



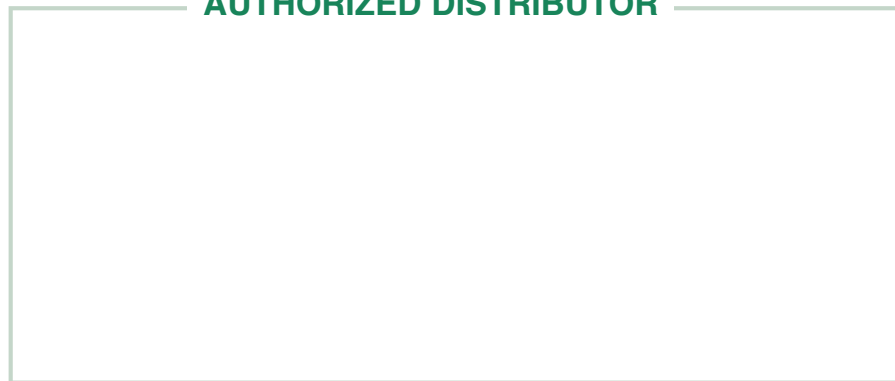
Trigonometry Tables and Handy References for Engineers

*No matter what angle
you figure...*



*Carr Lane is your best answer
for jig-and-fixture components!*

AUTHORIZED DISTRIBUTOR

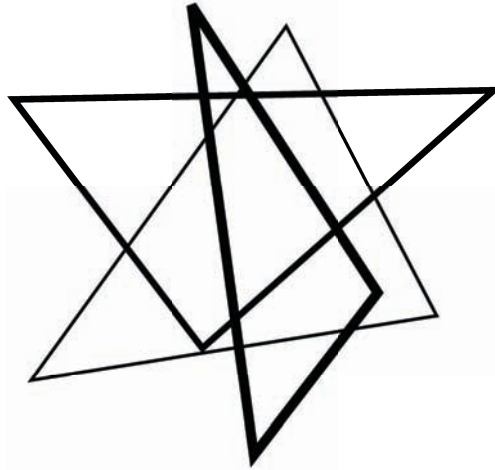


MANUFACTURING CO.
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St. Louis, Missouri 63119-7970
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USA THREADS

Thread Size*	Basic Major Diameter	Tap Drill Size**
#0-80	.0600	3/64
#2-56	.0860	#50
#2-64	.0860	#50
#4-40	.1120	#43
#4-48	.1120	#42
#5-40	.1250	#38
#5-44	.1250	#37
#6-32	.1380	#36
#6-40	.1380	#33
#8-32	.1640	#29
#8-36	.1640	#29
#10-24	.1900	#25
#10-32	.1900	#21
1/4-20	.2500	#7
1/4-28	.2500	#3
5/16-18	.3125	F
5/16-24	.3125	I
3/8-16	.3750	5/16
3/8-24	.3750	Q
7/16-14	.4375	U
7/16-20	.4375	25/64
1/2-13	.5000	27/64
1/2-20	.5000	29/64
9/16-12	.5625	31/64
9/16-18	.5625	33/64
5/8-11	.6250	17/32
5/8-18	.6250	37/64
3/4-10	.7500	21/32
3/4-16	.7500	11/16
7/8-9	.8750	49/64
7/8-14	.8750	13/16
1-8	1.0000	7/8
1-14	1.0000	15/16
1-1/8-7	1.1250	63/64
1-1/8-12	1.1250	1-3/64

METRIC THREADS

Thread Size*	Basic Major Diameter	Tap Drill Size**
M1.6 x0.35	.0630	1.25mm or #55
M2 x0.4	.0787	1.60mm or #52
M2.5 x0.45	.0984	2.05mm or #46
M3 x0.5	.1181	2.50mm or #39
M3.5 x0.6	.1378	2.90mm or #32
M4 x0.7	.1575	3.30mm or #30
M5 x0.8	.1969	4.20mm or #19
M6 x1	.2362	5.00mm or #8
M8 x1.25	.3150	6.80mm or H
M8x1	.3150	7.00mm or J
M10 x1.5	.3937	8.50mm or R
M10x1.25	.3937	8.80mm or 11/32
M12 x1.75	.4724	10.20mm or 13/32
M12x1.25	.4724	10.80mm or 27/64
M14 x2	.5512	12.00mm or 15/32
M14x1.5	.5512	12.50mm or 1/2
M16 x2	.6299	14.00mm or 35/64
M16x1.5	.6299	14.50mm or 37/64
M18 x2.5	.7087	15.50mm or 39/64
M18x1.5	.7087	16.50mm or 21/32
M20 x2.5	.7874	17.50mm or 11/16
M20x1.5	.7874	18.50mm or 47/64
M22 x2.5	.8661	19.50mm or 49/64
M22x1.5	.8661	20.50mm or 13/16
M24 x3	.9449	21.00mm or 53/64
M24x2	.9449	22.00mm or 7/8
M27 x3	1.0630	24.00mm or 15/16
M27x2	1.0630	25.00mm or 1

