Tables, standards

SI units system

SI is the modern system of units for measurement, accepted and used world wide. It is used in all areas of international standards and is commonly referred to as the metric system. SI is used in all areas of science, technology and trade and is applied in the same way world wide.
SI is built of: Base units, Supplementary units, Additional units, Prefixes.
The figures given in the conversion tables are rounded up to 3 or 4 digits.

Basic units of the SI system

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

Derived SI units

Quantity	Name	Symbol	Defining equation	
Frequency	hertz	Hz	1 Hz	$= 1\ s^{-1} = 1/s$
Force	newton	N	1 N	$= 1\ kg \cdot m/s^2$
Pressure and mechanical stress	pascal	Pa	1 Pa	$= 1\ N/m^2$
Work (energy, heat)	joule	J	1 J	$= 1\ N \cdot m = 1\ W \cdot s$
Power, energy flow, heat flow	watt	W	1 W	$= 1\ N \cdot m/s = J/s$
Electrical charge, quantity of electricity	coulomb	C	1 C	$= 1\ A \cdot s$
Plectrical potential, potential, difference voltage	volt	V	1 V	$= 1\ W/A$
Electric capacitance	farad	F	1 F	$= 1\ A \cdot s/V$
Impedance	ohm	Ω	1 Ω	$= 1\ V/A$
Electrical conductivity	siemens	S	1 S	$= 1\ \Omega^{-1} = 1\ A/V$
Magnetic flux	weber	Wb	1 WB	$= 1\ V \cdot s$
Magnetic flux density	tesla	T	1 T	$= 1\ Wb/m^2$
Industance	henry	H	1 H	$= 1\ Wb/A = 1\ V \cdot s/A$
Luminous flux	lumen	lm	1 lm	$= 1\ cd \cdot sr$
Illumination	lux	lx	1 lx	$= 1\ lm/m^2$
Plan angle	radian	rad	1 rad	$= 1\ m/m = 1 = 180°/\pi$
Solid angle	steradian	sr	1 sr	$= 1\ m^2/m^2 = 1$

Conversion tables

Conversion table for units of force

	N	p	kp	dyn
1 Newton = 1 N	1	102	0,102	10^5
1 pond = 1 p	$9{,}81 \cdot 10^{-3}$	1	10^{-3}	981
1 Kilopond = kp	9,81	1000	1	$9{,}81 \cdot 10^5$
1 dyn	10^{-5}	$1{,}02 \cdot 10^{-3}$	$1{,}02 \cdot 10^{-6}$	1

Conversion table for units of mechanical stress

	Pa	N/mm^2	kp/cm^2	kp/mm^2
$1\ Pa = 1\ N/m^2 = 10\ N/cm^2$	1	10^{-6}	$1{,}02 \cdot 10^{-5}$	$1{,}02 \cdot 10^{-7}$
$1\ N/mm^2 = 1$ MPa	10^6	1	10,2	0,102
$1\ kp/cm^2 = 1$ at	$9{,}81 \cdot 10^4$	$9{,}81 \cdot 10^{-2}$	1	10^{-2}
$1\ kp/mm^2$	$9{,}81 \cdot 10^6$	9,81	100	1

Tables, standards

Conversion table for units of work, energy and heat

	J	kJ	kWh	kcal	kpm
1 J = 1 N · m = 1 W · s	1	10^{-3}	$2{,}78 \cdot 10^{-7}$	$2{,}39 \cdot 10^{-4}$	0,102
1 kJ	1000	1	$2{,}78 \cdot 10^{-4}$	0,239	102
1 kWh	$3{,}6 \cdot 10^{6}$	$3{,}6 \cdot 10^{3}$	1	860	$3{,}67 \cdot 10^{5}$
1 kcal	$4{,}19 \cdot 10^{3}$	4,19	$1{,}16 \cdot 10^{-3}$	1	427
1 kpm	9,81	$9{,}81 \cdot 10^{-3}$	$2{,}72 \cdot 10^{-6}$	$2{,}34 \cdot 10^{-3}$	1

