

TABLE 1-4 Conversion Factors: U.S. Customary and Commonly Used Units to SI Units

Quantity	Customary or commonly used unit	SI unit	Alternate SI unit	Conversion factor; multiply customary unit by factor to obtain SI unit	
Space, † time					
Length	naut mi	km		1.852°	E + 00
	mi	km		1.609 344°	E + 00
	chain	m		2.011 68°	E + 01
	link	m		2.011 68°	E - 01
	fathom	m		1.828 8°	E + 00
	yd	m		9.144°	E - 01
	ft	m		3.048°	E - 01
		cm		3.048°	E + 01
	in	mm		2.54°	E + 01
	in	cm		2.54°	E + 00
mil	µm		2.54°	E + 01	
Length/length	ft/mi	m/km		1.893 939	E - 01
Length/volume	ft/U.S. gal	m/m ³		8.051 964	E + 01
	ft/ft ³	m/m ³		1.076 391	E + 01
	ft/bbl	m/m ³		1.917 134	E + 00
Area	mi ²	km ²		2.589 988	E + 00
	section	ha		2.589 988	E + 02
	acre	ha		4.046 856	E - 01
	ha	m ²		1.000 000°	E + 04
	yd ²	m ²		8.361 274	E - 01
	ft ²	m ²		9.290 304°	E - 02
	in ²	mm ²		6.451 6°	E + 02
	cm ²		6.451 6°	E + 00	
Area/volume	ft ² /in ³	m ² /cm ³		5.699 291	E - 03
	ft ² /ft ³	m ² /m ³		3.280 840	E + 00
Volume	cubem	km ³		4.168 182	E + 00
	acre-ft	m ³		1.233 482	E + 03
		ha·m		1.233 482	E - 01
	yd ³	m ³		7.645 549	E - 01
	bbl (42 U.S. gal)	m ³		1.589 873	E - 01
	ft ³	m ³		2.831 685	E - 02
		dm ³	L	2.831 685	E + 01
		m ³		4.546 092	E - 03
	U.K. gal	dm ³	L	4.546 092	E + 00
		m ³		3.785 412	E - 03
	U.S. gal	dm ³	L	3.785 412	E + 00
		dm ³	L	1.136 523	E + 00
	U.K. qt	dm ³	L	9.463 529	E - 01
	U.S. qt	dm ³	L	4.731 765	E - 01
	U.K. fl oz	cm ³		2.841 307	E + 01
	U.S. fl oz	cm ³		2.957 353	E + 01
	in ³	cm ³		1.638 706	E + 01
Volume/length (linear displacement)	bbl/in	m ³ /m		6.259 342	E + 00
	bbl/ft	m ³ /m		5.216 119	E - 01
	ft ³ /ft	m ³ /m		9.290 304°	E - 02
	U.S. gal/ft	m ³ /m		1.241 933	E - 02
		L/m		1.241 933	E + 01
Plane angle	rad	rad		1	
	deg (°)	rad		1.745 329	E - 02
	min (')	rad		2.908 882	E - 04
	sec (")	rad		4.848 137	E - 06
Solid angle	sr	sr		1	
Time	year	a		1	
	week	d		7.0°	E + 00
	h	s		3.6°	E + 03
		min		6.0°	E + 01
	min	s		6.0°	E + 01
		h		1.666 667	E - 02
	mµs	ns		1	
Mass, amount of substance					
Mass	U.K. ton	Mg	t	1.016 047	E + 00
	U.S. ton	Mg	t	9.071 847	E - 01
	U.K. cwt	kg		5.080 234	E + 01
	U.S. cwt	kg		4.535 924	E + 01
	lbm	kg		4.535 924	E - 01
	oz (troy)	g		3.110 348	E + 01
	oz (av)	g		2.834 952	E + 01
	gr	mg		6.479 891	E + 01

TABLE 1-4 Conversion Factors: U.S. Customary and Commonly Used Units to SI Units (Continued)

Quantity	Customary or commonly used unit	SI unit	Alternate SI unit	Conversion factor; multiply customary unit by factor to obtain SI unit	
Amount of substance	lbm-mol	kmol		4.535 924	E - 01
	std m ³ (0°C, 1 atm)	kmol		4.461 58	E - 02
	std ft ³ (60°F, 1 atm)	kmol		1.195 30	E - 03
Enthalpy, calorific value, heat, entropy, heat capacity					
Calorific value, enthalpy (mass basis)	Btu/lbm	MJ/kg	J/g	2.326 000	E - 03
		kJ/kg		2.326 000	E + 00
	cal/g cal/lbm	kWh/kg	J/g	6.461 112	E - 04
		kJ/kg J/kg		4.184 ^a	E + 00 9.224 141 E + 00
Caloric value, enthalpy (mole basis)	kcal/(g-mol)	kJ/kmol		4.184 ^a	E + 03
	Btu/(lb-mol)	kJ/kmol		2.326 000	E + 00
Calorific value (volume basis—solids and liquids)	Btu/U.S. gal	MJ/m ³	kJ/dm ³	2.787 163	E - 01
		kJ/m ³		2.787 163	E + 02
		kWh/m ³		7.742 119	E - 02
	Btu/U.K. gal	MJ/m ³	kJ/dm ³	2.320 800	E - 01
		kJ/m ³		2.320 800	E + 02
	Btu/ft ³	kWh/m ³	kJ/dm ³	6.446 667	E - 02
		MJ/m ³		3.725 895	E - 02
		kJ/m ³		3.725 895	E + 01
		kWh/m ³		1.034 971	E - 02
	cal/mL (ft-lbf)/U.S. gal	MJ/m ³		4.184 ^a	E + 00
kJ/m ³			3.581 692	E - 01	
Calorific value (volume basis—gases)	cal/mL	kJ/m ³	J/dm ³	4.184 ^a	E + 03
		kcal/m ³	J/dm ³	4.184 ^a	E + 00
	Btu/ft ³	kJ/m ³	J/dm ³	3.725 895	E + 01
		kWh/m ³	J/dm ³	1.034 971	E - 02
Specific entropy	Btu/(lbm-°R)	kJ/(kg-K)	J/(g-K)	4.186 8 ^a	E + 00
	cal/(g-K)	kJ/(kg-K)	J/(g-K)	4.184 ^a	E + 00
	kcal/(kg-°C)	kJ/(kg-K)	J/(g-K)	4.184 ^a	E + 00
Specific-heat capacity (mass basis)	kWh/(kg-°C)	kJ/(kg-K)	J/(g-K)	3.6 ^a	E + 03
		kJ/(kg-K)	J/(g-K)	4.186 8 ^a	E + 00
	Btu/(lbm-°F) kcal/(kg-°C)	kJ/(kg-K)	J/(g-K)	4.184 ^a	E + 00
Specific-heat capacity (mole basis)	Btu/(lb-mol-°F)	kJ/(kmol-K)		4.186 8 ^a	E + 00
	cal/(g-mol-°C)	kJ/(kmol-K)		4.184 ^a	E + 00
Temperature, pressure, vacuum					
Temperature (absolute)	°R	K		5/9	
	K	K		1	
Temperature (traditional)	°F	°C		5/9(°F - 32)	
Temperature (difference)	°F	K, °C		5/9	
Pressure	atm (760 mmHg at 0°C or 14.696 psi)	MPa		1.013 250 ^a	E - 01
		kPa		1.013 250 ^a	E + 02
		bar		1.013 250 ^a	E + 00
	bar	MPa		1.0 ^a	E - 01
		kPa		1.0 ^a	E + 02
	mmHg (0°C) = torr	MPa		6.894 757	E - 03
		kPa		6.894 757	E + 00
		bar		6.894 757	E - 02
	μmHg (0°C)	kPa		3.376 85	E + 00
	μ bar	kPa		2.488 4	E - 01
	mmHg = torr (0°C)	kPa		1.333 224	E - 01
	cmH ₂ O (4°C)	kPa		9.806 38	E - 02
	lbf/ft ² (psf)	kPa		4.788 026	E - 02
	mHg (0°C)	Pa		1.333 224	E - 01
	bar	Pa		1.0 ^a	E + 05
	dyn/cm ²	Pa		1.0 ^a	E - 01
	Vacuum, draft	inHg (60°F)	kPa		3.376 85
inH ₂ O (39.2°F)		kPa		2.490 82	E - 01
inH ₂ O (60°F)		kPa		2.488 4	E - 01
mmHg (0°C) = torr		kPa		1.333 224	E - 01
cmH ₂ O (4°C)		kPa		9.806 38	E - 02
Liquid head	ft	m		3.048 ^a	E - 01
	in	mm		2.54 ^a	E + 01
		cm		2.54 ^a	E + 00
Pressure drop/length	psi/ft	kPa/m		2.262 059	E + 01

TABLE 1-4 Conversion Factors: U.S. Customary and Commonly Used Units to SI Units (Continued)

