Federation University

Units & Unit Conversion

Units and unit conversion can be a bit daunting. The key to converting between different units is to use a systematic approach. It also helps to understand the background of the metric system.

In Table 1 below is a scale. The unit corresponding to ‘one/1’ is our main unit. We use the prefixes to tell us how far away we are from this main unit. For example, a kilometre is 1000 times greater than one (1) meter (meter being our main unit), and one kilogram is 1000 times greater than one (1) gram.

Similarly, one millimetre is one-thousandth of a meter, or one meter divided by 1000 (1m/1000), and one milligram is one-thousandth of one gram (1g/1000).

Table 1: Unit Conversion

Scale	Prefix	Symbol	Decimal	Scientific notation	Fraction
trillion*	tera	T	1 000 000 000 000	10^{12}	
billion*	giga	G	1 000 000 000	10^{9}	
million	mega	M	1 000 000	10^{6}	
thousand	kilo	K	1 000	10^{3}	
hundred	hecto	H	100	10^{2}	
ten	deca	da	10	10^{1}	
one	**main unit**	**no symbol**	**1**	$\mathbf{10^{0}}$	
tenth	deci	d	0.1	10^{-1}	$\frac{1}{10}$
hundredth	centi	c	0.01	10^{-2}	$\frac{1}{100}$
thousandth	milli	m	0.001	10^{-3}	$\frac{1}{1000}$
millionth	micro	µ	0.000 001	10^{-6}	$\frac{1}{1000\,000}$
billionth*	nano	n	0.000 000 001	10^{-9}	$\frac{1}{1000\,000\,000}$
trillionth*	pico	p	0.000 000 000 001	10^{-12}	$\frac{1}{1000\,000\,000\,000}$

* Using the short scale system

Scientific notation

Because numbers can get really large and really small, scientific notation is often used for any numbers over 1000 or below 0.001 (above and below the thousand and thousandth scales).

In scientific notation you will see a 10 with a superscript number. The superscript indicates how many times 10 will be multiplied by itself. For example,

$10^{2} = 10 \times 10 = 100$
$10^{4} = 10 \times 10 \times 10 \times 10 = 10\,000$

If the superscript is negative, this represent how many times we multiply $\frac{1}{10}$. For example,

$10^{-2} = \frac{1}{10} \times \frac{1}{10} = \frac{1}{100} = 0.01$

$10^{-4} = \frac{1}{10} \times \frac{1}{10} \times \frac{1}{10} \times \frac{1}{10} = \frac{1}{10000} = 0.0001$

Engineering notation

Engineering notation is similar to scientific notation, however the exponent is only used in multiples of 3 (stepping up by 1000). For example, 10^3, 10^6, 10^9 and 10^{12}. Where scientific notation would express 23500 as 2.35×10^4, in engineering notation it would be written as 23.4×10^3.

International System of Units (SI Units)

SI Units are a system of units that have been accepted as the standard units across the world. Some countries still use other unit systems, such as the imperial system (which includes cups, feet and stone). However, the metric SI system is the system used within science.

Table 2: The Seven Base SI Units

Base SI Units	Symbol	Miscellaneous information
Metre (length)	m	We also use length to measure volume. Volume = m^3 1 Liter (L) = $1dm^3$
Kilogram* (mass)	Kg*	Note that kg is a measurement for *mass* and not *weight*. Weight is mass times gravity (gravity on earth = $9.8m/s^2$).
Second (time)	s	60s = 1minute; 60 minutes=1 hour
Kelvin (temperature)	K	0°C = 273.15K
Mole (amount of substance)	mol	Frequently used in chemistry to measure amounts of a substance. 1 mole = $6.022\text{x}10^{23}$ individual particles (e.g. atoms or molecules).
Ampere (electric current)	A	Flow of electric charge.
Candela (luminous intensity)	cd	The amount of visible light that is emitted in a particular direction per unit solid angle.

*Kg is the SI unit for mass, however, the units are named as if gram (g) was the base unit!

Numerous other units are derived from these base units. For example:

Volume = m^3

NB: 1L = $1dm^3$

Area = m^2

Newton (N) = $\text{kg} \times \text{m} \times \text{s}^{-2}$

Volt (V) = $\text{kg} \times \text{m}^2 \times \text{s}^{-1} \times \text{A}^{-1}$

Conversion process

Numerous different units can be derived, such as from the imperial system to the metric system. When converting units, you need to multiply your unit with the relevant conversion factor.

Example 1: convert kilometres to metres

To find how many metres are in 0.5 km, first refer to the table on page one of this helpsheet. You will note that 1 km is the same as 1000 metres (or 10^3m).

So: 0.5km = 0.5×10^3 = 500m

The best method is to use a **conversion equation**, particularly if you are converting multiple units.

We know that in 1 km, we have 1000 m. Hence, we have 1000m/1km (read as 1000 metres per 1 kilometre).

$$0.5km \times \frac{1000m}{1km} = 500m$$

NB: Because any number can be divided by one and *remain itself*, we can also write 0.5km as 0.5km/1. (Imagine: if you have a small cake for one person, to "divide" in to one serve, you will not cut the cake; it will remain its original size.)

