A Dictionary of Units

This provides a summary of most of the units of measurement to be found in use around the world today (and a few of historical interest), together with the appropriate conversion factors needed to change them into a 'standard' unit of the S I.

The units may be found either by looking under the category in which they are used [such as length, mass, density, energy etc.], or else by picking one unit from an alphabetically ordered list of units. There are NO units of currency. There is an outline of the S I; a list of its basic defining standards and also some of its derived units; then another list of all the S I prefixes and some notes on conventions of usage. There is a short historical note on measures generally; descriptions of the Metric system, the U K (Imperial) system with a statement on the implementation of 'metrication' in the U K, and the U S system. Finally there is a list of other sources concerned with the topic of measures and units (including other Web sites) and also some notes about this document.

A Summary of the conversion factors most often required is available.

Summary table of conversion factors most often required

x means 'multiply by' . . . **/** means 'divide by' . . . **#** means it is an exact value
All other values given to an appropriate degree of accuracy.

To change . .	into . .	do this . .	To change . .	into . .	do this . .
acres	hectares	**x 0.4047**	kilograms	ounces	**x 35.3**
acres	sq. kilometres	**/ 247**	kilograms	pounds	**x 2.2046**
acres	sq. metres	**x 4047**	kilograms	tonnes	**/ 1000 #**
acres	sq. miles	**/ 640 #**	kilograms	tons (UK/long)	**/ 1016**
barrels (oil)	cu.metres	**/ 6.29**	kilograms	tons (US/short)	**/ 907**
barrels (oil)	gallons (UK)	**x 34.97**	kilometres	metres	**x 1000 #**
barrels (oil)	gallons (US)	**x 42 #**	kilometres	miles	**x 0.6214**
barrels (oil)	litres	**x 159**	litres	cu.inches	**x 61.02**
centimetres	feet	**/ 30.48 #**	litres	gallons (UK)	**x 0.2200**
centimetres	inches	**/ 2.54 #**	litres	gallons (US)	**x 0.2642**
centimetres	metres	**/ 100 #**	litres	pints (UK)	**x 1.760**
centimetres	millimetres	**x 10 #**	litres	pints (US liquid)	**x 2.113**
cubic cm	cubic inches	**x 0.06102**	metres	yards	**/ 0.9144 #**
cubic cm	litres	**/ 1000 #**	metres	centimetres	**x 100 #**
cubic cm	millilitres	**x 1 #**	miles	kilometres	**x 1.609**
cubic feet	cubic inches	**x 1728 #**	millimetres	inches	**/ 25.4 #**
cubic feet	cubic metres	**x 0.0283**	ounces	grams	**x 28.35**
cubic feet	cubic yards	**/ 27 #**	pints (UK)	litres	**x 0.5683**
cubic feet	gallons (UK)	**x 6.229**	pints (UK)	pints (US liquid)	**x 1.201**
cubic feet	gallons (US)	**x 7.481**	pints (US liquid)	litres	**x 0.4732**
cubic feet	litres	**x 28.32**	pints (US liquid)	pints (UK)	**x 0.8327**
cubic inches	cubic cm	**x 16.39**	pounds	kilograms	**x 0.4536**
cubic inches	litres	**x 0.01639**	pounds	ounces	**x 16 #**
cubic metres	cubic feet	**x 35.31**			

To change . .	into . .	do this . .	To change . .	into . .	do this . .
			square cm	sq. inches	**x 0.1550**

feet	centimetres	**x 30.48 #**	square feet	sq. inches	**x 144 #**
feet	metres	**x 0.3048 #**	square feet	sq. metres	**x 0.0929**
feet	yards	**/ 3 #**	square inches	square cm	**x 6.4516 #**
fl.ounces (UK)	fl.ounces (US)	**x 0.961**	square inches	square feet	**/ 144 #**
fl.ounces (UK)	millilitres	**x 28.41**	square km	acres	**x 247**
fl.ounces (US)	fl.ounces (UK)	**x 1.041**	square km	hectares	**x 100 #**
fl.ounces (US)	millilitres	**x 29.57**	square km	square miles	**x 0.3861**
gallons	pints	**x 8 #**	square metres	acres	**/ 4047**
gallons (UK)	cubic feet	**x 0.1605**	square metres	hectares	**/ 10 000 #**
gallons (UK)	gallons (US)	**x 1.2009**	square metres	square feet	**10.76**
gallons (UK)	litres	**x 4.54609 #**	square metres	square yards	**x 1.196**
gallons (US)	cubic feet	**x 0.1337**	square miles	acres	**x 640 #**
gallons (US)	gallons (UK)	**x 0.8327**	square miles	hectares	**x 259**
gallons (US)	litres	**x 3.785**	square miles	square km	**x 2.590**
grams	kilograms	**/ 1000 #**	square yards	square metres	**1.196**
grams	ounces	**/ 28.35**	tonnes	kilograms	**x 1000 #**
hectares	acres	**x 2.471**	tonnes	tons (UK/long)	**x 0.9842**
hectares	square km	**/ 100 #**	tonnes	tons (US/short)	**x 1.1023**
hectares	square metres	**x 10000 #**	tons (UK/long)	kilograms	**x 1016**
hectares	square miles	**/ 259**	tons (UK/long)	tonnes	**x 1.016**
hectares	square yards	**x 11 960**	tons (US/short)	kilograms	**x 907.2**
inches	centimetres	**x 2.54 #**	tons (US/short)	tonnes	**x 0.9072**
inches	feet	**/ 12 #**	yards	metres	**x 0.9144 #**

The Systeme International [S I]

Le Systeme international d'Unites officially came into being in October 1960 and has been adopted by nearly all countries, though the amount of actual usage varies considerably.

It is based upon 7 principal units, 1 in each of 7 different categories -

Category	*Name*	*Abbreviation*
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Temperature	kelvin	K
Amount of substance	mole	mol
Luminous intensity	candela	cd

Definitions of these basic units are given. Each of these units may take a prefix. From these basic units many other units are derived and named.