Quantity	Customary or commonly used unit	SI unit	Alternate SI unit	Conversion factor; multiply customary unit by factor to obtain SI unit
Density, specific volume, concentration, dosage				
Density	lbm/ft ³	kg/m ³		1.601 846 E + 01
		g/m ³		1.601 846 E + 04
	lbm/U.S. gal	kg/m ³		1.198 264 E + 02
		g/cm ³		1.198 264 E - 01
	lbm/U.K. gal	kg/m ³		9.977 633 E + 01
	lbm/ft ³	kg/m ³		1.601 846 E + 01
		g/cm ³		1.601 846 E - 02
	g/cm ³	kg/m ³		1.0 ^a E + 03
	lbm/ft ³	kg/m ³		1.601 846 E + 01
Specific volume	ft ³ /lbm	m ³ /kg		6.242 796 E - 02
		m ³ /g		6.242 796 E - 05
	ft ³ /lbm	dm ³ /kg		6.242 796 E + 01
	U.K. gal/lbm	dm ³ /kg	cm ³ /g	1.002 242 E + 01
	U.S. gal/lbm	dm ³ /kg	cm ³ /g	8.345 404 E + 00
Specific volume (mole basis)	L/(g-mol)	m ³ /kmol		1
	ft ³ /(lb-mol)	m ³ /kmol		6.242 796 E - 02
Specific volume	bbbl/U.S. ton	m ³ /t		1.752 535 E - 01
	bbbl/U.K. ton	m ³ /t		1.564 763 E - 01
Yield	bbbl/U.S. ton	dm ³ /t	L/t	1.752 535 E + 02
	bbbl/U.K. ton	dm ³ /t	L/t	1.564 763 E + 02
	U.S. gal/U.S. ton	dm ³ /t	L/t	4.172 702 E + 00
	U.S. gal/U.K. ton	dm ³ /t	L/t	3.725 627 E + 00
Concentration (mass/mass)	wt %	kg/kg		1.0 ^a E - 02
		g/kg		1.0 ^a E + 01
	wt ppm	mg/kg		1
Concentration (mass/volume)	lbm/ bbl	kg/m ³	g/dm ³	2.853 010 E + 00
	g/U.S. gal	kg/m ³		2.641 720 E - 01
	g/U.K. gal	kg/m ³	g/L	2.199 692 E - 01
	lbm/1000 U.S. gal	g/m ³	mg/dm ³	1.198 264 E + 02
	lbm/1000 U.K. gal	g/m ³	mg/dm ³	9.977 633 E + 01
	gr/U.S. gal	g/m ³	mg/dm ³	1.711 806 E + 01
	gr/ft ³	mg/m ³		2.288 351 E + 03
	lbm/1000 bbl	g/m ³	mg/dm ³	2.853 010 E + 00
	mg/U.S. gal	g/m ³	mg/dm ³	2.641 720 E - 01
	gr/100 ft ³	mg/m ³		2.288 351 E + 01
Concentration (volume/volume)	ft ³ /ft ³	m ³ /m ³		1
	bbbl/(acre-ft)	m ³ /m ³		1.288 931 E - 04
	vol%	m ³ /m ³		1.0 ^a E - 02
	U.K. gal/ft ³	dm ³ /m ³	L/m ³	1.605 437 E + 02
	U.S. gal/ft ³	dm ³ /m ³	L/m ³	1.336 806 E + 02
	mL/U.S. gal	dm ³ /m ³	L/m ³	2.641 720 E - 01
	mL/U.K. gal	dm ³ /m ³	L/m ³	2.199 692 E - 01
	vol ppm	cm ³ /m ³		1
		dm ³ /m ³	L/m ³	1.0 ^a E - 03
	U.K. gal/1000 bbl	cm ³ /m ³		2.859 403 E + 01
	U.S. gal/1000 bbl	cm ³ /m ³		2.380 952 E + 01
U.K. pt/1000 bbl	cm ³ /m ³		3.574 253 E + 00	
Concentration (mole/volume)	(lb-mol)/U.S. gal	kmol/m ³		1.198 264 E + 02
	(lb-mol)/U.K. gal	kmol/m ³		9.977 644 E + 01
	(lb-mol)/ft ³	kmol/m ³		1.601 846 E + 01
	std ft ³ (60°F, 1 atm)/bbl	kmol/m ³		7.518 21 E - 03
Concentration (volume/mole)	U.S. gal/1000 std ft ³ (60°F/60°F)	dm ³ /kmol	L/kmol	3.166 91 E + 00
	bbbl/million std ft ³ (60°F/60°F)	dm ³ /kmol	L/kmol	1.330 10 E - 01
Facility throughput, capacity				
Throughput (mass basis)	U.K. ton/year	t/a		1.016 047 E + 00
	U.S. ton/year	t/a		9.071 847 E - 01
	U.K. ton/day	t/d		1.016 047 E + 00
		t/h		4.233 529 E - 02
	U.S. ton/day	t/d		9.071 847 E - 01
		t/h		3.779 936 E - 02
	U.K. ton/h	t/h		1.016 047 E + 00
	U.S. ton/h	t/h		9.071 847 E - 01
	lbm/h	kg/h		4.535 924 E - 01

TABLE 1-4 Conversion Factors: U.S. Customary and Commonly Used Units to SI Units (Continued)

Quantity	Customary or commonly used unit	SI unit	Alternate SI unit	Conversion factor; multiply customary unit by factor to obtain SI unit
Throughput (volume basis)	bbbl/day	t/a		5.803 036 E + 01
		m ³ /d		1.589 873 E - 01
	ft ³ /day	m ³ /h		1.179 869 E - 03
	bbbl/h	m ³ /h		1.589 873 E - 01
	ft ³ /h	m ³ /h		2.831 685 E - 02
	U.K. gal/h	m ³ /h		4.546 092 E - 03
		L/s		1.262 803 E - 03
	U.S. gal/h	m ³ /h		3.785 412 E - 03
		L/s		1.051 503 E - 03
	U.K. gal/min	m ³ /h		2.727 655 E - 01
	L/s		7.576 819 E - 02	
U.S. gal/min	m ³ /h		2.271 247 E - 01	
	L/s		6.309 020 E - 02	
Throughput (mole basis)	(lbm-mol)/h	kmol/h		4.535 924 E - 01
		kmol/s		1.259 979 E - 04
Flow rate				
Flow rate (mass basis)	U.K. ton/min	kg/s		1.693 412 E + 01
	U.S. ton/min	kg/s		1.511 974 E + 01
	U.K. ton/h	kg/s		2.822 353 E - 01
	U.S. ton/h	kg/s		2.519 958 E - 01
	U.K. ton/day	kg/s		1.175 980 E - 02
	U.S. ton/day	kg/s		1.049 982 E - 02
	million lbm/year	kg/s		5.249 912 E + 00
	U.K. ton/year	kg/s		3.221 864 E - 05
	U.S. ton/year	kg/s		2.876 664 E - 05
	lbm/s	kg/s		4.535 924 E - 01
	lbm/min	kg/s		7.559 873 E - 03
	lbm/h	kg/s		1.259 979 E - 04
	Flow rate (volume basis)	bbbl/day	m ³ /d	
		L/s		1.840 131 E - 03
ft ³ /day		m ³ /d		2.831 685 E - 02
		L/s		3.277 413 E - 04
bbbl/h		m ³ /s		4.416 314 E - 05
		L/s		4.416 314 E - 02
ft ³ /h		m ³ /s		7.865 791 E - 06
		L/s		7.865 791 E - 03
U.K. gal/h		dm ³ /s	L/s	1.262 803 E - 03
U.S. gal/h		dm ³ /s	L/s	1.051 503 E - 03
U.K. gal/min		dm ³ /s	L/s	7.576 820 E - 02
U.S. gal/min		dm ³ /s	L/s	6.309 020 E - 02
ft ³ /min		dm ³ /s	L/s	4.719 474 E - 01
ft ³ /s	dm ³ /s	L/s	2.831 685 E + 01	
Flow rate (mole basis)	(lb-mol)/s	kmol/s		4.535 924 E - 01
	(lb-mol)/h	kmol/s		1.259 979 E - 04
	million scf/D	kmol/s		1.383 45 E - 02
Flow rate/length (mass basis)	lbm/(s-ft)	kg/(s-m)		1.488 164 E + 00
	lbm/(h-ft)	kg/(s-m)		4.133 789 E - 04
Flow rate/length (volume basis)	U.K. gal/(min-ft)	m ² /s	m ³ /(s-m)	2.485 833 E - 04
	U.S. gal/(min-ft)	m ² /s	m ³ /(s-m)	2.069 888 E - 04
	U.K. gal/(h-in)	m ² /s	m ³ /(s-m)	4.971 667 E - 05
	U.S. gal/(h-in)	m ² /s	m ³ /(s-m)	4.139 776 E - 05
	U.K. gal/(h-ft)	m ² /s	m ³ /(s-m)	4.143 055 E - 06
	U.S. gal/(h-ft)	m ² /s	m ³ /(s-m)	3.449 814 E - 06
Flow rate/area (mass basis)	lbm/(s-ft ²)	kg/(s-m ²)		4.882 428 E + 00
	lbm/(h-ft ²)	kg/(s-m ²)		1.356 230 E - 03
Flow rate/area (volume basis)	ft ³ /(s-ft ²)	m/s	m ³ /(s-m ²)	3.048° E - 01
	ft ³ /(min-ft ²)	m/s	m ³ /(s-m ²)	5.08° E - 03
	U.K. gal/(h-in ²)	m/s	m ³ /(s-m ²)	1.957 349 E - 03
	U.S. gal/(h-in ²)	m/s	m ³ /(s-m ²)	1.629 833 E - 03
	U.K. gal/(min-ft ²)	m/s	m ³ /(s-m ²)	8.155 621 E - 04
	U.S. gal/(min-ft ²)	m/s	m ³ /(s-m ²)	6.790 972 E - 04
	U.K. gal/(h-ft ²)	m/s	m ³ /(s-m ²)	1.359 270 E - 05
	U.S. gal/(h-ft ²)	m/s	m ³ /(s-m ²)	1.131 829 E - 05

