Documentation for ChangeUnits Excel Add-In
Version 3.2
February 2007

ChangeUnits.xll is a free Excel add-in for parseable units conversion as well as conversion to and from standard metric Meter-Kilogram-Second (MKS) units. This document describes the ChangeUnits functions and gives some simple examples.

Overview

ChangeUnits allows units to be expressed as simple combinations of pre-programmed base units. ChangeUnits interprets "m / s^2" and "m / s / s" as equivalent units for acceleration and "slug – m / s^2" as a force, even though it combines metric and English units. ChangeUnits also changes to and from standard metric MKS units, which is useful for programming formulas.

Other unit conversion tools, including Excel's own Convert function (available in the Analysis ToolPak add-in), require multiple calls to convert units not included on its list of known units, increasing the risk of typing errors and incorrect conversion. ChangeUnits lets you directly convert any combination of units to any other combination of units in a single step.

ChangeUnits parses the input units by converting each separate base unit in turn. One of the advantages of changing units this way is that only a relatively small number of base units need to be recognized (currently, there are about 180 base units). If, instead of parsing, ChangeUnits attempted to recognize all possible combinations of units, the number of units that would have to be recognized would be huge. For example, if there were 10 different length units and 10 different time units, then there would be 100 possible velocity (length / time) units and 1000 possible acceleration (length / time^2) units. Not only would this be tedious to program and maintain, it would require many unnecessary syntax decisions such as whether or not to allow "m / s^2" or "m / s / s". Because ChangeUnits parses, it recognizes these different syntaxes as equivalent, allowing the user to use the units and syntax that best suits his or her needs and preferences.

Installation

Unzip the file ChangeUnits3.2.zip to create a new directory called ChangeUnits3.2 containing the following files:
- **ChangeUnits.pdf** – A brief summary of and documentation for ChangeUnits.
- **ChangeUnits.xll** – The Excel add-in file.
- **ChangeUnits_Examples.xls** – An Excel file with sample calculations.
- **BaseUnits.pdf** – A one page summary of the base units ChangeUnits recognizes.

The downloaded file for Mac OS X is a Stuffit archive. If you have difficulty expanding the archive, visit www.stuffit.com to download the free Stuffit Expander utility.

It is best to fully install the add-in prior to opening the ChangeUnits_Examples.xls file.

Installation on Windows

Although not required, it is often best to copy ChangeUnits.xll to the default Microsoft add-in directory. This directory depends on the version of Windows used and its setup. It is something like

"C:\Documents and Settings\username\Application Data\Microsoft\Addins"

where "username" is the name of your account on the machine. To find out what your default add-in directory is, open Excel and choose **Tools|Add Ins|Browse**. The file selection window opens in the default add-in directory.

Note: If the folder "Application Data" is not visible, you can make it visible by changing the Folder Options in the Control Panels. From **Start** button in Windows, select "**Control Panel**" and then double-click on "**Folder Options**". Select the **View** tab and under the "**Hidden files and folders**" option make sure "**Show hidden files and folders**" is selected.

Installation on Mac OS X

Although not required, it is often best to copy ChangeUnits.xll to the default Microsoft Office add-in directory. Depending on the version of Office you are using, the directory is usually located in

"Applications:Microsoft Office 2004:Office:Add-Ins"

or

"Applications:Microsoft Office:Office X:Add-Ins"

To find out what your default add-in directory is, open Excel and choose **Tools|Add Ins** and click on the **Select…** button. The file selection window opens in the default add-in directory.

Loading the Add-In Into Excel (Windows and Mac)

To load the ChangeUnits into Excel, open Excel. From the main menu, choose **Tools|Add Ins**. Locate and select the file ChangeUnits.xll.

If the computer responds with a question similar to "A file named ChangeUnits.xll already exists in this location. Do you want to replace it?", answer Yes.

ChangeUnits is now installed and ready to use.

The ChangeUnits add-in will be installed each time you start Excel. If you don't want this to happen, you must uncheck the ChangeUnits box in the **Tools|Add Ins** menu.

In older versions of Excel, you cannot overwrite an old version of an add-in, but must deselect it from the add-in menu, exit Excel, re-open Excel, and then load the new add-in.