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Definitions of the Seven Basic S I Units

metre [m]
The metre is the basic unit of length. It is the distance light travels, in a vacuum, in 1/299792458*th* of a second.
kilogram [kg]

The kilogram is the basic unit of mass. It is the mass of an international prototype in the form of a platinum-iridium cylinder kept at Sevres in France. *It is now the only basic unit still defined in terms of a material object, and also the only one with a prefix[kilo] already in place.*

second [s]
: The second is the basic unit of time. It is the length of time taken for 9192631770 periods of vibration of the caesium-133 atom to occur.

ampere [A]
: The ampere is the basic unit of electric current. It is that current which produces a specified force between two parallel wires which are 1 metre apart in a vacuum.*It is named after the French physicist Andre Ampere (1775-1836).*

kelvin [K]
: The kelvin is the basic unit of temperature. It is 1/273.16*th* of the thermodynamic temperature of the triple point of water. *It is named after the Scottish mathematician and physicist William Thomson 1st Lord Kelvin (1824-1907).*

mole [mol]
: The mole is the basic unit of substance. It is the amount of substance that contains as many elementary units as there are atoms in 0.012 kg of carbon-12.

candela [cd]
: The candela is the basic unit of luminous intensity. It is the intensity of a source of light of a specified frequency, which gives a specified amount of power in a given direction.

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Derived Units of the S I

From the 7 basic units of the SI many other units are derived for a variety of purposes. Only some of them are explained here. The units printed in **bold** are either basic units or else, in some cases, are themselves derived.

farad [F]
: The farad is the SI unit of the capacitance of an electrical system, that is, its capacity to store electricity. It is a rather large unit as defined and is more often used as a microfarad. *It is named after the English chemist and physicist Michael Faraday (1791-1867).*

hertz [Hz]
: The hertz is the SI unit of the frequency of a periodic phenomenon. One hertz indicates that 1 cycle of the phenomenon occurs every **second**. For most work much higher frequencies are needed such as the kiloherz [kHz] and megaherz [MHz]. *It is named after the German physicist Heinrich Rudolph Herz (1857-94).*

joule [J]
: The joule is the SI unit of work or energy. One joule is the amount of work done when an applied force of 1 **newton** moves through a distance of 1 **metre** in the direction of the force.*It is named after the English physicist James Prescott Joule (1818-89).*

newton [N]
: The newton is the SI unit of force. One newton is the force required to give a mass of 1 **kilogram** an acceleration of 1 **metre** per **second** per **second.** *It is named after the English mathematician and physicist Sir Isaac Newton (1642-1727).*

ohm [*]
: The ohm is the SI unit of resistance of an electrical conductor. Its symbol, shown here as [*] is the Greek letter known as 'omega'. *It is named after the German physicist Georg Simon Ohm (1789-1854).*

pascal [Pa]
: The pascal is the SI unit of pressure. One pascal is the pressure generated by a force of 1 **newton** acting on an area of 1 square **metre**. It is a rather small unit as defined and is more often used as a kilopascal [kPa]. *It is named after the French mathematician, physicist and philosopher Blaise Pascal (1623-62).*

volt [V]
: The volt is the SI unit of electric potential. One volt is the difference of potential between two points of an electical conductor when a current of 1 **ampere** flowing between those points dissipates a power of 1 **watt**. *It is named after the Italian physicist Count Alessandro Giuseppe Anastasio Volta (1745-1827).*

watt [W]
: The watt is used to measure power or the rate of doing work. One watt is a power of 1 **joule** per **second**. *It is named after the Scottish engineer James Watt (1736-1819).*

Note that prefixes may be used in conjunction with any of the above units.

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The Prefixes of the S I

The S I allows the sizes of units to be made bigger or smaller by the use of appropriate prefixes. For example, the electrical unit of a watt is not a big unit even in terms of ordinary household use, so it is generally used in terms of 1000 watts at a time. The prefix for 1000 is *kilo* so we use kilowatts[kW] as our unit of measurement. For makers of electricity, or bigger users such as industry, it is common to use megawatts[MW] or even gigawatts[GW]. The full range of prefixes with their [symbols or abbreviations] and their multiplying factors *which are also given in other forms* is

```
yotta [Y] 1 000 000 000 000 000 000 000 000     = 10^24
zetta [Z] 1 000 000 000 000 000 000 000         = 10^21
exa   [E] 1 000 000 000 000 000 000             = 10^18
peta  [P] 1 000 000 000 000 000                 = 10^15
tera  [T] 1 000 000 000 000                     = 10^12
giga  [G] 1 000 000 000                    (a thousand millions = a billion)
mega  [M] 1 000 000                        (a million)
kilo  [k] 1 000                            (a thousand)
hecto [h] 100
deca  [da]10
          1
deci  [d] 0.1
centi [c] 0.01
milli [m] 0.001                            (a thousandth)
micro [µ] 0.000 001                        (a millionth)
nano  [n] 0.000 000 001                    (a thousand millionth)
pico  [p] 0.000 000 000 001                     = 10^-12
femto [f] 0.000 000 000 000 001                 = 10^-15
atto  [a] 0.000 000 000 000 000 001             = 10^-18
zepto [z] 0.000 000 000 000 000 000 001         = 10^-21
yocto [y] 0.000 000 000 000 000 000 000 001     = 10^-24
```

[µ] the symbol used for **micro** is the Greek letter known as 'mu'
Nearly all of the S I prefixes are multiples or sub-multiples of 1000. However, these are inconvenient for many purposes and so **hecto**, **deca**, **deci**, and **centi** are also used.
deca also appears as **deka [da]** or **[dk]** in the USA and Contintental Europe. So much for standards!

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Conventions of Usage in the S I

There are various rules laid down for the use of the SI and its units as well as some observations to be made that will help in its correct use.

Any unit may take only ONE prefix. For example 'millimillimetre' is incorrect and should be written as 'micrometre'.
Most prefixes which make a unit bigger are written in capital letters (M G T etc.), but when they make a unit smaller then lower case (m n p etc.) is used. Exceptions to this are the kilo [k] to avoid any possible confusion with kelvin [K]; hecto [h]; and deca [da] or [dk]
A unit which is named after a person is written all in lower case (newton, volt, pascal etc.) when named in full, but starting with a capital letter (N V Pa etc.) when abbreviated. An exception to this rule is the litre which, if written as a lower case 'l' could be mistaken for a '1' (one) and so a capital 'L' is allowed as an alternative. It is intended that a single letter will be decided upon some time in the future when it becomes clear which letter is being favoured most in use.
Units written in abbreviated form are NEVER pluralised. So 'm' could always be either 'metre' or 'metres'. 'ms' could represent 'metre second' (whatever that is) or, more correctly, 'millisecond'.
An abbreviation (such as J N g Pa etc.) is NEVER followed by a full-stop unless it is the end of a sentence.
To make numbers easier to read they may be divided into groups of 3 separated by spaces (or half-spaces) but NOT commas.
The SI preferred way of showing a decimal fraction is to use a comma (123,456) to separate the whole number from its fractional part. The practice of using a point, as is common in English-speaking countries, is acceptable providing only that the point is placed ON the line of the bottom edge of the numbers (123.456).
It will be noted that many units are eponymous, that is they are named after persons. This is always someone who was prominent in the early work done within the field in which the unit is used.

