# Section 3.1 The Metric System

**Getting Started** – How do you simplify, multiply and divide fractions?

* How do you use the basic units of measurement in the metric system?
* How do you make conversions between metric measurements?

## **Getting Started –** How do you simplify, multiply and divide fractions?

Fractions may be written in three different formats: a common fraction, a decimal, or a percentage. In earlier sections, we have utilized fractions by converting them to decimals or percentages. Now we focus on common fraction which are just a fancy way of saying divide.

A common fraction, like , is written in the form , where *a* and *b* are numbers and *b* is not equal to zero, The top of the fraction is called the numerator and the bottom is called the denominator.

Common fractions may be simplified if the numerator and denominator have common factors. Numerator and denominator may be factored, and any common factors cancelled. For example:



When we multiply fractions, the numerator and denominators are multiplied together:



We can also simplify fraction as we multiply by cancelling out common factors in the numerator and denominator:



Note that when all the factor in the numerator or denominator cancel, a hidden factor of 1 remains.

## How do you use the basic units of measurement in the metric system?

Key Terms

Base units Meter Gram Liter

Summary

Have you ever looked at the labels of the products you are eating and drinking? Notice that the labels come in multiple units. Why do you think that is? Assume you worked for a country that distributed their products globally; everyone would need to be able to read and understand that label and some countries use the metric system and others use the U.S. Customary System (or Imperial System).

Mass is used to measure the weight of an object. For example, you are measuring the mass of your body when you step on to a scale. In the metric system of measurement, the most common units of mass are the gram and kilogram. Examples: a gram is about the weight of a paperclip, while a kilogram is about the weight of a baseball bat.

Distance measures length. For example, the distance of a snake is how long the snake is. In the metric system of measurement, the most common units of distance are millimeters, centimeters, meters, and kilometers. Examples of distance: a millimeter is about the width of a paper clip, a centimeter is about the width of a fingernail, one meter is about the length of a guitar, and a kilometer is about half a mile.

Volume measures capacity. For example, the volume of a bowl is the amount of space inside the bowl or how much water, for example it would take to fill the bowl. In the metric system of measurement, the most common units of volume are milliliters and liters. Examples: a milliliter is about the contents of a raindrop and a liter is about the contents of a soda bottle.

Notes

Guided Example 1 Practice

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| Which of the above units would you use to measure the capacity of a bottle of liquid detergent?  **Solution** The capacity of a bottle of liquid detergent is a measure of volume. An appropriate unit of volume would most likely be liters. | Which unit would you use to measure the length of a soccer field? |

## How do you make conversions between metric measurements?

Key Terms

Prefixes Kilo Hecto Deka Deci Centi Milli

Summary

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| --- | --- | --- | --- | --- | --- | --- |
| Milli | Centi | Deci | Base Unit | Deka | Hecto | Kilo |
|  |  |  | 1 | 10 | 100 | 1000 |

This table represents the multiplier to go from the base unit to each prefix. For instance, if the base unit was meters, the table would look like the one below:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Millimeter | Centimeter | Decimeter | Meter | Dekameter | Hectometer | Kilometer |
|  |  |  | 1 | 10 | 100 | 1000 |

The units get smaller as we move to the left of the base unit and the units get larger as we move to the right of the base unit. For instance, a millimeter is much smaller than a meter and a kilometer is much larger than a meter.

The table is also useful for seeing how the units with prefixes are related to the base unit. Looking at the column farthest to the right we find a 1000 under the kilometer. This means that 1000 meters is equal to one meter. Similarly, the  under centimeter means that a centimeter is  of a meter (or 100 centimeters is equal to 1 meter).

To convert larger units to smaller units we multiply the number of larger units by 10 each time for the number of steps you are converting. To convert smaller units to larger, you divide by 10 each time you step across the table. You also commonly see moving the decimal place used to convert metric as you are multiplying and dividing by 10.

Notes

Guided Example 2 Practice

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| Convert 55.2 decimeters to millimeters.  **Solution** Millimeters are smaller than decimeters since millimeters are two steps to the left of decimeters in the table above. This means we need to multiply 55.2 by 10 twice to get millimeters,    So, 55.2 decimeters is equal to 5520 millimeters. | Convert 2.1 kilometers to dekameters. |

Guided Example 3

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Convert 1120 centiliters to hectoliters.  **Solution** Let’s look at the table of prefixes for the base unit liters.   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | Milliliter | Centiliter | Deciliter | liter | Dekaliter | Hectoliter | Kiloliter | |  |  |  | 1 | 10 | 100 | 1000 |   Centiliters are smaller than hectoliters since it is 4 steps to the left of hectoliters. This means we need to divide 1120 by 10 a total of four times,    This means 1120 centiliters is equal to 0.1120 hectoliters. |

Practice

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| Convert 600 milliliters to deciliters. |

# Section 3.2 Dimensional Analysis

* What is dimensional analysis?