TABLE 1-4 Conversion Factors: U.S. Customary and Commonly Used Units to SI Units (Continued)

Quantity	Customary or commonly used unit	SI unit	Alternate SI unit	Conversion factor; multiply customary unit by factor to obtain SI unit	
Energy, work, power					
Energy, work	therm	MJ		1.055 056 E + 02	
		kJ		1.055 056 E + 05	
	U.S. tonf-mi	kWh			2.930 711 E + 01
		MJ			1.431 744 E + 01
	hp-h	MJ			2.684 520 E + 00
		kJ			2.684 520 E + 03
		kWh			7.456 999 E - 01
	ch-h or CV-h	MJ			2.647 780 E + 00
		kJ			2.647 780 E + 03
		kWh			7.354 999 E - 01
	kWh	MJ			3.6° E + 00
		kJ			3.6° E + 03
	Chu	kJ			1.899 101 E + 00
		kWh			5.275 280 E - 04
	Btu	kJ			1.055 056 E + 00
		kWh			2.930 711 E - 04
kcal	kJ			4.184° E + 00	
	cal	kJ		4.184° E - 03	
ft-lbf	kJ			1.355 818 E - 03	
	lbf-ft	kJ		1.355 818 E - 03	
J	kJ			1.0° E - 03	
	(lbf-ft ²)/s ²	kJ		4.214 011 E - 05	
erg	J			1.0° E - 07	
	J				
Impact energy	kgf-m	J		9.806 650° E + 00	
	lbf-ft	J		1.355 818 E + 00	
Surface energy	erg/cm ²	mJ/m ²		1.0° E + 00	
Specific-impact energy	(kgf-m)/cm ²	J/cm ²		9.806 650° E - 02	
	(lbf-ft)/in ²	J/cm ²		2.101 522 E - 03	
Power	million Btu/h	MW		2.930 711 E - 01	
	ton of refrigeration	kW		3.516 853 E + 00	
	Btu/s	kW		1.055 056 E + 00	
	kW	kW		1	
	hydraulic horsepower—hhp	kW		7.460 43 E - 01	
	hp (electric)	kW		7.46° E - 01	
	hp [(550 ft-lbf)/s]	kW		7.456 999 E - 01	
	ch or CV	kW		7.354 999 E - 01	
	Btu/min	kW		1.758 427 E - 02	
	(ft-lbf)/s	kW		1.355 818 E - 03	
	kcal/h	W		1.162 222 E + 00	
	Btu/h	W		2.930 711 E - 01	
(ft-lbf)/min	W		2.259 697 E - 02		
Power/area	Btu/(s-ft ²)	kW/m ²		1.135 653 E + 01	
	cal/(h-cm ²)	kW/m ²		1.162 222 E - 02	
	Btu/(h-ft ²)	kW/m ²		3.154 591 E - 03	
Heat-release rate, mixing power	hp/ft ³	kW/m ³		2.633 414 E + 01	
	cal/(h-cm ³)	kW/m ³		1.162 222 E + 00	
	Btu/(s-ft ³)	kW/m ³		3.725 895 E + 01	
	Btu/(h-ft ³)	kW/m ³		1.034 971 E - 02	
Cooling duty (machinery)	Btu/(bhp-h)	W/kW		3.930 148 E - 01	
Specific fuel consumption (mass basis)	lbm/(hp-h)	mg/J	kg/MJ	1.689 659 E - 01	
		kg/kWh		6.082 774 E - 01	
Specific fuel consumption (volume basis)	m ³ /kWh	dm ³ /MJ	mm ³ /J	2.777 778 E + 02	
	U.S. gal/(hp-h)	dm ³ /MJ	mm ³ /J	1.410 089 E + 00	
	U.K. pt/(hp-h)	dm ³ /MJ	mm ³ /J	2.116 806 E - 01	
Fuel consumption	U.K. gal/mi	dm ³ /100 km	L/100 km	2.824 807 E + 02	
	U.S. gal/mi	dm ³ /100 km	L/100 km	2.352 146 E + 02	
	mi/U.S. gal	km/dm ³	km/L	4.251 437 E - 01	
	mi/U.K. gal	km/dm ³	km/L	3.540 064 E - 01	

TABLE 1-4 Conversion Factors: U.S. Customary and Commonly Used Units to SI Units (Continued)

Quantity	Customary or commonly used unit	SI unit	Alternate SI unit	Conversion factor; multiply customary unit by factor to obtain SI unit	
Velocity (linear), speed	knot	km/h		1.852°	E + 00
	mi/h	km/h		1.609 344°	E + 00
	ft/s	m/s		3.048°	E - 01
		cm/s		3.048°	E + 01
	ft/min	m/s		5.08°	E - 03
	ft/h	mm/s		8.466 667	E - 02
	ft/day	mm/s		3.527 778	E - 03
		m/d		3.048°	E - 01
	in/s	mm/s		2.54°	E + 01
	in/min	mm/s		4.233 333	E - 01
Corrosion rate	in/year (ipy)	mm/a		2.54°	E + 01
	mil/year	mm/a		2.54°	E - 02
Rotational frequency	r/min	r/s		1.666 667	E - 02
		rad/s		1.047 198	E - 01
Acceleration (linear)	ft/s ²	m/s ²		3.048°	E - 01
		cm/s ²		3.048°	E + 01
Acceleration (rotational)	rpm/s	rad/s ²		1.047 198	E - 01
Momentum	(lbm-ft)/s	(kg-m)/s		1.382 550	E - 01
Force	U.K. tonf	kN		9.964 016	E + 00
	U.S. tonf	kN		8.896 443	E + 00
	kgf (kp)	N		9.806 650°	E + 00
	lbf	N		4.448 222	E + 00
	dyn	mN		1.0	E - 02
Bending moment, torque	U.S. tonf-ft	kN-m		2.711 636	E + 00
	kgf-m	N-m		9.806 650°	E + 00
	lbf-ft	N-m		1.355 818	E + 00
	lbf-in	N-m		1.129 848	E - 01
Bending moment/length	(lbf-ft)/in	(N-m)/m		5.337 866	E + 01
	(lbf-in)/in	(N-m)/m		4.448 222	E + 00
Moment of inertia	lbm-ft ²	kg-m ²		4.214 011	E - 02
Stress	U.S. tonf/in ²	MPa	N/mm ²	1.378 951	E + 01
	kgf/mm ²	MPa	N/mm ²	9.806 650°	E + 00
	U.S. tonf/ft ²	MPa	N/mm ²	9.576 052	E - 02
	lbf/in ² (psi)	MPa	N/mm ²	6.894 757	E - 03
	lbf/ft ² (psf)	kPa		4.788 026	E - 02
	dyn/cm ²	Pa		1.0°	E - 01
Mass/length	lbm/ft	kg/m		1.488 164	E + 00
Mass/area structural loading, bearing capacity (mass basis)	U.S. ton/ft ²	Mg/m ²		9.764 855	E + 00
	lbm/ft ²	kg/m ²		4.882 428	E + 00
Miscellaneous transport properties					
Diffusivity	ft ² /s	m ² /s		9.290 304°	E - 02
	m ² /s	mm ² /s		1.0°	E + 06
	ft ² /h	m ² /s		2.580 64°	E - 05
Thermal resistance	(°C-m ² -h)/kcal	(K-m ²)/kW		8.604 208	E + 02
	(°F-ft ² -h)/Btu	(K-m ²)/kW		1.761 102	E + 02
Heat flux	Btu/(h-ft ²)	kW/m ²		3.154 591	E - 03
Thermal conductivity	(cal-cm)/(s-cm ² -°C)	W/(m-K)		4.184°	E + 02
	(Btu-ft)/(h-ft ² -°F)	W/(m-K)		1.730 735	E + 00
		(kJ-m)/(h-m ² -K)		6.230 646	E + 00
	(kcal-m)/(h-m ² -°C)	W/(m-K)		1.162 222	E + 00
	(Btu-in)/(h-ft ² -°F)	W/(m-K)		1.442 279	E - 01
	(cal-cm)/(h-cm ² -°C)	W/(m-K)		1.162 222	E - 01
Heat-transfer coefficient	cal/(s-cm ² -°C)	kW/(m ² -K)		4.184°	E + 01
	Btu/(s-ft ² -°F)	kW/(m ² -K)		2.044 175	E + 01
	cal/(h-cm ² -°C)	kW/(m ² -K)		1.162 222	E - 02
	Btu/(h-ft ² -°F)	kW/(m ² -K)		5.678 263	E - 03
		kJ/(h-m ² -K)		2.044 175	E + 01
		Btu/(h-ft ² -°R)	kW/(m ² -K)		5.678 263
	kcal/(h-m ² -°C)	kW/(m ² -K)		1.162 222	E - 03