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A Brief History of Measurement

One of the earliest types of measurement concerned that of length. These measurements were usually based on parts of the body. A well documented example (the first) is the Egyptian cubit which was derived from the length of the arm from the elbow to the outstretched finger tips. By 2500 BC this had been standardised in a royal master cubit made of black marble (about 52 cm). This cubit was divided into 28 digits (roughly a finger width) which could be further divided into fractional parts, the smallest of these being only just over a millimetre.

In England units of measurement were not properly standardised until the 13th century, though variations (and abuses) continued until long after that. For example, there were three different gallons (ale, wine and corn) up until 1824 when the gallon was standardised.

In the U S A the system of weights and measured first adopted was that of the English, though a few differences came in when decisions were made at the time of standardisation in 1836. For instance, the wine-gallon of 231 cubic inches was used instead of the English one (as defined in 1824) of about 277 cubic inches. The U S A also took as their standard of dry measure the old Winchester bushel of 2150.42 cubic inches, which gave a dry gallon of nearly 269 cubic inches.

Even as late as the middle of the 20th century there were some differences in UK and US measures which were nominally the same. The UK inch measured 2.53998 cm while the US inch was 2.540005 cm. Both were standardised at 2.54 cm in July 1959, though the U S continued to use 'their' value for several years in land surveying work - this too is slowly being metricated.

In France the metric system officially started in June 1799 with the declared intent of being 'For all people, for all time'. The unit of length was the metre which was defined as being one ten-millionth part of a quarter of the earth's circumference. The production of this standard required a very careful survey to be done which took several years. However, as more accurate instruments became available so the 'exactness' of the standard was called into question. Later efforts were directed at finding some absolute standard based on an observable physical phenomenon. Over two centuries this developed into the S I. So maybe their original slogan was more correct than anyone could have foreseen then.

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Metric System of Measurements

Length

```
  10 millimetres = 1 centimetre
  10 centimetres = 1 decimeter
  10 decimetres  = 1 metre
  10 metres      = 1 decametre
  10 decametres  = 1 hectometre
  10 hectometres = 1 kilometre
1000 metres      = 1 kilometre
```

Area

```
      100 sq. mm     = 1 sq. cm
   10 000 sq. cm     = 1 sq. metre
      100 sq. metres = 1 are
      100 ares       = 1 hectare
   10 000 sq. metres = 1 hectare
      100 hectares   = 1 sq. kilometre
1 000 000 sq. metres = 1 sq. kilometre
```

Volume

```
     1000 cu. mm = 1 cu. cm
     1000 cu. cm = 1 cu. decimetre
     1000 cu. dm = 1 cu. metre
1 million cu. cm = 1 cu. metre
```

Capacity

```
  10 millilitres = 1 centilitre
  10 centilitree = 1 decilitre
  10 decilitres  = 1 litre
1000 litres      = 1 cu. metre
```

Mass

```
1000 grams     = 1 kilogram
1000 kilograms = 1 tonne
```

The distinction between 'Volume' and 'Capacity' is artificial and kept here only for historic reasons.
A **millitre** is a **cubic centimetre** and a **cubic decimetre** is a **litre**. But see under 'Volume' for problems with the **litre**.

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The U K (Imperial) System of Measurements

Length
```
  12 inches   = 1 foot
   3 feet     = 1 yard
  22 yards    = 1 chain
  10 chains   = 1 furlong
   8 furlongs = 1 mile
5280 feet     = 1 mile
1760 yards    = 1 mile
```

Area
```
 144 sq. inches = 1 square foot
   9 sq. feet   = 1 square yard
4840 sq. yards  = 1 acre
 640 acres      = 1 square mile
```

Volume
```
1728 cu. inches = 1 cubic foot
  27 cu. feet   = 1 cubic yard
```

Capacity
```
20 fluid ounces = 1 pint
 4 gills        = 1 pint
 2 pints        = 1 quart
 4 quarts       = 1 gallon (8 pints)
```

Mass (Avoirdupois)
```
437.5 grains = 1 ounce
 16 ounces   = 1 pound (7000 grains)
 14 pounds   = 1 stone
  8 stones   = 1 hundredweight [cwt]
 20 cwt      = 1 ton (2240 pounds)
```

Troy Weights
```
24 grains        = 1 pennyweight
20 pennyweights  = 1 ounce (480 grains)
12 ounces        = 1 pound (5760 grains)
```

Apothecaries' Measures
```
 20 minims      = 1 fl.scruple
  3 fl.scruples = 1 fl.drachm
  8 fl.drachms  = 1 fl.ounce
 20 fl.ounces   = 1 pint
```

Apothecaries' Weights
```
20 grains   = 1 scruple
 3 scruples = 1 drachm
 8 drachms  = 1 ounce (480 grains)
12 ounces   = 1 pound (5760 grains)
```

The old Imperial (now UK) system was originally defined by three standard measures - the yard, the pound and the gallon which were held in London. They are now defined by reference to the S I measures of the metre, the kilogram and the litre. These equivalent measures are **exact**.

1 yard = 0.9144 metres - same as US
1 pound = 0.453 592 37 kilograms - same as US
1 gallon = 4.546 09 litres
Note particularly that the UK gallon is a different size to the US gallon so that NO liquid measures of the same name are the same size in the UK and US systems.
Also that the ton(UK) is 2240 pounds while a ton(US) is 2000 pounds. These are also referred to as a long ton and short ton respectively.

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Metrication in the U K

There have been three major Weights and Measures Acts in recent times (1963, 1976 and 1985) all gradually abolishing various units, as well re-defining the standards. All the Apothecaries' measures are gone, and of the Troy measures, only the ounce remains. Currently legislation has decreed that -

From the 1st October 1995, for economic, public health, public safety and administrative purposes, only metric units are allowed EXCEPT that -

- pounds and ounces for weighing of goods sold from bulk
- pints and fluid ounces for beer, cider, waters, lemonades and fruit juices in RETURNABLE containers
- therms for gas supply
- fathoms for marine navigation

may be used until 31st December 1999.

The following may continue to be used WITHOUT time limit -

- miles, yards, feet and inches for road traffic signs and related measurements of speed and distance
- pints for dispensing draught beer and cider, and for milk in RETURNABLE containers
- acres for land registration purposes
- troy ounces for transactions in precious metals.