Conversion table for units of power and heat flow

	W	kW	kcal/s	kcal/h	kpm/s
1 W = 1 N · m/s = 1 J/s	1	10^{-3}	$2{,}39 \cdot 10^{-4}$	0,860	0,102
1 kW	1000	1	0,239	860	102
1 kcal/s	$4{,}9 \cdot 10^{3}$	4,19	1	$3{,}6 \cdot 10^{3}$	427
1 kcal/h	1,16	$1{,}6 \cdot 10^{-3}$	$2{,}78 \cdot 10^{-4}$	1	0,119
1 kpm/s	9,81	$9{,}81 \cdot 10^{-3}$	$2{,}34 \cdot 10^{-3}$	8,34	1

Conversion table for units of pressure for gases, vapours and liquides

	Pa	bar	kp/m2	at	Torr
1 Pa = 1 N/m^2	1	10^{-5}	0,102	$1{,}02 \cdot 10^{-5}$	$7{,}5 \cdot 10^{-3}$
1 bar = 0,1 MPa = 0,1 N/mm^2	10^{5}	1	$1{,}02 \cdot 10^{4}$	1,02	750
1 kp/m^2	9,81	$9{,}81 \cdot 10^{-5}$	1	10^{-4}	$7{,}36 \cdot 10^{-2}$
1 at = 1 kp/cm^2	$9{,}81 \cdot 10^{4}$	0,981	10^{4}	1	736
1 Torr = 1/760 atm	133	$1{,}33 \cdot 10^{-3}$	13,6	$1{,}36 \cdot 10^{-3}$	1

Conversion of the units into SI units

Value	Previous unit	Symbol	New unit	Symbol	Defining equation
Length	Ångström	Å	meter	m	1 Å = 10^{-10}m
Pressure	mm mercury	mm Hg	pascal	Pa	1 mm Hg = 133,3 Pa
Energy	Erg	erg	joule	J	1 erg = 10^{-7} J
Power	horsepower	PS	watt	W	1 PS = 735,5 W
Dynamic viscosity	Poise	P	pascal second	Pa · s	1 P = 0,1 Pa · s/1c P = 1 m Pa · s
Kinematic viscosity	Stokes	St	cm^2/s	–	1 St = 1 cm^2/s = 10^{-4} m^2/s
Impact value	kpm/cm^2	–	J/cm^2	–	1 kpm/cm^2 = 9,087 J/cm^2
Heat capacity	kcal/°C	–	J/K	–	1 kcal/°C = $4{,}187 \cdot 10^{3}$ J/K
Heat conductivity	kcal/m · h · °C	–	W/K · m	–	1 kcal/m · h °C = 1,163 W/K · m
Specific heat	kcal/kg · °C	–	J/kg · K	–	1 kcal/kg · °C = $4{,}187 \cdot 10^{3}$ J/kg · K
Magnetic field strength	Oersted	Oe	ampere / meter	A/m	1 Oe = 79,6 A/m
Magnetic flux density	Gauss	G	tesla	T	1 G = 10^{-4} T
Magnetic flux	Maxwell	M	weber	Wb	1 M = 10^{-8} Wb
Luminous intensity	internat. candle	IK	candela	cd	1 IK = 1,019 cd
Luminace	Stilb	sb	cd/m^2	–	1 sb = 10^{4} cd/m^2
Absorbed dose	Rem	rem	J/kg	–	1 rem = 0,01 J/kg
Ion dose	Röntgen	R	C/kg	–	1 R = $2{,}58 \cdot 10^{-4}$ C/kg