ChangeUnits Functions

(1) ChangeUnits(Val, InUnits, OutUnits)
        Change Val from InUnits to OutUnits.
        Input: Val = Input value expressed in InUnits (number)
                    InUnits = The units of Val (text)
                    OutUnits = The units to output (text)
        Output: Val expressed in OutUnits (number)

(2) ToMetric(Val, InUnits)
        Change Val from InUnits to standard metric MKS units.
        Input   Val = Input value expressed in InUnits (number)
                    InUnits = The units of Val (text)
        Output: Val expressed in MKS units (number)

(3) FromMetric(Val, OutUnits)
        Change Val from standard metric MKS units to OutUnits.
        Input   Val = Input value expressed in MKS units (number)
                    OutUnits = The units to output (text)
        Output: Val expressed in OutUnits (number)

(4) ShowMetric(InUnits)
        Show the standard metric MKS units equivalent of InUnits.
        Input   InUnits = Input units (text)
        Output: Equivalent MKS units of InUnits (text)

(5) ShowCommonMetric(InUnits)
        Show the common metric MKS units equivalent to InUnits, simplifying, if
        applicable:
                kg m^2 / s^2 to J
                kg m / s^2 to N
                kg m^2 / s^3 to W
                kg / m / s^2 to Pa
                C / s to A
                C^2 s^2 / m^2 kg to F
                m^2 kg / s^2 C to V
                m^2 kg / s C to ohm
                m^2 kg / C^2 to H
                kg m^2 / s C to Wb
                kg / s C to T
        Input   InUnits = Input units (text)
        Output: Equivalent MKS units of InUnits (text)

(6) Grav( )
        Output: Returns 9.806652 m/s^2, the gravitational constant.

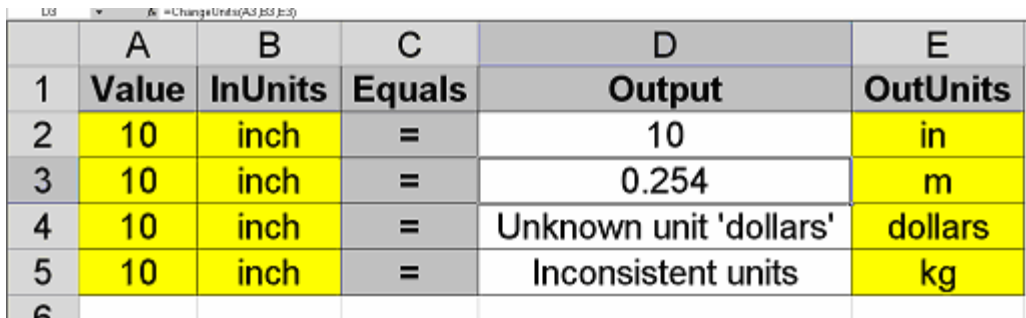**(7) GasConst** ()
        Output: Returns 8.31434 J / mol / degK, the universal gas constant.

Examples

NOTE: All of the following examples are programmed in the Excel file ChangeUnits_Examples.xls on the first worksheet (Examples) that is included with the ChangeUnits add-in.

The simplest use of ChangeUnits is to change a value from one unit to another using the ChangeUnits function. Figure 1 below shows an Excel worksheet in which 10 inches has been changed to different units using the ChangeUnits function. Column D has the call to the function: in cell D2, the formula is "= ChangeUnits(A2, B2, E2)". In cell D3, the formula is "= ChangeUnits(A3, B3, E3)". And so on.
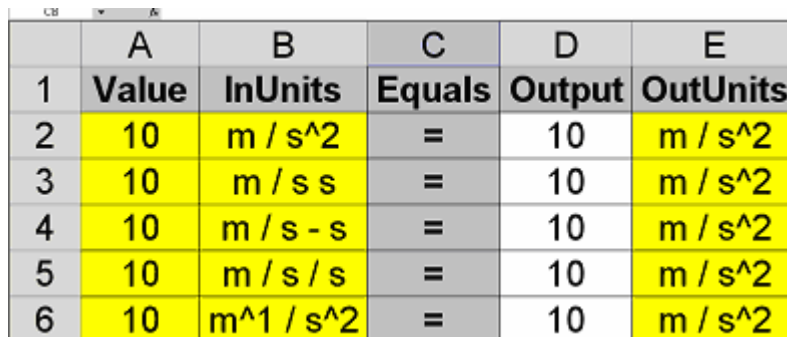
In cell D2, 10 "inch" changes to 10 "in", since both "inch" and "in" are interpreted or parsed as inches. In cell D3, 10 "inch" is equal to 0.254 "m". In cell D4, we have tried to change "inch" into "dollars". Since "dollars" is unknown to ChangeUnits, the error message returned is "Unknown unit 'dollars'". Finally, in cell D5, we have tried to change 10 "inch" into "kg". Since "inch" and "kg" are not equivalent units, ChangeUnits returns the error message "Inconsistent units".

	A	B	C	D	E
	Value	InUnits	Equals	Output	OutUnits
1	Value	InUnits	Equals	Output	OutUnits
2	10	inch	=	10	in
3	10	inch	=	0.254	m
4	10	inch	=	Unknown unit 'dollars'	dollars
5	10	inch	=	Inconsistent units	kg
6					

Figure 1. The ChangeUnits function.