Sports are exempt from all of this, but most of them have (voluntarily) changed their relevant regulations into statements of equivalent metric measures.

That is how the legislation is framed. In common usage the 'old' units are still very apparent.

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The U S System of Measurements

Most of the US system of measurements is the same as that for the UK. The biggest differences to be noted are in Capacity which has both liquid and dry measures as well as being based on a different standard - the US liquid gallon is smaller than the UK gallon. There is also a measurement known at the US survey foot. It is gradually being phased out as the maps and land plans are re-drawn under metrication. (The changeover is being made by putting 39.37 US survey feet = 12 metres)

Length

12 inches	=	1 foot
3 feet	=	1 yard
220 yards	=	1 furlong
8 furlongs	=	1 mile
5280 feet	=	1 mile
1760 yards	=	1 mile

Area

144 sq. inches	=	1 square foot
9 sq. feet	=	1 square yard
4840 sq. yards	=	1 acre
640 acres	=	1 square mile
1 sq.mile	=	1 section
36 sections	=	1 township

Volume

1728 cu. inches	=	1 cubic foot
27 cu. feet	=	1 cubic yard

Capacity (Dry)

2 pints	=	1 quart
8 quarts	=	1 peck
4 pecks	=	1 bushel

Capacity (Liquid)

16 fluid ounces	=	1 pint
4 gills	=	1 pint
2 pints	=	1 quart
4 quarts	=	1 gallon (8 pints)

Mass

437.5 grains	=	1 ounce
16 ounces	=	1 pound (7000 grains)
14 pounds	=	1 stone
100 pounds	=	1 hundredweight [cwt]
20 cwt	=	1 ton (2000 pounds)

Troy Weights

24 grains	=	1 pennyweight
20 pennyweights	=	1 ounce (480 grains)
12 ounces	=	1 pound (5760 grains)

Apothecaries' Measures

60 minims	=	1 fl.dram
8 fl.drams	=	1 fl.ounce
16 fl.ounces	=	1 pint

Apothecaries' Weights

20 grains	=	1 scruple
3 scruples	=	1 dram
8 drams	=	1 ounce (480 grains)
12 ounces	=	1 pound (5760 grains)

As with the UK system these measures were originally defined by physical standard measures - the yard, the pound, the gallon and the bushel.They are now all defined by reference to the S I measures of the metre, the kilogram and the litre. These equivalent measures are **exact**.

1 yard = 0.9144 metres - same as UK
1 pound = 0.453 592 37 kilograms - same as UK
1 gallon (liquid) = 3.785 411 784 litres
1 bushel = 35.239 070 166 88 litres

Note particularly that the US gallon is a different size to the UK gallon so that NO liquid measures of the same name are the same size in the US and UK systems.
Also that the ton(US) is 2000 pounds while a ton(UK) is 2240 pounds. These are also referred to as a short ton and long ton respectively.
Note than in matters concerned with land measurements, for the most accurate work, it is necessary to establish whether the US survey measures are being used or not.

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Categories of Units

- length
- area
- volume or capacity
- mass
- temperature
- density, area
- density, line
- density, volume
- energy
- force
- fuel consumption
- line density
- mass per unit length
- mass per unit area
- mass per unit volume
- power
- pressure
- speed
- spread rate (by mass)
- spread rate (by volume)
- stress
- torque

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List of Units

The units are listed in alphabetical order but scanning can be speeded up by selecting the initial letter of the unit from these individual letters or groups

A - B - C - D - E - F - G - H - IJ - K - L - M

N - O - PQ - R - S - T - UVW - XYZ

A

acres
angstroms

B

C

D

E

F

G

H

IJ

K

L

M

N

O

PQ

R

S

T

UVW

XYZ

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Length

The S I unit of length is the **metre**. To change any of these other units of length into their **equivalent values in metres** use the operation and conversion factor given. Those marked with # are **exact.** Other values are given to an appropriate degree of accuracy. *Where some uncertainty is indicated it means that a good idea of the size of the unit can be given but that a better value would depend upon knowing the period and/or culture in which the unit was being used.*

angstroms	divide by 10 000 000 000 #
astronomical units	x 149 598 550 000
barleycorns	x 0.008 467
centimetres	x 0.01 #
chains (surveyors')	x 20.1168 #
cubits	x (0.45 to 0.5)
ells (UK)	x 0.875 *(but many variations)*
ems (pica)	x 0.004 233 3
fathoms	x 1.8288 #
feet (UK and US)	x 0.3048 #
feet (US survey)	x 0.304 800 609 6
furlongs	x 201.168 #
hands	x 0.106 #
inches	x 0.0254 #
kilometres	x 1000 #
leagues	x (4000 to 5000)
light years	x 9 460 500 000 000 000
links (surveyors')	x 0.201 168 #
metres [m]	**1**
microns (=micrometres)	x 0.000 001 #
miles (UK and US)	x 1609.344 #
miles (nautical)	x 1852 #
parsecs	x 30 856 770 000 000 000
perch (=rods or poles)	x 5.0292 #
picas (computer)	x 0.004 233 333

picas (printers')	x 0.004 217 518
points (computer)	x 0.000 352 777 8
points (printers')	x 0.000 351 459 8
yards	x 0.9144 #

Note than in matters concerned with land measurements, for the most accurate work, it is necessary to establish whether the US survey measures are being used or not.

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Area

The S I unit of area is the **square metre**. To change any of these other units of area into their **equivalent values in square metres** use the operation and conversion factor given. Those marked with # are **exact.** Other values are given to an appropriate degree of accuracy. *Where some uncertainty is indicated it means that a good idea of the size of the unit can be given but that a better value would depend upon knowing the period and/or culture in which the unit was being used.*

acres	x 4046.856 422 4 #
ares	x 100 #
circular inches	x 0.000 506 707 479
hectares	x 10 000 #
hides	x 485 000 *(with wide variations)*
roods	x 1011.714 105 6 #
square centimetres	x 0.000 1 #
square feet (UK and US)	x 0.092 903 04 #
square feet (US survey)	x 0.092 903 411 613
square inches	x 0.000 645 16 #
square kilometres	x 1 000 000 #
square metres	**1**
square miles	x 2 589 988.110 336 #
square millimetres	x 0.000 001 #
squares (of timber)	x 9.290 304 #
square rods (or poles)	x 25.292 852 64 #
square yards	x 0.836 127 36 #
townships	x 93 239 571.972

Note than in matters concerned with land measurements, for the most accurate work, it is necessary to establish whether the US survey measures are being used or not.