So add '1' under the 0.5 km, thus:

$$\frac{0.5km}{1} \times \frac{1000m}{1km} = 500m$$

Cancel out the kilometers, thus:

$$\frac{0.5\cancel{km}}{1} \times \frac{1000\boxed{m}}{1\cancel{km}} = 500\boxed{m}$$

The reason cancelling out the kilometres works is because we are multiplying the two numerators (top numbers) together, and the denominators (bottom numbers) together.

We end up with:

$$\frac{0.5km}{1} \times \frac{1000m}{1km} = \frac{500km \times m}{1km}$$

Remember, any number divided by itself equals one. Therefore, the full equation with all steps would be:

$$\frac{0.5km}{1} \times \frac{1000m}{1km} = \frac{500km \times m}{1km} = \frac{500m}{1} \times 1 = 500m$$

Example 2: convert millimeters per second to metres per minute

Now let's make it a bit trickier! How would you go about converting a measurement in millimeters per second to metres per minute?

With an example measurement of 24 mm/s, FIRST write the equation with the conversion factors.

Tip: if you forget what unit to put as a numerator or denominator, remember that we want to cancel out the mm and the s. To do this, we need to have *one of each* on the top, and one on the bottom. This means putting the 1000 mm on the bottom, as the 24 mm are on top.

$$\frac{24mm}{1s} \times \frac{60s}{1min} \times \frac{1m}{1000mm} = 1.44\ m/min$$

Now let's start cancelling out. We cancel out the millimeters (red circle) as we have one on the top and one down the bottom. We can also cancel out the seconds (s), which leaves us with meters (m) on top, and minutes on the bottom (min).

$$\frac{24\cancel{mm}}{1\cancel{s}} \times \frac{60\cancel{s}}{1min} \times \frac{1m}{1000\cancel{mm}} = 1.44\ m/min$$

Our final unit is metres per minute.

Example 3: convert inches to centimeters

To convert a measurement from inches to centimeters, you need to know how many inches are in one centimeter. A quick internet search tells us there are 2.54 cm per inch.

Follow these steps to convert 3 inches to cm:

$$\frac{3\ inches}{1} \times \frac{2.54\ cm}{1\ inches} = 7.62\ cm$$

$$\frac{3\ \cancel{inches}}{1} \times \frac{2.54\ \boxed{cm}}{1\ \cancel{inches}} = 7.62\ \boxed{cm}$$

Activity

Convert the following units:

1. 2.45 cm to metres

$$\frac{\quad}{\quad} \times \frac{\quad}{\quad} =$$

2. 7853 g to kg

$$\frac{\quad}{\quad} \times \frac{\quad}{\quad} =$$

3. 45 g/mL to kg/L

   1L = 1 ____ and 1mL = 1 ____

$$\frac{\quad}{\quad} \times \frac{\quad}{\quad} \times \frac{\quad}{\quad} =$$

Answers

1. $\frac{2.45cm}{1} \times \frac{1m}{100cm} = \frac{2.45m}{100} = 0.0245\ (or\ 2.45 \times 10^2)$

2. $\frac{7853g}{1} \times \frac{1kg}{1000g} = \frac{7853kg}{1000} = 7.853kg$

3. 1L= $1dm^3$ and 1mL= $1cm^3$

$$\frac{45g}{1cm^3} \times \frac{1000cm^3}{1dm^3} \times \frac{1kg}{1000g} = \frac{4500kg}{1000dm^3} = 4.5kg/dm^3 = 4.5kg/L$$

Were you confused about $1dm^3$ equaling $1000cm^3$?

Check the unit conversion table again, you will see dm (decimetre) and cm (centimetre) are only one step apart! This is because the units are *cubed*.

Remember from scientific notation, that $10^3 = 1000$. The same concept applies to a unit which has been cubed. Looking at Figure 1 below, we can see that it would take 1000 cubic centimetres to fill one cubic decimeter (which is one litre).

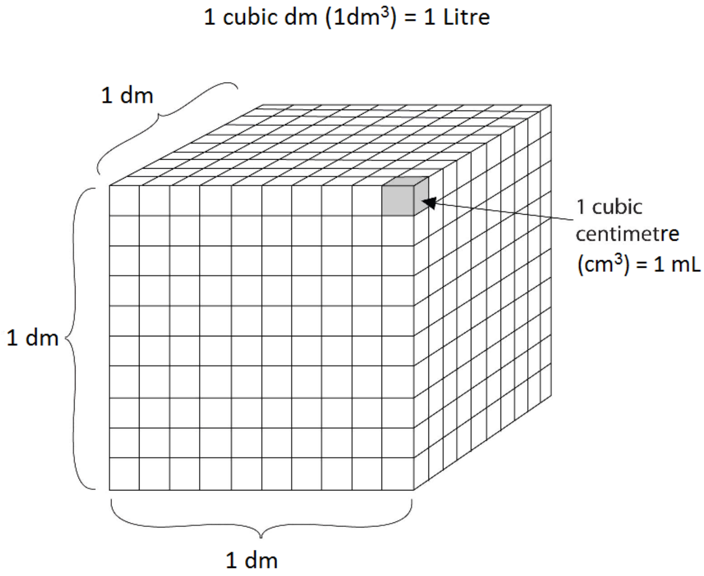

Figure 1: 1dm³ compared to 1cm³

Figure 2: Cubic dm (Litre) compared to cubic cm (mL)

Other helpsheets available

- Rearranging Equations
- Fractions
- Percentages
- Figures & Tables
- Incorporating Evidence into your Writing