Units of Measure

SI Units

Definition

A standardised system of metric measurement known as the **International System of Units.**

Background

"SI" comes from the French definition as **Le Système international d'unités**. The system was established in 1960, based on the metre-kilogram-second (mks) system and is the world's most widely used system of measurement. However, the United States and Canada use SI units in some areas (e.g. science) but retain the imperial system (feet, inches, pounds, gallons etc.) for manufacturing and commerce.
The UK has adopted the SI system but also officially retains imperial units (despite having a goal of complete metrication by 1975!). Manufacturing is, however, significantly metricated.

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The system

The SI system is devised around seven base units:-

Quantity	Unit	Symbol
length	metre	**m**
mass	kilogram	**kg**
time	second	**s**
electric current	ampere	**A**
temperature	kelvin	**K**
luminous intensity	candela	**cd**
amount of substance	mole	**mol**

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The system

Also, the SI system is based on the number 10 as opposed to the imperial system which has no standard multiple for scaling units up or down (e.g. 12 inches to the foot, 16 ounces to the pound). Length, for example, under the SI system has millimetres (mm), 10 of which make a centimetre and 100 centimetres make a metre. Most commonly though, a multiple of 1000 is used. Thus 1000mm = 1m and 1000m = 1 kilometre (km). Some metric multipliers are:-

Symbol	Prefix	Multiple	Power of 10
μ	micro	1/1000000	10^{-6}
m	milli	1/1000	10^{-3}
(base unit)		1	
k	kilo	1000	10^{3}
M	mega	1000000	10^{6}
G	giga	1000000000	10^{9}

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The system

Such clearly defined rules should make for a simple system, but it is an evolving system and units are created and modified by international agreement as requirements progress.

Many units of measure are derived from combinations of the seven base units and may adopt new names for ease of use or to celebrate or honour notable scientific achievement. For example, pressure could be measured in kgf/m^2 (i.e. force over area) but is often specified in Pascals (Pa), where 1 Pascal equates to 1 kilogram force acting on 1 square metre.

This is perhaps one of the worst examples with 1 kilogram force also being known as 1 Newton, so a Pascal is also 1 N/m^2. It gets worse, but we'll leave it there for now!

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Some derived named units

Quantity	Unit	Symbol	Description/derivation
frequency	hertz	**Hz**	cycles per second s^{-1}
angle	radian	**rad**	
force, weight	newton	**N**	$kg.m/s^2$
pressure, stress	pascal	**Pa**	$kg.m^{-1}.s^{-2}$ or N/m^2
energy, work, heat	joule	**J**	$kg.m^2.s^{-2}$ or N.m
power	watt	**W**	$kg.m^2.s^{-3}$ or J/s
voltage (potential difference)	volt	**V**	$kg.m^2.s^{-3}.A^{-1}$ or W/A
temperature relative to 273.15K	degree Celcius	**^oC**	K-273.15

Many more units can be derived, e.g. **m^2** for area, **m/s** for speed, **N.m** for torque…..

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Conversion

Since some countries are still using imperial units of measurement it is necessary to be able to convert units from one system to the other. For this, conversion tables exist where equivalent values can be looked up, but it is more usual to use conversion factors to translate precise values. For example, the imperial system "inch" equals 25.4mm as a metric measurement.

A note here on the scale and suitability of values. The imperial system **inch** and the SI system **metre** differ greatly in terms of scale. The **millimetre** (mm) is therefore commonly used as the measurement in engineering and manufacture and is standardised on drawings such that even large values (as might be used on an aeroplane or a building) are specified in millimetres.

A useful conversion program can be downloaded from:
http://joshmadison.com/convert-for-windows/
and a multitude of conversion factors found at:
http://booksite.elsevier.com/9780340741528/appendices/default.htm

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Imperial Units

Imperial units on drawings

Some legacy drawings may have imperial units, as may current US drawings. It is important that this is made clear on the drawing. Drawing title blocks should say "**DIMENSIONS IN mm**" or "**DIMENSIONS IN INCHES**". However, dimensions are written differently:-

On a metric drawing with **mm** dimensions a value would appear as **0·25** for example. There is a leading zero on values less than 1, no unnecessary trailing zeros, and units are not stated.
(Note that BS8888 allows a comma delimiter, e.g. 0,25).

On an imperial drawing with **inch** dimensions a value would appear as **·750"** for example. Note that there is no leading zero, there are normally 3 decimal places (including trailing zeros), and the inch symbol **"** is appended.

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Some examples of Imperial Units

Quantity	Unit(s)	Symbol	Conversion factors
length	inch, foot	**in** (or ″), **ft** (or ′)	1″=25.4mm
mass	pound	**lb**	1lb=454g (to 3sf)
time	second	**sec**	
electric current	ampere	**A**	
temperature	degree Fahrenheit	**°F**	1°F=32+1.8(°C)

These are **English Units**. Many **US Customary Units** are the same, but some vary, e.g. the gallon, so beware!