Tables, standards

Conversions of part volumes
Example: one lump of sugar dissolved in

1 ppm (part per million) is 1 part out of 1 million parts	**1 milligram** per kilogram	0,001 g/kg (10^{-6})	 2700 litres
1 ppb (part per billion) is 1 part out of 1 milliard parts (b = billion, US English for milliard)	**1 mikrogram** per kilogram	0,000 001 g/kg (10^{-9})	 2,7 million litres
1 ppt (part per trillion) is 1 part out of 1 billion parts (t = trillion US English for billion)	**1 nanogram** per kilogram	0,000 000 001 g/kg (10^{-12})	 2,7 million litres
1 ppq (part per quadrillion) is 1 part out of 1 billiard parts (q = quadrillion US English for billiard)	**1 picogram** per kilogram	0,000 000 000 001 g/kg (10^{-15})	 2,7 trillion litres

Conversion tables metric – USA, USA – metric

Measures of length

metric		USA		
1 millimeter	mm	0,039337	inches	in.
1 centimeter	cm	0,39370	inches	in.
1 meter	m	39,3700	inches	in.
		3,2808	feet	ft.
		1,0936	yards	yd.
1 kilometer	km	0,62137	miles	m.

USA	metric	
1 inch	25,400	mm
	2,540	cm
1 foot	304,800	mm
	30,480	cm
	0,3048	m
1 yard	91,4400	cm
	0,9144	m
1 mile	1609,35	m
	1,609	km

Measures of area

metric	USA		
1 mm^2	0,00155	sq.inches	sq.in.
1 cm^2	0,1550	sq.inches	sq.in.
1 m^2	10,7640	sq.feet	sq.ft.
	1,196	sq.yard	sq.yd.
1 km^2	0,38614	sq.miles	sq.m.

USA	metric	
1 sq.inch	645,16	mm^2
	6,4516	cm^2
1 sq.foot	929,00	cm^2
	0,0929	m^2
1 sq.yard	0,836	m^2
1 sq.mile	2,5889	km^2

Measures of capacity

metric		USA		
1 milliliter	ml	0,27	fluid drachms	dr.fl.
1 centiliter	cl	0,338	fluid ounces	oz.fl.
1 deziliter	dl	0,0528	pints	pt.
1 liter	l	1,0567	quarts	qt.
		0,26	gallons	gal.
1 hectoliter	hl	26,417	gallons	gal.

USA	metric	
1 fluid ounce	2,957	cl
1 pint	4,732	dl
	0,4732	l
1 quart	0,9463	l
1 gallon	3,7853	l
1 barrel (bl)	119,237	l
	1,192	hl

Weights

metric		USA		
1 gram	g	15,432	grains	gr.
1 kilogram	kg	2,2046	pounds	lb.
1 quintal	dz.	220,46	pounds	lb.
1 tonne	t	2204,6	pounds	lb.
		1,102	shorttons	tn.sh.

USA	metric	
1 grain	64,7989	mg
1 ounce	28,35	g
1 pound	0,4536	kg
1 short	907,200	kg
	9,072	dz.
	0,9072	t

Tables, standards

Various

metric	USA	
1 N/mm² = 1 MPa = 10 bar	145,14	psi
1 Nm	8,85	in lb
	0,74	ft lb

USA	metric	
1 psi	0,00689	N/mm²
1 in lb	0,113	Nm
1 ft lb	1,35	Nm

Temperature

Conversion from Fahrenheit into Celsius:
Subtract 32; divide result by 1,8

°F	°C	°F	°C
212	100	100	37,8
200	93,3	90	32,2
194	90	86	30
190	87,8	80	26,7
180	82,8	70	21,1
176	80	68	20
170	76,7	60	15
160	71,1	50	10
158	70	40	4,4
150	65,6	–	–
140	60	32	0
130	54,4	30	–1,1
122	50	20	–6,7
120	48,9	14	–10
110	43,3	10	–12,2
104	40	0	–17,8

Conversion from Celsius into Fahrenheit:
Multiply by 1,8; add 32 to result

°C	°F	°C	°F
100	212	35	95
95	203	30	86
90	194	25	77
85	182	20	68
80	176	15	59
75	167	10	50
70	158	5	41
65	149	–	–
60	140	0	32
55	131	–5	23
50	122	–10	14
45	113	–15	5
40	104	–17,8	0