TABLE 1-4 Conversion Factors: U.S. Customary and Commonly Used Units to SI Units (Continued)

Quantity	Customary or commonly used unit	SI unit	Alternate SI unit	Conversion factor; multiply customary unit by factor to obtain SI unit
Volumetric heat-transfer coefficient	Btu/(s-ft ³ -°F)	kW/(m ³ -K)		6.706 611 E + 01
	Btu/(h-ft ³ -°F)	kW/(m ³ -K)		1.862 947 E - 02
Surface tension	dyn/cm	mN/m		1
Viscosity (dynamic)	(lbf-s)/in ²	Pa-s	(N-s)/m ²	6.894 757 E + 03
	(lbf-s)/ft ²	Pa-s	(N-s)/m ²	4.788 026 E + 01
	(kgf-s)/m ²	Pa-s	(N-s)/m ²	9.806 650 ^a E + 00
	lbm/(ft-s)	Pa-s	(N-s)/m ²	1.488 164 E + 00
	(dyn-s)/cm ²	Pa-s	(N-s)/m ²	1.0 ^a E - 01
	cP	Pa-s	(N-s)/m ²	1.0 ^a E - 03
Viscosity (kinematic)	lbm/(ft-h)	Pa-s	(N-s)/m ²	4.133 789 E - 04
	ft ² /s	m ² /s		9.290 304 ^a E - 02
	in ² /s	mm ² /s		6.451 6 ^a E + 02
	m ² /h	mm ² /s		2.777 778 E + 02
	ft ² /h	m ² /s		2.580 64 ^a E - 05
Permeability	darcy	μm ²		9.869 233 E - 01
	millidarcy	μm ²		9.869 233 E - 04
Thermal flux	Btu/(h-ft ²)	W/m ²		3.152 E + 00
	Btu/(s-ft ²)	W/m ²		1.135 E + 04
	cal/(s-cm ²)	W/m ²		4.184 E + 04
Mass-transfer coefficient	(lb-mol)/[h-ft ² (lb-mol/ft ³)]	m/s		8.467 E - 05
	(g-mol)/[s-m ² (g-mol/L)]	m/s		1.0 E + 01
Electricity, magnetism				
Admittance	S	S		1
Capacitance	μF	μF		1
Charge density	C/mm ³	C/mm ³		1
Conductance	S	S		1
	Ū (mho)	S		1
Conductivity	S/m	S/m		1
	Ū/m	S/m		1
	mŪ/m	mS/m		1
Current density	A/mm ²	A/mm ²		1
Displacement	C/cm ²	C/cm ²		1
Electric charge	C	C		1
Electric current	A	A		1
Electric-dipole moment	C-m	C-m		1
Electric-field strength	V/m	V/m		1
Electric flux	C	C		1
Electric polarization	C/cm ²	C/cm ²		1
Electric potential	V	V		1
	mV	mV		1
Electromagnetic moment	A-m ²	A-m ²		1
Electromotive force	V	V		1
Flux of displacement	C	C		1
Frequency	cycles/s	Hz		1
Impedance	Ω	Ω		1
Linear-current density	A/mm	A/mm		1
Magnetic-dipole moment	Wb-m	Wb-m		1
Magnetic-field strength	A/mm	A/mm		1
	Oe	A/m		7.957 747 E + 01
	gamma	A/m		7.957 747 E - 04
Magnetic flux	mWb	mWb		1

TABLE 1-4 Conversion Factors: U.S. Customary and Commonly Used Units to SI Units (Continued)

Quantity	Customary or commonly used unit	SI unit	Alternate SI unit	Conversion factor; multiply customary unit by factor to obtain SI unit
Magnetic-flux density	mT	mT		1
	G	T		1.0 ^a E - 04
	gamma	nT		1
Magnetic induction	mT	mT		1
Magnetic moment	A·m ²	A·m ²		1
Magnetic polarization	mT	mT		1
Magnetic potential difference	A	A		1
Magnetic-vector potential	Wb/mm	Wb/mm		1
Magnetization	A/mm	A/mm		1
Modulus of admittance	S	S		1
Modulus of impedance	Ω	Ω		1
Mutual inductance	H	H		1
Permeability	μH/m	μH/m		1
Permeance	H	H		1
Permittivity	μF/m	μF/m		1
Potential difference	V	V		1
Quantity of electricity	C	C		1
Reactance	Ω	Ω		1
Reluctance	H ⁻¹	H ⁻¹		1
Resistance	Ω	Ω		1
Resistivity	Ω·cm	Ω·cm		1
	Ω·m	Ω·m		1
Self-inductance	mH	mH		1
Surface density of charge	mC/m ²	mC/m ²		1
Susceptance	S	S		1
Volume density of charge	C/mm ³	C/mm ³		1
Acoustics, light, radiation				
Absorbed dose	rad	Gy		1.0 ^a E - 02
Acoustical energy	J	J		1
Acoustical intensity	W/cm ²	W/m ²		1.0 ^a E + 04
Acoustical power	W	W		1
Sound pressure	N/m ²	N/m ²		1.0 ^a
Illuminance	fc	lx		1.076 391 E + 01
Illumination	fc	lx		1.076 391 E + 01
Irradiance	W/m ²	W/m ²		1
Light exposure	fc·s	lx·s		1.076 391 E + 01
Luminance	cd/m ²	cd/m ²		1
Luminous efficacy	lm/W	lm/W		1
Luminous exitance	lm/m ²	lm/m ²		1
Luminous flux	lm	lm		1
Luminous intensity	cd	cd		1
Radiance	W/m ² ·sr	W/m ² ·sr		1
Radiant energy	J	J		1
Radiant flux	W	W		1
Radiant intensity	W/sr	W/sr		1
Radiant power	W	W		1

TABLE 1-4 Conversion Factors: U.S. Customary and Commonly Used Units to SI Units (Concluded)

Quantity	Customary or commonly used unit	SI unit	Alternate SI unit	Conversion factor; multiply customary unit by factor to obtain SI unit	
Wavelength	Å	nm		1.0*	E - 01
Capture unit	10 ⁻³ cm ⁻¹	m ⁻¹		1.0*	E + 01
	m ⁻¹	m ⁻¹	10 ⁻³ cm ⁻¹	1	1
Radioactivity	Ci	Bq		3.7*	E + 10

* An asterisk indicates that the conversion factor is exact.

† Conversion factors for length, area, and volume are based on the international foot. The international foot is longer by 2 parts in 1 million than the U.S. Survey foot (land-measurement use).

NOTE: The following unit symbols are used in the table:

Unit symbol	Name	Unit symbol	Name
A	ampere	lm	lumen
a	annum (year)	lx	lux
Bq	becquerel	m	meter
C	coulomb	min	minute
cd	candela	'	minute
Ci	curie	N	newton
d	day	naut mi	U.S. nautical mile
°C	degree Celsius	Oe	oersted
°	degree	Ω	ohm
dyn	dyne	Pa	pascal
F	farad	rad	radian
fc	footcandle	r	revolution
G	gauss	S	siemens
g	gram	s	second
gr	grain	"	second
Gy	gray	sr	steradian
H	henry	St	stokes
h	hour	T	tesla
ha	hectare	t	tonne
Hz	hertz	V	volt
J	joule	W	watt
K	kelvin	Wb	weber
L, ℓ, l	liter		

NOTE: Copyright SPE-AIME, *The SI Metric System of Units and SPE's Tentative Metric Standard*, Society of Petroleum Engineers, Dallas, 1977.

TABLE 1-5 Metric Conversion Factors as Exact Numerical Multiples of SI Units

The first two digits of each numerical entry represent a power of 10. For example, the entry “-02 2.54” expresses the fact that 1 in = 2.54 × 10⁻² m.