* Coarse series shown in bold. Pitch callout not required on metric coarse series.

** Closest size for 75% theoretical thread.

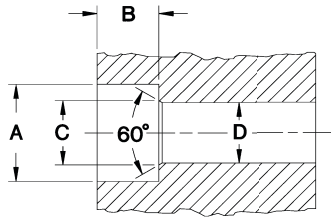
USA DRILL SIZES

Drill Decimal	Drill Decimal	Drill Decimal	Drill Decimal
80	.0135	40	.0980
79	.0145	39	.0995
1/64	.0156	38	.1015
78	.0160	37	.1040
77	.0180	36	.1065
76	.0200	7/64	.1094
75	.0210	35	.1100
74	.0225	34	.1110
73	.0240	33	.1130
72	.0250	32	.1160
71	.0260	31	.1200
70	.0280	1/8	.1250
69	.0292	30	.1285
68	.0310	29	.1360
1/32	.0312	28	.1405
67	.0320	9/64	.1406
66	.0330	27	.1440
65	.0350	26	.1470
64	.0360	25	.1495
63	.0370	24	.1520
62	.0380	23	.1540
61	.0390	5/32	.1562
60	.0400	22	.1570
59	.0410	21	.1590
58	.0420	20	.1610
57	.0430	19	.1660
56	.0465	18	.1695
3/64	.0469	11/64	.1719
55	.0520	17	.1730
54	.0550	16	.1770
53	.0595	15	.1800
1/16	.0625	14	.1820
52	.0635	13	.1850
51	.0670	3/16	.1875
50	.0700	12	.1890
49	.0730	11	.1910
48	.0760	10	.1935
5/64	.0781	9	.1960
47	.0785	8	.1990
46	.0810	7	.2010
45	.0820	13/64	.2031
44	.0860	6	.2040
43	.0890	5	.2055
42	.0935	4	.2090
3/32	.0938	3	.2130
41	.0960	7/32	.2188
		2	.2210
		1	.2280
		A	.2340
		15/64	.2344
		B	.2380
		C	.2420
		D	.2460
		E	.2500
		1/4	.2500
		F	.2570
		G	.2610
		17/64	.2656
		H	.2660
		I	.2720
		J	.2770
		K	.2810
		9/32	.2812
		L	.2900
		M	.2950
		19/64	.2969
		N	.3020
		5/16	.3125
		O	.3160
		P	.3230
		21/64	.3281
		Q	.3320
		R	.3390
		11/32	.3438
		S	.3480
		T	.3580
		23/64	.3594
		U	.3680
		3/8	.3750
		V	.3770
		W	.3860
		25/64	.3906
		X	.3970
		Y	.4040
		13/32	.4062
		Z	.4130
		27/64	.4219
		7/16	.4375
		29/64	.4531
		15/32	.4688
		31/64	.4844
		1/2	.5000
		33/64	.5156
		17/32	.5312
		35/64	.5469
		9/16	.5625
		37/64	.5781
		19/32	.5938
		39/64	.6094
		5/8	.6250
		41/64	.6406
		21/32	.6562
		43/64	.6719
		11/16	.6875
		45/64	.7031
		23/32	.7188
		47/64	.7344
		3/4	.7500
		49/64	.7656
		25/32	.7812
		51/64	.7969
		13/16	.8125
		53/64	.8281
		27/32	.8438
		55/64	.8594
		7/8	.8750
		57/64	.8906
		29/32	.9062
		59/64	.9219
		15/16	.9375
		61/64	.9531
		31/32	.9688
		63/64	.9844
		1	1.0000
			+64th increments up to 1-7/8"
			+32nd increments up to 2-1/4"
			+16th increments up to 4-1/4"

