

Scale Drawings

I Can... use ratio reasoning to find actual lengths and areas from a scale drawing and reproduce a scale drawing at a different scale.

Learn Use Scale Drawings to Find Length

Scale drawings, or scale models, are used to represent objects that are too large or too small to be drawn or built at actual size.

The scale gives the ratio that compares the measurements of the drawing or model to the measurements of the real object. The measurements on a drawing or model are proportional to the measurements on the object.

You can use a scale drawing to find the actual length of an object or the actual distance between two points.



Because the scale is 200 feet per unit, you can estimate that the distance along Bowman Road from the intersection of Morehart Road to the intersection of Blair Road is about 4 units, or 800 feet.

	Scale	Length	
		$\times 4$	
map \rightarrow	$\frac{1 \text{ unit}}{200 \text{ ft}}$	$= \frac{4 \text{ units}}{800 \text{ ft}}$	\leftarrow map
actual \rightarrow			\leftarrow actual
		$\times 4$	

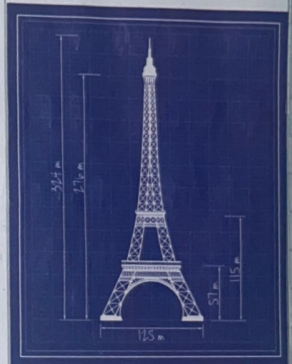
What Vocabulary Will You Learn?

- scale
- scale drawings
- scale factor
- scale models

اصطلاح المسطرة
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Talk About It!

What might be a good scale to use for the scale drawing of the Eiffel Tower, if the actual height of the tower is 324 meters?



1cm per 5m

1cm per 10m

Think About It!

How can you use equivalent ratios to solve the problem?

Example 1 Use Scale Drawings to Find Length

Use the scale of the map to find the actual distance between Hagerstown and Annapolis.



The distance between the two cities on the map is 4 units.

Step 1 Write an equation involving equivalent ratios, using the scale as one of the ratios. Let d represent the actual distance between the cities.

	Scale	Length	
map →	$\frac{1 \text{ unit}}{24 \text{ miles}}$	$= \frac{4 \text{ units}}{d \text{ miles}}$	← map
actual →			← actual

Step 2 Use scaling to find the missing value.

$$\frac{1 \text{ unit}}{24 \text{ miles}} = \frac{4 \text{ units}}{d \text{ miles}}$$

↻ $\times 4$

So, the actual distance between the cities is about 24×4 , or

96 miles.

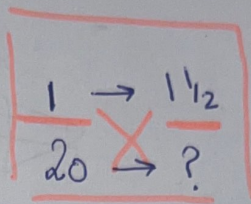
use the scale
to set up the
first ratio
Then set up
the second
ratio by using
the map distance
of 4 units and
the actual
distance d represent
by the variable d

Check

On the map, the distance between Akron and Cleveland is $1\frac{1}{2}$ units.
What is the actual distance between the cities?



Show your work here



$$20 \times 1\frac{1}{2} = 30$$

The actual distance between the cities is 30 miles

Go Online You can complete an Extra Example online.

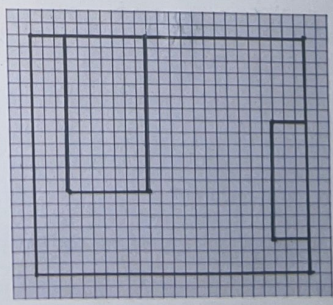
Learn Create Scale Drawings

Go Online Watch the video to see how you can make your own scale drawing if you know the actual measurements and the scale.

The video shows that, to make a scale drawing, first measure the lengths and widths of the actual objects. Record the measurements in a table. The table shows the measurements for the bedroom shown in the video.

Object	Length (ft)	Width (ft)
Room	10	12
Bed	3.5	6.5
Dresser	1.5	5

Choose a scale for the drawing and convert each measurement using the scale. On grid paper, use the scale to draw the measurements. One unit on the grid paper equals 0.5 foot of actual length.