To convert from	To	Multiply by	To convert from	To	Multiply by
abampere	ampere	+01 1.00	fluid ounce (U.S.)	meter ³	-05 2.957 352
abcoulomb	coulomb	+01 1.00	foot	meter	-01 3.048
abfarad	farad	+09 1.00	foot (U.S. survey)	meter	-01 3.048 006
abhenry	henry	-09 1.00	foot of water (39.2°F)	newton/meter ²	+03 2.988 98
abmho	mho	+09 1.00	footcandle	lumen/meter ²	+01 1.076 391
abohm	ohm	-09 1.00	footlambert	candela/meter ²	+00 3.426 259
abvolt	volt	-08 1.00	furlong	meter	+02 2.011 68
acre	meter ²	+03 4.046 856	gal (galileo)	meter/second ²	-02 1.00
ampere (international of 1948)	ampere	-01 9.998 35	gallon (U.K. liquid)	meter ³	-03 4.546 087
angstrom	meter	-10 1.00	gallon (U.S. dry)	meter ³	-03 4.404 883
are	meter ²	+02 1.00	gallon (U.S. liquid)	meter ³	-03 3.785 411
astronomical unit	meter	+11 1.495 978	gamma	tesla	-09 1.00
atmosphere	newton/meter ²	+05 1.013 25	gauss	tesla	-04 1.00
bar	newton/meter ²	+05 1.00	gilbert	ampere turn	-01 7.957 747
barn	meter ²	-28 1.00	gill (U.K.)	meter ³	-04 1.420 652
barrel (petroleum 42 gal)	meter ³	-01 1.589 873	gill (U.S.)	meter ³	-04 1.182 941
barye	newton/meter ²	-01 1.00	grad	degree (angular)	-01 9.00
British thermal unit (ISO/TC 12)	joule	+03 1.055 06	grad	radian	-02 1.570 796
British thermal unit (International Steam Table)	joule	+03 1.055 04	grain	kilogram	-05 6.479 891
British thermal unit (mean)	joule	+03 1.055 87	gram	kilogram	-03 1.00
British thermal unit (thermochemical)	joule	+03 1.054 350	hand	meter	-01 1.016
British thermal unit (39°F)	joule	+03 1.059 67	hectare	meter ²	+04 1.00
British thermal unit (60°F)	joule	+03 1.054 68	henry (international of 1948)	henry	+00 1.000 495
bushel (U.S.)	meter ³	-02 3.523 907	hoghead (U.S.)	meter ³	-01 2.354 809
cable	meter	+02 2.194 56	horsepower (550 ft lbf/s)	watt	+02 7.456 998
caliber	meter	-04 2.54	horsepower (boiler)	watt	+03 9.809 50
calorie (International Steam Table)	joule	+00 4.1868	horsepower (electric)	watt	+02 7.46
calorie (mean)	joule	+00 4.190 02	horsepower (metric)	watt	+02 7.354 99
calorie (thermochemical)	joule	+00 4.184	horsepower (U.K.)	watt	+02 7.457
calorie (15°C)	joule	+00 4.185 80	horsepower (water)	watt	+02 7.460 43
calorie (20°C)	joule	+00 4.181 90	hour (mean solar)	second (mean solar)	+03 3.60
calorie (kilogram, International Steam Table)	joule	+03 4.186 8	hour (sidereal)	second (mean solar)	+03 3.590 170
calorie (kilogram, mean)	joule	+03 4.190 02	hundredweight (long)	kilogram	+01 5.080 234
calorie (kilogram, thermochemical)	joule	+03 4.184	hundredweight (short)	kilogram	+01 4.535 923
carat (metric)	kilogram	-04 2.00	inch	meter	-02 2.54
Celsius (temperature)	kelvin	$t_K = t_C + 273.15$	inch of mercury (32°F)	newton/meter ²	+03 3.386 389
centimeter of mercury (0°C)	newton/meter ²	+03 1.333 22	inch of mercury (60°F)	newton/meter ²	+03 3.376 85
centimeter of water (4°C)	newton/meter ²	+01 9.806 38	inch of water (39.2°F)	newton/meter ²	+02 2.490 82
chain (engineer's)	meter	+01 3.048	inch of water (60°F)	newton/meter ²	+02 2.4884
chain (surveyor's or Gunter's)	meter	+01 2.011 68	joule (international of 1948)	joule	+00 1.000 165
circular mil	meter ²	-10 5.067 074	kayser	l/meter	+02 1.00
cord	meter ³	+00 3.624 556	kilocalorie (International Steam Table)	joule	+03 4.186 74
coulomb (international of 1948)	coulomb	-01 9.998 35	kilocalorie (mean)	joule	+03 4.190 02
cubit	meter	-01 4.572	kilocalorie (thermochemical)	joule	+03 4.184
cup	meter ³	-04 2.365 882	kilogram mass	kilogram	+00 1.00
curie	disintegration/second	+10 3.70	kilogram-force (kgf)	newton	+00 9.806 65
day (mean solar)	second (mean solar)	+04 8.64	kilopond-force	newton	+00 9.806 65
day (sidereal)	second (mean solar)	+04 8.616 409	kip	newton	+03 4.448 221
degree (angle)	radian	-02 1.745 329	knot (international)	meter/second	-01 5.144 444
denier (international)	kilogram/meter	-07 1.111 111	lambert	candela/meter ²	+04 1/π
dram (avoirdupois)	kilogram	-03 1.771 845	lambert	candela/meter ²	+03 3.183 098
dram (troy or apothecary)	kilogram	-03 3.887 934	langley	joule/meter ²	+04 4.184
dram (U.S. fluid)	meter ³	-06 3.696 691	lbf (pound-force, avoirdupois)	newton	+00 4.448 221
dyne	newton	-05 1.00	lbf (pound-mass, avoirdupois)	kilogram	-01 4.535 923
electron volt	joule	-19 1.602 10	league (British nautical)	meter	+03 5.559 552
erg	joule	-07 1.00	league (international nautical)	meter	+03 5.556
Fahrenheit (temperature)	kelvin	$t_K = (5/9)(t_F + 459.67)$	league (statute)	meter	+03 4.828 032
Fahrenheit (temperature)	Celsius	$t_C = (5/9)(t_F - 32)$	light-year	meter	+15 9.460 55
farad (international of 1948)	farad	-01 9.995 05	link (engineer's)	meter	-01 3.048
faraday (based on carbon 12)	coulomb	+04 9.648 70	link (surveyor's or Gunter's)	meter	-01 2.011 68
faraday (chemical)	coulomb	+04 9.649 57	liter	meter ³	-03 1.00
faraday (physical)	coulomb	+04 9.652 19	lux	lumen/meter ²	+00 1.00
fathom	meter	+00 1.828 8	maxwell	weber	-08 1.00
fermi (femtometer)	meter	-15 1.00	meter	wavelengths Kr 86	+06 1.650 763
			micrometer	meter	-06 1.00
			mil	meter	-05 2.54
			mile (U.S. statute)	meter	+03 1.609 344
			mile (U.K. nautical)	meter	+03 1.853 184
			mile (international nautical)	meter	+03 1.852
			mile (U.S. nautical)	meter	+03 1.852
			millibar	newton/meter ²	+02 1.00
			millimeter of mercury (0°C)	newton/meter ²	+02 1.333 224

TABLE 1-5 Metric Conversion Factors as Exact Numerical Multiples of SI Units (Concluded)

The first two digits of each numerical entry represent a power of 10. For example, the entry “-02 2.54” expresses the fact that 1 in = 2.54 × 10⁻²

