

Units of Measurement

THE SI SYSTEM AND UNITS OF MEASUREMENT

MEASUREMENT

- ✘ In the late 18th century, scientists used the metric system
- ✘ The metric system is a precursor to the SI System.
- ✘ Scientists all over the world use a single measurement system called *Le Systeme International d'Units*, abbreviated SI

SI SYSTEM OF MEASUREMENT

- ✘ This system was presented in 1960 by a General Conference of Weights and Measures and has both base units and derived units
- ✘ SI system:
 - + based on meter-kilogram-second system (m k s)
 - + replaces both the foot-pound-second system (f p s) and the centimeter-gram-second system
- ✘ There are seven SI base units, i.e. meter, kilogram, second, mole, ampere, Kelvin and candela

SI BASE UNITS

✘ The most common base units include:

Quantity	Quantity Symbol	Unit name	Unit abbreviation
Length	l	meter	m
Mass	m	kilogram	kg
Time	t	second	s
Temperature	T	Kelvin	K

UNITS IN THE METRIC SYSTEM

In the metric and SI systems, one unit is used for each type of measurement:

Measurement	Metric	SI
Length	meter (m)	meter (m)
Volume	liter (L)	cubic meter (m ³)
Mass	gram (g)	kilogram (kg)
Time	second (s)	second (s)
Temperature	Celsius (°C)	Kelvin (K)

UNITS IN THE METRIC SYSTEM

TABLE 2 BASE QUANTITIES AND THEIR SYMBOLS IN THE SI SYSTEM

Quantity	Unit name	Symbol
Length	meter	m
Mass	kilogram	kg
Time	second	s
Temperature	kelvin	K
Electric current	ampere	A
Luminous intensity	candela	cd
Amount of substance	mole	mol

SI BASE UNITS

- SI Units system includes a set of prefixes
- Use of a prefix makes a unit larger or smaller
- Ranges of SI unit prefixes are listed in the tables 1 and 2

TABLE 1

<i>Prefix</i>	<i>Symbol</i>	<i>Function</i>	<i>Divided by</i>
deci	d	10^{-1}	10
centi	c	10^{-2}	100
milli	m	10^{-3}	1000
micro	μ	10^{-6}	1,000,000
nano	n	10^{-9}	1,000,000,000
pico	p	10^{-12}	1,000,000,000,000
femto	f	10^{-15}	1,000,000,000,000,000

TABLE 2

<i>Prefix</i>	<i>Symbol</i>	<i>Function</i>	<i>Multiply by</i>
deca	da	10^1	10
hector	h	10^2	100
kilo	k	10^3	1000
mega	M	10^6	1,000,000
Giga	G	10^9	1,000,000,000
tera	T	10^{12}	1,000,000,000,000
peta	P	10^{15}	1,000,000,000,000,000

MEASUREMENT SYSTEM COMPARISONS

MEASUREMENT	ENGLISH (US)	SI SYSTEM
LENGTH	Foot / Inch	Meter / Centimeter
MASS	Ounce / Pound	Gram / Kilogram
VOLUME	Quart	Liter
TEMPERATURE	Fahrenheit	Celsius / Kelvin
TIME	Second	Second

TEMPERATURE

- ✘ The standard unit of measurement for temperature is Kelvins (K)
- ✘ Temperature can also be measured in degrees Celsius ($^{\circ}\text{C}$) and degrees Fahrenheit ($^{\circ}\text{F}$)
- ✘ To convert degrees Celsius ($^{\circ}\text{C}$) to degrees Fahrenheit ($^{\circ}\text{F}$) multiply by 1.8 and then add 32. To convert degrees Fahrenheit to degrees Celsius, subtract 32 and then divide by 1.8
- ✘ $K = ^{\circ}\text{C} + 273$

DERIVED UNITS

- ✘ Derived units are combinations of base units. They are produced by multiplying or dividing standard units

Quantity	Quantity symbol	Unit	Unit abbreviation
Area	A	square meter	m ²
Volume	V	cubic meter	m ³
Density	D	kilograms per cubic meter	kg/m ³

CONVERSIONS

TABLE 3 UNIT CONVERSION FACTORS

Quantity	To convert from	To	Multiply by
Length	mi	km	1.609 344*
	yd	m	0.9144*
	ft	m	0.304 8*
	ft	mm	304.8*
	in.	mm	25.4*
Area	mi ²	km ²	2.590 00*
	acre	m ²	4 046.87
	acre	ha**	0.404 687
	ft ²	m ²	0.092 903 04*
	in. ²	mm ²	645.16*
Volume	yd ³	m ³	0.764 555
	ft ³	m ³	0.028 3168
	100 board feet	m ³	0.235 974
	gal	L	3.785 41
	in. ³	cm ³	16.387 064
	in. ³	mm ³	16 387.064
	ft/s	m/s	0.3048
	ft ³ /s	m ³ /s	0.028 3168
gal/h	mL/s	1.051 50	
Acceleration	ft/s ²	m/s ²	0.3048
Mass	lb	kg	0.453 59
Mass per unit area	psf	kg/m ²	4.882 43
Mass density	pcf	kg/m ³	16.018 5
Force	lb	N	4.448 22
Force per unit length	plf	N/m	14.593 9
Pressure, stress	psf	Pa	47.880 26
	psi	kPa	6.894 76
	in. of mercury (in. Hg)	kPa	3.386 38
	in. of Hg (in. Hg)	psf	70.72
	atm***	kPa	101.325

CONT. CONVERSIONS

Temperature	°F	°C	$5/[9(°F - 32)]$
	°F	K	$(°F + 459.7)/1.8$
Quantity of heat	Btu	J	1055.056
Power	ton (refrigeration)	kW	3.517
	Btu/h	W	0.293 07
	hp	W	745.7
	Btu/(h·ft ²)	W/m ²	3.154 59
Thermal conductivity	Btu-in/(ft ² -h-°F)	W/(m·°C)	0.144 2
Thermal conductance, or thermal transmittance, U	Btu/(ft ² -h-°F)	W/(m ² ·°C)	5.678 263
Thermal resistance	(ft ² -h-°F)/Btu	(m ² ·°C)/W	0.176 110
Thermal capacity	Btu/(ft ² -°F)	kJ/(m ² ·°C)	20.44
Specific heat	Btu/(lb-°F)	J/(kg·°C)	4.186 8
Vapor permeability	perm-in	ng/(Pa·m·s)	1.459 29
Vapor permeance	perm	ng/(Pa·m ² ·s)	57.213 5
Angle	degree	radian	0.017 453

DECIMAL AND THOUSANDS SEPARATORS

- ✘ UK and US are 2 places use period (.) to indicate decimal place
 - ✘ Other countries use a comma instead (,)
 - ✘ Decimal separator aka “radix character”
- ✘ Using comma to separate groups of thousands
 - ✘ Used in U.K. and U.S.
 - ✘ Many other countries use a period instead
 - ✘ Some countries separate thousands groups with a thin space
 - ✘ See next slide for some commonly used numeric formats

DECIMAL AND THOUSANDS SEPARATORS

Region	Large Number
Canadian (English and French)	4 294 967 295,000
Danish	4 294 967 295,000
Finnish	4 294 967 295,000
French	4 294 967 295,000
German	4 294 967.295,000
Italian	4.294.967.295,000
Norwegian	4.294.967.295,000
Spanish	4.294.967.295,000
Swedish	4 294 967 295,000
UK-English	4,294,967,295.00
US-English	4,294,967,295.00