

## Essential Mathematics and Statistics in Science

by Graham Currell and Antony Dowman, Wiley-Blackwell, 2009

### Units in Science

Most measurements are made as a comparison with an agreed standard, or **unit**. For example, the height of Nelson's column in London could be measured using a 1 foot ruler, giving a value of  $169.5 \times (1 \text{ foot})$  which would be written simply as 169.5 ft. Alternatively, using a 1 metre rule the height would be  $51.66 \times (1 \text{ metre})$  which would be written as 51.66 m.

We can convert from the 'foot' system of units to the 'metre' system of units by using a **conversion equation**. For example, using the conversion from feet to metres

$$1.0 \text{ ft} = 0.3048 \text{ m}$$

for the height of Nelson's column:

$$169.5 \text{ ft} = 169.5 \times (1 \text{ ft}) = 169.5 \times (0.3048 \text{ m}) = 51.66 \times (1 \text{ m}) = 51.66 \text{ m}$$

The **Systeme international d'unites**, abbreviated to '**SI Units**', (see p 16) is the internationally agreed standard for the use of units.

The system is based on a limited number of 'base' units

#### SI Base Units:

Quantity	Name	Symbol
Length	metre	m
Mass	kilogram (gram)	kg (g)
Time	second	s
Electric current	ampere	A
Temperature	kelvin	K
Amount	mole	mol
Luminous intensity	candela	cd

Notes:

Although the SI base unit for mass is the kilogram, kg, the multiple units are given in terms of the gram, g, e.g. mg.

Where a unit is based on a person's name, the name of the unit starts with a lower case letter, e.g. kelvin, but the symbol is given in upper case, K.

Many other units are then derived from these base units, some of which have specific names:

#### Examples of SI Derived Units:

Quantity	Name	Symbol	In other SI units	In base units
Area	square metre			$\text{m}^2$
Volume	cubic metre			$\text{m}^3$

Table continued overleaf

Quantity	Name	Symbol	In other SI units	In base units
Speed	metres per second			$\text{m s}^{-1}$
Density	kilograms per cubic metre			$\text{kg m}^{-3}$
Force	newton	N		$\text{kg m s}^{-2}$
Pressure	pascal	Pa	$\text{N m}^{-2}$	$\text{kg m}^{-1} \text{s}^{-2}$
Energy	joule	J	$\text{N m}$	$\text{kg m}^2 \text{s}^{-2}$
Power	watt	W	$\text{J s}^{-1}$	$\text{kg m}^2 \text{s}^{-3}$
Frequency	hertz	Hz		$\text{s}^{-1}$
Charge	coulomb	C		A s

Notes:

Combined units are written with a space between separate units.

## SI Prefixes

Where a derived unit is a multiple of a base unit, the standards are normally in multiples or divisors of 1000, giving the most common SI prefixes:

Factor	$10^{-12}$	$10^{-9}$	$10^{-6}$	$10^{-3}$	1	$10^3$	$10^6$	$10^9$	$10^{12}$
Prefix	pico	nano	micro	milli	(unit)	kilo	mega	giga	tera
Symbol	p	n	$\mu$	m	-	k	M	G	T

Some other prefixes are in use, although not multiples/divisors of 1000, for example:

Factor	$10^{-2}$	$10^{-1}$	1	$10^2$
Prefix	centi	deci	(unit)	hecto
Symbol	c	d	-	h

The **Imperial** system of units is still widely used and is based on the foot (length), pound (mass) and second. Other units have also developed, based on a range of different purposes, e.g, the nautical mile was defined as one minute of arc of latitude and is used in air and sea navigation.

## Scientific (or standard) notation (see p 8)

In scientific notation (also known as standard notation) the value is written with the decimal point after the first non-zero digit on the left and then multiplied by an appropriate power of ten to provide the correct overall value.

For example, 0.00839 would be written as  $8.39 \times 10^{-3}$ .

## Significant figures and decimal places (see p 11)

The precision of a value can be defined by using the number of **significant figures** to show only the digits that are claimed to be true. For example, if, after measuring a mass, it was believed that the true value was somewhere between 3.897 g and 3.903 g, it would be appropriate to present the result to 3 significant figures (3 sf), i.e. 3.90 g.

The presentation of a value can also be defined by using the number of **decimal places**. For example 5.796 to 2 decimal places (2 dp) would be written as 5.80.