

# Units and Prefixes

In science, the (SI) international system (metric) for units is used

At certain times, it becomes necessary to convert from one unit to another... it is important to be able to perform those conversions with accuracy

Most quantities are stated as either a very large number or very small number

**Prefixes** relate to powers of 10 that are multiples of +3 or -3

The first use of the prefixes occurred in the 1790s in France...others have since been added as better technology allowed for more precise measurements

The prefixes are typically used with the metric unit system.....very uncommon to use with the imperial unit system

We will use the prefixes only with the metric units

# The Importance of Units and Conversion

Designed to orbit Mars as the first interplanetary weather satellite, the Mars Orbiter was lost in 1999 because the NASA team used metric units while a contractor used imperial. The \$125 million probe came too close to Mars as it tried to manoeuvre into orbit, and is thought to have been destroyed by the planet's atmosphere. An investigation said the "root cause" of the loss was the "failed translation of English units into metric units" in a piece of ground software.

In 1628, crowds in Sweden watched in horror as a new warship, Vasa, sank less than a mile into her maiden voyage, with the death of 30 people on board. Armed with 64 bronze cannons, it was considered by some to be the most powerful warship in the world. Experts who have studied it since it was raised in 1961 say it is asymmetrical, being thicker on the port side than the starboard side. One reason for this could be that the workmen were using different systems of measurement. Archaeologists have found four rulers used by the workmen who built the ship. Two were calibrated in Swedish feet, which had 12 inches, while the other two measured Amsterdam feet, which had 11 inches.

In 1983, an Air Canada flight ran out of fuel above Gimli, Manitoba. Canada had switched to the metric system in 1970, and the plane is reported to have been Air Canada's first aircraft to use metric measurements. The plane's on-board fuel gauge was not working, so the crew used measuring "dripsticks" to check how much fuel the plane took on during refuelling. Things went wrong when they converted this measurement of volume into one of weight. They got the number right, but the unit wrong - mistaking pounds of fuel for kilograms. As a result the plane was carrying about half as much fuel as they thought. Luckily, the pilot was able to land the plane safely on the Gimli runway, giving the plane the nickname "Gimli Glider".

# Prefixes – Metric System

Prefix	Symbol	Power of 10
Exa	E	$10^{18}$
Peta	P	$10^{15}$
Tera	T	$10^{12}$
Giga	G	$10^9$
Mega	M	$10^6$
Kilo	k	$10^3$
hecto	h	$10^2$
deca	da/dk	$10^1$
Base unit (meter, seconds, grams...)		$10^0$
deci	d	$10^{-1}$
centi	c	$10^{-2}$
milli	m	$10^{-3}$
micro	$\mu$	$10^{-6}$
nano	n	$10^{-9}$
pico	p	$10^{-12}$
femto	f	$10^{-15}$
atto	a	$10^{-18}$

# Prefixes – Metric System

Metric Symbol	Metric Prefix	Power of 10 with Respect to <b>Base Unit</b>
E	1 Exa_ <b>BaseUnit</b> =	$10^{18}$ <b>BaseUnit</b>
P	1 Peta_ <b>BaseUnit</b> =	$10^{15}$ <b>BaseUnit</b>
T	1 Tera_ <b>BaseUnit</b> =	$10^{12}$ <b>BaseUnit</b>
G	1 Giga_ <b>BaseUnit</b> =	$10^9$ <b>BaseUnit</b>
M	1 Mega_ <b>BaseUnit</b> =	$10^6$ <b>BaseUnit</b>
k	1 Kilo_ <b>BaseUnit</b> =	$10^3$ <b>BaseUnit</b>
h	1 hecto_ <b>BaseUnit</b> =	$10^2$ <b>BaseUnit</b>
dk/da	1 deca_ <b>BaseUnit</b> =	$10^1$ <b>BaseUnit</b>
	Base unit (meter, seconds, grams...)	$10^0 = 1$
d	1 deci_ <b>BaseUnit</b> =	$10^{-1}$ <b>BaseUnit</b>
c	1 centi_ <b>BaseUnit</b> =	$10^{-2}$ <b>BaseUnit</b>
m	1 milli_ <b>BaseUnit</b> =	$10^{-3}$ <b>BaseUnit</b>
μ	1 micro_ <b>BaseUnit</b> =	$10^{-6}$ <b>BaseUnit</b>
n	1 nano_ <b>BaseUnit</b> =	$10^{-9}$ <b>BaseUnit</b>
p	1 pico_ <b>BaseUnit</b> =	$10^{-12}$ <b>BaseUnit</b>
f	1 femto_ <b>BaseUnit</b> =	$10^{-15}$ <b>BaseUnit</b>
a	1 atto_ <b>BaseUnit</b> =	$10^{-18}$ <b>BaseUnit</b>