METRIC DRILL SIZES

Drill	Decimal	Drill	Decimal	Drill	Decimal	Drill	Decimal
.35mm	.0138	2.50mm	.0984	6.20mm	.2441	10.00mm	.3937
.38mm	.0150	2.55mm	.1004	6.25mm	.2461	10.20mm	.4016
.40mm	.0157	2.60mm	.1024	6.30mm	.2480	10.50mm	.4134
.42mm	.0165	2.65mm	.1043	6.40mm	.2520	10.80mm	.4252
.45mm	.0177	2.70mm	.1063	6.50mm	.2559	11.00mm	.4331
.48mm	.0189	2.75mm	.1083	6.60mm	.2598	11.20mm	.4409
.50mm	.0197	2.80mm	.1102	6.70mm	.2638	11.50mm	.4528
.55mm	.0217	2.90mm	.1142	6.75mm	.2657	11.80mm	.4646
.60mm	.0236	3.00mm	.1181	6.80mm	.2677	12.00mm	.4724
.65mm	.0256	3.10mm	.1220	6.90mm	.2717	12.20mm	.4803
.70mm	.0276	3.20mm	.1260	7.00mm	.2756	12.50mm	.4921
.75mm	.0295	3.25mm	.1280	7.10mm	.2795	13.00mm	.5118
.80mm	.0315	3.30mm	.1299	7.20mm	.2835	13.50mm	.5315
.85mm	.0335	3.40mm	.1339	7.25mm	.2854	14.00mm	.5512
.90mm	.0354	3.50mm	.1378	7.30mm	.2874	14.50mm	.5709
.95mm	.0374	3.60mm	.1417	7.40mm	.2913	15.00mm	.5906
1.00mm	.0394	3.70mm	.1457	7.50mm	.2953	15.50mm	.6102
1.05mm	.0413	3.75mm	.1476	7.60mm	.2992	16.00mm	.6299
1.10mm	.0433	3.80mm	.1496	7.70mm	.3031	16.50mm	.6496
1.15mm	.0453	3.90mm	.1535	7.75mm	.3051	17.00mm	.6693
1.20mm	.0472	4.00mm	.1575	7.80mm	.3071	17.50mm	.6890
1.25mm	.0492	4.10mm	.1614	7.90mm	.3110	18.00mm	.7087
1.30mm	.0512	4.20mm	.1654	8.00mm	.3150	18.50mm	.7283
1.35mm	.0531	4.25mm	.1673	8.10mm	.3189	19.00mm	.7480
1.40mm	.0551	4.30mm	.1693	8.20mm	.3228	19.50mm	.7677
1.45mm	.0571	4.40mm	.1732	8.25mm	.3248	20.00mm	.7874
1.50mm	.0591	4.50mm	.1772	8.30mm	.3268	20.50mm	.8071
1.55mm	.0610	4.60mm	.1811	8.40mm	.3307	21.00mm	.8268
1.60mm	.0630	4.70mm	.1850	8.50mm	.3346	21.50mm	.8465
1.65mm	.0650	4.75mm	.1870	8.60mm	.3386	22.00mm	.8661
1.70mm	.0669	4.80mm	.1890	8.70mm	.3425	22.50mm	.8858
1.75mm	.0689	4.90mm	.1929	8.75mm	.3445	23.00mm	.9055
1.80mm	.0709	5.00mm	.1969	8.80mm	.3465	23.50mm	.9252
1.85mm	.0728	5.10mm	.2008	8.90mm	.3504	24.00mm	.9449
1.90mm	.0748	5.20mm	.2047	9.00mm	.3543	24.50mm	.9646
1.95mm	.0768	5.25mm	.2067	9.10mm	.3583	25.00mm	.9843
2.00mm	.0787	5.30mm	.2087	9.20mm	.3622		
2.05mm	.0807	5.40mm	.2126	9.25mm	.3642	+1.00mm	
2.10mm	.0827	5.50mm	.2165	9.30mm	.3661	increments	
2.15mm	.0846	5.60mm	.2205	9.40mm	.3701	up to 48mm	
2.20mm	.0866	5.70mm	.2244	9.50mm	.3740		
2.25mm	.0886	5.75mm	.2264	9.60mm	.3780	+5.00mm	
2.30mm	.0906	5.80mm	.2283	9.70mm	.3819	increments	
2.35mm	.0925	5.90mm	.2323	9.75mm	.3839	from 50mm	
2.40mm	.0945	6.00mm	.2362	9.80mm	.3858	up to 105mm	
2.45mm	.0965	6.10mm	.2402	9.90mm	.3898		

