

GEOMETRIC LENGTH

Unit	M	km	mile	yd	feet	inches	nautical mile
m	1	0.001	0.6213712×10^{-3}	1.093613	3.280839	39.370079	0.539957×10^{-3}
km	1000	1	0.6213712	1093.613	3280.839	39370.079	0.539957
mile	1609.344	1.609344	1	1760	5280	63360	0.868976
yd	0.9144	0.9144×10^{-3}	0.568182×10^{-3}	1	3	36	0.493736×10^{-3}
ft	0.3048	0.3046×10^{-3}	0.189394×10^{-3}	0.333333	1	12	0.164579×10^{-3}
in	0.0254	0.0254×10^{-3}	15.7828×10^{-4}	0.0277778	0.083333	1	-
nautical mile	1852	1.852	1.15078	2025.373	6076.12	-	1

- This is the international unit: 1 (int) n. mile = 0.999362 UK n. mile
- Note. The micron is now called the micrometre (μm) and = 39.3701 μ inch
- 10 Angstrom units (A) = 1 millimicron - 1×10^{-9} mm

AREA

- Square the conversion factors given in Table to obtain the desired factor

VOLUME

Unit	m ³	litre	ft ³	in ³	UK gal
m ³	1	10 ³	35.31467	61023.74	219.9688
litre	10 ⁻³	1	0.0353147	61.02374	0.2199688
ft ³	0.0283168	20.31685	1	1728	6.22837
in ³	16.38706×10^{-6}	16.38706×10^{-3}	0.5787×10^{-3}	1	-
UK gal	0.0045461	4.546091	0.160544	277.419	1

- 1 UK gal = 0.0045461 USA gal
- 1 US gal = 0.832957 UK gal

MASS

Uni	kg	lb	t	UK ton	slug
kg	1	2.204623	10 ⁻³	0.984207×10^{-3}	0.06852177
lb	0.453550237	1	0.0004536	0.00044643	0.03108095
t	1000	2264.623	1	0.96421	-
UK ton	1016.0467	2240	1.0160467	1	-
slug	14.5635	32.17406	-	-	1

- UK ton = 2000 lb = 0.892857 UK tons = 1.12 US ton

DENSITY (MASS/VOLUME)

Unit	kg m ⁻³	g cm ⁻³	lb ft ⁻³	lb in ⁻³	lb gal ⁻³	slug ft ⁻³
kg m ⁻³	1	10 ⁻³	62.42796 x 10 ⁻³	0.036128 x 10 ⁻³	0.0100224	1.94032 x 10 ⁻³
g cm ⁻³	10	1	62.42796	0.036128	10.0224	1.94032
lb ft ⁻³	16.01846	0.01601846	1	0.0576704 x 10 ⁻³	0.160544	0.031081
lb in ⁻³	27679.9	27.6799	1728	1	277.42	53.708
lb gal ⁻³	99.7764	0.099764	6.228843	0.00360465	1	-
slug ft ⁻³	515.379	0.515379	32.17405	0.018619	-	1

- 1 g cm⁻³ = 1 kg dm⁻³ = 1kg 1⁻³ The value of the litre as defined in 1901 is 1.000028 dm³. In 1964 the XII CGPM ruled that for practical purposes the cubic decimetre can be called the litre. The values in the above tables are based on this decision
- 1 gal = 1.20095 US gal; 1 Us gal = 0.832675 gal

FORCE

Unit	N	lbf	pdl	kgf	UK tonf
N	1	0.224809	7.233011	0.101971621	0.100361 x 10 ⁻³
lbf	4.448222	1	32.17405	0.453602	0.446429 x 10 ⁻³
pdl	0.138255	0.031081	1	0.0140961	0.01388 x 10 ⁻³
kgf	9.80655	2.204622	70.931607	1	0.984207 x 10 ⁻³
UK tonf	9964.0173	2240	72069672	1016.047	1