To convert from	To	Multiply by	To convert from	To	Multiply by
minute (angle)	radian	-04 2.908 882	second (ephemeris)	second	+00 1.000 000
minute (mean solar)	second (mean solar)	+01 6.00	second (mean solar)	second (ephemeris)	Consult
minute (sidereal)	second (mean solar)	+01 5.983 617			American
month (mean calendar)	second (mean solar)	+06 2.628			Ephemeris
nautical mile (international)	meter	+03 1.852			and Nautical
nautical mile (U.S.)	meter	+03 1.852			Almanac
nautical mile (U.K.)	meter	+03 1.853 184	second (sidereal)	second (mean solar)	-01 9.972 695
oersted	ampere/meter	+01 7.957 747	section	meter ²	+06 2.589 988
ohm (international of 1948)	ohm	+00 1.000 495	scruple (apothecary)	kilogram	-03 1.295 978
ounce-force (avoirdupois)	newton	-01 2.780 138	shake	second	-08 1.00
ounce-mass (avoirdupois)	kilogram	-02 2.834 952	skein	meter	+02 1.097 28
ounce-mass (troy or apothecary)	kilogram	-02 3.110 347	slug	kilogram	+01 1.459 390
ounce (U.S. fluid)	meter ³	-05 2.957 352	span	meter	-01 2.286
pace	meter	-01 7.62	statampere	ampere	-10 3.335 640
parsec	meter	+16 3.083 74	statcoulomb	coulomb	-10 3.335 640
pascal	newton/meter ²	+00 1.00	statfarad	farad	-12 1.112 650
peck (U.S.)	meter ³	-03 8.809 767	stathenry	henry	+11 8.987 554
pennyweight	kilogram	-03 1.555 173	statmho	mho	-12 1.112 650
perch	meter	+00 5.0292	statohm	ohm	+11 8.987 554
phot	lumen/meter ²	+04 1.00	statute mile (U.S.)	meter	+03 1.609 344
pica (printer's)	meter	-03 4.217 517	statvolt	volt	+02 2.997 925
pint (U.S. dry)	meter ³	-04 5.506 104	stere	meter ³	+00 1.00
pint (U.S. liquid)	meter ³	-04 4.731 764	stilb	candela/meter ²	+04 1.00
point (printer's)	meter	-04 3.514 598	stoke	meter ² /second	-04 1.00
poise	(newton-second)/meter ²	-01 1.00	tablespoon	meter ³	-05 1.478 676
pole	meter	+00 5.0292	teaspoon	meter ³	-06 4.928 921
pound-force (lbf avoirdupois)	newton	+00 4.448 221	ton (assay)	kilogram	-02 2.916 666
pound-mass (lbm avoirdupois)	kilogram	-01 4.535 923	ton (long)	kilogram	+03 1.016 046
pound-mass (troy or apothecary)	kilogram	-01 3.732 417	ton (metric)	kilogram	+03 1.00
poundal	newton	-01 1.382 549	ton (nuclear equivalent of TNT)	joule	+09 4.20
quart (U.S. dry)	meter ³	-03 1.101 220	ton (register)	meter ³	+00 2.831 684
quart (U.S. liquid)	meter ³	-04 9.463 529	ton (short, 2000 lb)	kilogram	+02 9.071 847
rad (radiation dose absorbed)	joule/kilogram	-02 1.00	tonne	kilogram	+03 1.00
Rankine (temperature)	kelvin	$t_K = (5/9)t_R$	torr (0°C)	newton/meter ²	+02 1.333 22
rayleigh (rate of photon emission)	1/second-meter ²	+10 1.00	township	meter ²	+07 9.323 957
rhe	meter ² /(newton-second)	+01 1.00	unit pole	weber	-07 1.256 637
rod	meter	+00 5.0292	volt (international of 1948)	volt	+00 1.000 330
roentgen	coulomb/kilogram	-04 2.579 76	watt (international of 1948)	watt	+00 1.000 165
rutherford	disintegration/second	+06 1.00	yard	meter	-01 9.144
second (angle)	radian	-06 4.848 136	year (calendar)	second (mean solar)	+07 3.1536
			year (sidereal)	second (mean solar)	+07 3.155 815
			year (tropical)	second (mean solar)	+07 3.155 692
			year 1900, tropical, Jan., day 0, hour 12	second (ephemeris)	+07 3.155 692
			year 1900, tropical, Jan., day 0, hour 12	second	+07 3.155 692

TABLE 1-6 Alphabetical Listing of Common Conversions

To convert from	To	Multiply by	To convert from	To	Multiply by
Acres	Square feet	43,560	B.t.u. (60°F.) per degree Fahrenheit	Calories per degree centigrade	453.6
Acres	Square meters	4074	Bushels (U.S. dry)	Cubic feet	1.2444
Acres	Square miles	0.001563	Bushels (U.S. dry)	Cubic meters	0.03524
Acres-foot	Cubic meters	1233	Calories, gram	B.t.u.	3.968×10^{-3}
Ampere-hours (absolute)	Coulombs (absolute)	3600	Calories, gram	Foot-pounds	3.087
Angstrom units	Inches	3.937×10^{-9}	Calories, gram	Joules	4.1868
Angstrom units	Meters	1×10^{-10}	Calories, gram	Liter-atmospheres	4.130×10^{-2}
Angstrom units	Microns	1×10^{-4}	Calories, gram	Horsepower-hours	1.5591×10^{-6}
Atmospheres	Millimeters of mercury at 32°F	760	Calories, gram, per gram per degree C.	Kilowatt-hours	4186.8
Atmospheres	Dynes per square centimeter	1.0133×10^6	Calories, kilogram	Kilowatts	0.0011626
Atmospheres	Newton's per square meter	101,325	Calories, kilogram per second	Lumens	4.185
Atmospheres	Feet of water at 39.1°F	33.90	Candle power (spherical)	Grams	12.556
Atmospheres	Grams per square centimeter	1033.3	Carats (metric)	B.t.u.	0.2
Atmospheres	Inches of mercury at 32°F	29.921	Centigrade heat units	Angstrom units	1×10^8
Atmospheres	Pounds per square foot	2116.3	Centimeters	Feet	0.03281
Atmospheres	Pounds per square inch	14.696	Centimeters	Inches	0.3937
Bags (cement)	Pounds (cement)	94	Centimeters	Meters	0.01
Barrels (cement)	Pounds (cement)	376	Centimeters	Microns	10,000
Barrels (oil)	Cubic meters	0.15899	Centimeters of mercury at 0°C.	Atmospheres	0.013158
Barrels (U.S. liquid)	Gallons	42	Centimeters of mercury at 0°C.	Feet of water at 39.1°F.	0.4460
Barrels (U.S. liquid)	Cubic meters	0.11924	Centimeters of mercury at 0°C.	Newtons per square meter	1.333.2
Barrels per day	Gallons	31.5	Centimeters of mercury at 0°C.	Pounds per square foot	27.845
Bars	Gallons per minute	0.02917	Centimeters of mercury at 0°C.	Pounds per square inch	0.19337
Bars	Atmospheres	0.9869	Centimeters per second	Feet per minute	1.9685
Bars	Newton's per square meter	1×10^5	Centimeters of water at 4°C.	Newtons per square meter	98.064
Board foot	Pounds per square inch	14.504	Centistokes	Square meters per second	1×10^{-6}
Boiler horsepower	Cubic feet	$\frac{1}{2}$	Circular mils	Square centimeters	5.067×10^{-6}
Boiler horsepower	B.t.u. per hour	33,480	Circular mils	Square inches	7.854×10^{-7}
B.t.u.	Kilowatts	9.803	Cords	Cubic feet	0.7854
B.t.u.	Calories (gram)	252	Cubic centimeters	Cubic feet	128
B.t.u.	Centigrade heat units (c.h.u. or p.c.u.)	0.55556	Cubic centimeters	Gallons	3.532×10^{-5}
B.t.u.	Foot-pounds	777.9	Cubic centimeters	Gallons (U.S. fluid)	2.6417×10^{-4}
B.t.u.	Horsepower-hours	3.929×10^{-4}	Cubic centimeters	Ounces (U.S. fluid)	0.03381
B.t.u.	Joules	1055.1	Cubic centimeters	Quarts (U.S. fluid)	0.0010567
B.t.u.	Liter-atmospheres	10.41	Cubic feet	Bushels (U.S.)	0.8036
B.t.u.	Pounds carbon to CO ₂	6.88×10^{-5}	Cubic feet	Cubic centimeters	28,317
B.t.u.	Pounds water evaporated from and at 212°F	0.001036	Cubic feet	Cubic meters	0.028317
B.t.u.	Cubic foot-atmospheres	0.3676	Cubic feet	Cubic yards	0.03704
B.t.u.	Kilowatt-hours	2.930×10^{-4}	Cubic feet	Gallons	7.481
B.t.u. per cubic foot	Joules per cubic meter	37,260	Cubic feet	Liters	28.316
B.t.u. per hour	Watts	0.29307	Cubic foot-atmospheres	Foot-pounds	2116.3
B.t.u. per minute	Horsepower	0.02357	Cubic foot-atmospheres	Liter-atmospheres	28.316
B.t.u. per pound	Joules per kilogram	2326	Cubic feet of water (60°F.)	Pounds	62.37
B.t.u. per pound per degree Fahrenheit	Calories per gram per degree centigrade	1	Cubic feet per minute	Cubic centimeters per second	472.0
B.t.u. per pound per degree Fahrenheit	Joules per kilogram per degree Kelvin	4186.8	Cubic feet per second	Gallons per minute	0.1247
B.t.u. per second	Watts	1054.4	Cubic feet per second	Million gallons per day	0.64632
B.t.u. per square foot per hour	Joules per square meter per second	3.1546	Cubic inches	Cubic meters	1.6387×10^{-5}
B.t.u. per square foot per minute	Kilowatts per square foot	0.1758	Cubic yards	Cubic meters	0.76456
B.t.u. per square foot per second	Calories, gram (15°C.), per square centimeter per second for a temperature gradient of 1°C. per inch	1.2405	Curies	Disintegrations per minute	2.2×10^{12}
			Degrees	Radians	1.1×10^{12}
			Drams (apothecaries' or troy)	Grams	0.017453
					3.888

