MATHS AND STATS

Units of measurement and conversions

Over centuries, many different units have been devised and used to measure quantities of vegetables, time, cloth, distances, etc. Currently in Australia and many countries in the world, the International System of Units or SI system is used.

Each physical quantity has a base unit. This quantity is then divided into smaller units by dividing the base unit by multiples of 10 to make suitably sized smaller units. The base unit can also be bundled into multiples of 10 to form larger units.

Eg In length, a metre is the base unit and this is fine to use for measuring trees, material, desks, house lengths, etc. The metre would not be suitable to use to measure a bacteria or the distance across Australia. The metre is too big to measure bacteria and too small for measuring large distances.

Divisions or bundles of the base unit are often indicated by prefixes. Prefixes can be used with any base unit.

Eg centi_ means hundredth part of a unit
kilo_ means a bundle of one thousand units

Common SI units

Physical Quantity	Name of unit (Base units shown in bold. Prefixes underlined.)	Symbol
Length	small ↓ large	millimetre centimetre decimetre **metre** kilometre	mm cm dm **m** km
Area	small ↓ large	square millimetre square centimetre **square metre** square kilometre hectare	mm^2 cm^2 **m^2** km^2 ha
Volume (solids)		**cubic metre**	**m^3**
Capacity (volume for liquids)	small ↓ large	millilitre **litre** kilolitre	mL **L** kL

Mass	small ↓ large	milligram **gram** kilogram tonne	mg **g** kg t
Time	small ↓ large	millisecond **second** minute hour day	ms s min h d
Temperature	degrees Celsius		^{o}C
Chemical Substance		**mole** millimole	mol mmol

Prefixes

- Prefixes are used instead of numbers.

  1000 metres => 1 **KILO** metre

- Prefixes ensure the number of units is not too large or too small

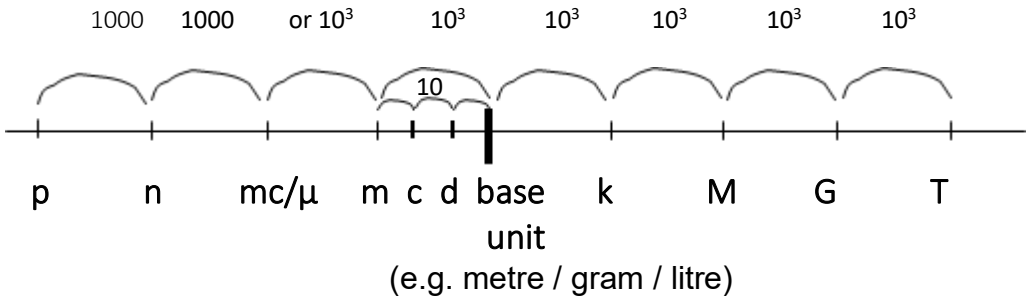
  Tip > Usually the prefixes are associated with multiples of a thousand bundles or divisions of units

- **smaller units** are formed by dividing the base unit by usually multiples of 1000 or 10^3 . For example the new unit is one **thousandth** the size of the base unit.
  There are 2 exceptions
  centi – divides the base unit by 100 ie it is one **hundredth** the size of the base unit.
  deci – divides the base unit by 10 ie it is one **tenth** the size of the base unit.

Prefix	Abbreviation
nano_	n_
micro_	mc_ (or μ_ greek letter *mu*)
milli_	m_
centi_	c_
deci_	d_
base unit	

- **larger units** are formed by multiplying the base unit by usually multiples of 1000 or 10^3 . For example the new unit is a bundle of one thousand units, ie **one thousand times bigger**.

Prefix	Abbreviation
base unit	
kilo	k_
mega	M_
giga	G_
tera	T_



small units large units

small unit to large unit
÷ by the conversion factor

large unit to small unit
× by conversion factor

Unit conversions

Any unit can be expressed in terms of another unit for a given physical quantity. In order to do this the conversion factor has to be determined, that is, the multiple of 10 difference between the two units involved has to be worked out.

