

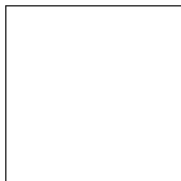
2.2.16: Converting Units of Area

You may use a calculator throughout this module.

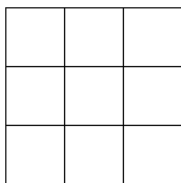
Converting between units of area requires us to be careful because square units behave differently than linear units.

U.S. System: Converting Measurements of Area

Consider a square yard; the area of a square with sides 1 yard long.



1 yard = 3 feet, so we can divide the square into three sections vertically and three sections horizontally to convert both dimensions of the square from yards to feet. This forms a 3 by 3 grid, which shows us visually that 1 square yard equals 9 square feet, not 3 square feet!



The linear conversion ratio of 1 to 3 means that the conversion ratio for the areas is 1 to 3^2 , or 1 to 9.

Here's another way to think about it without a diagram: 1 yd = 3 ft, so $(1 \text{ yd})^2 = (3 \text{ ft})^2$. To remove the parentheses, we must square the number *and* square the units: $(3 \text{ ft})^2 = 3^2 \text{ ft}^2 = 9 \text{ ft}^2$.

More generally, we need to **square** the linear conversion factors when converting units of area. If the linear units have a ratio of 1 to n , the square units will have a ratio of 1 to n^2 .

? Exercises 2.2.16.1

1. An acre is defined as the area of a 660 foot by 66 foot rectangle. (That's a furlong by a chain, if you were curious.) How many square feet are in 1 acre?
2. How many square yards are in 1 acre?
3. How many square inches equals 1 square foot?

Answer

1. 43,560 ft^2
2. 4,840 yd^2
3. 144 in^2

It should be no surprise that this module will be full of conversion ratios. As always, if you discover other conversion ratios that aren't provided here, it would be a good idea to write them down so you can use them as needed.

- $1 \text{ ft}^2 = 144 \text{ in}^2$
- $1 \text{ yd}^2 = 9 \text{ ft}^2$
- $1 \text{ acre (ac)} = 43,560 \text{ ft}^2$
- $1 \text{ ac} = 4,840 \text{ yd}^2$
- $1 \text{ mi}^2 = 27,878,400 \text{ ft}^2$
- $1 \text{ mi}^2 = 3,097,600 \text{ yd}^2$

- $1 \text{ mi}^2 = 640 \text{ ac}$

An acre is defined as a unit of area; it would be wrong to say “acres squared” or put an exponent of 2 on the units.

? Exercises 2.2.16.1

4. A hallway is 9 yards long and 2 yards wide. How many square feet of linoleum are needed to cover the hallway?
5. A proposed site for an elementary school is 600 feet by 600 feet. Find its area, in acres.

Answer

4. 162 ft^2
5. 8.3 ac

Metric System: Converting Measurements of Area

- $1 \text{ cm}^2 = 100 \text{ mm}^2$
- $1 \text{ m}^2 = 1,000,000 \text{ mm}^2$
- $1 \text{ m}^2 = 10,000 \text{ cm}^2$
- $1 \text{ hectare (ha)} = 10,000 \text{ m}^2$
- $1 \text{ km}^2 = 1,000,000 \text{ m}^2$
- $1 \text{ km}^2 = 100 \text{ ha}$

A hectare is defined as a square with sides 100 meters long. Dividing a square kilometer into ten rows and ten columns will make a 10 by 10 grid of 100 hectares. As with acres, it would be wrong to say “hectares squared” or put an exponent of 2 on the units.

? Exercises 2.2.16.1

6. A hallway is 9 meters long and 2 meters wide. How many square centimeters of linoleum are needed to cover the hallway?
7. A proposed site for an elementary school is 200 meters by 200 meters. Find its area, in hectares.

Answer

6. $180,000 \text{ cm}^2$
7. 4 ha

Both Systems: Converting Measurements of Area

Converting between the U.S. and metric systems will involve messy decimal values. For example, because $1 \text{ in} = 2.54 \text{ cm}$, we can square both numbers and find that $(1 \text{ in})^2 = (2.54 \text{ cm})^2 = 6.4516 \text{ cm}^2$. The conversions are rounded to three or four significant digits in the table below.

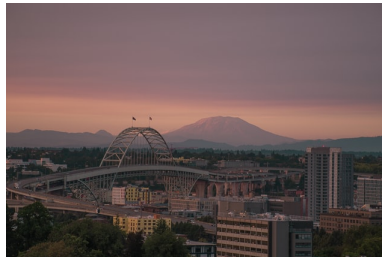
- $1 \text{ in}^2 \approx 6.45 \text{ cm}^2 \leftrightarrow 1 \text{ cm}^2 \approx 0.155 \text{ in}^2$
- $1 \text{ in}^2 \approx 6.45 \text{ cm}^2 \leftrightarrow 1 \text{ cm}^2 \approx 0.155 \text{ in}^2$
- $1 \text{ yd}^2 \approx 0.836 \text{ m}^2 \leftrightarrow 1 \text{ m}^2 \approx 1.196 \text{ yd}^2$
- $1 \text{ mi}^2 \approx 2.59 \text{ km}^2 \leftrightarrow 1 \text{ km}^2 \approx 0.386 \text{ mi}^2$
- $1 \text{ ac} \approx 0.405 \text{ ha} \leftrightarrow 1 \text{ ha} \approx 2.47 \text{ ac}$

? Exercises 2.2.16.1

8. The area of Portland is 145 mi^2 . Convert this area to square kilometers.
9. How many hectares is a 5,000 acre ranch?
10. A sheet of paper measures 8.5 inches by 11 inches. What is the area in square centimeters?
11. A soccer field is 100 meters long and 70 meters wide. What is its area in square feet?

Answer

8. 376 km^2
9. 2, 000 ha(to one sig fig) or $2, \bar{0}00$ ha(to two sig figs)
10. $6\bar{0}0 \text{ cm}^2$ (to two sig figs)
11. $75,300 \text{ ft}^2$



Areas of Similar Figures

Earlier in this module, it was stated that if the linear units have a ratio of 1 to n , the square units will have a ratio of 1 to n^2 . This applies to similar figures as well.

If the linear dimensions of two similar figures have a ratio of 1 to n , then the areas will have a ratio of 1 to n^2 . This is true for circles, similar triangles, similar rectangles, similar hexagons, you name it. We'll verify this in the following exercises.

? Exercises 2.2.16.1

A personal pizza has a 7-inch diameter. A medium pizza has a diameter twice that of a personal pizza.

12. Determine the area of the medium pizza.
13. Determine the area of the personal pizza.
14. What is the ratio of the areas of the two pizzas?

Right triangle ABC has legs 3 cm and 4 cm long. Right triangle DEF has legs triple the length of ABC 's.

15. Determine the area of the larger triangle, DEF .
16. Determine the area of the smaller triangle, ABC .
17. What is the ratio of the areas of the two triangles?

Answer

12. 154 in^2
13. 38.5 in^2
14. 4 to 1
15. 54 cm^2
16. 6 cm^2
17. 9 to 1

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