Converting Units

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WHAT'S COVERED

In this lesson, you will learn how to use simple conversion factors to convert units in a given scenario. Specifically, this lesson will cover:

1. Introduction to Converting Units

Unit conversion is a simple process to overlook, but doing so can have dramatic effects on the results of any project we may be working on. For example, suppose someone told us that a machine needs to be able to handle a 50,000 N load. If we were in a country that uses the metric system, that may make perfect sense to us. If we are in the United States, where English units are used, that may not make any sense at all. The need then arises to convert 50,000 N into pounds (lbs.), so that we can more easily understand the quantities we are working with. Unit conversion allows us to express 50,000 N as roughly 11,240 lbs.,or 5.62 tons. While the numbers and units are different, the actual quantity they represent is the same.

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Notice that each of these values has different units, but they represent the same amount of force. That is why unit conversion is important. It allows us to represent quantities in terms of measurements we understand or need to work with.

Lets look at how to do some unit conversion.

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2. Simple Unit Conversion

In order to convert units, we first need to understand something called a conversion factor, which is basically a fraction equaling 1 that relates two different units.

STEP BY STEP

1. List the value you are given.
2. Determine the conversion factor.
3. Multiply the conversion factor to the given value, making sure that the units we start with cancel or and the unit we are looking for will be left.
4. Simplify as needed.

↪ EXAMPLE Suppose we have 160 cups of water, and we want to determine how many gallons of water this is equal to. Before we make any calculations, we might recall that there are 16 cups in one gallon of water. This knowledge will help us determine what our conversion factor will be.

So how do we actually begin converting?

For the problem involving cups to water, this would look like the following:

$\frac{160 \text{ cups}}{1} \cdot \frac{1 \text{ gallon}}{16 \text{ cups}}$	Conversion factor: 1 gallon = 16 cups
$\frac{160 \cdot \text{cups} \cdot \text{gallons}}{1 \cdot 16 \text{ cups}}$	Multiplying across numerators and denominators
$\frac{160 \text{ gallons}}{16}$	Units of cups cancel
10 gallons	Our Solution

TRY IT

Try doing the following calculations on your own and then check the solutions.

Convert 7200 seconds into hours. +

$\frac{7200 \text{ seconds}}{1} \cdot \frac{1 \text{ hour}}{3600 \text{ seconds}}$	Conversion factor: 1 hour = 3600 seconds
$\frac{7200 \cdot \text{seconds} \cdot \text{hours}}{1 \cdot 3600 \text{ seconds}}$	Multiplying across numerators and denominators
$\frac{7200 \text{ hours}}{3600}$	Units of seconds cancel
2 hours	Our Solution

Convert 2 miles into feet. +

$\frac{2 \text{ miles}}{1} \cdot \frac{5280 \text{ feet}}{1 \text{ miles}}$	Conversion factor: 5280 feet = 1 mile
$\frac{2 \text{ miles} \cdot 5280 \text{ feet}}{1 \cdot 1 \text{ miles}}$	Multiply numerators and denominators
10560 feet	Our Solution

3. Multi-Step Unit Conversion

In the above example of converting seconds to hours, suppose we did not know a conversion factor between hours and seconds. Do you think we can make the conversion?

Of course! In cases such as this, we may wish to use multiple conversion factors to help us make a conversion. For example, we may know that there are 60 seconds in 1 minute, and 60 minutes in 1 hour.

Therefore, we can do the following:

↱ EXAMPLE

$\frac{7200\text{ sec}}{1} \cdot \frac{1\text{ min}}{60\text{ sec}} \cdot \frac{1\text{ hr}}{60\text{ min}}$	Conversion factors: 1 min = 60 sec; 1 hr = 60 min
$\frac{7200 \cdot 1 \cdot 1 \cdot \text{sec} \cdot \text{min} \cdot \text{hr}}{1 \cdot 60 \cdot 60\ \text{sec} \cdot \text{min}}$	Multiply numerators and denominators
$\frac{7200\text{ hr}}{3600}$	Units of seconds and minutes cancel, leaving hours
2 hours	Our Solution

TRY IT

Try your hand at converting 3 meters into inches. Note that there are 2.54 centimeters in 1 inch, and 100 centimeters in 1 meter.

Convert 3 meters into inches. +

To solve this problem, we can implement the conversion factors 2.54 centimeter = 1 inch and 100 centimeter = 1 meter, and string the conversion factors together.

