Scale Factor to Find Actual Dimensions

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Learning Objectives

In this concept, you will learn to use scale factor to find actual dimensions.

Sam is at the county fair looking at model train displays. The smallest one is an "N" gauge, which is a scale of 1:160. If the display area is 4 feet by 8 feet, how big an area does the display represent?

In this concept, you will learn how to use a scale factor to find actual dimensions.

Using Scale Factor to Find Actual Dimensions

A ratio compares two quantities. Ratios can be written as fractions, with a colon or with the word “to.”

$\frac{2}{3}$, 2:3, and "2 to 3" are ratios.

A proportion is created when two ratios are found to be equivalent or equal.

$\frac{1}{2} = \frac{3}{6}$ is a proportion.

A unit rate is a comparison of two measurements, one of which has a value of 1.

55 miles per hour, $\frac{55 \text{ miles}}{1 \text{ hour}}$ is a unit rate.

A unit scale is a ratio that compares the dimensions of an actual object to the dimensions of a scale drawing or model that represents the actual object. Neither value in a unit scale has to equal 1.

The unit scale on a map may read $\frac{1}{2} \text{ inch} = 100 \text{ feet}$.

The ratio would be written $\frac{0.5}{100}$.
To represent a line 500 feet long, the unit scale would be used to draw a line $2\frac{1}{2}$ inches long.

A line 4 inches long would represent an actual line of 800 feet.

Unit scales and proportions can be used to calculate actual distances from maps, drawings, or models.

Actual distances can be represented on maps, drawings, or models by using unit scales.

A **scale factor** is somewhat like a unit scale. It is a ratio that compares scale dimensions to actual dimension. It differs because it does not give any specific units.

A scale factor for a scale drawing might be $\frac{1}{160}$, which means that the actual size is 200 times the drawing.

Scale factors can be used to determine both scale and actual sizes or dimensions.

**Examples**

**Example 1**

Earlier, you were given a problem about the model train displays at the fair.

The smallest one is an "N" gauge, which is a scale of 1:160. If the display area is 4 feet by 8 feet, how big an area does the display represent?

First, write the scale factor.

$$\frac{\text{scale}}{\text{actual}} = \frac{1}{160}$$

Next, write ratios to represent the unknown actual length and width of the display to the scale length and width of the display.

$$\frac{\text{Length}}{\text{scale}} = \frac{4}{1}$$

$$\frac{\text{Width}}{\text{scale}} = \frac{8}{w}$$

Then, write two proportions by setting the two length ratios equal to one another and the two width ratios equal to one another. The given unit is feet.

$$\frac{\text{Length}}{\text{scale}} = \frac{4}{1} = \frac{1}{160}$$

$$\frac{\text{Width}}{\text{scale}} = \frac{8}{w} = \frac{1}{160}$$

Next, cross multiply each equation.

$$L = 4 \times 160$$

$$L = 640 \text{ feet}$$

$$W = 8 \times 160$$

$$W = 1,280 \text{ feet}$$
Then, to find the area of the display, multiply length times width.

\[ 640 \text{ ft.} \times 1,280 \text{ ft.} = 819,200 \text{ sq. ft.} \]

The answer is 819,200 square feet.

**Example 2**

A small airplane has a wing span of 16 feet. The scale factor for a model is \( \frac{1}{48} \). Find the wing span of the model in inches.

First, write the scale factor.

\[ \frac{\text{scale}}{\text{actual}} = \frac{1}{48} \]

Next, write a ratio to represent the actual length of the wingspan to the unknown scale length of the wingspan.

\[ \frac{\text{scale}}{\text{actual}} = \frac{w}{16} \]

Then, write a proportion by setting the two ratios equal to one another. Remember that feet is the only unit given.

\[ \frac{1}{48} = \frac{w}{16} \]

Next, cross multiply.

\[ 48w = 16 \]

Then, convert feet to inches.

\[ \frac{1}{3} \text{ foot} \times \frac{12 \text{ inches}}{1 \text{ foot}} = 4 \text{ inches} \]

The answer is 4 inches. The wingspan on the model plane will be 4 inches long.

**Example 3**

The longest side of a triangular flower bed is 5.5 meters long. Leah wants to make a scale drawing of the flower bed. The scale factor for her drawing will be \( \frac{1}{20} \). What will be the length of the longest side of the flower bed in her drawing?

First, write the scale factor.
Next, write a ratio to represent the actual length of the side to the unknown scale length of the side.

\[
\frac{\text{scale}}{\text{actual}} = \frac{1}{20}
\]

Then, write a proportion by setting the two ratios equal to one another. Meters is the only unit given.

\[
\frac{1}{20} = \frac{l}{5.5}
\]

meters

Next, cross multiply.

\[
5.5 = 20l
\]

\[
l = 0.275 \text{ meters}
\]

Then, convert meters to centimeters.

\[
0.275 \text{ meters} \times \frac{100 \text{ cm}}{1 \text{ m}} = 2.75 \text{ cm}
\]

The answer is 27.5 centimeters.

**Example 4**

An ant that Alison observed was too small to draw at its actual size. So, Alison made the scale drawing shown below. The scale factor for the drawing is 5. Find the actual length of the ant Alison observed.