In Figure 2 below, we show a number of alternative but equivalent methods for expressing the same units that are recognized by ChangeUnits (m / s^2 in this example).

	A	B	C	D	E
1	Value	InUnits	Equals	Output	OutUnits
2	10	m / s^2	=	10	m / s^2
3	10	m / s s	=	10	m / s^2
4	10	m / s - s	=	10	m / s^2
5	10	m / s / s	=	10	m / s^2
6	10	m^1 / s^2	=	10	m / s^2

Figure 2. Alternative Syntaxes Recognized by ChangeUnits

Figure 3 below illustrates the ToMetric and FromMetric functions by calculating the area of a rectangle.

	A	B	C	D	E	F
1	Calculate the area of a rectangle					
2		Symbol or			MKS	MKS
3	Description	Formula	Value	Units	Value	Units
4	Width	b	1	m	1	m
5	Height	h	2	m	2	m
6	Area	A = b h	2	m^2	2	m^2

Figure 3. Calculating the area of a rectangle in typical units.

The cells have been color coded so that the user inputs are yellow, the final answer is white, and the formula is light blue. The pale green cells show the equivalent MKS units.

The width of the rectangle, b, is given in cell C4 and its units are given in cell D4. In this example, b = 1 m. The height of the rectangle, h, is shown in cell C5 and its units are shown in cell D5. In this case, h = 2 m.

Although the input units are already in MKS units, we don't assume that this will always be the case. Instead, we change the input units into MKS values in column E. So cell E4 is the function "= ToMetric(C4, D4)", which gives a value of 1, and cell E5 is "= ToMetric(C5, D5)", which gives a value of 2.

The formula for the area of a rectangle, A = b * h, is programmed in cell E6 *using the values in the MKS column E*, namely, E6 = E4 * E5. For this problem, the area is 2 m^2.

As output, we list the units we want in cell D6, in this case m^2. The answer to the problem is given in C6 using the formula C6 "= FromMetric(E6, D6)".

We show the MKS units used in column F. For example, cell F4 "= ShowMetric(D4)".

Now suppose that we want to calculate the area of a rectangle with different inputs. Suppose b = 1.0e4 inches, h = 2 mm, and we want the answer in mile^2. We simply change the yellow cells C4, D4, D5, and D6, and obtain Figure 4.

	A	B	C	D	E	F
1	Calculate the area of a rectangle					
2		Symbol or			MKS	MKS
3	Description	Formula	Value	Units	Value	Units
4	Width	b	1.00E+04	in	254	m
5	Height	h	2	mm	0.002	m
6	Area	A = b h	1.96E-07	mile^2	0.508	m^2

Figure 4. Area of a rectangle in some unexpected units.

The formula itself (cell E6) did not need to be changed, only the input units and values and the output units. Once a formula has been correctly programmed, the only errors that occur are typographical errors in the yellow input boxes.

The disadvantage of doing calculations this way is that the add-in does not know the correct output units of the formula that has been programmed, so it cannot catch when the user asks for inconsistent output units. For example, in Figure 4, if one puts "lbm" into cell D6, then cell F6 correctly updates to kg, but the value in cell C6 is 1.119948292, the equivalent of 0.508 kg even though the formula intends that cell E6 be interpreted as length-squared rather than mass.

ChangeUnits uses the following syntax rules and conventions:

ChangeUnits Syntax

- **All units are case and spelling sensitive.**

- **All units are singular (inch rather than inches)**

- **The only characters that matter are the units, the first division sign ("/") encountered, the exponentiation character ("^"), and numerical exponents (which must be positive). Everything else is ignored (i.e., treated as white space). So, for example, the following are all interpreted as equivalent:**
  m / s / s = m / s – s = m / s s = m / s s = m / s^2
  Parentheses are always ignored.

- **Negative exponents are not allowed.**

- **Exponents can be expressed as positive integers, simple decimals (no scientific notation), or simple fractions (one number divided by another). For example, psi^1/2 = psi^0.5 are valid (and useful for the Hertz contact stress formulas). Note that since parentheses are ignored, (lbf / in)^1/2 is interpreted as lbf / in^1/2, not psi^1/2. You can check your units using the ShowMetric function.**

- **A one "1" can be used as a placeholder as in "1 / m" or to indicated dimensionless units.**

6

- **The units text to parse can have at most 256 characters.**

The list of pre-programmed base units only has lbf, lbm, ozf, and ozm to distinguish English mass and force. The units lb and oz are not recognized.

Derived units with special names are included in the list of pre-programmed base units. Combinations of base units are not included. For example, velocity can be represented by any length per time combination. However, "mph" is a common unit that cannot be parsed from basic units. Hence, "mph" is included in the list of base units while "m / s" is not. "m / s" is simply recognized by ChangeUnits.