COUNTERBORED HOLES



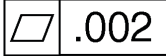


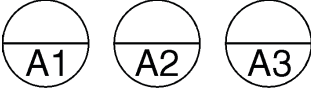
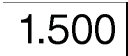




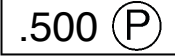
USA SOCKET-HEAD CAP SCREWS

SCREW DIA	A COUNTERBORE DIA	B COUNTERBORE DEPTH	C COUNTERSINK DIA	D CLEARANCE DIA	
				NORMAL FIT	CLOSE FIT
#0	1/8	.060	.074	#49	#51
#2	3/16	.086	.102	#36	3/32
#4	7/32	.112	.130	#29	1/8
#5	1/4	.125	.145	#23	9/64
#6	9/32	.138	.158	#18	#23
#8	5/16	.164	.188	#10	#15
#10	3/8	.190	.218	#2	#5
1/4	7/16	.250	.278	9/32	17/64
5/16	17/32	.312	.346	11/32	21/64
3/8	5/8	.375	.415	13/32	25/64
7/16	23/32	.438	.483	15/32	29/64
1/2	13/16	.500	.552	17/32	33/64
5/8	1	.625	.689	21/32	41/64
3/4	1-3/16	.750	.828	25/32	49/64
7/8	1-3/8	.875	.963	29/32	57/64
1	1-5/8	1.000	1.100	1-1/32	1-1/64
1-1/4	2	1.250	1.370	1-5/16	1-9/32
1-1/2	2-3/8	1.500	1.640	1-9/16	1-17/32
1-3/4	2-3/4	1.750	1.910	1-13/16	1-25/32
2	3-1/8	2.000	2.180	2-1/16	2-1/32

METRIC SOCKET-HEAD CAP SCREWS

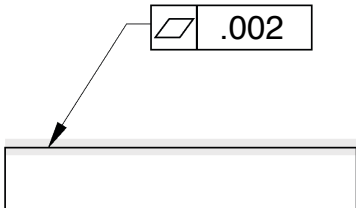
M1.6	3.50mm	1.6mm	2.0mm	1.95mm	1.80mm
M2	4.40mm	2mm	2.6mm	2.40mm	2.20mm
M2.5	5.40mm	2.5mm	3.1mm	3.00mm	2.70mm
M3	6.50mm	3mm	3.6mm	3.70mm	3.40mm
M4	8.25mm	4mm	4.7mm	4.80mm	4.40mm
M5	9.75mm	5mm	5.7mm	5.80mm	5.40mm
M6	11.20mm	6mm	6.8mm	6.80mm	6.40mm
M8	14.50mm	8mm	9.2mm	8.80mm	8.40mm
M10	17.50mm	10mm	11.2mm	10.80mm	10.50mm
M12	19.50mm	12mm	14.2mm	13.00mm	12.50mm
M14	22.50mm	14mm	16.2mm	15.00mm	14.50mm
M16	25.50mm	16mm	18.2mm	17.00mm	16.50mm
M20	31.50mm	20mm	22.4mm	21.00mm	20.50mm
M24	37.50mm	24mm	26.4mm	25.00mm	24.50mm
M30	47.50mm	30mm	33.4mm	31.50mm	31.00mm
M36	56.50mm	36mm	39.4mm	37.50mm	37.00mm
M42	66.00mm	42mm	45.6mm	44.00mm	43.00mm
M48	75.00mm	48mm	52.6mm	50.00mm	49.00mm

