches

An architect makes a scale drawing. She uses 2 cm to represent 100 m.

8. a. What is the scale ratio for her drawing? Show your work.

   b. What do you think she is drawing?
Scale Models

Instead of a scale drawing on a piece of paper, you can make a three-dimensional scale model.

The photo on the left shows a plane with a scale model of the plane on its wing.

The model is built with a scale of 1:6. The actual length of the plane is 6.6 m and its wingspan is 8 m.

9. a. What is the length of the scale model airplane?

You may want to use a ratio table like the one below for your calculations. (Note: Instead of using centimeters, you may prefer to use meters.)

<table>
<thead>
<tr>
<th>Length of Actual Plane (in cm)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of Scale Model (in cm)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

b. How long is the wingspan of the scale model airplane?

The photo on the left shows six different model trains. Each of them is built to a different scale. The five scales below are commonly used.

- Z scale: trains built to a ratio of 1:220
- N scale: trains built to a ratio of 1:160
- HO scale: trains built to a ratio of 1:87
- S scale: trains built to a ratio of 1:64
- Scale O: trains built to a ratio of 1:48

10. What scale was used to build the smallest train shown? How do you know for sure?
Maps

You may remember doing other work with scale lines on a map. Scale lines are like a ruler. You can use scale lines to estimate or even measure distances on a map. The map below shows the northern part of San Francisco.

Sarita walks from the Marina Green to Fort Point National Historic Site. The black dotted line shows Sarita’s walking path.

11. Estimate the length of Sarita’s walking path.

If you want to find a distance on a map, you need to go from one measurement unit to another. The following conversions are common. Do you know them?

12. Check what you know by copying and filling in the following measuring relationships. Add others that you might know.

1 meter = ....... centimeters
1 kilometer = ....... meters

You can transform a scale line on the map into a double number line. Here is a double number line adapted from the scale line on the San Francisco map.
13. a. Describe the differences and similarities between the scale line on the map and the double number line on the previous page.

b. Use the double number line to find the missing numbers in the table below.

<table>
<thead>
<tr>
<th>Distance on Map (in cm)</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual Distance (in m)</td>
<td></td>
</tr>
<tr>
<td>Actual Distance (in cm)</td>
<td></td>
</tr>
</tbody>
</table>

c. What is the scale ratio of the map?

14. Suppose you have a map made on a scale of 1:50,000. You measure 10 cm on the map. How many kilometers does this distance represent?

Here are three different maps of three different islands: Norfolk (Australia), Iwo Jima (Japan), and Hierro (Spain). Each map was made using a different scale. The scale is indicated on each map.

If you compare the size of the islands visually, you might think the three islands all look about the same size. In reality, this is not true!

15. Write the names of the islands in order from the largest to the smallest island. Explain how you decided what the order was.
You use a scale drawing to represent things that are too large or too small to draw. A scale ratio indicates the relationship between the dimensions on the scale drawing and the actual dimensions. You use a scale ratio to create scale models.

To create a scale drawing or model, you need to know the relationship between the scaled dimensions and the actual dimensions. This relationship can be given with:

- **a scale line**

  ![Scale Line Diagram]

  A scale ratio always begins with the number 1. Both numbers represent identical units. The scale ratio 1:1,000 means that 1 cm on the drawing represents 1,000 cm in reality.

- **a scale ratio**

  1:1000

- **a statement**

  On the map, a distance of 1 cm is actually 1,000 cm, which is 10 m.

  A ratio table and a double number line can help you to organize your work and make your calculations involving scale easy.

**Ratio Table:**

<table>
<thead>
<tr>
<th>Distance on Map (in cm)</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual Distance (in cm)</td>
<td>1000</td>
</tr>
</tbody>
</table>

**Double Number Line**

- **1000 centimeters = 10 meters**

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D Ratios and Rates
1. A room is 3 m wide and 4 m long.
   Make a scale drawing of this room using a scale of 1:50

Here is a photo of a Swallowtail butterfly (*Papilio machaon*). The wingspan of the actual butterfly is 10 cm.

2. a. If you wanted to make a life-size drawing of the butterfly, would it fit on a page in this book?
   b. What is the size of the wingspan in the photo?
   c. Use a double number line or a ratio table to find the scale ratio of the photo.
   d. What is the actual length of the body of the butterfly? Show your calculations.

Here is a scale line from a map:

```
<table>
<thead>
<tr>
<th>0</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>kilometers</td>
</tr>
</tbody>
</table>
```

3. a. What is the actual distance of 1 cm on this map?
   b. What is the scale ratio of the map?
The map below shows a part of downtown Philadelphia.

4. a. Copy and complete the following ratio table for the map.