The list of pre-programmed base units includes multiple spellings of the same units to allow the user to use both "inch" and "in" and to compensate for Excel's automatic spelling correction. For example, Excel frequently changes "MPa" to the "Mpa". In other cases, such as "Torr" and "torr", both spellings are encountered and both are included as base units.

Many of the SI prefixes have been included in the list of pre-programmed base units. For example, in addition to m, the lengths include km, cm, and mm.

The number one ("1") can be used as a dimensionless place holder in any formula. For example, the units for a dimensionless parameter can be listed as "1". Or, inverse units can denoted be prefacing the unit with either "1 / " or even " / ". For example, inverse length units can be listed as "1 / m" or "/ m".

Temperature
Temperature is a special unit because in some cases temperature is absolute and in other cases, it is relative (a difference in temperature, not an absolute temperature). For example, if I want to change from degrees Fahrenheit to degrees Celsius, the formula is:

$$\deg C = \left(\frac{5}{9}\right)(\deg F - 32)$$

However, to change the units for thermal expansion from (in / in / degF) to (m / m / degC), I need to divide by 5/9 only. I do not subtract off 32 because thermal expansion is measured in changes of temperature, not absolute temperature.

To handle this, ChangeUnits has adopted the following convention. ChangeUnits distinguishes the case where temperature is a single unit in the numerator (in which case it assumes an absolute conversion) from all other cases in which case it assumes a relative conversion.

For example, in Figure 5 below we change absolute temperature using the ChangeUnits function. Because all the units listed in columns B and E show only degC, degF, degK, or degR as a single base unit in the numerator, all of these interpret temperature as absolute.

	A	B	C	D	E
1	**Absolute Temperature Example**				
2	Value	InUnits	Equals	Output	OutUnits
3	1	degC	=	1	degC
4	1	degC	=	33.8	degF
5	1	degC	=	274.15	degK
6	1	degC	=	493.47	degR
7					

Figure 5. Changing absolute temperature.

In Figure 6 below, we change relative temperature by putting the temperature unit in the denominator.

	B	C	D	E
1	**Temperature Example**			
2	InUnits	Equals	Output	OutUnits
3	1 / degC	=	1	1 / degC
4	1 / degC	=	0.555556	1 / degF
5	1 / degC	=	1	1 / degK
6	1 / degC	=	0.555556	1 / degR

Figure 6. Changing relative temperature.

In these examples the base units degC, degF, etc. all appear in the denominator, so they are treated as relative temperatures (e.g., differences in temperature), not absolute temperatures. Whenever temperature units are embedded in other units (such as, for example, "J / degC") it is always interpreted as a relative temperature.

Sometimes, one wants to input a temperature difference as an input quantity, for example a change of 3 degrees Fahrenheit. This is not directly possible with the syntax convention listed above. A temperature difference of 3 degrees Fahrenheit, if input as "degF", would be converted as an absolute temperature (to, for example, to -16 degrees C) rather than a relative temperature (i.e., convert an increase of 3 degrees Fahrenheit to an equivalent increase of 1.67 degrees C). In order to input temperature differences directly in ChangeUnits, the four relative temperature units *degCdiff*, *degKdiff*, *degFdiff*, and *degRdiff* have been provided.

Figure 7 below shows how to input temperature differences directly in ChangeUnits. (As an alternative, one could also input two different input temperatures, convert each as absolute temperatures, and then subtract them to get the converted temperature difference. However, this is cumbersome.)

	B	C	D	E	F
1	**Value**	**InUnits**	**Equals**	**Output**	**OutUnits**
2	1	degCdiff	=	1	degCdiff
3	1	degCdiff	=	1.8	degFdiff
4	1	degCdiff	=	1	degKdiff
5	1	degCdiff	=	1.8	degRdiff

Figure 7. Relative temperature units degCdiff, degKdiff, degFdiff, and degRdiff.

Sometimes, one wishes to use combinations of absolute temperature. For example, in radiant heat, the formula involves absolute temperature to the fourth power. Because of the exponentiation, ChangeUnits will interpret degC^4 as a relative temperature. *ChangeUnits does not provide a method for combined, absolute temperature conversion.* Instead, the absolute temperature should be input in degC as a distinct input, and then the combination (raising to the fourth power in this case) should be done as a separate Excel formula calculation.

Finally, we show in Figure 8 the results of using the Grav( ) and GasConst( ) functions.

	B	C	D
1	**Constants**		
2	**Function**	**Output**	**MKS Units**
3	Grav	9.806652	m / s^2
4	GasConst	8.31434	J / mol / degK

Figure 8. The Grav and GasConst functions.