# Fundamental Units

Fundamental Unit	Abbreviation	Unit
Distance	m	meter
Mass	kg	kilogram
Time	s	seconds
Electric Current	A	Ampere
Temperature	K	Kelvin
Amount of Substance	mol	mole
Light Intensity	cd	candela

Fundamental units are not derived from other units

All other units are derived from these 7 fundamental units

# Common Base Units – Metric and Imperial

Unit	Abbreviation		Unit	Abbreviation
Angstrom	Å		mile*	mi
atmosphere	atm		minute	min
British Thermal Units*	BTU		nautical mile	NM or nmi
Coulomb	C		Newton	N
calorie	cal		Ohm	Ω
decibel	dB		ounce*	oz
electron volt	eV		Pascal	Pa
Farad	F		pint*	pt
fluid ounce*	fl. oz.		pound*	lb
foot*	ft		quart*	qt
gallon*	gal		teaspoon*	tsp
gram	g		tablespoon*	tbsp
Henry	H		Volt	V
horsepower*	hp		Watt	W
Hertz	Hz		Weber	Wb
hour	h		yard*	yd
inch*	in			
Joule	J			
litre	L		* (imperial units)	

# Dimensional Analysis

Conversion from one unit to another using dimensional analysis is one technique

**Dimensional analysis** – uses the base quantities (m, s, g...) and the ratios of units ( $1 \text{ km} = 1000 \text{ m}$ ) to perform the conversion between units

An easy way to remember dimensional analysis is to “match” the units that you want to eliminate

Convert 2700 g to kg

Convert 53 nA to kA

# Dimensional Analysis – Metric Conversion

Convert 0.00000487 ng to Tg

Convert  $5.83 \times 10^4$  fs to  $\mu\text{s}$



# Imperial Units

Since the whole world does not use metric units, sometimes you will have to convert to imperial units and vice versa....dimensional analysis can be used for conversion of these units as well

Imperial – Imperial Converters	Imperial – Metric Converters
12 inches (in) = 1 foot (ft)	1 inch (in) = 2.54 cm
3 feet = 1 yard (yd)	1 mile (mi) = 1.609 km
5280 feet = 1 mile (mi)	
16 ounces (oz) = 1 pound (lb)	1 ounce (oz) = 28.35 grams
2000 pounds = 1 ton (t)	1 pound (lb) = 453.6 grams
16 fluid ounces (fl. oz.) = 1 pint (pt) (US)	1 US pt = 0.473176 liters
2 pint (pt) = 1 quart (qt) (US)	1 US gal = 3.78541 liters
4 quarts (qt) = 1 gallon (gal) (US)	

# Dimensional Analysis – Imperial-Metric Conversion

Convert 2178 ft to Tm

Convert 475 lb to Mg

# Dimensional Analysis – More Practice

Convert 27 mi/US gal to L/100 km

Convert 0.0000236 km/s to yd/h

# Unit Conversion Chart

Metric Symbol	Metric Prefix	Power of 10
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M	1 Mega =	$10^6$
k	1 Kilo =	$10^3$
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n	1 nano =	$10^{-9}$
p	1 pico =	$10^{-12}$
f	1 femto =	$10^{-15}$
a	1 atto =	$10^{-18}$

## Imperial Conversion Units

### Length

12 in = 1 ft  
 3 ft = 1 yd  
 5280 ft = 1 mi  
 1760 yd = 1 mi  
 1852 m = 1 nmi

### Weight

16 oz = 1 lb  
 2000 lb = 1 ton

### Capacity

3 tsp = 1 tbsp  
 1 fl. oz. = 2 tbsp  
 16 tbsp = 1 cup  
 2 cups = 1 US pt  
 2 pt = 1 US qt  
 4 qt = 1 US gal  
 1 cup = 8 fl. oz.

### Time

60 min = 1 h  
 60 s = 1 min  
 24 h = 1 day  
 365 day = 1 yr

### Angles

$\pi$  rad =  $180^\circ$   
 $1^\circ = 60$  min (60')  
 $1' = 60$  s (60")

### Temperature

$^\circ\text{C} = 5/9 (^\circ\text{F} - 32)$   
 $\text{K} = ^\circ\text{C} + 273$   
 $^\circ\text{F} = (9/5)^\circ\text{C} + 32$   
 $\text{R} = ^\circ\text{F} + 460$

## Metric – Imperial Conversion Units

### Length

1 in = 2.54 cm  
 1 m = 39.37 in  
 1 mi = 1.609 km

### Weight

1 lb = 453.6 g  
 1 kg = 2.205 lb  
 1 oz = 28.35 g

### Capacity

1 US gal = 3.79 L  
 1 tsp = 4.93 mL  
 1 US pt = 0.473 L

## Heat - Energy - Power Units

1 cal = 4.186 J  
 1 BTU = 1055 J  
 1 hp = 745.7 W

## Area

1 hectare = 10000 m<sup>2</sup>  
 1 acre = 4840 yd<sup>2</sup>  
 1 hectare = 2.47 acres