

Useful Conversion Tables, Equations and Engineering Data

In compiling the following information care has been taken to avoid errors, however we cannot accept any responsibility or liability for any inaccuracies.

Conversion Factors

Length

Millimetre mm	metre m	inch in	foot ft	yard yd
1	0.001	0.0394	0.0033	0.0011
1000	1	39.3701	3.2808	1.0936
25.4	0.0254	1	0.0833	0.0278
304.8	0.3048	12	1	0.3333
914.4	0.9144	36	3	1

Volume

cubicmetre m ³	cubic centremetre cm ³	litre l	cubic inch in ³	cubic foot ft ³	UK gallon UK gal	US gallon US gal
1	1,000,000	999.972	61,023.7	35.3147	219.969	264.172
0.000 001	1	0.0009997	0.0610	0.0000353	0.00022	0.00026
0.001	1,000.028	1	61.0255	0.0353	0.22	0.2642
0.000016	16.3871	0.0164	1	0.00058	0.0036	0.0043
0.0283	28316.8	28.316	1,728	1	6.2288	7.4805
0.0045	4,546.09	4.546	277.419	0.1605	1	1.201
0.0038	3,785.41	3.7853	231	0.1337	0.8327	1

Velocity

Metre per second m/s	foot per second ft/s	foot per minute ft/m	kilometre per hour km/h	mile per hour mile/h
1	3.2808	0.0547	3.6	2.2369
0.3048	1	0.0167	1.0973	0.6818
18.288	60	1	65.8368	40.9091
0.2778	0.9113	0.0152	1	0.6214
0.4470	1.4667	0.0245	1.6093	1

Mass

kilogram kg	pound lb	hundredweight cwt	tonne t	UK ton	US short ton sh ton
1	2.2046	0.0197	0.001	0.00098	0.0011
0.4536	1	0.0089	0.000454	0.000446	0.0005
50.8023	112	1	0.0508	0.05	0.056
1000	2204.62	19.6841	1	0.9842	1.1023
1016.05	2240	20	1.0161	1	1.12
907.185	2000	17.8571	0.9072	0.8929	1

Mass Rate of Flow

kilogram per second kg/s	kilogram per hour kg/h	pound per hour lb/h	ton per hour UK ton/hr	tonne per day t/d
1	3600	7936.64	3.543 14	86.40
0.000 278	1	2.2046	0.000 984	.024
0.000 126	0.4536	1	0.000 446	.0109
0.282 2	1016.05	2240	1	24.3852
0.011 6	41.6667	91.8592	0.041 01	1

Volumetric Rate of Flow

litre per second l/s	litre per minute l/min	cubic metre per hour m³/h	cubic foot per hour ft³/h	cubic foot per minute ft³/m	UK gallon per minute UK gal/min	US gallon per minute US gal/min	US barrel per day US barrel/d
1	60	3.6001	127.136	2.1189	13.1986	15.8508	543.456
0.0167	1	0.0600	2.1189	0.3532	0.22	0.2642	9.0576
0.2778	16.6666	1	35.3147	0.5886	3.6662	4.4029	150.956
0.0079	0.4719	0.0283	1	0.1067	0.1038	0.1247	4.2746
0.4719	28.316	1.6990	60	1	6.2288	7.4805	256.475
0.0768	4.546	0.2728	9.6326	0.1605	1	1.201	41.1754
0.0631	3.7853	0.2271	8.0208	0.1337	0.8327	1	34.2857
0.0018	0.1104	0.0066	0.2339	0.0039	0.0243	0.0292	1