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Volume or Capacity

The S I unit of volume is the cubic metre. However, this seems to be much less used than the **litre** (1000 litres = 1 cubic metre).To change any of these other units of volume into their **equivalent values in litres** use the operation and conversion factor given. Those marked with # are **exact.** Other values are given to an appropriate degree of accuracy.
The **litre**. There can be some ambiguity about the size of the litre. In 1901 it was defined by reference to a kilogram of pure water under certain particular conditions. (This was similar to the way the old UK gallon was set.) In 1964 it was re-defined as a common usage term for a cubic decimetre. They differ very slightly and for really accurate work, to avoid any possible confusion, it is recommended that the litre is not used . It is used here as being a cubic decimetre.

barrels (oil)	x 158.987 294 928 #
bushels (UK)	x 36.368 72 #
bushels (US)	x 35.239 070 166 88 #
centilitres	x 0.01 #

cubic centimetres	x 0.001 #
cubic decimetres	1
cubic decametres	x 1 000 000 #
cubic feet	x 28.316 846 592 #
cubic inches	x 0.016 387 064 #
cubic metres	x 1000 #
cubic millimetres	x 0.000 001 #
cubic yards	x 764.554 857 984 #
decilitres	x 0.1 #
fluid ounces (UK)	x 0.028 413 062 5 #
fluid ounces (US)	x 0.029 573 529 562 5 #
gallons (UK)	x 4.546 09 #
gallons, dry (US)	x 4.404 883 770 86 #
gallons, liquid (US)	x 3.785 411 784 #
litres [l or L]	**1**
litres (1901 - 1964)	x 1.000 028
millilitres	x 0.001 #
pints (UK)	x 0.568 261 25 #
pints, dry (US)	x 0.550 610 471 357 5 #
pints, liquid (US)	x 0.473 176 473 #
quarts (UK)	x 1.136 522 5 #
quarts, dry (US)	x 1.101 220 942 715 #
quarts, liquid (US)	x 0.946 352 946 #

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Mass (or Weight)

The S I unit of mass is the **kilogram**. To change any of these other units of mass into their **equivalent values in kilograms** use the operation and conversion factor given. Those marked with # are **exact.** Other values are given to an appropriate degree of accuracy.

carats, metric	x 0.000 2 #
grains	x 0.000 064 798 91 #
grams	x 0.001 #
hundredweights, long	x 50.802 345 44 #
hundredweights, short	x 45.359 237 #
kilograms [kg]	**1**
ounces, avoirdupois	x 0.028 349 523 125 #
ounces, troy	x 0.031 103 476 8 #
pounds	x 0.453 592 37 #
slugs (or g-pounds)	x 14.593 903
stones	x 6.350 293 18 #
tons (UK or long)	x 1016.046 908 8 #
tons (US or short)	x 907.184 74 #
tonnes	x 1000 #

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Temperature

There have been five main temperature scales, each one being named after the person who invented it.
G D FAHRENHEIT (1686-1736) a German physicist, in about 1714 proposed the first practical scale. He called the freezing-point of water 32 degrees (so as to avoid negative temperatures) and the boiling-point 212 degrees.
R A F de REAUMUR (1673-1757) A French entomologist, proposed a similar scale in 1730, but set the

freezing-point at 0 degrees and the boiling-point at 80 degrees. This was used quite a bit but is now obsolete.
Anders CELSIUS (1701-1744) a Swedish astronomer, proposed the 100-degree scale (from 0 to 100) in 1742. This was widely adopted as the centigrade scale. But since grades and centigrades were also measures of angle, in 1948 it officially became the Celsius scale. Also, the S I system of units gives preference to naming units after people where possible.
William Thomson, 1st Lord KELVIN (1824-1907) a Scottish mathematician and physicist, worked with J P Joule - about 1862 - to produce an absolute scale of temperature based on laws of heat rather than the freezing/boiling-points of water. This work produced the idea of 'absolute zero', a temperature below which it was not possible to go. Its value is -273.15 degrees on the Celsius scale.
William J M RANKINE (1820-1872) a Scottish engineer and scientist, promoted the Kelvin scale in its Fahrenheit form, when the equivalent value of absolute zero is -459.67 degrees Fahrenheit.
Nowadays, while scientists use the KELVIN scale, the CELSIUS scale is the preferred scale in our everyday lives. However, the Fahrenheit scale is still widely used and there frequently is a need to be able to change from one to the other.
To change temperature given in Fahrenheit (***F***) to Celsius (***C***)

```
Start with (F);   subtract 32;   multiply by 5;   divide by 9;   the answer is (C)
```

To change temperature given in Celsius (***C***) to Fahrenheit (***F***)

```
Start with (C);   multiply by 9;   divide by 5;   add on 32;   the answer is (F)
```

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Line density

Line density is a measure of mass per unit length. The S I compatible unit of line density is **kilograms/metre**. A major use of line density is in the textile industry to indicate the coarseness of a yarn or fibre. For that purpose the SI unit is rather large so the preferred unit there is the **tex**. (1 tex = 1 gram/kilometre) To change any of these other units of line density into their **equivalent values in kilograms/metre** use the operation and conversion factor given. Those marked with # are **exact.** Other values are given to an appropriate degree of accuracy.

denier	divide by 9 000 000 #
drex	divide by 10 000 000 #
grams/centimetre	divide by 10 #
grams/kilometre (tex)	divide by 1 000 000 #
grams/metre	divide by 1000 #
grams/millimetre	1
kilograms/kilometre	divide by 1000 #
kilograms/metre	**1**
milligrams/centimetre	divide by 10 000 #
milligrams/millimetre	divide by 1000 #
ounces/inch	x 1.116 125
ounces/foot	x 0.093 01
pounds/inch	x 17.858
pounds/foot	x 1.488 164
pounds/yard	x 0.496 055
pounds/mile	x 0.000 281 849
tex	divide by 1 000 000 #
tons(UK)/mile	x 0.631 342
tons(US)/mile	x 0.563 698
tonnes/kilometre	1