GEOMETRIC SYMBOLS AND DEFINITIONS

 <p>Individual Features</p>	 <p>Related Features</p>
<p>Feature-Control Frame</p> <p>A specification box that shows a particular geometric characteristic (flatness, straightness, etc.) applied to a part feature and states the allowable tolerance. The feature's tolerance may be individual, or related to one or more datums. Any datum references and tolerance modifiers are also shown.</p>	
 <p>Datum Feature</p> <p>A flag which designates a physical feature of the part to be used as a reference to measure geometric characteristics of other part features.</p>	 <p>Datum Targets</p> <p>Callouts occasionally needed to designate specific points, lines, or areas on an actual part to be used to establish a theoretical datum feature.</p>
 <p>Basic Dimension</p> <p>A box around any drawing dimension makes it a "basic" dimension, a theoretically exact value used as a reference for measuring geometric characteristics and tolerances of other part features.</p>	 <p>Cylindrical Tolerance Zone</p> <p>This symbol, commonly used to indicate a diameter dimension, also specifies a cylindrically shaped tolerance zone in a feature-control frame.</p>
 <p>Maximum Material Condition</p> <p>Abbreviation: MMC. A tolerance modifier that applies the stated tight tolerance zone only while the part theoretically contains the maximum amount of material permitted within its dimensional limits (e.g. minimum hole diameters and maximum shaft diameters), allowing more variation under normal conditions.</p>	 <p>Least Material Condition</p> <p>Abbreviation: LMC. A tolerance modifier that applies the stated tight tolerance zone only while the part theoretically contains the minimum amount of material permitted within its dimensional limits (e.g. maximum hole diameters and minimum shaft diameters), allowing more variation under normal conditions.</p>
 <p>Regardless of Feature Size</p> <p>Abbreviation: RFS. A tolerance modifier that applies the stated tight tolerance zone under all size conditions. RFS is generally assumed if neither MMC nor LMC are stated.</p>	 <p>Projected Tolerance Zone</p> <p>An additional specification box attached underneath a feature-control frame. It extends the feature's tolerance zone beyond the part's surface by the stated distance, ensuring perpendicularity for proper alignment of mating parts.</p>

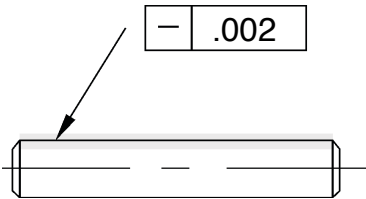
GEOMETRIC CHARACTERISTICS

Flatness



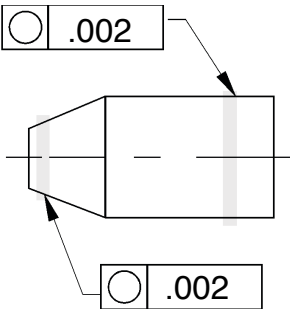
All points on the indicated surface must lie in a single plane, within the specified tolerance zone.

Straightness



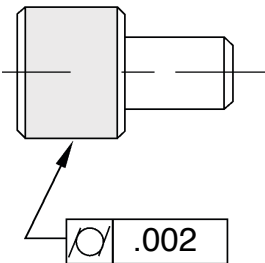
All points on the indicated surface or axis must lie in a straight line in the direction shown, within the specified tolerance zone.

Circularity (Roundness)



If the indicated surface were sliced by any plane perpendicular to its axis, the resulting outline must be a perfect circle, within the specified tolerance zone.

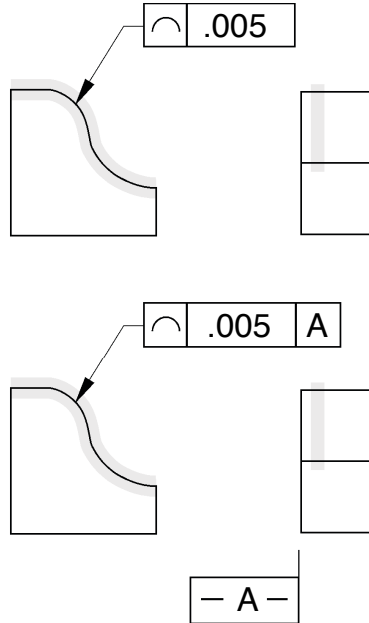
Cylindricity



All points on the indicated surface must lie in a perfect cylinder around a center axis, within the specified tolerance zone.

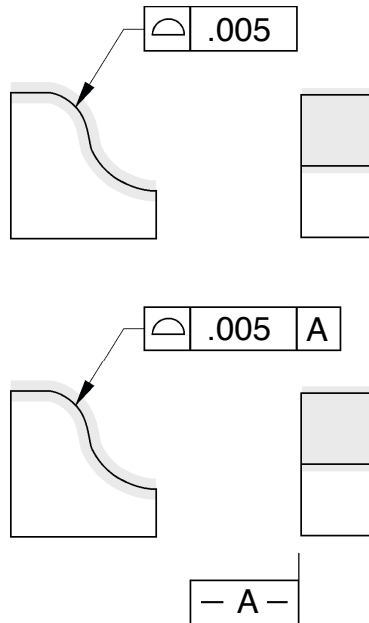
GEOMETRIC CHARACTERISTICS

Linear Profile



All points on any full slice of the indicated surface must lie on its theoretical two-dimensional profile, as defined by basic dimensions, within the specified tolerance zone. The profile may or may not be oriented with respect to datums.