## What is dimensional analysis?

Key Terms

Dimensional analysis

Summary

Until now we have worked primarily in one measurement system or the other. Now we will convert between the US Customary System and the Metric system. To do this, we will use dimensional analysis and unit fractions.

Here are basic conversion factors for each type of measurement:

**Length**

1 foot (ft) = 12 inches (in) 1 yard (yd) = 3 feet (ft)

1 mile = 5,280 feet 1 meter ≈ 3.281 feet

1 inch ≈ 2.54 centimeters

**Weight and Mass**

1 pound (lb) = 16 ounces (oz)

1 ton = 2000 pounds

1 kilogram ≈ 2.2 pounds

**Volume**

1 cup = 8 fluid ounces (fl oz)\* 1 pint = 2 cups

1 quart = 2 pints = 4 cups 1 gallon = 4 quarts = 16 cups

1 gallon ≈ 3.785 liters 1 liter ≈ 33.8 fluid ounces

\*Fluid ounces are a capacity measurement for liquids. 1 fluid ounce ≈ 1 ounce (weight) for water only.

Unit fractions are fractions which help us to convert from one unit to another. For instance, suppose we want to convert 48 inches to feet. From the table above, we see that 1 ft = 12 in. We can convert this relationship to two unit fractions,

 and 

In each of these unit fractions, the distance in the top and bottom are physically equal. When the quantities in the top and bottom of a fraction are equal, the fraction is equal to one. However, these fractions do not “look” equal to one since our eyes are drawn to the numbers and not the units. The units on each number are what make the fraction equal to one.

To make the conversion from 48 inches to feet, we multiply by the appropriate unit fraction,  . This allows us to treat the units like numbers and cancel units:



If you are familiar with US/Customary units, this is not very surprising. So, let’s look at a more complicated example where we convert 100 feet per second to miles per hour.

Start by writing the rate 100 feet per second as a fraction:



The “per” indicates division. This fraction indicates a distance of 100 feet covered in a time of 1 second. To convert to miles per hour, we must change feet to miles and seconds to hours. We’ll do this with several unit fractions:

, , and 

Multiply these unit fractions times 100 feet per second:



A speed of 100 feet per second is approximately equal to 68.2 miles per hour.

Notes

Guided Example 1 Practice

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| Convert 2.2 miles to feet.  **Solution** We know that 1 mile is equal to 5280 feet. Using this in a unit fraction and multiplying gives | Convert 10 yards to feet |

Guided Example 2 Practice

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| Convert 13 feet to centimeters.  **Solution** We know two facts: 2.54 cm ≈ 1 inch and 12 in = 1 ft. Combine these facts in unit fractions and multiply: | Convert 200 fluid ounces to pints. |

Guided Example 3 Practice

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| --- | --- |
| Convert 100 kilometers per hour to miles per hour.  **Solution** We know two facts: 1609 meters ≈ 1 mile and 1000 meters = 1 kilometer. Combine these facts in unit fractions and multiply: | Convert 55 miles per hour to kilometers per hour. |

Guided Example 4

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| The velocity of a 50-caliber bullet as it leaves the barrel of a gun is 853 meters per second.  What is the velocity in miles per hour?  **Solution** Several fact will help us to make this conversion:  1 meter ≈ 3.281 feet  5280 feet = 1 mile  60 seconds = 1 minute  60 minutes = 1 hour  Use these in unit fraction to make the conversion:    So, 853 meters per second is approximately 1908.2 miles per hour. |

Practice 4

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| The mileage of a new car is 48 miles per gallon.  What is this mileage in kilometers per liter? |

Guided Example 5 Practice

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| I ran the 3000 meter run in high school (and not very fast). I ran the race in 13 minutes and 35 seconds. Find my speed in miles per hour.     Convert minutes to seconds to get all the same units for time.  So my total time was 780+35 = 815 seconds  Now set up your fraction  and conversion facts.      Multiply across your fraction  = 8.24 miles per hour | I ran a half marathon recently. I ran the 13.2 mile race in 2 hours and 15 minutes. Convert the time to hours, and find my speed in miles per hour. |

Guided Example 6 Practice

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| Nursing example: How many mL will you draw up to prepare a 1.2 g dosage if the solution available is labeled 2 g in 3 mL?    Note the conversion:  Put your dosage over 1  Multiply by the conversion fact  Simplify: | Medication with a strength of 0.75 mg per mL is available to prepare a dosage of 2 mg. Calculate the mL this will require. |

**Chapter 3 Practice Solutions**

Section 3.1

1. meters or yards depending on where the soccer field is located.
2. 210
3. 6

Section 3.2

1. 30
2. a) Approximately 5.9

b) 12.5

1. 88.495 km/hr
2. Approximately 20.4
3. 5.87 miles per hour
4. 2.67 mL