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Density

Density is the shortened term generally used in place of the more accurate description *volumetric density*.It is a measure of mass per unit volume. The S I compatible unit of density is **kilograms/cubic metre**. However, this a rather large unit for most purposes (iron is over 7000, wood is about 600 and even cork is over 200). A much more useful size of unit is **kilograms/litre** (for which the previous values then become 7, 0.6 and 0.2 respectively). This unit also has the great advantage of being numerically unchanged for grams/cubic centimetre and tonnes/cubic metre (or megagrams/cubic metre). To change any of these other units of density into their **equivalent values in kilograms/litre** use the operation and conversion factor given. Those marked with # are **exact.** Other values are given to an appropriate degree of accuracy.

```
grains/gallon(UK)       divide by  70 156
grains/gallon(US)       divide by  58 418
grams/cubic centimetre  1
grams/litre             divide by 1000 #
grams/millilitre        1
kilograms/cubic metre   divide by 1000 #
megagrams/cubic metre   1
milligrams/millilitre   divide by 1000 #
milligrams/litre        divide by 1 000 000 #

kilograms/litre         1

ounces/cubic inch       x 1.729 994 044
ounces/gallon(UK)       x 0.006 236 023
ounces/gallon(US)       x 0.007 489 152
pounds/cubic inch       x 27.679 904
pounds/cubic foot       x 0.016 018 463
pounds/gallon(UK)       x 0.099 776 373
pounds/gallon(US)       x 0.119 826 427
tonnes/cubic metre      1
tons(UK)/cubic yard     x 1.328 939 184
tons(US)/cubic yard     x 1.186 552 843
```

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Energy or work

There is a lot of room for confusion in some of the units used here. The **calorie** can take 5 different values and, while these do not vary by very much, for accurate work it is necessary to specify which calorie is being used.
The 5 calories are known as the International Table calorie - cal(IT); the thermochemical calorie - cal(th); the mean calorie - cal(mean); the 15 degree C calorie - cal(15C); and the 20 degree C calorie - cal(20C).
As a further complication, in working with food and expressing nutritional values, the unit of a Calorie *(capital C)* is often used to represent 1000 calories, and again it is necessary to specify which calorie is being used for that.
The **British thermal unit** (Btu) can also take different values and they are named in a similar way to the calorie, that is Btu (IT), (th), etc. Also note that the **therm** is 100 000 Btu so its exact size depends on which Btu is being used.

The S I unit of energy or work is the **joule**. To change any of these other units of energy or work into their **equivalent values in joules** use the operation and conversion factor given. Those marked with # are **exact.** Other values are given to an appropriate degree of accuracy.

```
British thermal units(IT)x 1055.056
             Btu (th)    x 1054.350
             Btu (mean)  x 1055.87
calories   - cal (IT)    x 4.1868 #
           - cal (th)    x 4.184 #
           - cal (mean)  x 4.190 02
           - cal (15C)   x 4.185 80
           - cal (20C)   x 4.181 90
Calorie (food)           x 4186 (approx.)
centigrade heat units    x 1900.4
ergs                     divide by 10 000 000 #
foot pounds-force        x 1.355 817
foot poundals            x 0.042 140
```

gigajoules [GJ]	x 1000 000 000 #
horsepower hours	x 2 684 520 (approx.)
joules [J]	**1**
kilocalories (IT)	x 4186.8 #
kilocalories (th)	x 4184 #
kilogram-force metres	x 9.806 65 #
kilojoules [kJ]	x 1000 #
kilowatt hours [kWh]	x 3 600 000 #
megajoules [MJ]	x 1 000 000 #
newton metres [Nm]	x 1 #
therms	x 105 500 000 (approx.)
watt seconds [Ws]	1
watt hours [Wh]	x 3600 #

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Force

The S I unit of force is the **newton**. To change any of these other units of force into their **equivalent values in newtons** use the operation and conversion factor given. Those marked with # are **exact.** Other values are given to an appropriate degree of accuracy.

dynes	divide by 100 000 #
kilograms force	x 9.806 65 #
kilonewtons [kN]	x 1000 #
kips	x 4448.222
meganewtons [MN]	x 1 000 000 #
newtons [N]	**1**
pounds force	x 4.448 222
poundals	x 0.138 255
sthenes (=kN)	x 1000
tonnes force	x 9806.65 #
tons(UK) force	x 9964.016
tons(US) force	x 8896.443

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Fuel Consumption

Fuel consumption of any means of transport (car, aeroplane, ship etc.) that uses fuel is a measure giving the relationship between the distance travelled for an amount of fuel used. The most common example is the car where it is usually expressed (in English-speaking countries) in miles per gallon.
It could also be expressed in gallons per mile. However, for a car the latter method gives a rather small figure: 35 miles per gallon is about 0.0286 gallons per mile. In that case it would be better to give a figure for 100 miles, so it would be 2.86 gallons per 100 miles. That is the metric way of expressing fuel consumption - as **litres per 100 kilometres.**
From regular enquiries it appears that in real life people are using all sorts of ways of expressing their fuel consumption, so this section (unlike all the others) tries to cover as many ways as possible. All the values are given to an accuracy of 4 significant figures.

To change	into
miles per gallon (UK)	miles per gallon (US) multiply by 0.833
miles per gallon (UK)	miles per litre multiply by 0.22
miles per litre	miles per gallon (UK) multiply by 4.546
miles per gallon (UK)	kilometres per litre multiply by 0.354

miles per gallon (US)	miles per gallon (UK) multiply by 1.2
miles per gallon (US)	miles per litre multiply by 0.2642
miles per litre	miles per gallon (US) multiply by 3.785
miles per gallon (US)	kilometres per litre multiply by 0.4251
X miles per gallon	gallons per 100 miles: divide 100 by *X* (both gallons must of the same type)
X miles per gallon (UK)	litres per 100 km: divide 282.5 by *X*
X miles per gallon (US)	litres per 100 km: divide 235.2 by *X*
X km per litre	litres per 100 km: divide 100 by *X*
X miles per litre	litres per 100 km: divide 62.14 by *X*

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Power

Since power is a measure of the rate at which work is done, the underlying units are those of work or energy, and that section should be looked at for explanations concerning the **calorie** and **Btu**. In this section the (IT) values have been used.
In this section it is the **horsepower** which provides confusion. Just like the calorie, it can take 5 different values, and these are identified as necessary by the addition of (boiler), (electric), (metric), (UK) and (water). Unlike the calorie *(whose 5 values are reasonably close to each other)*, the horsepower has 4 which are close and 1 (boiler) which is considerably different - it is about 13 times bigger than the others - but it seems to be very little used.

The S I unit of power is the **watt**. To change any of these other units of energy or work into their **equivalent values in watts** use the operation and conversion factor given. Those marked with # are **exact.** Other values are given to an appropriate degree of accuracy.

