



Douglas College

Douglas College Learning Centre

## CONVERTING UNITS

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*To use this worksheet you should be comfortable with scientific notation, basic multiplication and division, moving decimal places and basic fractions. If you aren't, you can review the handout titled Scientific Notation and speak with your tutor.*

### The Metric System

If you reach into your piggy bank today, you might find pennies, dimes, loonies, ten-dollar bills, and (if you're lucky) hundred-dollar bills. Each of these denominations shares a relationship with the others. Can you tell what it is?

Each denomination of money differs from the others by a power of ten. To convert from one unit to the others, notice that all you need to do is move decimal places to the left or right. Watch how:

**1 hundred-dollar bill = 10 ten-dollar bills = 100 loonies = 1000 dimes = 10000 pennies**

or

**1 penny = 0.1 dimes = 0.01 loonies = 0.001 ten-dollar bills = 0.0001 hundred-dollar bills**

Money works exactly the same way as the metric system. The metric system makes use of the *base ten place value system*, which means that, just like we did with your money, you can convert from one metric measure to another just by multiplying or dividing by ten or moving a decimal place. For example, to convert 1 kilometer to meters, you need only move the decimal three places to the right to get 1000 meters.

The metric system attaches different prefixes to each unit to show the unit's size. Above, we encountered the term 'kilometer'. Notice that the prefix 'kilo' is attached to the word 'meter', the basic metric unit that measures length. Using the prefix 'kilo' indicates that the unit is multiplied by 1000 or  $1 \times 10^3$ . Therefore, 1 kilometer indicates 1 meter multiplied by 1000, which is simply 1000 meters.

The following table shows many of the prefixes that you may encounter:

Prefix	Symbol	Power of ten indicated	
		Numeral form	Scientific notation
nano	n	= 0.000000001	= $1 \times 10^{-9}$
micro	$\mu$	= 0.000001	= $1 \times 10^{-6}$
milli	m	= 0.001	= $1 \times 10^{-3}$
centi	c	= 0.01	= $1 \times 10^{-2}$
deci	d	= 0.1	= $1 \times 10^{-1}$
deka	da	= 10	= $1 \times 10$
hecto	h	= 100	= $1 \times 10^2$
kilo	k	= 1000	= $1 \times 10^3$

These prefixes can be attached to different basic metric units. Watch how this happens in the following list of some of the most common metric units:

Basic unit	Symbol	Measure of	Examples
meter	m	length	nanometer (nm) centimeter (cm)
gram	g	mass	microgram ( $\mu$ g) kilogram (kg)
liter	$\ell$	volume	milliliter (m $\ell$ ) dekaliter (da $\ell$ )

## Converting Metric Units

When you need to convert one metric unit to another, you may want to just move the decimal place. Although some conversions may be simple enough for this to work, many others are more complex so the chance of making a decimal error is

very likely. Writing out an equation that will allow you to methodically convert the unit is a good way to make sure that these errors don't happen.

You need to set up an equation that will allow the initial unit to cancel out and produce the new unit. *You do this by first making a fraction that relates the units.*

Let's try an example to see exactly how this is done.

$$\Rightarrow 2500 \text{ millimeters} = \text{ \_\_\_\_ } \text{ meters}$$

$\Rightarrow$  When we look at the prefix 'milli', we know that it signifies 0.001 or  $1 \times 10^{-3}$ , so 1000 millimeters equals one meter. To convert the measurement, we know to set up a fraction that relates meters to millimeters. We will put millimeters in the denominator and meters in the numerator so that when we multiply, the millimeter units will cancel to give us an answer in meters.

$$\Rightarrow 2500 \text{ mm} = 2500 \text{ mm} \times \frac{1 \text{ m}}{1000 \text{ mm}} = 2.5 \text{ m}$$

We have our answer: 2500 millimeters = 2.5 meters. Now let's try converting a slightly harder measurement.

$$\Rightarrow 67,400 \text{ centimeters} = \text{ \_\_\_\_ } \text{ kilometers}$$

$\Rightarrow$  Just as we did above, we will set up a fraction that relates centimeters to kilometers. To make it easier, we will use the unit meters as a sort of halfway point for our conversion. We'll set up a fraction with centimeters in the denominator and meters in the numerator so that when we multiply, the centimeter units will cancel to give us an answer in meters.

$$\Rightarrow 67,400 \text{ centimeters} = 67,400 \text{ cm} \times \frac{1 \text{ m}}{100 \text{ cm}} = 674 \text{ m}$$

$\Rightarrow$  Next, we'll set up a fraction to convert meters to kilometers. Note which units are put in the numerator and denominator:

$$\Rightarrow 674 \text{ meters} = 674 \text{ m} \times \frac{1 \text{ km}}{1000 \text{ m}} = 0.674 \text{ km}$$

Both the steps that we used above, first converting to meters and then to kilometers, can be condensed into one equation to speed up the calculation.