Suggestions for additional units to be included in the list of pre-programmed based units can be sent to webmaster@ChangeUnits.com.

Tips on Using Excel

The Excel Function Help Tool   If you forget the name of a function or the arguments it takes, you can have Excel help you. Simply click on the f_x button (or, in some older versions of Excel, the "=" to the left of the formula window). Excel then asks you which function you need help with. You can select from just the ChangeUnits functions by selecting that add-in category. Excel then gives a pop up window of the function and describes each parameter as you enter it. This feature is recommended since it eliminates the need to remember the order of the parameters and allows you to preview the answer.

The Excel Solver. The Excel Solver (installed as an add-in named Solver Add-in from the original Excel software) can be used to find roots and minimize or maximize functions. The enables you to solve for an input value if you are given the output value desired without re-programming a formula already set up using ChangeUnits.

Cell AutoCompletion. Excel often tries to automatically complete the typing of your input to cells assuming that you wish to repeat an input that you already have on your worksheet. This is useful when Excel's guess is correct. When constructing unit-based formulas, however, *Excel is often incorrect*, and it is very easy not to notice the mistakes Excel makes for you. For example, if you have previously entered a unit like "m / s" and then enter just "m" below it, Excel will often change that to "m / s" even if you typed only "m" and then hit return. The AutoComplete option can be turned off in Excel by deselecting (unchecking) the "**Enable AutoComplete Cell Values**" box under **Tools|Options** under the **Edit** tab (Windows) or under **Excel|Preferences** in the **Edit** pane (Mac).

Automatic Un-Capitalization. The default spell correction in Excel changes a word of three or more letters that begins with two capital letters and then small letters so that the second letter is not capitalized. This makes units such as MPa change to Mpa, which then have to be edited to get the correct spelling. A number of these common occurrences have been included in both spellings in the list of base units. For example, MPa and Mpa are both included. Excel autocorrection can be turned off by deselecting (unchecking) the "**Correct TWo INitial CApitals**" box under **Tools|Options** under the **Spelling** tab and the **"AutoCorrect Options …"** button (Windows) or from the **Tools|AutoCorrect** menu (Mac).

Array Formulas. The ChangeUnits functions all work as specified above. However, in some cases, it is desirable to use them as Excel "Array Formulas" so that their output consists of two cells rather than a single cell. For example, for the **Grav ()** function, it is sometimes convenient to output not just the value 9.806652 but also the underlying units "m/s^2".

In fact, this is exactly what ChangeUnits *always* does. The function **Grav( )** is an array function which returns 9.806652 in the first cell and "m / s^2" in the second cell. If only one cell is selected for the output, only the first output, 9.806652, is given as output.

The functions **ToMetric( ), FromMetric( ), Grav( ),** and **GasConst( )** are all array formulas, returning the value in the first cell and the units in the second cell. Illustrations of how to use array functions for Examples 3 and 7 above are given in ChangeUnits_Examples.xls at the bottom of the "Examples" worksheet, with the array formulas highlighted in orange.

For users unfamiliar with array formulas, they require getting used to. Here are the basics:
1. To input the function, highlight two adjoining cells.
2. Type the formula desired.
3. Hit "Ctrl-Shift-Enter".

4. The formula you typed in will now be listed in both cells with curly brackets around it. The two output values will be displayed in the two cells.
5. Once you have an array function, you cannot delete only one cell's value – you must delete both at once by highlighting both.
6. To update the formula, you must use "Ctrl-Shift-Enter" to complete the change. Hitting only "Enter" will give an error.
7. When editing (and sometimes inputting) array functions, it is sometimes necessary to make sure the cursor is located in the formula bar on the top of the Excel window, not in the cell itself, which is where it is when you select a cell and start typing. If you are having difficulty getting Excel to accept a correction to an array formula, make sure that the cursor is in the formula bar, not the cell.
8. You can get Microsoft help by searching "array formula".

Legal

ChangeUnits is to be used at the users own risk.   We make no representations or warranties, express or implied, about the accuracy of this software. By way of example, but not limitation, we make no representations or warranties of the merchantability or fitness of ChangeUnits for any particular purpose or that the use of this software, components, or documentation will not infringe any patents, copyrights, trademarks, or other rights. Certain features of ChangeUnits are patent pending.

Comments and Contact Information

Any questions, bugs, or comments should be sent to webmaster@ChangeUnits.com.

List of Pre-Programmed Base Units by Group

The following units are pre-programmed. This list is in the file
ChangeUnits_Examples.xls included in the ChangeUnits download.