Pressure and Liquid Head

	kilogram force per square centimetre	pound force per square inch		foot of water	inch of water	metre of water	centimetre of mercury	inch of mercury	millimetre of mercury
1 bar	2 kgf/cm²	3 lbf/in²	4 atm	5 ft H ₂ O	in H ₂ O	m H ₂ O	cm Hg	in Hg	6 mm Hg
1	1.0197	14.5038	0.9869	33.4553	401.463	10.1972	75.0062	29.530	750.062
0.9807	1	14.2233	0.9878	32.8084	393.701	10	73.556	28.959	735.559
0.0689	0.0703	1	0.0609	2.3067	27.68	0.7031	5.1715	2.036	51.715
1.0133	1.0332	14.6959	1	33.889	406.782	10.3323	76.0	29.9213	760
0.0299	0.0305	0.4335	0.0295	1	12	0.3048	2.242	0.8827	22.4198
0.0025	0.0025	0.0361	0.0025	0.0833	1	0.0254	0.1868	0.0734	1.8683
0.0981	0.1000	1.422	0.0968	3.2808	39.3701	1	7.3556	2.896	73.356
0.0133	0.0136	0.1934	0.0132	0.4461	5.3524	0.136	1	0.3937	10
0.0339	0.0345	0.4911	0.0334	1.133	13.5951	0.3453	2.54	1	25.4
0.0013	0.0014	0.0193	0.0013	0.446	0.5352	0.0136	0.1	0.0394	1

1 1 bar = 10⁵ N/m²

3 Often denoted non-technically as psi

5 At density 1g/cm³

2 Technical (metric) atmosphere (at)

4 International standard atmosphere

6 Also known as torr

Density

gram per millilitre g/ml	kilogram per cubic metre kg/m ³	pound per cubic foot lb/ft ³	pound per cubic inch lb/in ³
1	1 000	62.428	0.036 1
0.001	1	0.0624	0.000 036
0.016	16.02	1	0.000 58
27.6807	27 679.9	1728	1

Torque

newton metre Nm	kilogram force metre kgf m	pound force foot lbf ft	pound force inch lbf in
1	0.102	0.7376	8.8508
9.8067	1	7.2330	86.7962
1.3558	0.1383	1	12
0.113	0.0115	0.0833	1

Conversions Factors for Vacuum

	newton per square metre N/m ²	torr torr	standard atmosphere atm	dyne per square centimetre dyn/cm ²	millibar mbar	micrometre of mercury µmHg	inches of mercury in.Hg	feet of water Ft.H ₂ O	psi absolute
1 newton per square metre N/m ² =	1	7.500 62 x 10 ⁻³	9.869 23 x 10 ⁻⁶	10	7.500 62 x 10 ⁻³	7.500 62	2.95 x 10 ⁻⁴	3.35 x 10 ⁻⁴	1.45 x 10 ⁻⁴
1 torr torr =	133.322	1	1.315 79 x 10 ⁻³	1333.22	(1)	(10 ³)	0.0394	0.0446	0.0193
1 standard atmosphere atm =	101 325	760	1	1 013 250	760.000	760 000	29.92	33.93	14.7
1 dyne per square centimetre dyn/cm ² =	10 ⁻¹	7.500 62 x 10 ⁻⁴	9.869 23 x 10 ⁻⁷	1	7.500 62 x 10 ⁻⁴	7.500 62 x 10 ⁻¹	2.95 x 10 ⁻⁵	3.3 x 10 ⁻⁵	1.45 x 10 ⁻⁵
1 millibar mbar =	10 ²	0.750 062 (³ / ₄)	9.86923 x 10 ⁻⁴	10 ³	0.750 062 (³ / ₄)	750.062	0.0295	0.033	0.0145
1 millimetre of mercury mmHg =	133.322	(1)	1.315 79 x 10 ⁻³	1 333.22	1	10 ³	0.0394	0.0446	0.0193
1 micrometre of mercury µmHg =	1.333 22 x 10 ⁻¹	(10 ⁻³)	1.315 79 x 10 ⁻⁶	1.333 22	10 ⁻³	1	3.94 x 10 ⁻⁶	4.46 x 10 ⁻⁵	1.93 x 10 ⁻⁵
1 inch of mercury in.Hg =	3390	25.4	0.033	33898	25.4	25400	1	1.13	0.49
1 foot of water Ft.H ₂ O =	2985	22.4	0.029	30303	22.4	2240	0.88	1	0.43
1 PSI absolute =	6897	51.7	0.068	68966	51.7	51700	2.04	2.31	1