TABLE 1-6 Alphabetical Listing of Common Conversions (Concluded)

To convert from	To	Multiply by	To convert from	To	Multiply by
Drams (avoirdupois)	Grams	1.7719	Horsepower (British)	Pounds water evaporated per hour at 212°F	2.64
Dynes	Newtons	1×10^{-5}	Horsepower (metric)	Foot-pounds per second	542.47
Ergs	Joules	1×10^{-7}	Horsepower (metric)	Kilogram-meters per second	75.0
Fathoms	Coulombs (abs.)	96,500	Hours (mean solar)	Seconds	3600
Feet	Meters	6	Inches	Meters	0.0254
Feet per minute	Centimeters per second	0.3048	Inches of mercury at 60°F	Newtons per square meter	3376.9
Feet per minute	Miles per hour	0.5080	Inches of water at 60°F	Newtons per square meter	248.84
Feet per (second) ²	Meters per (second) ²	0.011364	Joules (absolute)	B.t.u. (mean)	9.480×10^{-4}
Feet of water at 39.2°F	Meters per square meter	0.3048	Joules (absolute)	Calories, gram (mean)	0.2389
Foot-pounds	Newtons per square meter	2989	Joules (absolute)	Cubic foot-atmospheres	0.3485
Foot-pounds	B.t.u.	3.995×10^{-5}	Joules (absolute)	Foot-pounds	0.7376
Foot-pounds	Joules	0.04214	Joules (absolute)	Kilowatt-hours	2.7778×10^{-7}
Foot-pounds	Liter-atmospheres	4.159 $\times 10^{-4}$	Joules (absolute)	Liter-atmospheres	0.0098669
Foot-pounds	B.t.u.	0.0012856	Kilocalories	Joules	4186.8
Foot-pounds	Calories, gram	0.3239	Kilograms	Pounds (avoirdupois)	2.2046
Foot-pounds	Foot-pounds	32.174	Kilograms force	Newtons	9.807
Foot-pounds force	Horsepower	5.051×10^{-7}	Kilograms per square centimeter	Pounds per square inch	14.223
Foot-pounds per second	Kilowatt-hours	3.766×10^{-7}	Kilometers	Miles	0.6214
Foot-pounds per second	Liter-atmospheres	0.013381	Kilowatt-hours	B.t.u.	3414
Foot-pounds force	Joules	1.3558	Kilowatt-hours	Foot-pounds	2.6552×10^6
Foot-pounds per second	Horsepower	0.0018182	Kilowatts	Horsepower	1.3410
Foot-pounds per second	Kilowatts	0.0013558	Knots (international)	Meters per second	0.5144
Furlongs	Miles	0.125	Knots (nautical miles per hour)	Miles per hour	1.1516
Gallons (U.S. liquid)	Barrels (U.S. liquid)	0.03175	Lamberts	Candles per square inch	2.054
Gallons	Cubic meters	0.003785	Liter-atmospheres	Cubic foot-atmospheres	0.03532
Gallons	Cubic feet	0.13368	Liters	Foot-pounds	74.74
Gallons	Gallons (Imperial)	0.8327	Liters	Cubic feet	0.03532
Gallons	Liters	3.785	Liters	Cubic meters	0.001
Gallons	Ounces (U.S. fluid)	128	Liters	Gallons	0.26418
Gallons	Cubic feet per hour	8.021	Lumens	Watts	0.001496
Gallons per minute	Cubic feet per second	0.002228	Micrometers	Microns	1×10^{-6}
Gallons per minute	Grams	0.06480	Microns	Angstrom units	1×10^{-4}
Grains	Pounds	$\frac{1}{7000}$	Miles (nautical)	Meters	1×10^{-6}
Grains	Grams per cubic meter	2.2584	Miles (nautical)	Feet	6080
Grains per cubic foot	Parts per million	17.118	Miles (U.S. statute)	Miles (U.S. statute)	1.1516
Grains per gallon	Drams (avoirdupois)	0.5644	Meters	Feet	5280
Grams	Drams (troy)	0.2572	Miles per hour	Meters	1609.3
Grams	Grains	15.432	Miles per hour	Feet per second	1.4667
Grams	Kilograms	0.001	Milliliters	Cubic centimeters	1
Grams	Pounds (avoirdupois)	0.0022046	Millimeters	Meters	0.001
Grams	Pounds (troy)	0.002679			
Grams per cubic foot	Pounds per cubic foot	62.43			

TABLE 1-6 Alphabetical Listing of Common Conversions (Concluded)

To convert from	To	Multiply by	To convert from	To	Multiply by
Grams per cubic centimeter	Pounds per gallon	8.345	Millimeters of mercury at 0°C.	Newtons per square meter	133.32
Grams per liter	Grains per gallon	58.42	Millimicrons	Microns	0.001
Grams per liter	Pounds per cubic foot	0.0624	Mils	Inches	0.001
Grams per square centimeter	Pounds per square foot	2.0482	Mils (U.S.)	Meters	2.54×10^{-5}
Grams per square centimeter	Pounds per square inch	0.014223	Minutes (angle)	Radians	0.06161
Hectares	Acres	2.471	Minutes (mean solar)	Seconds	2.909×10^{-4}
Hectares	Square meters	10,000	Newtons	Newtontons	60
Horsepower (British)	B.t.u. per minute	42.42	Ounces (avoirdupois)	Kilograms	0.10197
Horsepower (British)	B.t.u. per hour	2545	Ounces (avoirdupois)	Kilograms	0.02835
Horsepower (British)	Foot-pounds per minute	33,000	Ounces (avoirdupois)	Ounces (troy)	0.9115
Horsepower (British)	Foot-pounds per second	550	Ounces (U.S. fluid)	Cubic meters	2.957×10^{-5}
Horsepower (British)	Watts	745.7	Ounces (troy)	Ounces (apothecaries)	1.000
Horsepower (British)	Horsepower (metric)	1.0139	Pints (U.S. liquid)	Cubic meters	4.732×10^{-4}
Horsepower (British)	Pounds carbon to CO ₂ per hour	0.175	Poundals	Newtontons	0.13826
Pounds (avoirdupois)	Grams	7000	Square feet	Square meters	0.0929
Pounds (avoirdupois)	Kilograms	0.45359	Square feet per hour	Square meters per second	2.581×10^{-5}
Pounds (troy)	Pounds (troy)	1.2153	Square inches	Square centimeters	6.452
Pounds per cubic foot	Grams per cubic centimeter	0.016018	Square inches	Square meters	6.452×10^{-4}
Pounds per cubic foot	Kilograms per cubic meter	16.018	Square yards	Square meters	0.8361
Pounds per square foot	Atmospheres	4.725×10^{-4}	Stokes	Square meters per second	1×10^{-4}
Pounds per square foot	Kilograms per square meter	4.882	Tons (long)	Kilograms	1016
Pounds per square inch	Atmospheres	0.06805	Tons (long)	Pounds	2240
Pounds per square inch	Kilograms per square centimeter	0.07031	Tons (metric)	Kilograms	1000
Pounds per square inch	Newtontons per square meter	6894.8	Tons (metric)	Pounds	2204.6
Pounds force	Newtontons	4.4482	Tons (metric)	Tons (short)	1.1023
Pounds force per square foot	Newtontons per square meter	47.88	Tons (short)	Kilograms	907.18
Pounds water evaporated from and at 212°F.	Horsepower-hours	0.379	Tons (short)	Pounds	2000
Quarts (U.S. liquid)	B.t.u.	1.8	Tons (refrigeration)	B.t.u. per hour	12,000
Radians	Cubic meters	9.464×10^{-4}	Tons (British shipping)	Cubic feet	42.00
Revolutions per minute	Degrees	57.30	Tons (U.S. shipping)	Cubic feet	40.00
Seconds (angle)	Radians per second	0.10472	Torr (mm. mercury, 0°C.)	Newtons per square meter	133.32
Slugs	Radians	4.848×10^{-6}	Watts	B.t.u. per hour	3.413
Slugs	Cee pounds	1	Watts	Joules per second	1
Slugs	Kilograms	14.584	Watt-hours	Kilogram-meters per second	0.10197
Slugs	Pounds	32.17	Yards	Joules	3600
Square centimeters	Square feet	0.0010764	Yards	Meters	0.9144