Btu/hour	x 0.293 071
Btu/minute	x 17.584 267
Btu/second	x 1055.056
calories/hour	x 0.001 639
calories/minute	x 0.069 78
calories/second	x 4.1868 #
ft lb-force/minute	x 0.022 597
ft lb-force/second	x 1.355 82
gigawatts [GW]	x 1 000 000 000
horsepower (electric)	x 746 #
horsepower (metric)	x 735.499
watts [W]	**1**
joules/hour	divide by 3600 #
joules/minute	divide by 60 #
joules/second	1
kilocalories/hour	x 1.163
kilocalories/minute	x 69.78
kg-force metres/hour	x 0.002 724
kg-force metres/minute	x 0.163 444
kilowatts [kW]	x 1000 #
megawatts [MW]	x 1 000 000 #

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Pressure or Stress

The S I unit of pressure is the **pascal**. The units of pressure are defined in the same way as those for stress - force/unit area. To change any of these other units of pressure (or stress) into their **equivalent values in pascals** use the operation and conversion factor given. Those marked with # are **exact.** Other values are given to an appropriate degree of accuracy. Measures based on water assume a density of 1 kg/litre - a value which rarely matched in the real world, though the error is small.

atmospheres	x 101 325 #
bars	x 100 000 #
centimetres of mercury	x 1333.22
centimetres of water	x 98.066 5 #
feet of water	x 2989.066 92 #
hectopascals [hPa]	x 100 #
inches of water	x 249.088 91 #
inches of mercury	x 3386.388
kg-force/sq.centimetre	x 98 066.5 #
kg-force/sq.metre	x 9.806 65 #
kilonewton/sq.metre	x 1000 #
kilopascal [kPa]	x 1000 #
kips/sq.inch	x 6 894 760
meganewtons/sq.metre	x 1 000 000 #
metres of water	x 9806.65 #
millibars	x 100 #
pascals [Pa]	**1**
millimetres of mercury	x 133.322
millimetres of water	x 9.806 65 #
newtons/sq.centimetre	x 10 000
newtons/sq.metre	1
newtons/sq.millimetre	x 1 000 000 #
pounds-force/sq.foot	x 47.880
pounds-force/sq.inch	x 6894.757
poundals/sq.foot	x 1.448 16
tons(UK)-force/sq.foot	x 107 251
tons(UK)-force/sq.inch	x 15 444 256
tons(US)-force/sq.foot	x 95 760
tons(US)-force/sq.inch	x 13 789 500
tonnes-force/sq.cm	x 98 066 500 #
tonnes-force/sq.metre	x 9806.65 #

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Speed

The S I compatible unit of speed is **metres/second**. To change any of these other units of speed into their **equivalent values in metres/second** use the operation and conversion factor given. Those marked with # are **exact.** Other values are given to an appropriate degree of accuracy.

centimetres/minute	divide by 6000 #
centimetres/second	divide by 100 #
feet/hour	divide by 11 811
feet/minute	x 0.005 08 #
feet/second	x 0.3048 #
inches/minute	divide by 2362.2
inches/second	x 0.0254 #
kilometres/hour	divide by 3.6 #
kilometres/second	x 1000 #
knots	x 0.514 444
Mach number	x 331.5
metres/hour	divide by 3600 #
metres/minute	divide by 60 #
metres/second [m/s]	**1**
miles/hour	x 0.447 04 #

miles/minute	x 26.8224 #
miles/second	x 1609.344 #
yards/hour	divide by 3937
yards/minute	x 0.015 24 #
yards/second	x 0.9144 #

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Spread Rate (by mass)

The spread rate of a substance is a measure of how much of it there is covering a unit area. The 'how much' can be measured by volume or by mass. The S I compatible unit of spread rate by mass is **kilograms/square metre**. It is also a measure of area density (mass/unit area) and is similar to - but not the same as - pressure, which is force/unit area. For the rainfall conversions a density of 1 kg/litre has been assumed. To change any of these other units of spread rate into their **equivalent values in kilograms/square metre** use the operation and conversion factor given. Those marked with # are **exact.** Other values are given to an appropriate degree of accuracy. The conversion for rainfall assumes a density of 1 kg/litre which is accurate enough for all practical purposes.

grams/sq.centimetre	x 10 #
grams/sq.metre	divide by 1000 #
inches of rainfall	x 2.54
kilograms/hectare	divide by 10 000 #
kilograms/sq.centimetre	x 10 000 #
milligrams/sq.metre	divide by 1000 #
millimetres of rainfall	1
kilograms/sq.metre	**1**
ounces/sq.foot	x 0.305 152
ounces/sq.inch	x 43.942
ounces/sq.yard	divide by 49.494
pounds/acre	divide by 8921.791
pounds/sq.foot	x 4.882 428
pounds/sq.inch	x 703.07
pounds/sq.yard	x 0.542 492
tonnes/hectare	divide by 10 #
tons(UK)/acre	divide by 3.982 942
tons(US)/acre	divide by 4.460 896

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Spread Rate (by volume)

The spread rate of a substance is a measure of how much of it there is covering a unit area. The 'how much' can be measured by volume or by mass. The S I compatible unit of spread rate by volume is **cubic metres/square metre**. However, this is a rather large unit for most purposes and so litres/square metre is often preferred. To change any of these other units of spread rate into their **equivalent values in litres/square metre** use the operation and conversion factor given. Those marked with # are **exact.** Other values are given to an appropriate degree of accuracy.

cubic feet/acre	divide by 142.913
cubic inches/sq.yard	divide by 51.024
cubic yards/sq.mile	divide by 3387.577
cubic metres/hectare	divide by 10 #
cubic metres/sq.km	divide by 1000 #
cubic metres/sq.metre	x 1000 #
fl. ounces(UK)/sq.yard	divide by 29.428
litres/square metre	**1**

```
gallons(UK)/acre        divide by 890.184
gallons(US)/acre        divide by 1069.066
gallons(UK)/hectare     divide by 2199.692
gallons(US)/hectare     divide by 2641.721
inches of rainfall      x 25.4 #
litres/hectare          divide by 10 000 #
millilitres/sq.metre    divide by 1000 #
millimetres of rainfall 1
```

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Torque

The S I compatible unit of torque is the **newton metre**. To change any of these other units of torque into their **equivalent values in newton metres** use the operation and conversion factor given. Those marked with # are **exact.** Other values are given to an appropriate degree of accuracy.

```
dyne centimetres        divide by 10 000 000 #
gram-force centimetres  x 0.000 098 066 5 #
kg-force centimetres    x 0.098 066 5 #
kg-force metres         x 9.806 65 #
newton centimetres      divide by 100 #

newton metres [Nm]      1

ounce-force inches      divide by 141.612
pound-force inches      x 0.112 984
pound-force feet        x 1.355 818
poundal feet            x 0.042 140
ton(UK)-force feet      x 3 037.032
ton(US)-force feet      x 2 711.636
tonne-force metres      x 9 806.65 #
```

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Other Sources in Books

Conversion Tables of Units for Science and Engineering
by Ari L Horvath
Macmillan Reference Books, London, 1986 (147 pages)
ISBN 0 333 40857 8
Probably the most comprehensive set of conversion factors in print, covering both old and modern units. There are 77 tables covering categories from Length to Radiation dosage. The Length table alone lists 107 units together with the conversion factors needed to change each one into metres.