Dimensions of Nominal Bore and OD. Pipe

Pipe Size (in.)	O.D. Pipe		Nominal Bore Outside Diameter (mm)	Nominal Wall Thickness		
	Outside Diameter (mm)	Approximate Inside Diameter (mm)		Schedule 10	Schedule 40	Schedule 80
1/8"	-	-	10.30	1.24	1.73	2.41
1/4"	-	-	13.70	1.65	2.24	3.02
3/8"	9.53	7.09	17.10	1.65	2.31	3.20
1/2"	12.70	10.26	21.30	2.11	2.77	3.73
3/4"	19.05	16.61	26.70	2.11	2.87	3.91
1"	25.40	22.96	33.40	2.77	3.38	4.55
1 1/4"	31.75	29.31	42.20	2.77	3.56	4.85
1 1/2"	38.10	35.66	48.30	2.77	3.68	5.08
2"	50.80	48.36	60.30	2.77	3.91	5.54
2 1/2"	63.50	60.25	73.00	3.05	5.16	7.01
3"	76.20	72.95	88.90	3.05	5.49	7.62
3 1/2"	88.90	85.66	101.60	3.05	5.74	8.08
4"	101.60	98.36	114.30	3.05	6.02	8.56
6"	-	-	168.30	3.40	7.11	10.97

Temperature Conversion

°C	°F	°C	°F
-40	-40	115	239
-35	-31	120	248
-30	-22	125	257
-25	-13	130	266
-20	- 4	135	275
-15	+ 5	140	284
-10	+14	145	293
- 5	+23	150	302
0	32	155	311
5	41	160	320
10	50	165	329
15	59	170	338
20	68	175	347
25	77	180	356
30	86	185	365
35	95	190	374
40	104	195	383
45	113	200	392
50	122	205	401
55	131	210	410
60	140	215	419
65	149	220	428
70	158	225	437
75	167	230	446
80	176	235	455
85	185	240	464
90	194	245	473
95	203	250	482
100	212	255	491
105	221	260	500
110	230		

$$^{\circ}\text{C} = \frac{5}{9} (^{\circ}\text{F} - 32)$$

$$^{\circ}\text{Kelvin} = ^{\circ}\text{C (abs)} = ^{\circ}\text{C} + 273$$

$$^{\circ}\text{F} = \left(\frac{9}{5} ^{\circ}\text{C}\right) + 32$$

$$^{\circ}\text{Rankine} = ^{\circ}\text{F (abs)} = ^{\circ}\text{F} + 460$$

Simplified Basic Valve Sizing Formulae

Liquid

$$K_v = Q \sqrt{\frac{R.D.}{\Delta P}}$$

where:

- K_v = Valve capacity coefficient
- Q = Flow through valve (m³/hr)
- R.D. = Relative density of liquid (water = 1)
- ΔP = Pressure drop across valve (bar)

Metric units

- 1 bar = 14.5038 (pound per square inch)
- 1m³/hr = 4.4029 USGPM (US gallon per minute)
- 1m/s = 3.2808 fps (foot per second)
- 1Nm = 0.7376 lbf. ft (poundforce foot)
- 1m = 39.3701 in (inch)
- K_v = 0.8650 C_v

Simplified basis sizing equation (showing service conditions required for sizing)

Gas

$$K_v = \frac{Q}{28.5} \sqrt{\frac{R.D.}{P_2 \Delta P}}$$

where:

- K_v = Valve capacity coefficient (same value as for liquids)
- Q = Flow through valve (m³/hr)
- R.D. = Relative density of gas (air = 1)
- ΔP = Pressure drop across valve (bar) [Less than 1/2 inlet pressure (bar)]
- P₂ = Outlet pressure (bar abs.)

