

Converting Unit Rates

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WHAT'S COVERED

In this lesson, you will learn how to convert a unit rate in a given scenario. Specifically, this lesson will cover:

1. Converting Units

When converting from one unit to another, we multiply a quantity by a conversion factor. A conversion factor is a fraction equivalent to 1, so multiplying it by a quantity doesn't change its actual measure. However, the fraction certainly doesn't look like it's equal to one (at least not until you inspect it). The expressions in the numerator and denominator are equal quantities but measured in different units. During unit conversion, units are also canceled out when they appear in both the numerator and the denominator.

➞ **EXAMPLE** Convert 1.5 feet into inches, using the fact that 1 foot is equivalent to 12 inches.

$\frac{1.5 \text{ feet}}{1} \cdot \frac{12 \text{ inches}}{1 \text{ foot}}$	Create conversion factor with feet and inches so that units of feet cancel, leaving inches
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$\frac{1.5 \cancel{\text{ feet}}}{1} \cdot \frac{12 \text{ inches}}{1 \cancel{\text{ foot}}}$	Multiply numbers in numerator and denominator
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$\frac{18 \text{ inches}}{1}$	Simplify
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18 inches	Our Solution
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2. Unit Rates

A unit rate is a ratio between two quantities with different units. Speed is a unit rate because it is the ratio between distance traveled and the time taken to travel that distance, like 20 miles per hour, or $\frac{20 \text{ miles}}{\text{hour}}$.

There are two different types of units that make up this ratio, distance and time.

Another characteristic of a unit rate is that a unit rate has a denominator of 1. Let's think about speed again: we wouldn't normally say that a car travels 120 miles per 2 hours. Instead, we simplify the ratio to 1 hour, and say 60 miles per hour or $\frac{60 \text{ miles}}{1 \text{ hour}}$.

Here are some more examples of unit rates:

- dollars per hour, such as $\frac{\$17.50}{1 \text{ hour}}$
- words per minutes, such as $\frac{200 \text{ words}}{1 \text{ minute}}$
- calories per serving, such as $\frac{250 \text{ calories}}{1 \text{ serving}}$
- steps per day, such as $\frac{3,000 \text{ steps}}{1 \text{ day}}$

3. Converting Unit Rates

When converting unit rates, we need to make use of multiple conversion factors: as many conversion factors as needed to convert from one quantity to another for every unit involved in our unit rate. In the example below, we will work more with miles per hour. First, we'll need to convert miles to feet, but also hours to seconds. Let's first list our conversion factors:

- 1 mile = 5280 feet
- 1 foot = 0.0002 miles
- 1 hour = 3600 seconds
- 1 second = 0.00028 hours



HINT

When using a conversion factor to create a fraction equal to 1, think about what unit you wish to convert into. In most cases, this will be the numerator of the fraction, which places the unit you wish to cancel in the denominator of that fraction. This is because the unit you wish to cancel will likely be in the numerator of another fraction. Units are canceled when they appear in the numerator and denominator of the combined fraction.



HINT

Keep in mind that although we have listed some very helpful conversion factors, we may not need to use all of them. For example, as we will see when we are converting from miles per hour into feet per second, we will use the conversion factor that 1 mile = 5280 feet, instead of 1 foot = 0.0002 miles. This all depends on which unit you want to convert into and which unit you wish to cancel.

➞ **EXAMPLE** Convert 60 miles per hour to feet per second.

$$\begin{array}{l} \frac{60 \text{ mi}}{1 \text{ hour}} \cdot \frac{5280 \text{ ft}}{1 \text{ mi}} \quad \text{Start with } \frac{60 \text{ mi}}{1 \text{ hour}} \text{ and use the conversion factor } \frac{5280 \text{ ft}}{1 \text{ mi}} \text{ to cancel miles} \\ \\ \frac{60 \text{ mi}}{1 \text{ hour}} \cdot \frac{5280 \text{ ft}}{1 \text{ mi}} \cdot \frac{1 \text{ hour}}{3600 \text{ sec}} \quad \text{Use a second conversion factor } \frac{1 \text{ hour}}{3600 \text{ sec}} \text{ to cancel hours} \\ \\ \frac{60 \text{ mi}}{1 \text{ hour}} \cdot \frac{5280 \text{ ft}}{1 \text{ mi}} \cdot \frac{1 \text{ hour}}{3600 \text{ sec}} \quad \text{Multiply numbers in numerator and denominator, noting which units were} \\ \hspace{10em} \text{canceled and which units remained} \end{array}$$

$$\frac{60 \cdot 5280 \cdot 1 \text{ ft}}{1 \cdot 1 \cdot 3600 \text{ sec}}$$

Evaluate

$$\frac{316800 \text{ feet}}{3600 \text{ sec}}$$

Divide 316800 by 3600 for a denominator of 1

$$\frac{88 \text{ feet}}{1 \text{ sec}}$$

Our Solution

60 miles per hour is equivalent to 88 feet per second.



SUMMARY

When **converting units**, we multiply a quantity by a conversion factor. **Unit rates** are ratios comparing two quantities with different units. Conversion factors, which can be used to convert between different units, can also then be used when **converting unit rates**.

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