- **Since units are usually bundled by thousands, all you have to remember is the order of the prefixes. ie memorise the conversion bar – copy it onto your page!!!**
- **Count the tens (zeros) between prefixes to work out the conversion factor**

Pico – nano – micro – milli – centi – deci – base – kilo – mega – giga – tera
p – n – mc (or μ (mu)) – m – c – d – base – k – M – G – T

(**Pn**eu-**m**onics **m**ake **c**reative **d**itties **b**ased on **k**eywords **m**aking **g**ood **t**ips)

The difference is given by the multiple of 10 difference between the prefixes being used.

eg between **centi** (c) and the **base** unit there is a factor of **100** (10 x 10 from the bar)
between **micro** (mc / μ) and the **base** unit there is is a factor of 1000×1000 or $\mathbf{10^6}$
between **nano** (n) and **kilo** (k) there is a factor of 1000×1000×1000×1000 or $\mathbf{10^{12}}$ **(12 zeros)**
between **deci** (d) and **mega** (M) there is is a factor of 10×1000×1000 or $\mathbf{10^7}$ **(7 zeros)**

- Converting a smaller unit into a larger unit => divide by the conversion factor.
- In reverse when converting a larger unit into a smaller unit => multiply.

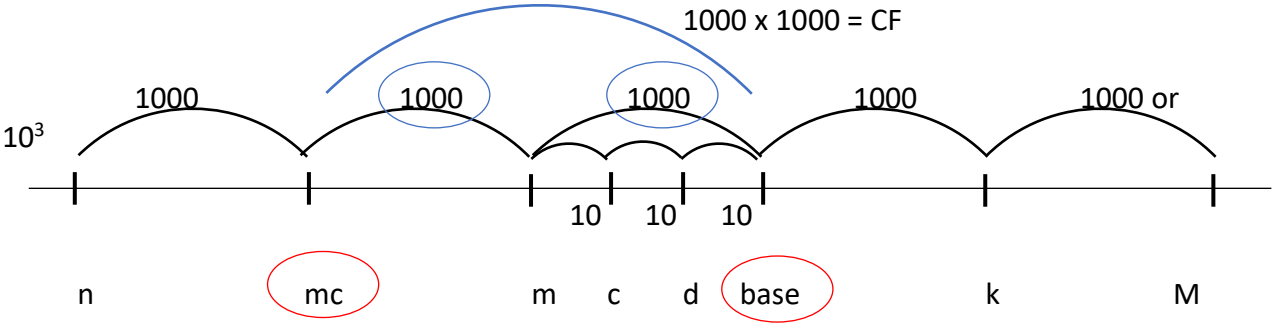
Examples

1) <u>Metres (base unit) to centimetres:</u> larger unit into smaller unit ie how many smaller units in a larger unit so we multiply by the conversion factor (CF) found in the previous example using the bar.

3.5 *metres* = 3.5 × 100 *centimetres*
CF | move 2 places (2 zeros) to make it bigger
= 350 *centimetres*

2) <u>Micrograms to grams (base unit):</u> small units into larger units so divide by the conversion factor (CF) found above

78 200 000 *micrograms* = 78 200 000 ÷ 1 000 000 *grams*
CF | move 6 places smaller
= 78.2 *grams*