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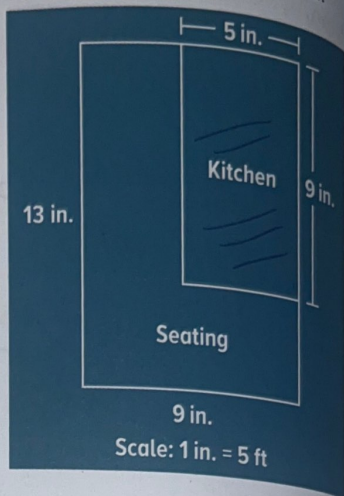
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Learn Use Scale Drawings to Find Area

You can use scale drawings to find the actual area of a space. First, write an equation involving equivalent ratios to find the actual length and width of the space. Then use the area formula to find the area.

The drawing shows the map of a restaurant, drawn to scale. On the map, 1 inch represents 5 feet. What is the actual area of the kitchen?

The kitchen is a rectangle. To find the area of the kitchen, first find the length and width of the kitchen.



Step 1 Find the actual length of the kitchen.

$$\frac{1 \text{ in.}}{5 \text{ ft}} = \frac{9 \text{ in.}}{\ell \text{ ft}}$$

Because $1 \times 9 = 9$, multiply 5×9 .

Actual length: 45 ft

Step 2 Find the actual width of the kitchen.

$$\frac{1 \text{ in.}}{5 \text{ ft}} = \frac{5 \text{ in.}}{w \text{ ft}}$$

Because $1 \times 5 = 5$, multiply 5×5 .

Actual width: 25 ft

Step 3 Find the actual area of the kitchen.

$$\begin{aligned} \text{Area} &= \text{length} \times \text{width} \\ &= 45 \times 25 \\ &= 1,125 \text{ ft}^2 \end{aligned}$$

So, the actual area of the kitchen is 1,125 square feet.

$\frac{1}{5} = \frac{9}{\ell}$
To find the area of scale drawing. When you write the ratio for the scale in the equation use the square of the scale.

$$\frac{1 \text{ in.}}{25 \text{ ft}} \times \frac{45 \text{ ft}}{?}$$

$$25 \times 45$$

$$\begin{aligned} A &= L \times W \\ 45 \times 25 &= 1125 \end{aligned}$$

Example 2 Use Scale Drawings to Find Area

The scale of the floor plan is
1 inch = 3 feet.

What is the actual area of
Bedroom 3?

Bedroom 3 is a rectangle.
To find the area of Bedroom 3,
first find the length and width
of Bedroom 3.



Step 1 Find the actual length of Bedroom 3.

$$\begin{array}{c} \times 4\frac{1}{2} \\ \curvearrowright \\ \frac{1 \text{ in.}}{3 \text{ ft}} = \frac{4\frac{1}{2} \text{ in.}}{x \text{ ft}} \\ \curvearrowleft \\ \times 4\frac{1}{2} \end{array}$$

The actual length of Bedroom 3 is $3 \times 4\frac{1}{2}$, or $13\frac{1}{2}$ feet.

Step 2 Find the actual width of Bedroom 3.

$$\begin{array}{c} \times 3 \\ \curvearrowright \\ \frac{1 \text{ in.}}{3 \text{ ft}} = \frac{3 \text{ in.}}{w \text{ ft}} \\ \curvearrowleft \\ \times 3 \end{array}$$

The actual width of Bedroom 3 is 3×3 , or 9 feet.

Step 3 Find the area.

The area is 13.5×9 or 121.5 square feet.

Check

Find the actual area of Bedroom 1.

Actual Length = $\frac{1 \text{ in.}}{3 \text{ ft}} = \frac{3\frac{1}{4}}{?} = 9.75 = L \times W$

Actual Width = $\frac{1 \text{ in.}}{3 \text{ ft}} = \frac{3}{?} = 9 = 9 \times 9.75 = 87.75$

Actual Area = 87.75

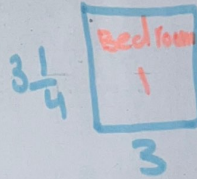
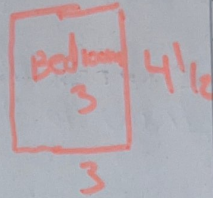
Go Online You can complete an Extra Example online.