Notice that both the centimeters and meters cancel leaving kilometers as the final unit:

$$\Rightarrow 67,400 \text{ cm} \times \frac{1 \text{ m}}{100 \text{ cm}} \times \frac{1 \text{ km}}{1000 \text{ m}} = \frac{1 \text{ km}}{100,000 \text{ cm}} = 0.674 \text{ km}$$

### **Exercise 1: Converting Metric Units**

Write the fraction(s) that will allow you to convert the first unit to the second unit. (Hint: when deciding what to put in the numerator and denominator, remember that you want the first unit to cancel.)

- 1) mg to g                      2) nm to m                      3) daℓ to dℓ                      4) km to μm

Convert each measurement.

- 5) 500 mg to \_\_\_\_ g                      6) 94,000 watts to \_\_\_\_ kilowatts  
 7) 1.74 kilojoules to \_\_\_\_ joules                      8) 0.0069 kℓ to \_\_\_\_ mℓ  
 9) 9.27 cm to \_\_\_\_ nm                      10) 3600.5 mg to kg

## **Converting Between the English and Metric Systems**

The English system is unlike the metric system in that you can't convert between English measures just by multiplying or dividing by ten or moving a decimal place. Converting between the English and metric systems is therefore a little more challenging than just converting between metric units, although it involves the exact steps.

When you need to convert an English unit to a metric unit or a metric unit to an English unit, you need to set up an equation, just as we did earlier, that will allow the initial unit to cancel out and produce the new unit. Again, you must make a fraction that relates the units of each system.

The following tables show the relationships between some English and metric units. When converting between the two systems, you will need to use these relationships to create the fraction(s) that will make your initial unit cancel out to produce the new unit.

English-Metric Conversions		Metric-English Conversions	
1 inch	= 2.54 centimeters	1 centimeter	= 0.3937 inches
1 foot	= 0.3048 meter	1 meter	= 3.281 feet
1 yard	= 0.9144 meter	1 meter	= 1.094 yards
1 mile	= 1.609 kilometers	1 kilometer	= 0.6214 mile
1 quart	= 0.946 liter	1 liter	= 1.057 quarts
1 gallon	= 3.785 liters	1 liter	= 0.2642 gallon
1 ounce	= 28.35 grams	1 gram	= 0.0353 ounce
1 pound	= 453.59 grams	1 gram	= 0.0022 pound

Length		Volume	
12 inches (in.)	= 1 foot (ft)	2 cups (c)	= 1 pint (pt)
3 feet (ft)	= 1 yard (yd)	2 pints (pt)	= 1 quart (qt)
5280 feet (ft)	= 1 mile (mi)	4 quarts (qt)	= 1 gallon (gal)
Weight			
16 ounces (oz)	= 1 pound (lb)		
2000 pounds (lb)	= 1 ton		

Let's convert an English measurement to a metric measurement to see how it is done.

$$\Rightarrow 500 \text{ feet} = \underline{\hspace{2cm}} \text{ kilometers}$$

⇒ To convert the measurement, we know to set up a fraction that relates feet to kilometers. Because we know the relationship between feet and meters from the table above, we will use meters as a halfway point in our conversion. We will put feet in the fraction's denominator and meters in the numerator so that when we multiply, the foot unit will cancel to give us an answer in meters.

$$\Rightarrow 500 \text{ feet} = 500 \text{ feet} \times \frac{0.3048 \text{ m}}{1 \text{ foot}} = 152.4 \text{ m}$$

⇒ Now, it's just a simple step to convert meters to kilometers.

$$\Rightarrow 152.4 \text{ m} = 152.4 \text{ m} \times \frac{1 \text{ km}}{1000 \text{ m}} = 0.1524 \text{ km}$$

⇒ Our answer is 0.1524 kilometers. If we want to condense both of the equations we wrote into one to save time, we would write:

$$\Rightarrow 500 \text{ feet} = 500 \text{ feet} \times \frac{0.3048 \text{ m}}{1 \text{ foot}} \times \frac{1 \text{ km}}{1000 \text{ m}} = 0.1524 \text{ km}$$

Now let's try a trickier conversion.

$$\Rightarrow 1.02 \text{ English tons} = \underline{\hspace{2cm}} \text{ dekagrams}$$

⇒ To complete this example, we need to convert tons to pounds, pounds to grams, and then grams to dekagrams.