Conversion table conductor cross sections AWG / MCM dimensions to mm²

AWG	metric conductor cross section mm²	equivalent conductor cross section mm²
27	0,102	–
26	0,129	0,14
25	0,162	–
24	0,205	0,25
23	0,258	–
22	0,326	0,34
21	0,410	0,5
20	0,518	–
19	0,653	0,75
18	0,823	1
17	1,038	–
16	1,31	–
15	1,65	–
14	2,08	2,5
13	2,62	–
12	3,31	–
11	4,17	–
10	5,26	6
9	6,63	–
8	8,37	10
7	10,55	–
6	13,3	16
5	16,75	–
4	21,15	25
3	26,67	–
2	33,62	35
1	42,4	50
1 / 0	53,49	–
2 / 0	67,43	70
3 / 0	85,01	95
4 / 0	107,2	120

MCM	metric conductor cross section mm²	equivalent conductor cross section mm²
250	127	120
300	152	150
350	177	185
400	203	–
500	253	240
600	304	300
700	355	–
800	405	400
900	456	–
1000	507	500
1250	633	625
1500	760	800
1750	887	–
2000	1010	1000

Tables, standards

Hardness comparison table

according to ISO 18265

Conversion table according to ISO18265 for carbon steel, low-alloy steel and cast steel, etc. A conversion of hardness values to each other or hardness values to tensile strength values is always subject to uncertainties. A direct evaluation of a hardness conversion is only possible with the same material sample.

For all other materials, the values only represent a general indicator. The results of a conversion from the table are no substitute for values determined using standardized test methods. For high-alloy and/or cold-formed steels (e.g. 6.8, A2-A4), there are considerable differences to be expected.

Tensile strength	Vickers hardness HV	Brinell hardness[1)]	Rockwell hardness		
[N/mm²]	[F ≥ 98 N]	HB	HRB	HRC	HRA
255	80	76	–	–	–
270	85	80,7	41	–	–
285	90	85,5	48	–	–
305	95	90,2	52	–	–
320	100	95	56,2	–	–
335	105	99,8	–	–	–
350	110	105	62,3	–	–
370	115	109	–	–	–
385	120	114	66,7	–	–
400	125	119	–	–	–
415	130	124	71,2	–	–
430	135	128	–	–	–
450	140	133	75	–	–
465	145	138	–	–	–
480	150	143	78,7	–	–
495	155	147	–	–	–
510	160	152	81,7	–	–
530	165	156	–	–	–
545	170	162	85	–	–
560	175	166	–	–	–
575	180	171	87,1	–	–
595	185	176	–	–	–
610	190	181	89,5	–	–
625	195	185	–	–	–
640	200	190	91,5	–	–
660	205	195	92,5	–	–
675	210	199	93,5	–	–
690	215	204	94	–	–
705	220	209	95	–	–
720	225	214	96	–	–
740	230	219	96,7	–	–
755	235	223	–	–	–
770	240	228	98,1	20,3	60,7
785	245	233	–	21,3	61,2
800	250	238	99,5	22,2	61,6
820	255	242	–	23,1	62
835	260	247	(101)	24	62,4
850	265	252	–	24,8	62,7
865	270	257	(102)	25,6	63,1
880	275	261	–	26,4	63,5
900	280	266	(104)	27,1	63,8
915	285	271	–	27,8	64,2
930	290	276	(105)	28,5	64,5
950	295	280	–	29,2	64,8
965	300	285	–	29,8	65,2
995	310	295	–	31	65,8
1030	320	304	–	32,2	66,4
1060	330	314	–	33,3	67
1095	340	323	–	34,3	67,6
1125	350	333	–	35,5	68,1
1155	360	342	–	36,6	68,7
1190	370	352	–	37,7	69,2
1220	380	361	–	38,8	69,8
1255	390	371	–	39,8	70,3
1290	400	380	–	40,8	70,8
1320	410	390	–	41,8	71,4
1350	420	399	–	42,7	71,8
1385	430	409	–	43,6	72,3
1420	440	418	–	44,5	72,8
1455	450	428	–	45,3	73,3
1485	460	437	–	46,1	73,6
1520	470	447	–	46,9	74,1
1555	480	(465)	–	47,7	74,5
1595	490	(466)	–	48,4	74,9
1630	500	(475)	–	49,1	75,3
1665	510	(485)	–	49,8	75,7
1700	520	(494)	–	50,5	76,1
1740	530	(504)	–	51,1	76,4
1775	540	(513)	–	51,7	76,7
1810	550	(523)	–	52,3	77
1845	560	(532)	–	53	77,4
1880	570	(542)	–	53,6	77,8
1920	580	(551)	–	54,1	78
1955	590	(561)	–	54,7	78,4
1995	600	(570)	–	55,2	78,6
2030	610	(580)	–	55,7	78,9
2070	620	(589)	–	56,3	79,2
2105	630	(599)	–	56,8	79,5
2145	640	(608)	–	57,3	79,8
2180	650	(618)	–	57,8	80
–	660	–	–	58,3	80,3
–	670	–	–	58,8	80,6
–	680	–	–	59,2	80,8
–	690	–	–	59,7	81,1
–	700	–	–	60,1	81,3
–	720	–	–	61	81,8
–	740	–	–	61,8	82,2
–	760	–	–	62,5	82,6
–	780	–	–	63,3	83
–	800	–	–	64	83,4
–	820	–	–	64,7	83,8
–	840	–	–	65,3	84,1
–	860	–	–	65,9	84,4
–	880	–	–	66,4	84,7
–	900	–	–	67	85
–	920	–	–	67,5	85,3
–	940	–	–	68	85,6