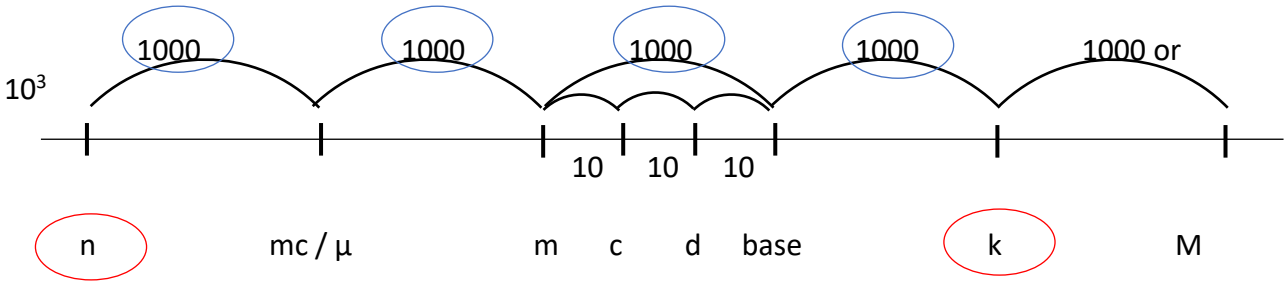


3) Nanolitres to kilolitres: small units into larger units so divide by the conversion factor (CF) found above

$500\,000\,000\,000\,nanolitres = 500\,000\,000\,000 \div 10^{12}\ kilolitres$

CF | move 12 places (12 zeros)

$= 0.5\ kilolitres$

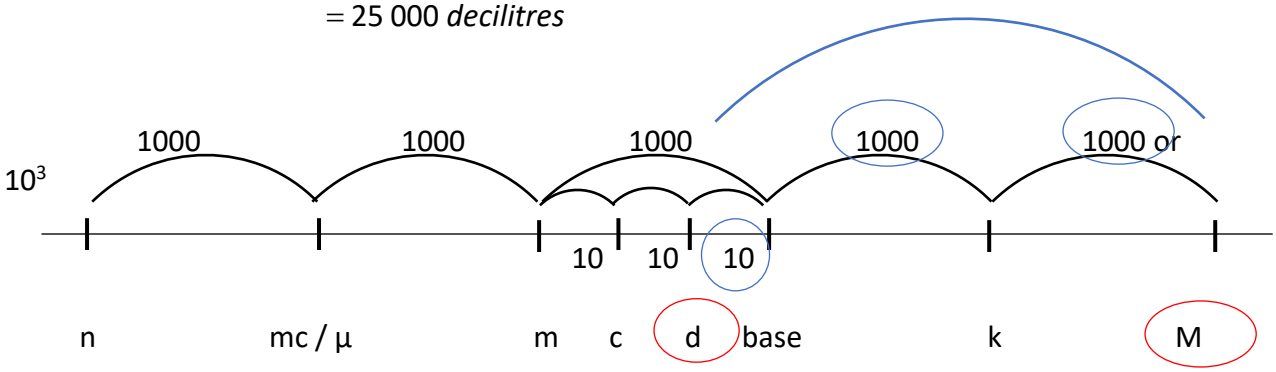


4) Megalitres to Decilitres: large units into smaller units so multiply by the conversion factor (CF) found above

$0.0025\,Megalitres = 0.0025 \times 10^{7}\ decilitres$

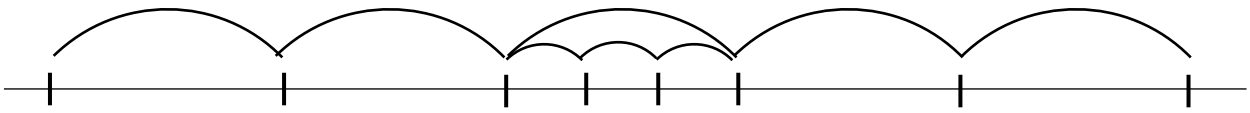
CF | move 7 places (7 zeros) to make it bigger

$= 25\,000\ decilitres$



Conversion bar - don't forget to memorise it!

- Cover the conversion bar and redraw it on your paper, filling in all the prefixes



Exercises

- X / ÷ by 10 means moving the decimal point ONE place each time.
- ÷ makes the result smaller and x makes the result bigger – check you got the right result!