$$\Rightarrow 1.02 \text{ tons} = 1.02 \text{ tons} \times \frac{2000 \text{ lbs}}{1 \text{ ton}} = 2040 \text{ lbs}$$

$$\Rightarrow 2040 \text{ lbs} = 2040 \text{ lbs} \times \frac{453.59 \text{ g}}{1 \text{ lb}} = 925323.6 \text{ g}$$

$$\Rightarrow 925323.6 \text{ g} = 925323.6 \text{ g} \times \frac{\text{dag}}{10 \text{ g}} = 92532.36 \text{ dag}$$

⇒ Again, we can condense our calculations to:

$$\Rightarrow 1.02 \text{ tons} \times \frac{2000 \text{ lbs}}{1 \text{ ton}} \times \frac{453.59 \text{ g}}{1 \text{ lb}} \times \frac{\text{dag}}{10 \text{ g}} = 92532.36 \text{ dag}$$

**Exercise 2: Converting Between the English and Metric Systems**

Use the tables on pages 2 and 5 to convert each measurement.

11) 57 inches to \_\_\_\_ mm

12) 0.047 kg to \_\_\_\_ ounces

13) 1.98 quarts to \_\_\_\_  $\text{d}\ell$

14) 6.905  $\ell$  to \_\_\_\_ cups

15) 956 kg to \_\_\_\_ tons

16) 3600.5 pints to  $\text{k}\ell$

**Answers**

1)  $\frac{1 \text{ g}}{1000 \text{ mg}}$

2)  $\frac{1 \text{ m}}{1,000,000,000 \text{ nm}}$

3)  $\frac{1 \ell}{10 \text{ dal}} \times \frac{1 \text{ dl}}{10 \ell} = \frac{1 \text{ dl}}{100 \text{ dal}}$

4)  $\frac{1000 \text{ m}}{1 \text{ km}} \times \frac{1,000,000 \mu\text{m}}{1 \text{ m}} = \frac{1,000,000,000 \mu\text{m}}{1 \text{ km}}$

5)  $500 \text{ mg} \times \frac{1 \text{ g}}{1000 \text{ mg}} = 0.5 \text{ g}$

6)  $94000 \text{ watts} \times \frac{1 \text{ kilowatt}}{1000 \text{ watts}} = 94 \text{ kilowatts}$

7)  $1.74 \text{ kilojoules} \times \frac{1000 \text{ joules}}{1 \text{ kilojoule}} = 1,740 \text{ joules}$

8)  $0.0069 \text{ kl} \times \frac{1000 \ell}{1 \text{ kl}} \times \frac{1000 \text{ ml}}{1 \ell} = 6,900 \text{ ml}$

9)  $9.27 \text{ cm} \times \frac{1 \text{ m}}{100 \text{ cm}} \times \frac{1,000,000,000 \text{ nm}}{1 \text{ m}} = 92,700,000 \text{ nm}$

10)  $3600.5 \text{ mg} \times \frac{1 \text{ g}}{1000 \text{ mg}} \times \frac{1 \text{ kg}}{1000 \text{ g}} = 0.0036005 \text{ kg}$

11)  $57 \text{ inches} \times \frac{2.54 \text{ cm}}{1 \text{ inches}} \times \frac{10 \text{ mm}}{1 \text{ cm}} = 1447.8 \text{ mm}$

12)  $0.047 \text{ kg} \times \frac{1000 \text{ g}}{1 \text{ kg}} \times \frac{0.0353 \text{ ounces}}{1 \text{ g}} = 1.7 \text{ ounces}$

13)  $1.98 \text{ quarts} \times \frac{0.946 \ell}{1 \text{ quart}} \times \frac{1 \text{ dal}}{10 \ell} = 0.187 \text{ dal}$

14)  $6.905 \ell \times \frac{1.057 \text{ quarts}}{1 \ell} \times \frac{2 \text{ pints}}{1 \text{ quart}} \times \frac{2 \text{ cups}}{1 \text{ pint}} = 29.19 \text{ pints}$

$$15) 956 \text{ kg} \times \frac{1000 \text{ g}}{1 \text{ kg}} \times \frac{0.0022 \text{ pounds}}{1 \text{ g}} \times \frac{1 \text{ ton}}{2000 \text{ pounds}} = 1.05 \text{ tons}$$

$$16) 3600.5 \text{ pints} \times \frac{1 \text{ quart}}{2 \text{ pints}} \times \frac{0.946 \ell}{1 \text{ quart}} \times \frac{1 \text{ k}\ell}{1000 \ell} = 1.70 \text{ k}\ell$$