- The force unit lbf, kgf, tonf, all contain the standard value of the free fall acceleration due to gravity, g_n = 32.17405 ft s⁻², 9.80665 m s⁻² eg the force to support 1 kg (mass) is 1 kgf = 9.80665 N
- The kgf is also known as the kilopond (kp)

PRESSURE - LOADING - STRESS

Unit	N m ⁻² (Pa)	kgf mm ²	lbf in ⁻²	lbf ft ⁻²	tonf in ⁻²	MN m ⁻² (MPa)
N m ⁻²	1	0.101972 x 10 ⁶	0.145038 x 10 ⁻³	0.0208854	64.7488 x 10 ⁻⁹	10 ⁻⁶
kgf mm ²	9.80665 x 10 ⁶	1	1422.334	204516.1	0.634971	9.80665
lbf in ⁻²	6894.761	0.70307 x 10 ⁻³	1	144	0.446429 x 10 ⁻³	6.894761 x 10 ⁻³
lbf ft ⁻²	47.8803	4.88243 x 10 ⁻⁶	6.9444 x 10 ⁻³	1	3.1002 x 10 ⁻⁶	47.8803 x 10 ⁻⁶
tonf ²	15.4443 x 10 ⁶	1.57488	2240	322560	1	15.4443
MN m ⁻²	10 ⁶	0.101972	145.0377	20885.43	64.7488 x 10 ⁻³	1

- 10 MN m⁻² = 1 hectobar (h bar) = 10 MPa = 10 N mm⁻²
- p_z = 1 sthene m⁻² (sn m⁻²) = 10³ Pa
- 1 atm = 1.01325 bar = 760 mm Hg = 1013.25 m bar = 0.101325 MN m⁻²

FORCE PER UNIT LENGTH - SPRING RATE - BEAM LOADING

Unit	Nm ⁻¹	kgf m ⁻¹	lbf in ⁻¹	lbf ft ⁻¹	tonf in ⁻¹
Nm	1	0.101972	5.71017 x 10 ⁻³	68.5221 x 10 ⁻³	2.546263 x 10 ⁻⁶
kgf m ⁻¹	9.80665	1	55.9975 x 10 ⁻³	0.671968	24.9967 x 10 ⁻³
lbf in ⁻¹	175.127	17.565	1	12	0.446429 x 10 ⁻³
lbf ft ⁻¹	14.5939	1.48816	0.083333	1	37.2024 x 10 ⁻⁶
tonf in ⁻¹	392264	40001.9	2240	26880	1

- Nm = 10⁻³ N mm⁻¹

MOMENT - TORQUE - TORSION

Unit	Nm	N cm	ft lbf	in lbf	ozf in
Nm	1	100	0.737562	8.850745	141.61192
N cm	10 ⁻²	1	7.37565 x 10 ⁻³	88.50745 x 10 ⁻³	1.4161192
lbf ft	1.355818	135.5818	1	12	192
lbf	0.112985	11.2985	0.833333	1	16
ozf in	0.007062	0.706155	0.00520833	0.0625	1

MOMENT OF INERTIA

Unit	kg m ²	kg mm ²	lb ft ²	slug ft ²	lb in ²
kg m ²	1	10 ⁶	23.7304	0.737565	3417.18
kg mm ²	10 ⁻⁶	1	23.7304 x 10 ⁻⁶	0.737565 x 10 ⁻⁶	3.41718 x 10 ⁻³
lb ft ²	0.04214	42140	1	0.031081	144
slug ft ²	1.35573	1355730	32.17405	1	4633.06
lb in ²	0.292639 x 10 ⁻³	292.639	6.94444 x 10 ⁻³	0.21588 x 10 ³	1

SECOND MOMENT OF AREA

Unit	cm ⁴	ft ⁴	in ⁴	mm ⁴
cm ⁴	1	1.15862 x 10 ⁻⁶	0.0240251	104
ft ⁴	863097	1	.20736	86309.7 x 10 ³
in ⁴	41.6231	48.2253 x 10 ⁻⁶	1	416.231 x 10 ³
mm ⁴	10 ⁻⁴	0.115862 x 10 ⁻⁹	2.4025 x 10 ⁻⁶	1