Think About It!
What unit of measure
will you use in your
answer?

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Actual Area

$9 \times 9.75 = 87.75$

How can I use a scale to create a scale drawing

I can divide the actual dimensions by the scale

to find the dimensions of the scale drawing

Then I could use the scale drawing dimension to draw the figure

Think About It!

Will your drawing be smaller or larger than the one shown?

$L =$

$$\frac{1}{30} \times \frac{4}{1} = 120$$

$W =$

$$\frac{1}{30} \times \frac{1.5}{1} = 45$$

Drawing

$$\frac{120}{10} = 12$$

$$\frac{45}{10} = 4.5$$

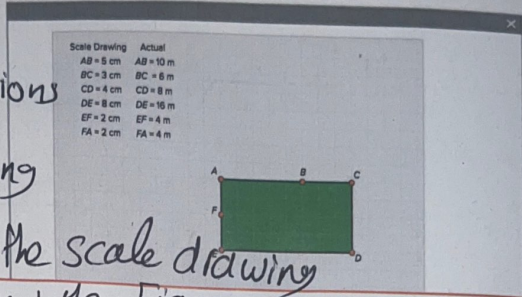
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Learn Reproduce Scale Drawings

Artists use scale drawings to create wall murals. An artist might draw the mural on a piece of grid paper. Then, he or she would draw a much larger grid on the wall before painting or drawing the mural. You can use a scale to reproduce a drawing that is similar to the original but a different size.

Explore Scale Drawings

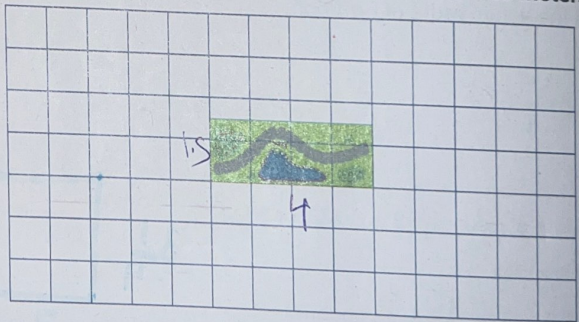
Online Activity You will use Web Sketchpad to explore how to reproduce scale drawings using different scales.



Example 3 Reproduce Scale Drawings

The diagram represents a city park. The scale is 1 unit = 30 meters.

Reproduce the drawing with a scale of 1 unit = 10 meters.



The length of the drawing of the park is 4 units.

The width of the drawing of the park is 1.5 units.

The actual dimensions of the park are $4 \cdot 30$ or 120 meters and $1.5 \cdot 30$ or 45 meters.

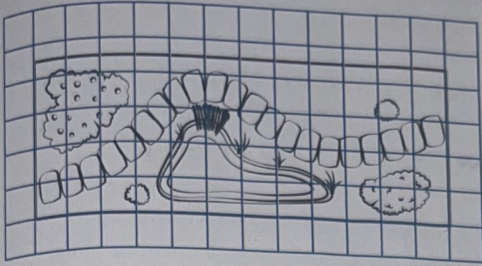
Using the new scale of 1 unit = 10 meters, the new drawing will have a length of $120 \div 10$ or 12 units.

The new drawing will have a width of $45 \div 10$ or 4.5 units.