1 Write each of the following
   I. as normal numbers
   II. in Scientific (Standard) notation

a	$56 \times 10\,000$	f	0.8×1000	k	0.098×10^{4}
b	0.067×100	g	6123×10^{6}	l	$86254000 \div 10\,000$
c	3280×1000	h	6.2×10^{-3}	m	0.566666×10^{3}
d	$418 \div 10\,000$	I	$0.025 \div 100$	n	$34000 \div 10$
e	$0.4625 \div 10^{2}$	j	0.0049×10^{-5}	o	0.005006×10^{-2}

2 I. Give the conversion factor (CF) for each unit change using the conversion bar
   II. If you converted the units, determine if you would x or ÷ by the CF

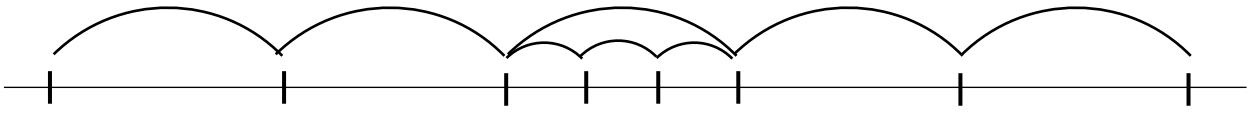
a	micrometre to metres	f	nm to cm	k	ng to kg
b	litres to decilitres	g	mL to kL	l	km to mm
c	milligrams to centigrams	h	Mg to g	m	dg to cg
d	km to cm	I	dL to mL	n	m to km
e	mm to nm	j	L to mcL	o	L to nL

3 Convert each of the following.

a	40.2 m to mm	f	382 g to kg	k	60 L to dL
b	8.9 km to m	g	0.05 g to mg	l	850 mL to dL
c	8400 cm to m	h	750 kg to *Mg	m	38200 mcL to mL
d	6.4 nm to mcm	I	35 mg to mcg	n	60 L to kL
e	2 mm to mcm	j	1100 *t to kg	o	0.4 L to mL

*Note: Megagrams (Mg) are more commonly called tonnes (t)

Test yourself again … fill in the conversion bar, then try to draw it yourself from scratch.



4 Convert each of the following to the units given.

a	836 000 mcm to m	f	4 920 000 nm to cm	k	5.8×10^{14} ng to kg
b	3.5 L to dL	g	30 860 000mL to kL	l	0.037 km to mm
c	4700 mg to cg	h	0.000 065 *t to g	m	7830 dg to cg
d	0.0004 km to cm	I	105 dL to mL	n	28047 m to km
e	0.000152 mm to nm	j	5.8×10^{10} L to mcL	o	5.8×10^{10} L to nL

Answers

1 I normal numbers II scientific notation

a	560 000	5.6×10^5	f	800	8×10^2	k	980	9.8×10^2
b	6.7	6.7×10^0	g	6123000000	6.123×10^9	l	8625.4	8.6254×10^3
c	3 280 000	3.28×10^6	h	0.0062	6.2×10^{-3}	m	566.666	5.66666×10^2
d	0.0418	4.18×10^{-2}	I	0.00025	2.5×10^{-4}	n	3400	3.4×10^3
e	0.004625	4.625×10^{-3}	j	0.000000049	4.9×10^{-8}	o	0.00005006	5.006×10^{-5}

2 I CF II **x** or ÷

a	10^6	÷	f	10^7	÷	k	10^{12}	÷
b	10	**x**	g	10^6	÷	l	10^6	**x**
c	10	÷	h	10^6	**x**	m	10	**x**
d	10^5	**x**	I	100 or 10^2	**x**	n	10^3	÷
e	10^6	**x**	j	10^6	÷	o	10^9	**x**

3

a	40 200 mm	f	0.382 kg	k	600 dL
b	8 900 m	g	50 mg	l	8.5 dL
c	84 m	h	0.75 Mg or t	m	38.2 mL
d	0.0064 mcm	I	35000 mcg	n	0.06 kL
e	2000 mcm	j	1100 000 kg	o	400 mL

4

a	0.836 000 m	f	0.492 cm	k	5.8×10^2 kg
b	35 dL	g	30.86 kL	l	37 000 mm
c	470 cg	h	65 g	m	78300 cg
d	40 cm	I	10500 mL	n	28.047 km
e	152 nm	j	5.8×10^4 mcL	o	5.8×10^{19} nL