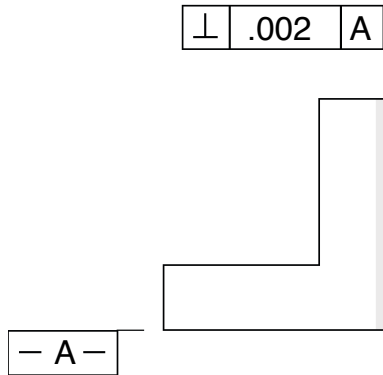
Surface Profile



All points on the indicated surface must lie on its theoretical three-dimensional profile, as defined by basic dimensions, within the specified tolerance zone. The profile may or may not be oriented with respect to datums.

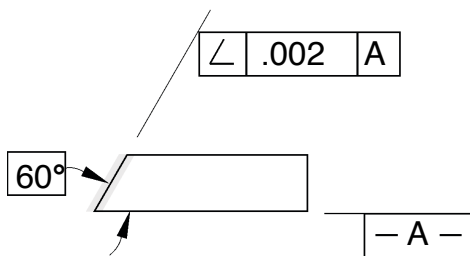
GEOMETRIC CHARACTERISTICS

\perp Perpendicularity (Squareness)



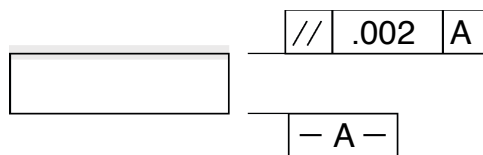
All points on the indicated surface, axis, or line must lie in a single plane exactly 90° from the designated datum plane or axis, within the specified tolerance zone.

\sphericalangle Angularity



All points on the indicated surface or axis must lie in a single plane at exactly the specified angle from the designated datum plane or axis, within the specified tolerance zone.

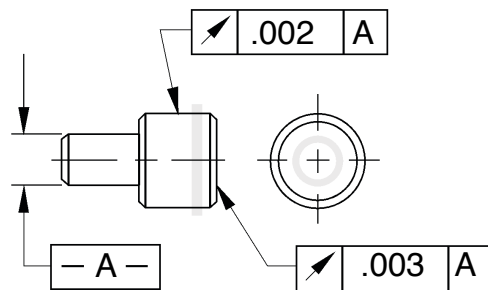
// Parallelism



All points on the indicated surface or axis must lie in a single plane parallel to the designated datum plane or axis, within the specified tolerance zone.

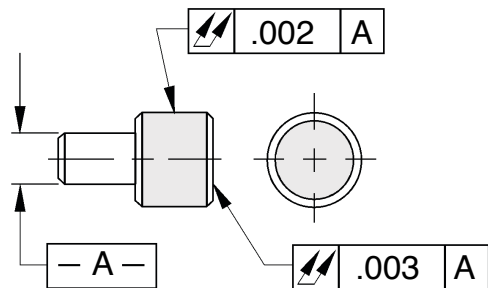
GEOMETRIC CHARACTERISTICS

Circular Runout



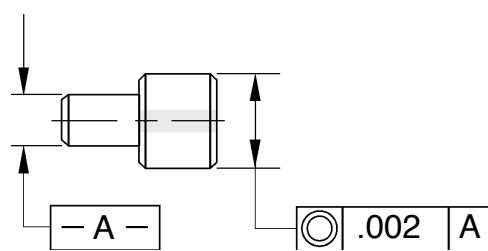
Each circular element of the indicated surface is allowed to deviate only the specified amount from its theoretical form and orientation during 360° rotation about the designated datum axis.

Total Runout



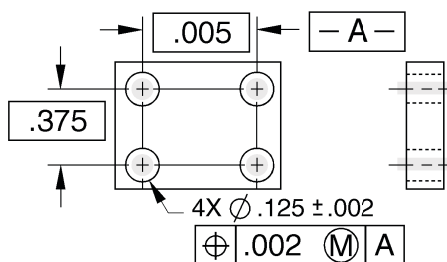
The entire indicated surface is allowed to deviate only the specified amount from its theoretical form and orientation during 360° rotation about the designated datum axis.