TABLE 1-7 Common Units and Conversion Factors*

Mass (M)	1 pound mass = 453.5924 grams = 0.45359 kilograms = 7000 grains 1 slug = 32.174 pounds mass 1 ton (short) = 2000 pounds mass 1 ton (long) = 2240 pounds mass 1 ton (metric) = 1000 kilograms = 2204.62 pounds mass 1 pound mole = 453.59 gram moles	1 atm = 760 millimeters of mercury at 0°C (density 13.5951 g/cm ³) = 29.921 inches of mercury at 32°F = 14.696 pounds force/square inch = 33.899 feet of water at 39.1°F = 1.01325 × 10 ⁶ dynes/square centimeter = 1.01325 × 10 ⁵ Newtons/square meter
Length (L)	1 foot = 30.480 centimeters = 0.3048 meters 1 inch = 2.54 centimeters = 0.0254 meters 1 mile (U.S.) = 1.60935 kilometers 1 yard = 0.9144 meters	Density (M/L ³) 1 pound mass/cubic foot = 0.01601846 grams/cubic centimeter = 16.01846 kilogram/cubic meter
Area (L ²)	1 square foot = 929.0304 square centimeters = 0.09290304 square meters 1 square inch = 6.4516 square centimeters 1 square yard = 0.836127 square meters	Energy (H or FL) 1 British thermal unit = 251.98 calories = 1054.4 joules = 777.97 foot-pounds force = 10.409 liter-atmospheres = 0.2930 watt-hour
Volume (L ³)	1 cubic foot = 28,316.85 cubic centimeters = 0.02831685 cubic meters = 28.31685 liters = 7.481 gallons (U.S.) 1 gallon = 3.7853 liters = 231 cubic inches	Diffusivity (L ² /θ) 1 square foot/hour = 0.258 cm ² /s = 2.58 × 10 ⁻⁵ m ² /s
Time (θ)	1 hour = 60 minutes = 3600 seconds	Viscosity (M/Lθ) 1 pound mass/foot hour = 0.00413 g/cm s = 0.000413 kg/m s 1 centipoise = 0.01 poise = 0.01 g/cm s = 0.001 kg/m s = 0.000672 lbm/ft s = 0.0000209 lbf _s /ft ²
Temperature (T)	1 centigrade or Celsius degree = 1.8 Fahrenheit degree Temperature, Kelvin = T°C + 273.15 Temperature, Rankine = T°F + 459.7 Temperature, Fahrenheit = 9/5 T°C + 32 Temperature, centigrade or Celsius = 5/9 (T°F - 32) Temperature, Rankine = 1.8 T K	Thermal conductivity [H/θL ² (T/L)] 1 Btu/hr ft ² (°F/ft) = 0.00413 cal/s cm ² (°C/cm) = 1.728 J/s m ² (°C/m)
Force (F)	1 pound force = 444,822.2 dynes = 4.448222 Newtons = 32.174 pounds	Heat transfer coefficient 1 Btu/hr ft ² °F = 5.678 J/s m ² °C Heat capacity (H/MT) 1 Btu/lbm °F = 1 cal/g °C = 4184 J/kg °C
Pressure (F/L ²)	Normal atmospheric pressure	Gas constant 1.987 Btu/lbm mole °R = 1.987 cal/mol K = 82.057 atm cm ³ /mol K = 0.7302 atm ft ³ /lb mole °F = 10.73 (lb _f /in. ²) (ft ³)/lb mole °R = 1545 (lb _f /ft ²) (ft ³)/lb mole °R = 8.314 (N/m ²) (m ³)/mol K
		Gravitational acceleration g = 9.8066 m/s ² = 32.174 ft/s ²

NOTE: U.S. customary units; or British units, on left and SI units on right.
 *Adapted from Faust et al., *Principles of Unit Operations*, John Wiley and Sons, 1980.

TABLE 1-8 Kinematic-Viscosity Conversion Formulas

Viscosity scale	Range of t, sec	Kinematic viscosity, stokes
Saybolt Universal	32 < t < 100	0.00226t - 1.95/t
	t > 100	0.00220t - 1.35/t
Saybolt Furol	25 < t < 40	0.0224t - 1.84/t
	t > 40	0.0216t - 0.60/t
Redwood No. 1	34 < t < 100	0.00260t - 1.79/t
	t > 100	0.00247t - 0.50/t
Redwood Admiralty Engler		0.027t - 20/t
		0.00147t - 3.74/t

TABLE 1-9 Values of the Gas-Law Constant

Temp. scale	Press. units	Vol. units	Wt. units	Energy units	R
Kelvin			g-moles	calories	1.9872
			g-moles	joules (abs)	8.3144
			g-moles	joules (int)	8.3130
			g-moles	atm cm ³	82.057
	atm.	cm ³	g-moles	atm liters	0.08205
	atm.	liters	g-moles	mm Hg-liters	62.361
	mm. Hg	liters	g-moles	bar-liters	0.08314
	bar	liters	g-moles	kg/(cm ²)(liters)	0.08478
	kg/cm ²	liters	g-moles	atm-ft ³	1.314
	atm	ft ³	lb-moles	mm Hg-ft ³	998.9
	mm Hg	ft ³	lb-moles	chu or pcu	1.9872
			lb-moles	Btu	1.9872
Rankine			lb-moles	hp-hr	0.0007805
			lb-moles	kw-hr	0.0005819
			lb-moles	atm-ft ³	0.7302
	atm	ft ³	lb-moles	in Hg-ft ³	21.85
	in Hg	ft ³	lb-moles	mm Hg-ft ³	555.0
	mm Hg	ft ³	lb-moles	(lb)(ft ³)/in ²	10.73
	lb/in ² abs	ft ³	lb-moles	ft-lb	1545.0
	lb/ft ² abs	ft ³	lb-moles		

TABLE 1-10 United States Customary System of Weights and Measures

Linear Measure	
12 inches (in) or (")	= 1 foot (ft) or (')
3 feet	= 1 yard (yd)
16.5 feet	} = 1 rod (rd)
5.5 yards	
5280 feet	} = 1 mile (mi)
320 rods	
1 mil	= 0.001 inch
<i>Nautical:</i>	
6080.2 feet	= 1 nautical mile
6 feet	= 1 fathom
120 fathoms	= 1 cable length
1 knot	= 1 nautical mile per hour
60 nautical miles	= 1° of latitude
Square Measure	
144 sq. inches (sq. in) or (in ²) or (□")	= 1 sq. foot (ft ²) or (□')
9 sq. feet (ft ²) (□')	= 1 sq. yard (yd ²)
30.25 sq. yards	= 1 sq. rod, pole, or perch
160 sq. rods	} = 1 acre
10 sq. chains	
43,560 sq. ft	
640 acres	= 1 sq. mile = 1 section
1 circular inch (area of circle of 1 inch diameter)	= 0.7854 sq. inch
1 sq. inch	= 1.2732 circular inch
1 circular mil (area of circle of 0.001 inch diameter)	
1,000,000 circular mils	= 1 circular inch
Circular Measure	
60 seconds (") (sec)	= 1 minute (min) or (')
60 minutes (')	= 1 degree (°)
90 degrees (°)	= 1 quadrant
360 degrees (°)	= 1 circumference
57.29578 degrees	} = 1 radian (rad.)
Volume Measure	
<i>Solid:</i>	
1728 cubic in (cu. in) (in ³)	= 1 cubic foot (cu. ft) (ft ³)
27 cu. ft	= 1 cubic yard (cu. yd)
<i>Dry Measure:</i>	
2 pints	= 1 quart
8 quarts	= 1 peck
4 pecks	= 1 bushel
1 United States Winchester bushel	= 2150.42 cubic inches
<i>Liquid:</i>	
4 gills	= 1 pint (pt)
2 pints	= 1 quart (qt)
4 quarts	= 1 gallon (gal)
7.4805 gallons	= 1 cubic foot
<i>Apothecaries' Liquid:</i>	
60 minims (min. or \mathfrak{m})	= 1 fluid dram or drachm
8 drams (\mathfrak{d})	= 1 fluid ounce
16 ounces (oz. \mathfrak{z})	= 1 pint
Avoirdupois Weight	
16 drams = 437.5 grains	= 1 ounce (oz)
16 ounces = 7000 grains	= 1 pound (lb)
100 pounds = 1 hundredweight (cwt)	
2000 pounds = 1 short ton: 2240 pounds	= 1 long ton
Troy Weight	
24 grains	= 1 pennyweight (dwt)
20 pennyweights	= 1 ounce (oz)
12 ounces	= 1 pound (lb)
Apothecaries' Weight	
20 grains (gr)	= 1 scruple (\mathfrak{s})
3 scruples	= 1 dram (\mathfrak{d})
8 drams	= 1 ounce (\mathfrak{z})
12 ounces	= 1 pound (lb)

TABLE 1-11 Temperature Conversion Formulas

$^{\circ}\text{F} = (^{\circ}\text{C} \times 5/9) + 32$
$^{\circ}\text{C} = (^{\circ}\text{F} - 32) \times 5/9$
$^{\circ}\text{R} = ^{\circ}\text{F} + 459.69$
$^{\circ}\text{K} = ^{\circ}\text{C} + 273.15$
$^{\circ}\text{K} = ^{\circ}\text{R} \times 5/9$

Temperature difference, ΔT
 $^{\circ}\text{F} = ^{\circ}\text{C} \times 9/5$

NOTE: An extensive table of temperature conversions may be found in the sixth edition of the *Handbook* (Table 1-12).