

Scale Drawings and Similar Figures: math lesson, Grade 7 – download the PDF

Architects, game designers, and mapmakers all shrink or enlarge real things so they fit on paper or a screen. In this chapter you will learn how a **scale** keeps every shape correct, how to move between a drawing and the real object, and what happens to area when you change the size.

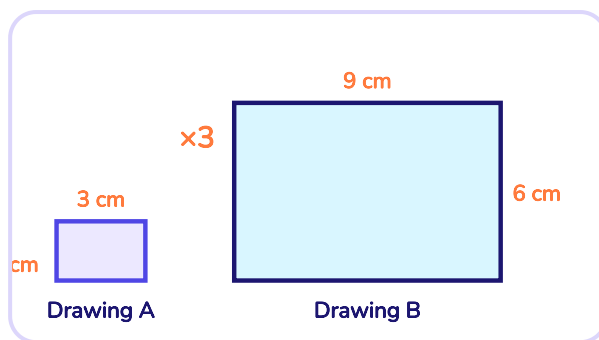
1. What Is a Scale Drawing?

A **scale drawing** is a picture of a real object or place that is larger or smaller than the original, but has exactly the same shape. Every length in the drawing is multiplied by the same number, and all angles stay the same.

D Scale drawing

A drawing whose lengths are all proportional to the matching actual lengths. Angles in the drawing are equal to the matching actual angles.

Look at the two rectangles below. Drawing B is an enlargement of Drawing A.



Drawing A is 3 cm by 2 cm. Drawing B is 9 cm by 6 cm. Both lengths were multiplied by the same number, so the two rectangles have the same shape.

2. The Scale Factor

The number that every length is multiplied by is called the **scale factor**. To find it, divide a length in the new figure by the matching length in the original figure.

D Scale factor

$$\text{scale factor} = \frac{\text{length in the new figure}}{\text{matching length in the original figure}}$$

If the scale factor is greater than 1 the figure is an enlargement. If it is between 0 and 1 the figure is a reduction. If it equals 1 the figure has the same size.

E Example 1: finding a scale factor

In the figure above, $\frac{9}{3} = 3$ and $\frac{6}{2} = 3$. Both give the same value, so the scale factor from Drawing A to Drawing B is 3.

Going back from B to A, the scale factor is $\frac{3}{9} = \frac{1}{3}$. A reduction uses a fraction less than 1.



Watch out!

Adding the same amount to each side does not make a scale drawing. A 3 by 2 rectangle becomes 6 by 5 if you add 3 to each side, but $\frac{6}{3} = 2$ and $\frac{5}{2} = 2.5$ are different, so the shape has changed.

3. Scales and Actual Lengths

A **scale** compares a length on the drawing with the actual length. It can be written in words (1 cm represents 5 m), as a ratio (1 cm : 5 m), or as a unit rate. Because lengths are proportional, you can solve every scale problem with multiplication or division.



Method: from the drawing to the real object

1. Write the scale as "1 unit on the drawing = k actual units".
2. Multiply the drawing length by k to get the actual length.
3. To go the other way, divide the actual length by k.
4. Write your answer with the correct unit.



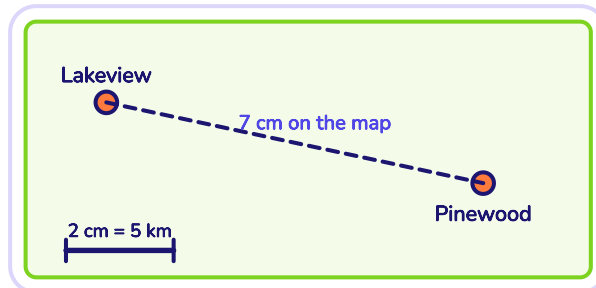
Example 2: a floor plan

On a floor plan the scale is 1 in : 4 ft. A bedroom measures 3.5 in on the plan. The actual length is $3.5 \times 4 = 14$ ft.

A hallway is 22 ft long in real life. On the plan it is $22 \div 4 = 5.5$ in long.

4. Maps and Models

Maps use small scales such as $2\text{ cm} = 5\text{ km}$, and models of cars, planes, and buildings use ratios such as $1 : 24$. In a ratio like $1 : 24$ both parts must use the **same unit**, so 1 cm on the model stands for 24 cm in real life.



E Example 3: reading a map

On the map, Lakeview and Pinewood are 7 cm apart. The scale bar shows that 2 cm represents 5 km, so 1 cm represents $5 \div 2 = 2.5$ km.