(continued on next page)

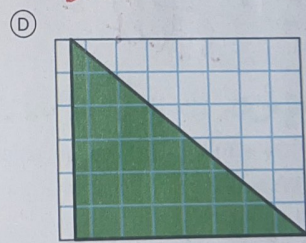
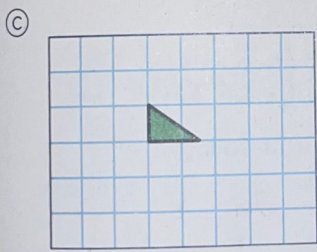
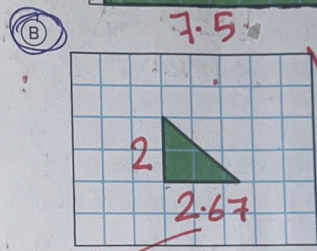
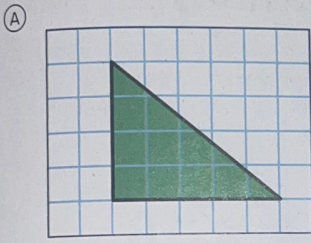
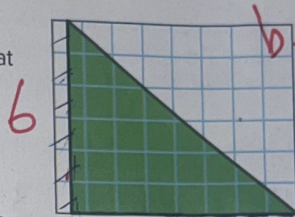
So, to reproduce a scale drawing, use the grid to count the number of squares for the length and width of the original drawing, use the new scale to find the length and width of the new drawing, and create the new drawing on the grid, counting the squares for the new length and width.

Using the new dimensions, the drawing is created with a length of 12 units and width of 4.5 units.



Check

The drawing shown uses a scale of 1 unit = 2 feet. Choose the drawing that is reproduced using the new scale, 1 unit = 6 feet.



Talk About It!
In the second scale drawing, why are the drawing dimensions multiplied by 10 instead of 30?

The New Scale is
1 unit = 10m
So, we multiplied $\times 10$

$$b = \frac{1}{2} = \frac{7.5}{p} = 15$$

$$\frac{15}{6} = 2.67$$

$$n = \frac{1}{2} = \frac{6}{p} = 12$$

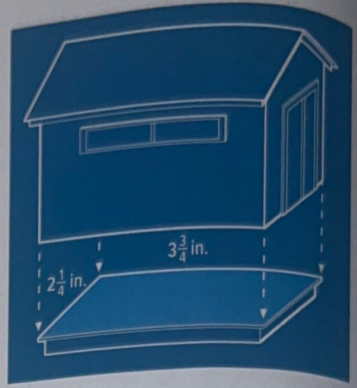
$$\frac{12}{6} = 2$$

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Go Online You can complete an Extra Example online.

Apply Construction

William is laying new flooring in a storage shed. The blueprint of the floor shown uses a scale of 1 inch = 3 feet. If the building material costs \$1.09 per square foot, how much will it cost for the new flooring? Round to the nearest cent if necessary.



1 What is the task?

Make sure you understand exactly what question to answer or problem to solve. You may want to read the problem three times. Discuss these questions with a partner.

First Time Describe the context of the problem, in your own words.

Second Time What mathematics do you see in the problem?

Third Time What are you wondering about?

2 How can you approach the task? What strategies can you use?

Record your observations here

$$L = \frac{1 \text{ inch}}{3 \text{ feet}} = 3 \frac{3}{4} = 11.25$$

3 What is your solution?

Use your strategy to solve the problem.

Show your work here

$$W = \frac{1 \text{ inch}}{3 \text{ feet}} = 2 \frac{1}{4} = 6.75$$

$$\text{Area} = L \times W = 11.25 \times 6.75$$

4 How can you show your solution is reasonable?

Write About It! Write an argument that can be used to defend your solution.

$$= 75.9375$$

$$\text{Cost} = 75.9375 \times 1.09 =$$

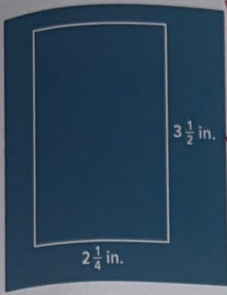
$$= \$82.77$$

Talk About It!

What do you need to determine before you calculate the cost of the flooring?