Angle
1	rad	=	1	rad
		=	57.2958	deg
		=	0.159155	rev

Angular Velocity
1	rad / s	=	0.159155	hz
		=	0.159155	Hz
		=	9.5493	rpm
		=	0.159155	rps

Area/Permeability
1	m^2	=	0.000247105	acre
		=	0.0001	hectare
		=	1.01325e+012	darcy
		=	1.01325e+012	D
		=	1.01325e+015	millidarcy
		=	1.01325e+015	mD

Electrical Capacitance
1	s^2 C^2 / kg m^2	=	1	farad
		=	1	F
		=	1000	millifarad
		=	1000	mF
		=	1e+006	microfarad
		=	1e+009	nanofarad

Electrical charge
1	C	=	1	coulomb
		=	1	C

Electrical Current
1	C / s	=	1	ampere
		=	1	amp
		=	1	A
		=	1000	milliamp
		=	1000	mA
		=	1e+006	microamp

Electrical Potential
1	kg m^2 / s^2 C	=	1	volt
		=	1	V
		=	1000	millivolt
		=	1000	mV
		=	1e+006	microvolt

Electrical Resistance

1	kg m^2 / s C^2 =		1	ohm

Electromagnetic Inductance

1	kg m^2 / C^2	=	1	henry
		=	1	H

Energy

1	kg m^2 / s^2	=	1	J
		=	1000	mJ
		=	0.001	kJ
		=	1e-006	MJ
		=	1e-009	GJ
		=	0.238846	cal
		=	0.000238846	kcal
		=	0.000947817	btu
		=	0.000947817	Btu
		=	1e+007	erg
		=	6.24151e+018	eV

Force

1	kg m / s^2	=	1	N
		=	0.001	kN
		=	100000	dyne
		=	0.224809	lbf
		=	3.59694	ozf
		=	0.000224809	kip
		=	0.101972	kgf

Length

1	m	=	1	m
		=	100	cm
		=	1000	mm
		=	1e+006	micron
		=	1e+009	nm
		=	1e+010	angstrom
		=	0.001	km
		=	39.3701	in
		=	39.3701	inch
		=	39370.1	mil
		=	3.28084	ft
		=	3.28084	feet
		=	1.09361	yard
		=	1.09361	yd
		=	0.000621371	mi
		=	0.000621371	mile
		=	0.000179986	Nmile
		=	0.000179986	league
		=	2.18722	cubit
		=	0.546807	fathom
		=	1.05702e-016	lightyear
		=	1.65076e+006	KrWavelength

Magnetic Field Strength

1	C / s m	=	0.0125664	oersted
		=	0.0125664	Oe

Magnetic Flux

1	kg m^2 / s C	=	1	weber
		=	1	Wb
		=	1e+008	maxwell
		=	1e+008	Mx

Magnetic Flux Density

1	kg / s C	=	1	tesla
		=	1	T
		=	1000	mT
		=	10000	gauss
		=	10000	G

Mass

1	kg	=	1	kg
		=	0.001	Mg
		=	1000	g
		=	1e+006	mg
		=	0.0685218	slug
		=	0.000984207	ton
		=	0.001	tonne
		=	35.274	ozm
		=	2.20462	lbm
		=	5000	carat
		=	15432.4	grain
		=	0.157473	stone

Mole

1	mol	=	1	mol
		=	0.001	kmol

Power

1	kg m^2 / s^3	=	1	W
		=	1	Watt
		=	1	watt
		=	1000	mW
		=	0.001	kW
		=	1e-006	MW
		=	1e-009	GW
		=	0.00134102	hp

Pressure/Stress

1	kg / s^2 m	=	1	Pa
		=	1000	mPa
		=	1000	mpa
		=	0.001	kPa
		=	0.001	kpa
		=	1e-006	MPa

	=	1e-006	Mpa
	=	1e-009	GPa
	=	1e-009	Gpa
	=	0.000145038	psi
	=	1.45038e-007	ksi
	=	1.45038e-010	Mpsi
	=	1.45038e-013	Gpsi
	=	9.86923e-006	atm
	=	1e-005	bar
	=	0.01	millibar
	=	0.00750062	mmHg
	=	0.000750062	cmHg
	=	0.000296134	inHg
	=	0.00750062	torr
	=	0.00750062	Torr
	=	0.0101974	cmWater
	=	0.00401865	inWater

Temperature

1 degK	=	-272.15	degC
	=	-457.87	degF
	=	1	degK
	=	1.8	degR
	=	1	degCdiff
	=	1.8	degFdiff
	=	1	degKdiff
	=	1.8	degRdiff

Time

1 s	=	1	s
	=	1	sec
	=	1000	ms
	=	1000	msec
	=	0.0166667	min
	=	0.000277778	h
	=	0.000277778	hr
	=	0.000277778	hour
	=	1.15741e-005	day
	=	1.65344e-006	week
	=	3.16888e-008	yr
	=	3.16888e-008	year

