

CUSTOMARY AND METRIC UNITS

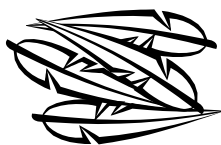
In this unit, you are provided a chart of conversion factors. You are to use the table of conversions to compare and translate between the customary and metric systems of measurement. You will also be introduced to “dimensional analysis” which is a scientific way to make conversions between units. You will see this method used again in future science classes.

Compare Customary and Metric Units

Convert Units with Dimensional Analysis

Compare Customary and Metric Units

Which weighs more, a pound of feathers or a pound of lead?



This of course is an old trick question that gives us the opportunity to discuss the concept of density. (The answer is at the bottom of the page.)

In this section we will discuss less trick questions with more important comparisons between the metric and customary units of measure.

Which is longer, a mile or a kilometer?

Which is more, a gallon or a liter?

Which is more, a pound or a kilogram?

Which is longer, a centimeter or an inch?

Consider the following chart of measurements to decide on the answers to the questions above.

Length	Weight	Capacity
1 mm \approx 0.04 inch	1 mg \approx 0.00004 oz	1 ml \approx 0.03 fl oz
1 cm \approx 0.4 inch	1 g \approx 0.04 oz	1 l \approx 1.06 qt
1 m \approx 1.1 yd	1 kg \approx 2.2 lb	1 kl \approx 264 gal
1 km \approx 0.6 mi	1 metric ton \approx 2205 lb	1 oz \approx 30 ml
1 in \approx 2.54 cm	1 oz \approx 28 g	1 c \approx 237 ml
1 ft \approx 30 cm	1 lb \approx 454 g	1 qt \approx 946 ml or 0.9 l
1 yd \approx 91 cm	1 ton \approx 907 kg	1 gal \approx 3785 ml or 3.8 l
1 mi \approx 1.6 km or 1600 m		

*Note: Since no measurement is exact, conversions are given as approximate values.

Which is longer, a mile or a kilometer? **Mile since $1 \text{ km} \approx 0.6 \text{ mi}$**

Which is more, a gallon or a liter? **Gallon since $1 \text{ gal} \approx 3785 \text{ ml} \approx 3.8 \text{ l}$**

Which is more, a pound or a kilogram? **Kilogram since $1 \text{ kg} \approx 2.2 \text{ lb}$**

Which is longer, a centimeter or an inch? **Inch since $1 \text{ cm} \approx 0.4 \text{ in}$**

Answer to the introductory question:

They both weigh the same, one pound!

Converting Units with Dimensional Analysis

When using dimensional analysis, we use a system of cancellation where our goal is to cancel out “units”, and then compute the remaining numbers.

To change units of measure, we begin with a known ratio of equivalences.

Example 1: Convert 20 inches to centimeters.

Conversion Factor: 1 inch (in) is equivalent to 2.54 centimeters (cm)
(This is an approximation.)

Write the ratio $\frac{2.54 \text{ cm}}{1 \text{ in}}$. We can then use this ratio to convert.

*Note: The “1 inch” is in the denominator of the ratio. We’ll examine why below.

Write a multiplication sentence in which the inch units will cancel.

$$20 \text{ in} \times \left(\frac{2.54 \text{ cm}}{1 \text{ in}} \right) \rightarrow \frac{20 \cancel{\text{ in}}}{1} \times \left(\frac{2.54 \text{ cm}}{1 \cancel{\text{ in}}} \right) \rightarrow \frac{20 \times 2.54 \text{ cm}}{1} = 50.8 \text{ cm}$$

*By placing the “1 inch” in the denominator of the ratio, we can cancel out the inch units and are left with centimeters.

Twenty inches is approximately equivalent to 50.8 centimeters.

When the conversion ratio is known, this process (**dimensional analysis**) may be used to change any metric to a standard value and vice versa.

Example 2: Convert: $5\frac{1}{2}$ mi = _____ km

Conversion Factor: 1 mile (mi) is equivalent to 1.6 kilometers (km)
(This is an approximation.)

Write the ratio: $\frac{1.6 \text{ km}}{1 \text{ mi}}$

*Place the “1 mi” in the denominator of the ratio so that it will cancel out with the given measurement (in miles).

Write a multiplication sentence in which the mile units will cancel.

$$5\frac{1}{2} \text{ mi} \times \left(\frac{1.6 \text{ km}}{1 \text{ mi}} \right) \rightarrow \frac{5\frac{1}{2} \cancel{\text{mi}}}{1} \times \left(\frac{1.6 \text{ km}}{1 \cancel{\text{mi}}} \right) \rightarrow \frac{5.5 \times 1.6 \text{ km}}{1} = 8.8 \text{ km}$$

Five and one-half miles is approximately equivalent to 8.8 kilometers.

Example 3: Convert: 46 mm = _____ in

Conversion Factor: 1 millimeter (mm) is equivalent to 0.04 inches (in). (This is an approximation.)

Write the ratio: $\frac{0.04 \text{ in}}{1 \text{ mm}}$

*Place the “1 mm” in the denominator of the ratio so that it will cancel out with the given measurement (in millimeters).

Write a multiplication sentence in which the millimeter units will cancel.

$$46 \text{ mm} \times \left(\frac{0.04 \text{ in}}{1 \text{ mm}} \right) \rightarrow \frac{46 \cancel{\text{mm}}}{1} \times \left(\frac{0.04 \text{ in}}{1 \cancel{\text{mm}}} \right) \rightarrow \frac{46 \times 0.04 \text{ in}}{1} = 1.84 \text{ in}$$

Forty-six millimeters is approximately equivalent to 1.84 inches.

In some conversions, two or more units may be needed to make the conversion.

Example 4: Convert: 4 m = _____ in

In this example, two conversion factors will be used.

Conversion Factor 1: 1 meter (m) is equivalent to 100 centimeters (cm)

Conversion Factor 2: 1 centimeter (cm) is equivalent to 0.4 inches (in). (This is an approximation.)

Write the ratios: $\frac{100 \text{ cm}}{1 \text{ m}}$, $\frac{0.4 \text{ in}}{1 \text{ cm}}$

Step 1: Convert m to cm.

$$4 \text{ m} \times \left(\frac{100 \text{ cm}}{1 \text{ m}} \right) \rightarrow \frac{4 \cancel{\text{m}}}{1} \times \left(\frac{100 \text{ cm}}{1 \cancel{\text{m}}} \right) \rightarrow \frac{400 \text{ cm}}{1} \rightarrow 400 \text{ cm}$$

Step 2: Convert cm to in.

$$400 \text{ cm} \times \left(\frac{0.4 \text{ in}}{1 \text{ cm}} \right) \rightarrow \frac{400 \cancel{\text{cm}}}{1} \times \left(\frac{0.4 \text{ in}}{1 \cancel{\text{cm}}} \right) \rightarrow \frac{400 \times 0.4 \text{ in}}{1} \rightarrow 160 \text{ in}$$

Let's take another look at this problem putting both steps together.

Two Steps Together

$$4 \text{ m} \rightarrow \frac{4 \cancel{\text{m}}}{1} \times \left(\frac{100 \cancel{\text{cm}}}{1 \cancel{\text{m}}} \right) \times \left(\frac{0.4 \text{ in}}{1 \cancel{\text{cm}}} \right) \rightarrow 160 \text{ in}$$

This method is quicker. Keep in mind where you are starting and where you want to end. As you write the ratios, be sure that the conversion ratios and units are strategically placed so that the desired units to be cancelled out will be eliminated.

Click on the tracks below to play a game.