Check

Chantele is buying wallpaper for one wall of her living room. The blueprint of the wall uses a scale of 1 inch = 4 feet. If the wallpaper costs \$1.79 per square foot, how much will it cost to buy wallpaper for the actual wall of the living room? Round to the nearest cent if necessary.



$$L = \frac{1}{4} \times \frac{2\frac{1}{2}}{?} = 14$$

$$W = \frac{1}{4} \times \frac{3\frac{1}{2}}{?} = 9$$

$$L = 14$$
$$W = 9$$

$$\text{Area} = L \times W$$

$$14 \times 9 = 126 \text{ in}^2$$

$$\text{Cost} = 126 \times 1.79 = \$225.54$$

Show your work here

Go Online You can complete an Extra Example online.

Pause and Reflect

Compare what you learned about scales and scale drawings in this lesson to concepts you learned in an earlier module or grade. How did knowing those concepts help you in this lesson?

Record your observations here

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MRS / Aya

Talk About It!

How is scale factor different from scale?

A scale is given with units. A scale factor does not have units because the ratio is converted to be the same units and is written as a ratio in simplest form.

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فهم

Learn Find a Scale Factor

A scale written as a ratio without units in simplest form is called the **scale factor**.

Find the scale factor of a model sailboat if the scale is 1 inch = 6 feet.

$$\frac{1 \text{ inch}}{6 \text{ feet}}$$

$$\frac{1 \text{ inch}}{6 \text{ feet}} = \frac{1 \text{ inch}}{72 \text{ inches}}$$

$$\frac{1 \text{ inch}}{72 \text{ inches}} = \frac{1}{72}$$

So, the scale factor is $\frac{1}{72}$.

Write the ratio as a fraction.

Multiply 6 feet by 12 to convert feet to inches.

Divide out the common units.

Pause and Reflect

Using the grid paper shown, create a scale drawing of a room in your school or home. Include the scale in your drawing. Trade your drawings with a classmate. Find the actual length or area of the room of your classmate's drawing.

The blueprint shows that the height of the building is 22 ft. If the scale for the drawing is 1 cm = 2 ft how tall is building represented in the blue.

$$\frac{1 \text{ cm}}{2 \text{ ft}} = \frac{x}{22 \text{ ft}} \quad x = \frac{22}{2} = 11$$

Practice

Go Online You can complete your homework online.

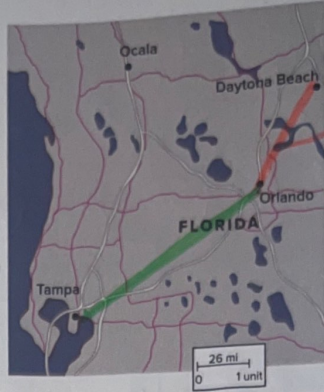
Refer to the map of Florida. (Example 1)

1. What is the actual distance between Daytona Beach and Orlando? Use a ruler to measure the map.

$$\frac{1}{26} \times \frac{2}{1} = 52 \text{ mi}$$

2. What is the actual distance between Tampa and Orlando? Use a ruler to measure the map.

$$\frac{1}{26} \times \frac{3.5}{1} = 90 \text{ mi}$$



Refer to the floor plan. The scale of the floor plan is 1 inch = 6 feet. (Example 2)

3. Find the actual area of the hallway.

$$L = \frac{1 \text{ in}}{6 \text{ ft}} \times \frac{5 \text{ in}}{1} = 30 \text{ ft}$$

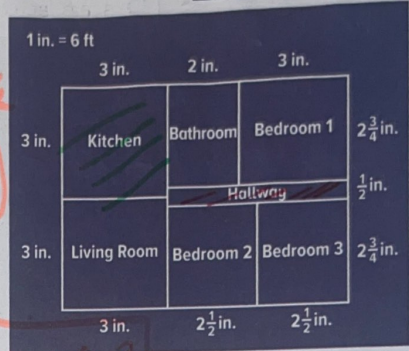
$$W = \frac{1}{6} = \frac{1}{2} = 3 \text{ ft} \quad A = 30 \times 3 = 90$$