Velocity

1 m / s	=	2.23694	mph
	=	3.6	kph
	=	1.94384	knot
	=	3.28084	fps
	=	196.85	fpm

Viscosity (Dynamic)

1 kg / s m	=	10	poise
	=	1000	centipoise

		=	1000	cp
		=	10000	millipoise
		=	1	poiseuille
		=	0.000145038	reyn

Viscosity (Kinematic)

1	m^2 / s	=	1e+006	centistokes
		=	10	stokes

Volume

1	m^3	=	264.172	gallon
		=	264.172	gal
		=	1000	liter
		=	1000	l
		=	1000	L
		=	1e+006	ml
		=	1e+006	cc
		=	6.28981	barrel
		=	423.776	boardfoot
		=	28.3776	bushel
		=	0.275896	cord
		=	4226.75	cup
		=	33814	fluidounce
		=	113.51	peck
		=	2113.38	pint
		=	1056.69	quart
		=	1	stere
		=	67628	Tbs
		=	202884	tsp

Alphabetical Listing of Pre-Programmed Units

1 A	=	1	C / s
1 acre	=	4046.86	m^2
1 amp	=	1	C / s
1 ampere	=	1	C / s
1 angstrom	=	1e-010	m
1 atm	=	101325	kg / s^2 m
1 bar	=	100000	kg / s^2 m
1 barrel	=	0.158987	m^3
1 boardfoot	=	0.00235974	m^3
1 Btu	=	1055.06	kg m^2 / s^2
1 btu	=	1055.06	kg m^2 / s^2
1 bushel	=	0.0352391	m^3
1 C	=	1	C
1 cal	=	4.1868	kg m^2 / s^2
1 carat	=	0.0002	kg
1 cc	=	1e-006	m^3
1 centipoise	=	0.001	kg / s m
1 centistokes	=	1e-006	m^2 / s
1 cm	=	0.01	m
1 cmWater	=	98.0638	kg / s^2 m
1 cmHg	=	1333.22	kg / s^2 m
1 cord	=	3.62456	m^3
1 coulomb	=	1	C
1 cp	=	0.001	kg / s m
1 cubit	=	0.457201	m
1 cup	=	0.000236588	m^3
1 D	=	9.8692e-013	m^2
1 darcy	=	9.8692e-013	m^2
1 day	=	86400	s
1 deg	=	0.0174533	rad
1 degC	=	274.15	degK
1 degCdiff	=	1	degKdiff
1 degF	=	255.928	degK
1 degFdiff	=	0.555556	degKdiff
1 degK	=	1	degK
1 degKdiff	=	1	degKdiff
1 degR	=	0.555556	degK
1 degRdiff	=	0.555556	degKdiff
1 dyne	=	1e-005	kg m / s^2
1 erg	=	1e-007	kg m^2 / s^2
1 eV	=	1.60218e-019	kg m^2 / s^2
1 F	=	1	s^2 C^2 / kg m^2
1 farad	=	1	s^2 C^2 / kg m^2
1 fathom	=	1.8288	m
1 feet	=	0.3048	m
1 fluidounce	=	2.95735e-005	m^3

1 fpm	=	0.00508	m / s
1 fps	=	0.3048	m / s
1 ft	=	0.3048	m
1 G	=	0.0001	kg / s C
1 g	=	0.001	kg
1 gal	=	0.00378541	m^3
1 gallon	=	0.00378541	m^3
1 gauss	=	0.0001	kg / s C
1 GJ	=	1e+009	kg m^2 / s^2
1 GPa	=	1e+009	kg / s^2 m
1 Gpa	=	1e+009	kg / s^2 m
1 Gpsi	=	6.89476e+012	kg / s^2 m
1 grain	=	6.47989e-005	kg
1 GW	=	1e+009	kg m^2 / s^3
1 H	=	1	kg m^2 / C^2
1 h	=	3600	s
1 hectare	=	10000	m^2
1 henry	=	1	kg m^2 / C^2
1 hour	=	3600	s
1 hp	=	745.7	kg m^2 / s^3
1 hr	=	3600	s
1 Hz	=	6.28319	rad / s
1 hz	=	6.28319	rad / s
1 in	=	0.0254	m
1 inch	=	0.0254	m
1 inWater	=	248.84	kg / s^2 m
1 inHg	=	3376.85	kg / s^2 m
1 J	=	1	kg m^2 / s^2
1 kcal	=	4186.8	kg m^2 / s^2
1 kg	=	1	kg
1 kgf	=	9.80665	kg m / s^2
1 kip	=	4448.22	kg m / s^2
1 kJ	=	1000	kg m^2 / s^2
1 km	=	1000	m
1 kmol	=	1000	mol
1 kN	=	1000	kg m / s^2
1 knot	=	0.514444	m / s
1 kPa	=	1000	kg / s^2 m
1 kpa	=	1000	kg / s^2 m
1 kph	=	0.277778	m / s
1 KrWavelength	=	6.0578e-007	m
1 ksi	=	6.89476e+006	kg / s^2 m
1 kW	=	1000	kg m^2 / s^3
1 L	=	0.001	m^3
1 l	=	0.001	m^3
1 lbf	=	4.44822	kg m / s^2
1 lbm	=	0.453592	kg
1 league	=	5556	m