Steam

$$K_v = \frac{W}{22.5 \sqrt{P_2 \Delta P}}$$

where:

- K_v = Valve capacity coefficient (same value as for liquids)
- W = Flow through valve (kg/hr)
- ΔP = Pressure drop across valve (bar) [Less than 1/2 inlet pressure (bar)]
- P₂ = Outlet pressure (bar abs.)

Conversion Equations

Mass/Volumetric Rate of Flow

Gases

$$\text{ft}^3/\text{h (std)} = \frac{\text{lb/h} \times 379}{M} \quad \text{m}^3/\text{h (norm)} = \frac{\text{kg/h} \times 22.40}{M}$$

$$\text{ft}^3/\text{h (std)} = \frac{\text{lb/h}}{\rho_1} \quad \text{m}^3/\text{h (norm)} = \frac{\text{kg/h}}{\rho_2}$$

$$\text{ft}^3/\text{h (std)} = \frac{\text{lb/h} \times 13.1}{G_1} \quad \text{m}^3/\text{h (norm)} = \frac{\text{kg/h} \times 0.82}{G_2}$$

where:

- (std) is at 14.7 lbf/in² (abs) and 67°F
- (norm) is at 760mm Hg and 0°C
- SG₁ Water = 1 at 60°F
- SG₂ Water = 1 at 4°C
- M = Molecular Weight
- ρ₁ = Density lb/ft³ (std)
- ρ₂ = Density kg/cm³ (norm)
- G₁ = sp. gr. Air = 1 (std)
- G₂ = sp. gr. Air = 1 (norm)

Liquids

$$\text{US gal/min} = \frac{\text{lb/h}}{500 \times SG_1} \quad \text{m}^3/\text{h} = \frac{0.001 \text{ kg/h}}{SG_2}$$

I.P. RATINGS

The IP rating system provides a means of classifying the degrees of protection from dust, water and impact afforded by electrical equipment and enclosures. The system is recognised in most European countries and is set out in a number of British and European standards. These include BS 5490:1977 (IEC529:1976) Classification of Degrees of Protection Provided by Enclosures, BS5420:1977 (IEC144:1963) Specification

for Degrees of Protection of Enclosures of Switchgear and Control Gear for Voltages up to and including 1000V a.c. and 1200 V d.c.

Details of a third IP numeral are also shown. Whilst not specified by the British Standards Institute, this figure is used in corresponding international standards to indicate degrees of resistances to impact.

FIRST NUMBER Protection against solid objects		SECOND NUMBER Protection against liquids		THIRD NUMBER Protection against mechanical impacts	
IP	TESTS	IP	TESTS	IP	TESTS
0	no protection	0	no protection	0	no protection
1	protection against solid objects over 50mm, e.g. accidental touch by hands.	1	protected against vertically falling drops of water.	1	impact 0.225 joule
2	protection against solid objects over 12mm, e.g. fingers	2	protected against direct sprays of water up to 15° from the vertical	2	impact 0.375 joule
3	protection against solid objects over 2.5mm, (tools + wires).	3	protected against sprays to 60° from the vertical.	3	impact 0.50 joule
4	protection against solid objects over 1mm, (tools, wires + small wires).	4	protected against water sprayed from all directions – limited ingress permitted	5	impact 2.00 joule
5	protection against dust – limited ingress (no harmful deposit).	5	protected against low pressure jets of water from all directions – limited ingress permitted	6	impact 6.00 joule
6	totally protected against dust.	6	protected against strong jets of water, eg for use on shipdecks – limited ingress permitted	7	impact 20,000 joule
		7	protected against the effects of immersion between 15cm and 1m	8	
		8	protected against long periods of immersion under pressure	9	