[1)] The Brinell hardness values up to 450 HB were determined using the steel ball as an indenter. The figures in brackets are approximate values for hardness specifications that lie outside the range defined by the standardized hardness test methods. In addition, the Brinell hardness values in brackets only apply to measurements with a hard metal ball.

Tables, standards

The Vickers testing method is applicable over a wide hardness range. The referee method per ISO 898-1 is the Vickers method.

The Rockwell C method is suitable for hardened steels, Rockwell A for sintered steel and Rockwell B for soft steels, copper alloys, etc.

The Brinell hardness method extends over a wide hardness range too.

Designation of organisations of different national standards

according to ISO

Country	Abbreviation
Algeria	IANOR
Argentina	IRAM
Australia	SAI
Austria	ON
Bangladesh	BSTI
Belgium	IBN
Brazil	ABNT
Bulgaria	BDS
Canada	SCC
Chile	INN
China	CSBTS
Colombia	ICONTEC
Cuba	NC
Cyprus	CYS
Czech Republic	CSNI
Denmark	DS
Egypt	EOS
Ethiopia	QSAE
Europe	EN
Finland	SFS
France	AFNOR
Germany	DIN
Ghana	GSB
Greece	ELOT
Hungary	MSZT
India / Inde	BIS
Indonesia	BSN
International	ISO
Iran	ISIRI
Ireland	NSAI
Israel	SII
Italy	UNI
Jamaica	JBS
Japan	JISC

Country	Abbreviation
Kenya	KEBS
Korea, Dem.P.Rep.of	CSK
Korea, Rep. of	KATS
Libya	LNCSM
Malaysia	DSM
Mexico	DGN
Mongolia	MNCSM
Morocco	SNIMA
Netherlands	NEN
New Zealand	SNZ
Nigeria	SON
Norway	NSF
Pakistan	PSI
Philippines	BPS
Poland	PKN
Portugal	IPQ
Romania	ASRO
Russia / Russie	GOST
Saudi Arabia	SASO
Singapore	PSB
South Africa, Rep. of	SABS
Spain	AENOR
Sri Lanka	SLSI
Sweden	SIS
Switzerland	SNV
Syria	SASMO
Tanzania	TBS
Thailand	TISI
Trinidad and Tobago	TTBS
Turkey	TSE
United Kingdom	BSI
USA	ANSI
Uzbekistan	UZGOST
Venezuela	FONDONORMA
Vietnam	TCVN