SPECIFIC HEAT

(mass basis; heat/mass x degree temperature)

Unit	J (kg °C) ⁻¹	kcal (kg °C) ⁻¹	Btu (lb °F) ⁻¹	ft (lbf °F) ⁻¹	kgf m (kg °C) ⁻¹
J (kg °C) ⁻¹	1	0.238846 x 10 ⁻³	0.238846 x 10 ⁻³	0.185863	0.101972
kcal (kg °C) ⁻¹	4186.8	1	1	778.169	426.935
Btu (lb °F) ⁻¹	4186.8	1	1	778.169	426.935
ft (lbf °F) ⁻¹	5.3803	0.00128507	0.00128507	1	0.54864
kgf m (kg °C) ⁻¹	9.80665	0.00234228	0.00234228	1.82269	2

SPECIFIC HEAT CAPACITY

Btu = British thermal units (volume basis; heat/mass x degree temperature)

Unit	J m ⁻³ °C ⁻¹	Kcal m ⁻³ °C	Btu ft ⁻³ °F ⁻¹
J m ⁻³ °C ⁻¹	1	0.238846 x 10 ⁻³	0.0149107 x 10 ⁻³
Kcal m ⁻³ °C	4186.8	1	0.062428
Btu ft ⁻³ °F ⁻¹	67066.1	16.0185	1

CALORIFIC VALUE (MASS)

(mass basis; heat/mass) (specific energy, specific latent heat)

Unit	J kg ⁻¹	Cal kg ⁻¹	Btu lb ⁻¹	Ft lbf lb ⁻¹	kgf m kg ⁻¹
J kg ⁻¹	1	0.238846 x 10 ⁻³	0.429923 x 10 ⁻³	0.334558	0.101972
kcal kg ⁻¹	4186.8	1	1.8	1400.7	426935
Btu lb ⁻¹	2326	0.555556	1	778.169	237.186
ft lbf lb ⁻¹	2.98907	0.713926 x 10 ⁻³	1.28507 x 10 ⁻³	1	0.3048
kgf m kg ⁻¹	9.806665	2.34228 x 10 ⁻³	4.2161 x 10 ⁻³	3.28084	1

CALORIFIC VALUE (VOLUME)

(volume basis ; heat/volume)

Unit	J cm ⁻³	kcal m ⁻³	Btu ft ⁻³
J cm ⁻³	1	238.846	26.8392
kcal m ⁻³	0.004186	1	0.11237
Btu ft ⁻³	0.0372589	8.89915	1

For gases it is assumed that the values involved in conversion are measured under the same conditions of temperature and pressure.

THERMAL CONDUCTANCE

(heat/area x time x degree temperature)

Unit	W m ⁻² °C ⁻¹	kcal m ⁻³ /Cal m ⁻¹	Btu ft ⁻² h ⁻¹ °F ⁻¹	kcal m ⁻² h ⁻¹ °C ⁻¹
W m ⁻² °C ⁻¹	1	0.238846	0.17611	0.859845
cal m ⁻² s ⁻¹ °C ⁻¹	4.1868	1	0.737338	3.6
Btu ft ⁻² h ⁻¹ °F ⁻¹	5.67826	1.35623	1	4.88243
kcal m ⁻² h ⁻¹ °C ⁻¹	1.163	0.277778	0.204816	1

ENERGY - WORK - QUANTITY OF HEAT

Unit	J = 1 Mn	W h	kgf m	lbf ft	cal	Btu
J	1	0.27778×10^{-3}	0.101971621	0.7375621	0.238846	0.947817×10^{-3}
W h	3600	1	367.09786	2655224	859.8456	3.412141
kgf m	9.80665	2.7241×10^{-3}	1	7.233013	2.348279	9.294901×10^{-3}
lbf ft	1.355818	3.76616×10^{-3}	0.138255	1	0.323832	1.2851×10^{-3}
cal	4.1868	0.001163	0.42935	3.088024	1	3.968318×10^{-3}
Btu	1055.056	0.2933071	107.5858	778.16931	251.9959	1