$\frac{3\text{ m}}{1} \cdot \frac{100\text{ cm}}{1\text{ m}} \cdot \frac{1\text{ in}}{2.54\text{ cm}}$	Conversion factors: 1 m = 100 cm; 1 in = 2.54 cm
$\frac{3 \cdot 100 \cdot 1 \cdot \text{m} \cdot \text{cm} \cdot \text{in}}{1 \cdot 1 \cdot 2.54\ \text{m} \cdot \text{cm}}$	Multiply numerators and denominators
$\frac{300\text{ in}}{2.54}$	Units of meters and centimeters cancel, leaving inches
118.11 inches	Our Solution

4. Converting Units of Area and Volume

Sometimes when converting units, we may need to convert between squared units (area) or cubed units (volume). In these instances, we follow the same process as before, but we have to be careful with our conversion factors. Let's look at some examples.

↱ EXAMPLE Suppose we are told that we need to convert 200 square feet into square inches. How would we go about doing this calculation?

Before we begin the conversion, we need to determine if we are using the correct conversion factor. Here, we may be tempted to use 12 inches in 1 foot, making the conversion factor (12 inches / 1 foot). However, we would be incorrect when making this calculation. In truth, there are 12 inches • 12 inches, or 144 square inches in 1 square foot.

Therefore, our conversion factor needs to be (144 square inches / 1 square foot). Going through the calculations, we would do the following:

$\frac{200 \text{ sq ft}}{1} \cdot \frac{144 \text{ sq in}}{1 \text{ sq ft}}$	Conversion factor: 1 sq ft = 144 sq in
$\frac{200 \cdot 144 \cdot \text{sq ft} \cdot \text{sq in}}{1 \cdot 1 \cdot \text{sq ft}}$	Multiply numerators and denominators
$\frac{28{,}800 \text{ sq in}}{1}$	Units of square feet cancel, leaving square inches
$28{,}800 \text{ sq in}$	Our Solution

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The key idea here is that we have to match squared units with squared units when choosing the conversion factor.

EXAMPLE Suppose you want to convert 5 cubic feet to liters. How would you make this conversion given that there are approximately 30.48 centimeters in 1 foot and 0.001 liters in 1 cubic centimeter?

Here, we have to first determine a conversion factor between cubic feet and liters. Right now, we do not have a conversion factor relating the two, however, we do know how many centimeters are in 1 foot. Therefore, if we take the cube of 30.48 centimeters, we would know how many cubic centimeters there are in 1 cubic foot. With this knowledge, we can use the other conversion factor we are given to convert between cubic centimeters to liters.

$$(1 \text{ ft})(1 \text{ ft})(1 \text{ ft}) = (30.48 \text{ cm})(30.48 \text{ cm})(30.48 \text{ cm})$$
$$1 \text{ ft}^3 = 28{,}316.85 \text{ cm}^3$$

Using this conversion factor, we can now begin making our conversion.

$\frac{5 \text{ ft}^3}{1} \cdot \frac{28{,}316 \text{ cm}^3}{1 \text{ ft}^3} \cdot \frac{0.001 \text{ L}}{1 \text{ cm}^3}$	Conversion factors factors for ft^3 to cm^3 and cm^3 to L
$\frac{5 \cdot 28{,}316.85 \cdot 0.001 \cdot \text{ft}^3 \cdot \text{cm}^3 \cdot \text{L}}{1 \cdot 1 \cdot 1 \cdot \text{ft}^3 \cdot \text{cm}^3}$	Multiply numerators and denominators
$\frac{141.58 \text{ L}}{1}$	Units of ft^3 and cm^3 cancel, leaving L
141.58 L	Our Solution, rounded to the hundredths place

BIG IDEA

When working with volume conversion, you must make sure your conversion factor is converting between cubic units.

SUMMARY

As an **introduction to converting units**, we learned that unit conversion allows us to express measurements with different units. They are the same measurement, but with different units. We can use **simple unit conversion** for any type of measurement such as length, time, area, volume, or rate, such as miles per hour. Some cases require **multi-step unit conversions**, such as hours to minutes to seconds. When **converting units of area and volume**, you're converting with square units or cubic units. Square units requires you to square the linear conversion, while cubic units requires you to cube the linear conversion.

TERMS TO KNOW

Conversion Factor
A fraction equal to one that is multiplied by a quantity to convert it into an equivalent quantity in different units.