First, write the scale factor.
\[
\frac{\text{scale}}{\text{actual}} = \frac{5}{1}
\]

Next, write a ratio to represent the unknown actual length of the ant to the scale length of the ant.

\[
\frac{\text{scale}}{\text{actual}} = \frac{2.75}{l}
\]

Then, write a proportion by setting the two ratios equal to one another. Centimeters is the only unit given.

\[
\frac{5}{1} = \frac{2.75}{l} \text{ cm}
\]

Next, cross multiply.

\[
2.75 = 5l
\]

\[
l = 0.55
\]

\[
l = 0.55 \text{ cm}
\]

Then, convert centimeters to millimeters.

\[
0.55 \text{ cm} \times \frac{10 \text{ mm}}{1 \text{ cm}} = 5.5 \text{ mm}
\]

**Example 5**

The scale drawing below shows a rectangular carpet. The scale factor for the drawing is \(\frac{1}{24}\). What is the area, in square feet, of the actual carpet?

![Scale Drawing of Carpet](image)

First, write the scale factor.

\[
\frac{\text{scale}}{\text{actual}} = \frac{1}{24}
\]
Next, write ratios to represent the unknown actual length and width of the carpet to the scale length and width of the carpet.

\[
\frac{\text{scale}}{\text{actual}} = \frac{4}{1} \quad \frac{\text{scale}}{\text{actual}} = \frac{2}{w}
\]

Then, write two proportions by setting the two length ratios equal to one another and the two width ratios equal to one another. The given unit is inches.

\[
\frac{\text{Length}}{\text{actual}} = \frac{4}{7} = \frac{1}{24} \\
\frac{\text{Width}}{\text{actual}} = \frac{2}{w} = \frac{1}{24}
\]

Next, cross multiply each equation.

\[
L = 4 \times 24 \\
L = 96 \text{ inches} \\
W = 2 \times 24 \\
W = 48 \text{ inches}
\]

Then, to find the area of the carpet, multiply length x width.

96

The answer is 4,608 square inches.

**Review**

Solve each problem. Keep in mind that several problems may have more than one part.

1. Calvin drew a map of his neighborhood. The scale factor he used for his map was \( \frac{1}{800} \). The actual distance between Calvin’s house and his best friend Frank’s house is 80 meters. What should be the distance, in centimeters, between those two places on his scale drawing?
2. If the distance from Calvin’s house to the park is 40 meters, what would be the distance in centimeters?
3. If the distance from Calvin’s house to the corner store is double the distance from his house to Frank’s, what would be the distance on the map in centimeters?
4. If the distance from Calvin’s house to his Grandmother’s was halfway between his and Frank’s, what would be the distance on the map in centimeters?
5. Madeline built a model of a boat. The actual length of the boat is 24 feet. The scale factor she used for the model was \( \frac{1}{36} \). What should be the length, in inches, of the model boat?
6. If the scale factor was \( \frac{1}{72} \), what would the length be in inches of the model boat?
7. A metal pipe is 2.5 meters long. Josh wants to make a scale drawing of the pipe. The scale factor for his drawing will be \( \frac{1}{100} \). What will be the length, in centimeters, of the metal pipe in his drawing?
8. Sydra observed a housefly that was too small to draw at its actual size. So she made a scale drawing, using 10 as a scale factor. The actual length of the housefly was 8 millimeters. What is the length of the housefly in Sydra’s drawing in millimeters?
9. What is the length of the housefly in Sydra’s drawing in centimeters?

10. Luis made a scale model of the doghouse he is going to build. The scale factor he used for this model was \( \frac{1}{24} \). He wants the actual height of the doghouse to be 6 feet. What should be the height of the doghouse in his scale model?

11. Jean-Marc used a scale factor of 5 to make this scale drawing of a moth.

![Moth drawing]

In the drawing, the wingspan of the moth measures 3 centimeters. What was the actual wingspan, in millimeters, of the moth Jean-Marc observed?

12. Below is a scale drawing of a swimming pool. In the scale drawing, the diameter of the pool measures 1\( \frac{1}{2} \) inches. The scale factor for the drawing is \( \frac{1}{72} \). What is the actual diameter of the pool in feet?

![Swimming pool drawing]

diameter = 1\( \frac{1}{2} \) in.

13. Barbara made a scale model of the Washington Monument. The scale factor for her model is \( \frac{1}{1332} \). The height of her model is 5 inches. What is the actual height, in feet, of the Washington Monument?

14. Below is a map of a city park. This map was created using a scale factor of \( \frac{1}{300} \).

![City park map]

1. On the map, the distance between the sandbox and the swings is 2.5 centimeters. What is the actual distance between the sandbox and the swings in meters?

2. On the map, the distance between the sandbox and the jungle gym is 1.7 centimeters. What is the actual distance between the sandbox and the jungle gym in meters?

15. The scale drawing below shows the floor of Julian’s bedroom.
The scale factor for the drawing is $\frac{1}{200}$.

1. What are the dimensions, in meters, of the actual floor?
2. What is the area, in square meters, of the actual floor?

Review (Answers)

To see the Review answers, open this PDF file and look for section 5.13.

Resources

References

1. CK-12 Foundation. <a href="CK-12 Foundation">CK-12 Foundation</a>.