The Dent Dictionary of Measurement
by Darton and Clark
J M Dent, London, 1994 (538 pages)
ISBN 0 460 861379
Very comprehensive coverage of all kinds of units (including currencies), ordered in conventional dictionary form, and giving several conversion factors.

The Economist Desk Companion
Random Century, London, 1992 (272 pages)
ISBN 0 7126 9816 7
A handy compendium of units used in Science, Medicine, Engineering, Industry, Commerce, Finance and many other places, together with all the necessary conversion factors. There is also much other incidental (but related) information.

The Encyclopaedia Britannica
The modern E B has many references to units, but extensive use needs to be made of the index to find them all. It gives a wide selection of weights and measures from countries around the world and the appropriate conversion factors.

World Weights and Measures
Statistical Office of the United Nations, New York 1955 (225 pages)
A very comprehensive survey of each country in the world (as it was then) from Aden to Zanzibar, giving the units used in each for Length, Area and Capacity with their British and Metric equivalents. There is an appendix on the measures used for selected commodities. Currencies are also given. The indexes are very thorough.

The Weights and Measures of England
by R D Connor
H M S O, London, 1987 (422 pages)
ISBN 0 460 86137 9
A scholarly and detailed account of the history of th development of the British (Imperial) system of weights and measures from the earliest times.

British Weights and Measures
by R E Zupko
A history from Antiquity to the Seventeenth Centur
The University of Wisconsin Press, 1977 [248 pag
ISBN 0 299 07340 8
The actual history occupies only 100 pages. There i then an extensive list of the various units used in commerce, tables of many pre-Imperial units, a lon list of pre-metric measures used in Europe together with their British and metric equivalents, and nearl pages giving other sources.

The World of Measurements
by H Arthur Klein
Allen and Unwin, London, 1975 (736 pages)
ISBN 0 04 500024 7
A very readable and comprehensive account of the history of units used in measuring, from the earlies known beginnings and around the world.

Scientific Unit Conversion
by Francois Cardarelli
Springer-Verlag, London, 1997 (456 pages)
ISBN 3-540-76022-9
It claims "This practical manual aims to be the most comprehensive work on the subject of unit convers It contains more than 10 000 precise conversion factors."
It is certainly a very chunky and compact (= handy-sized) book. Comprehensive it certainly is b still not complete. However, with its very wide coverage, both historical and modern, it should certainly satisfy nearly all users.

Other Sources on the World Wide Web

There are now several sites concerned with this topic.
In the **UK** the two organisations concerned with standards are the
British Standards Institute (BSI) and the **National Physical Laboratory** (NPL).
Sadly, the first offers nothing more than advertisements for its various books of standards, and the second is not very useful on the subject of units and their conversion.
Fortunately the **Yahoo! site** (based in the UK) does provide a gateway to many sources of information.

In the **USA** the
National Institute of Standards and Technology (NIST)
is much more forthcoming, and there is no shortage of information concerning units and their conversion. There is even an excellent 86-page book on the subject (SP 811) which can be read on-line or downloaded and printed out - but note that *Adobe Acrobat Reader* is needed.
The **US Metric Association** is also a good starting point which provides a wealth of links to other suitable sites.

The **International Standards Organisation]** [I S O] based in Switzerland, is responsible for the world-wide publication of standards for just about anything for which standards can be set. Whilst none of the actual data is online, details of the work of ISO and the publications they produce are. They also give many references to other organisations concerned with standards.

An excellent A to Z of units is available from this site run by Russ Rowlett at the University of North Carolina.

Another account of metrication and associated items which has, in addition, some very good pages on historic measures (Anglo-Saxon, Biblical etc.) is provided by Jack Proot (in Canada)

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Notes

Errors
: Whilst every care has been taken in the compilation of this document, and many checks have been carried out, the possibility of an error is always present in a work like this and that must be borne in mind by all users. The author would be glad to be told of any errors detected.

Accuracy
: In a general dictionary like this it is impossible to know just what accuracy is needed by any particular user. Where the given value is an **exact** one then it has been signalled. In most cases other values are accurate to at least the number of significant figures shown. In some cases it might be more than that as trailing zeros have not been included.

Presentation
: The conversion factors have mainly been presented as multipliers, but exceptions to that have been made for two reasons. First, it is easier to convey the exact value 'divide by 60' rather than the approximation 'multiply by 0.0166667' and it is more likely to be keyed in without errors if a calculator is being used. Second, most calculators accept only 8 digits, which means that 'multiply by 0.000 084 666' will become '0.000 0846' (3 significant figures) whereas 'divide by 11 811' will give the result to 6 significant figures. The appearance of a '1' needs no operator but shows that the named unit is exactly equivalent to the standard unit.

Inverse usage
: In nearly all cases the conversion factors ha been given to change 'non-standard' units i standard units of the SI. For those cases wl it is necessary to do a conversion the other it is only a matter of reversing the operatior For example to convert feet into metres you **multiply** by 0.3048 so, to convert metres feet you **divide** by 0.3048. Following on from this it can be seen how conversions ca be made between non-standard units, chang first into the standard unit and then back int the required unit.

Author's Note
: A guiding principle behind the writing and presentation of this document has been that **clarity** for non-specialist readers. To that e I have been guilty of breaking "the rules" in few places. I am sorry that these transgressions may offend some readers bu have done so in the belief that it will be a lit bit easier for many, and also help the flow c continuous narrative.
This dictionary is not meant to be encyclopaedic in its coverage, and there are many many more units which are not touch upon, but it is hoped that all 'ordinary' neec are covered. The many references to other sources, both in books and on-line should t care of anything beyond that.
Finally, I must thank all of those who wrot with suggestions (and corrections!) after reading the earlier editions.

Queries, comments and (further) corrections will be welcomed by *Frank Tapson*

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20th January 1999 (Minor corrections and alterations)
9th August 1999 (A few adjustments to links)
13th December 1999 (Summary table of conversion factors added)