<table>
<thead>
<tr>
<th>Distance on Map (in cm)</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual Distance (in cm)</td>
<td>............</td>
</tr>
</tbody>
</table>

b. How far is a walk from Sansom Street to Arch Street? (Use meters or kilometers for your distance.)

Suppose a map has a scale ratio of 1:20,000.

5. a. Do you think this map was designed to be used by someone who is walking or someone who is driving? Explain your answer.

b. Make a scale line for this map.

For Further Reflection

Write a paragraph describing the need for using scale lines and scale ratios in designing toy cars. Be exact in your descriptions.
Members of the Lewis and Clark expedition (1804–1806) searched for an overland route from the Mississippi River to the Pacific Ocean.

The scale of this map is 1:25,000,000.

1. Estimate the distance Lewis and Clark covered when they traveled from St. Louis to Fort Clatsop.

Here is an excerpt from a journal.

May 14, 1804  Expedition begins in St. Louis.

October 24, 1804  Expedition discovers earth lodge villages of the Mandan and Hidatsas Indians. The captains decide to build Fort Mandan across the river from the main village.

2. a. Use the information in the journal to estimate the average distance the expedition covered per month during this period. Note that Fort Mandan is about halfway between St. Louis and Fort Clatsop.

b. Also find the average distance per day.
Eiffel Tower Puzzle

The wrought-iron original has attracted millions of visitors and is the symbol of Paris. Now you can construct your own Eiffel Tower to a scale of 1:500.

The height of the actual tower is 312 meters.

3. What is the height of the model?
1. Here is one sample drawing. Your room dimensions should be 8 cm by 6 cm.

The scale ratio of 1:50, means 1 cm on the map is 50 cm in reality. Working up to 300 cm (3 m) and 400 cm (4 m), you can get the drawing dimensions needed.

1 → 50, 2 cm → 100 cm, 8 cm → 400 cm and 6 cm → 300 cm.

2. a. Yes, a life-size drawing of the butterfly would fit on a page in this book because it is 10 cm. Here is how 10 cm looks.

b. About 2.5 cm.

c. The scale ratio is 1:4.

Sample strategy using a double number line:

<table>
<thead>
<tr>
<th>In Drawing (in cm)</th>
<th>2.5</th>
<th>25</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual (in cm)</td>
<td>10</td>
<td>100</td>
<td>4</td>
</tr>
</tbody>
</table>
d. The actual length of the body of the butterfly is 3.6 cm.

Here is one strategy.

The body length in the reduction is about 0.9 cm. Since this represents \( \frac{1}{4} \) of the length, the body length is about 3.6 cm. (0.9 \( \times \) 4 \( \rightarrow \) 3.6).

3. a. 1 cm represents 1 kilometer, which is 1,000 meters.

b. The scale ratio is 1:100,000

On the map, 1 cm represents 1,000 m.
In reality, 1,000 m is 100,000 cm. So 1 cm on the map represents 100,000 cm in reality. The scale ratio is 1:100,000.

<table>
<thead>
<tr>
<th>On Map (in cm)</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>In Reality (in cm)</td>
<td>1,000</td>
</tr>
<tr>
<td>In Reality (in cm)</td>
<td>100,000</td>
</tr>
</tbody>
</table>

4. a. Distance on a Map (in cm) 1

| Actual Distance (in cm) | 5,000 |

b. About 385 m or 0.385 km.

The distance on the map is about 7.7 cm. Since 1 cm represents 5,000 cm, you can calculate 7.7 \( \times \) 5,000 \( \rightarrow \) 38,500 cm or 385 m. If you measured a distance between 7.3 cm and 7.8 cm on the map, your answer must be between 365 m and 390 m.

5. a. The map is designed to be used by someone who is walking.

Here is one way of reasoning.

1 cm on the map represents 20,000 cm in reality. This is about 200 m. If 1 cm represents 200 m then 10 cm represents 2,000 m, which is 2 km. I chose 10 cm, because that fits nicely on a page. The map is not for driving because you would be off the map before you knew it. 2 km is a short distance.
b. Here is one possible scale line.

![Scale Line Diagram](image)

Your scale line might look different. You might have other distances indicated like 400 m (at 2 cm); 600 m (at 3 cm); etc. Instead of meters, it may show kilometers, and every 5 cm is 1 km. Note that for a scale line to be correct, 1 cm must represent 200 m.
Tim decides to use dimensions of 13 cm by 15 cm for his floor plan.

2. Draw the same floor plan Tim will draw of his room. Indicate the location for the door to his room on the floor plan.

**Double Number Line:**
A double number line is a useful tool to show the relationship between the dimensions in a drawing and the actual room dimensions. An example for Tim’s room is in your student book.

3. Copy the double number line under your scale drawing and fill in the missing numbers.