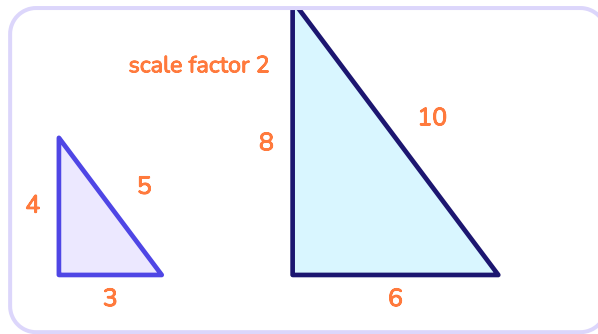
The actual distance is $7 \times 2.5 = 17.5$ km. In miles, since 1 km is about 0.62 mi, this is roughly 10.9 mi.

! Zyro's tip

On my home planet we always shrink the scale to "1 unit" first. Once you know what 1 cm stands for, every other length is a single multiplication!

5. Proportional Side Lengths and Similar Figures

Two figures are **similar** when one is a scale drawing of the other. Then all the pairs of matching sides have the same ratio, and the matching angles are equal. This is how you find a missing side.



P Property: proportional sides

If two polygons are similar, the ratio of any pair of matching sides is the same number, the scale factor. For the triangles above, $\frac{6}{3} = \frac{8}{4} = \frac{10}{5} = 2$.

E Example 4: a missing side

Triangle P has sides 5, 12, and 13. A similar triangle Q has a shortest side of 15. The scale factor is $\frac{15}{5} = 3$, so the other sides are $12 \times 3 = 36$ and $13 \times 3 = 39$.

6. Redrawing at a Different Scale

Sometimes you must copy a drawing so it fits another sheet. The new drawing uses a new scale factor applied to the *drawing* lengths, or you can go through the actual lengths.

M Method: change the scale

1. Use the old scale to find the actual lengths.
2. Use the new scale to turn the actual lengths into new drawing lengths.
3. Or compute the factor between the two scales and multiply every drawing length by it.

E

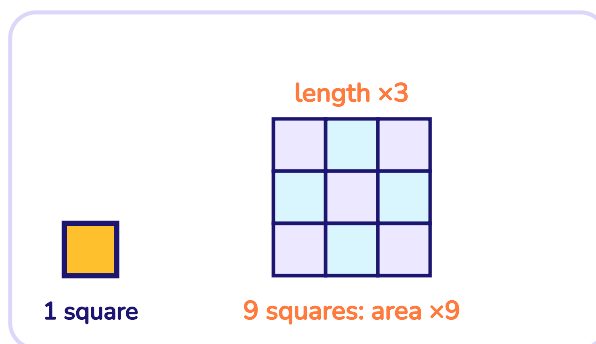
Example 5: a new scale

A garden is drawn with the scale 1 cm : 2 m, and a side measures 6 cm, so it is 12 m long. With the new scale 1 cm : 3 m this side becomes $12 \div 3 = 4$ cm.

Shortcut: the old scale shows 2 m per cm and the new one 3 m per cm, so the factor is $\frac{2}{3}$ and $6 \times \frac{2}{3} = 4$ cm.

7. Scale and Area

Area does not follow the same rule as length. When every length is multiplied by a scale factor k , the area is multiplied by k^2 , because area has two dimensions: a length times a width.



P

Property: scale and area

If the scale factor between two similar figures is k , then

$$\frac{\text{new area}}{\text{original area}} = k^2.$$

Perimeters, like all lengths, are multiplied by k .

E**Example 6: actual area**

A rectangle drawn at the scale 1 cm : 3 m measures 4 cm by 2 cm, so its area is 8 cm². Each centimeter stands for 3 m, so the actual area is $8 \times 3^2 = 72$ m².

Check: the actual sides are 12 m and 6 m and $12 \times 6 = 72$ m².

**Watch out!**

Do not multiply an area by the scale factor alone. If the scale factor is 5, the area grows 25 times, not 5 times.

Key takeaways

- A scale drawing has the same shape as the original: all lengths are multiplied by the same scale factor and all angles stay equal.
- Scale factor = new length $\div$ original length.
- To find an actual length, multiply the drawing length by the scale; to find a drawing length, divide.
- In a scale ratio such as 1 : 24 both parts use the same unit.
- Similar figures have proportional matching sides, so you can find a missing side with the scale factor.
- Lengths and perimeters are multiplied by k ; areas are multiplied by k^2 .



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