4. Find the actual area of the kitchen.

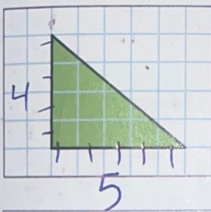
$$L = \frac{1}{6} \times \frac{3}{1} = 18$$

$$W = \frac{1}{6} \times \frac{3}{1} = 18$$

$$\text{Area} = L \times W = 18 \times 18 = 324 \text{ ft}^2$$

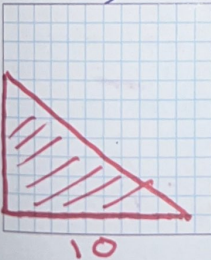


5. The drawing of a vegetable garden uses a scale of 1 unit = 10 feet. Reproduce the drawing with a scale of 1 unit = 5 feet. (Example 3)



$$\frac{1}{10} \times \frac{4}{1} = 40$$

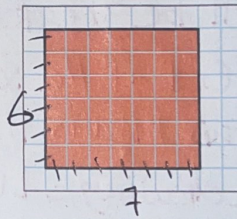
$$\frac{1}{10} \times \frac{5}{1} = 50$$



$$\frac{40}{5} = 8$$

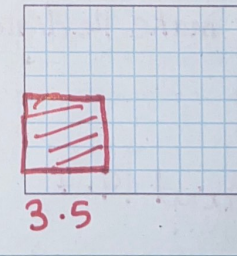
$$\frac{50}{5} = 10$$

6. Grid The drawing of a sandbox uses a scale of 1 unit = 12 inches. Reproduce the drawing with a scale of 1 unit = 24 inches.



$$\frac{1}{12} = \frac{7}{?} = 84$$

$$\frac{1}{12} = \frac{6}{?} = 72$$



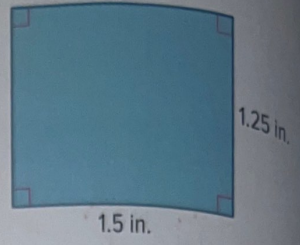
$$\frac{84}{24} = 3.5$$

$$\frac{72}{24} = 3$$

Apply

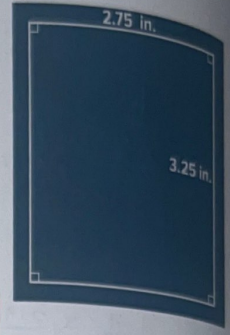
COST = $16.875 \times 5.99 = \$107.08$

7. Mr. Miller is tiling his shower floor. The blueprint of the shower floor shown uses a scale of 1 inch = 3 feet. If the tile costs \$5.99 per square foot, how much will it cost to tile the bathroom? Round to the nearest cent if necessary.



$L = \frac{1}{3} = \frac{1.5}{?}$
 $L = 4.5$
 $W = \frac{1}{3} = \frac{1.25}{?}$
 $W = 3.75$
 $A = 4.5 \times 3.75 = 16.875$

8. Raul is drawing a plan for his bedroom. He needs to determine the material costs for his flooring. The blueprint of the bedroom uses a scale of 1 inch = 4 feet. If the flooring material costs \$2.55 per square foot, how much will it cost to buy the flooring for Raul's bedroom?



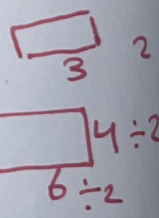
$L = \frac{1}{4} \times \frac{3.25}{?} = 13$
 $W = \frac{1}{4} \times \frac{2.75}{?} = 11$
 $Area = 13 \times 11 = 143$

COST = $143 \times 2.55 = \$364.65$

9. **MP Reason Abstractly** Determine if the following statement is true or false. Write an argument that can be used to defend your solution.

If the scale factor of a scale drawing is greater than one, the scale drawing is smaller than the object.

false, it will be greater than the object if the scale factor is 2 this means that 2 units on the drawing = 1 unit object that make the drawing greater



11. Two cities are 64 miles apart. If the distance on the map is $3\frac{1}{4}$ inches, what is the scale of the map?

1 inch is about 19.7

10. Conduct brief research to find what careers use scale drawings.

12. A rectangle has an area of 24 square inches. The rectangle is reduced by a scale factor of $\frac{1}{2}$. What is the area of the new rectangle?

$Area = 2 \times 3 = 6$