1 pdl ft = 0.04214011 J 1 Centigrade Heat Unit (CHU) = 1.8 Btu 1 them = 105.506MJ
 1 thermie = 4.1855 MJ The calorie used is the International Steam Table Calorie

EQUIVALENT MERCURY OF WATER COLUMN PRESSURES

Unit	N m ⁻² (Pa)	(torr) mm Hg	in Hg	mm H ₂ O	in H ₂ O	atm
N m ⁻²	1	7.50062×10^{-3}	0.2953×10^{-3}	0.101974	4.01474×10^{-3}	9.86923×10^{-6}
mm Hg	133.322	1	0.03937	13.5955	0.535255	1.31579×10^{-3}
in Hg	3386.39	25.4	1	345.325	13.5955	0.033421
mm H ₂ O	9.80638	0.073554	0.002896	1	0.03937	0.096771×10^{-3}
in H ₂ O	249.082	1.86827	0.073554	25.4	1	0.002458
atm	101.325×10^3	760	29.9213	10.3326×10^3	406.794	1

1 mm Hg = 1 torr Mercury column values based on t = 0 °C, p = 760 mm Hg, g_n = 2.80665 m s⁻²

Water column values are based on t = 4 °C, p = 760 mm Hg, g_n = 2.80665 m s⁻²

The french abbreviation for water column is CE; the German equivalent is WS

For any other values of temperature and pressure and local values of 'g' the table values will require to be altered p_n for Hg = 13595.1 kg m⁻³; on for water = 999.972 kg m⁻³

HEATING CALCULATIONS

Heating Sheet metal from 20 - 400° C in 5 minutes

$$P_{\text{theor}} = b \cdot l \cdot d \cdot p \cdot c \cdot \Delta T / t$$

P = heating power (kW)

b = width (m)

l = length (m)

d = thickness (m)

p = density (kg/m³)

c = specific heat capacity (kj/kgK)

ΔT = Temperature increase (K)

t = heating time

n = efficiency

m = mass (kg)

Data

b = 0.8

l = 2.0

d = 0.02

ΔT = 380

p = 7.8×10^3

c = 0.46

t = 300

n = 0.55

TYPICAL MATERIALS DATA

	Density at 20 °C (10 ³ kg/m ³)	Specific Heat capacity (kJ/kgK)
Aluminium	2.7	0.90
Brass	8.4	0.38
Cast Iron	5.7 - 7.2	0.50
Copper	8.9	0.39
Iron	7.85	0.45
Steel	7.8	0.46
Tin	7.3	0.23
Zinc	7.14	0.39
Water	1.00	4.18
Paper	0.6 - 1.2	1.5 - 1.7
Asbestos	2.0	0.84
Concrete, dry	1.5 - 2.4	0.90
Glass	2.5	0.84
Refractory brick	1.8	0.75
Polyethelene	0.92 - 0.96	2.3
PVC	1.4	0.85 - 1.17

UNITS OF VOLUME

Unit	=	in ³	ft ³	yd ³	gal (UK)	gal (US)	cm ³	dm ³ (l)	m ³
1 in ³	=	1	-	-	-	-	16.3871	0.01638	-
1 ft ³	=	1728	1	0.03704	6.229	7.481	-	28.3168	0.02832
1 yd ³	=	46656	27	1	168.18	201.97	-	764.555	0.76456
1 gal (UK)	=	277.42	0.16054	-	1	1.20095	4546.09	4.54609	-
1 gal (US)	=	231	0.13368	-	0.83267	1	3785.41	3.78541	-
1 cm ³	=	0.06102	-	-	-	-	-1	0.001	-
1 dm ³ (l)	=	61.0236	0.03531	0.00131	0.21997	0.26417	1000	10	0.001
1 m ³	=	61023.6	35.315	1.30795	219.969	264.172	10 ⁶	1000	1

in³ = cubic inch (cu in),

ft³ = cubic foot (cu ft),

yd³ = cubic yard (cu yd)

gal = gallon