1 lightyear	=	9.46055e+015	m
1 liter	=	0.001	m^3
1 m	=	1	m
1 mA	=	0.001	C / s
1 maxwell	=	1e-008	kg m^2 / s C
1 mD	=	9.8692e-016	m^2
1 mF	=	0.001	s^2 C^2 / kg m^2
1 Mg	=	1000	kg
1 mg	=	1e-006	kg
1 mi	=	1609.34	m
1 microamp	=	1e-006	C / s
1 microfarad	=	1e-006	s^2 C^2 / kg m^2
1 micron	=	1e-006	m
1 microvolt	=	1e-006	kg m^2 / s^2 C
1 mil	=	2.54e-005	m
1 mile	=	1609.34	m
1 milliamp	=	0.001	C / s
1 millibar	=	100	kg / s^2 m
1 millidarcy	=	9.8692e-016	m^2
1 millifarad	=	0.001	s^2 C^2 / kg m^2
1 millipoise	=	0.0001	kg / s m
1 millivolt	=	0.001	kg m^2 / s^2 C
1 min	=	60	s
1 MJ	=	1e+006	kg m^2 / s^2
1 mJ	=	0.001	kg m^2 / s^2
1 ml	=	1e-006	m^3
1 mm	=	0.001	m
1 mmHg	=	133.322	kg / s^2 m
1 mol	=	1	mol
1 MPa	=	1e+006	kg / s^2 m
1 Mpa	=	1e+006	kg / s^2 m
1 mPa	=	0.001	kg / s^2 m
1 mpa	=	0.001	kg / s^2 m
1 mph	=	0.44704	m / s
1 Mpsi	=	6.89476e+009	kg / s^2 m
1 ms	=	0.001	s
1 msec	=	0.001	s
1 mT	=	0.001	kg / s C
1 mV	=	0.001	kg m^2 / s^2 C
1 MW	=	1e+006	kg m^2 / s^3
1 mW	=	0.001	kg m^2 / s^3
1 Mx	=	1e-008	kg m^2 / s C
1 N	=	1	kg m / s^2
1 nanofarad	=	1e-009	s^2 C^2 / kg m^2
1 nm	=	1e-009	m
1 Nmile	=	5556	m
1 Oe	=	79.5775	C / s m
1 oersted	=	79.5775	C / s m

```
1 ohm         =  1               kg m^2 / s C^2
1 ozf         =  0.278014        kg m / s^2
1 ozm         =  0.0283495       kg
1 Pa          =  1               kg / s^2 m
1 peck        =  0.00880977      m^3
1 pint        =  0.000473176     m^3
1 poise       =  0.1             kg / s m
1 poiseuille  =  1               kg / s m
1 psi         =  6894.76         kg / s^2 m
1 quart       =  0.000946353     m^3
1 rad         =  1               rad
1 rev         =  6.28319         rad
1 reyn        =  6894.76         kg / s m
1 rpm         =  0.10472         rad / s
1 rps         =  6.28319         rad / s
1 s           =  1               s
1 sec         =  1               s
1 slug        =  14.5939         kg
1 stere       =  1               m^3
1 stokes      =  0.1             m^2 / s
1 stone       =  6.35029         kg
1 T           =  1               kg / s C
1 Tbs         =  1.47868e-005    m^3
1 tesla       =  1               kg / s C
1 ton         =  1016.05         kg
1 tonne       =  1000            kg
1 Torr        =  133.322         kg / s^2 m
1 torr        =  133.322         kg / s^2 m
1 tsp         =  4.92892e-006    m^3
1 V           =  1               kg m^2 / s^2 C
1 volt        =  1               kg m^2 / s^2 C
1 W           =  1               kg m^2 / s^3
1 Watt        =  1               kg m^2 / s^3
1 watt        =  1               kg m^2 / s^3
1 Wb          =  1               kg m^2 / s C
1 weber       =  1               kg m^2 / s C
1 week        =  604800          s
1 yard        =  0.9144          m
1 yd          =  0.9144          m
1 year        =  3.15569e+007    s
1 yr          =  3.15569e+007    s
```