Concentricity



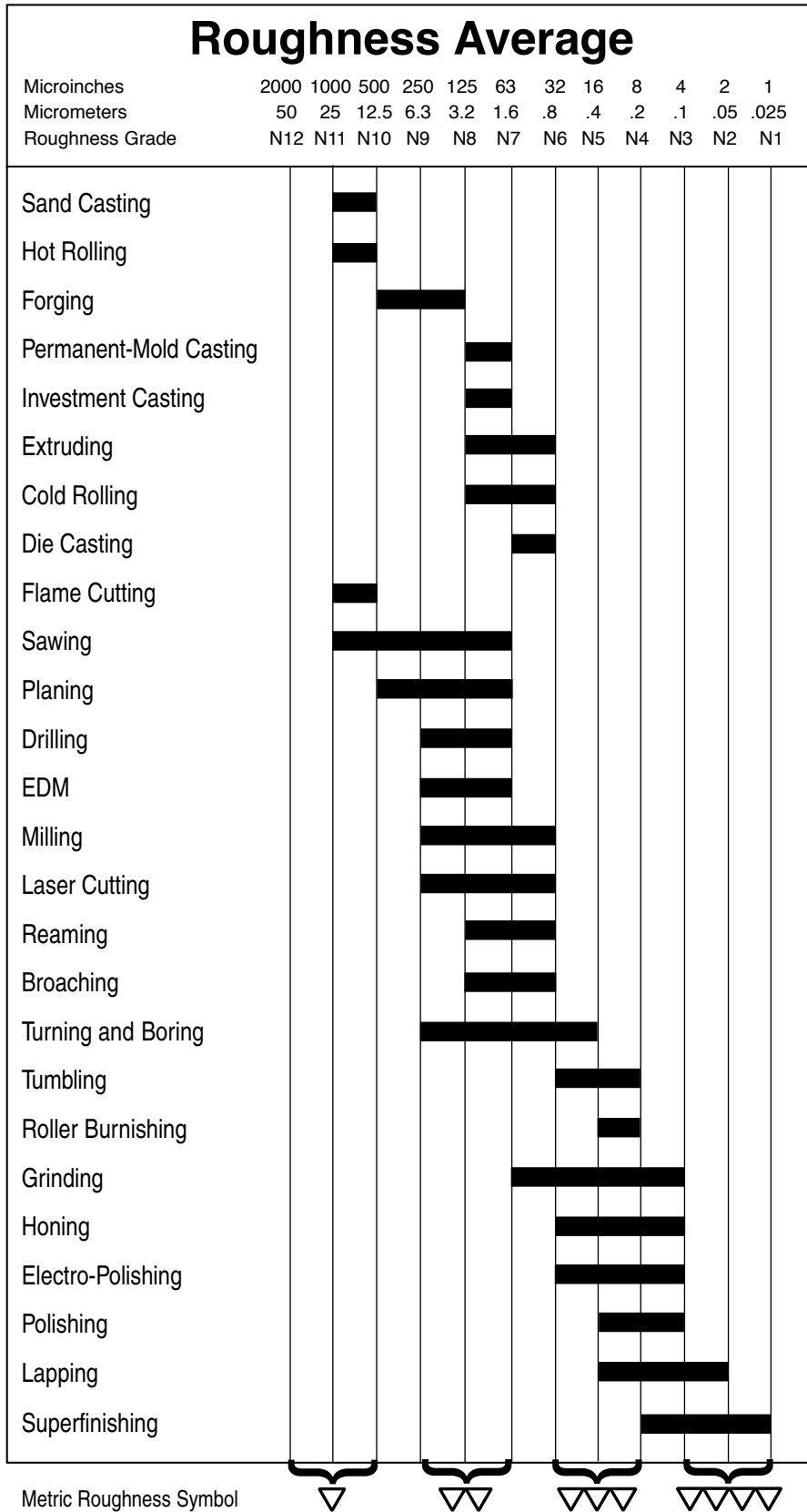
If the indicated surface were sliced by any plane perpendicular to the designated datum axis, every slice's center of area must lie on the datum axis, within the specified cylindrical tolerance zone (controls rotational balance).

Position (Replaces Symmetry)

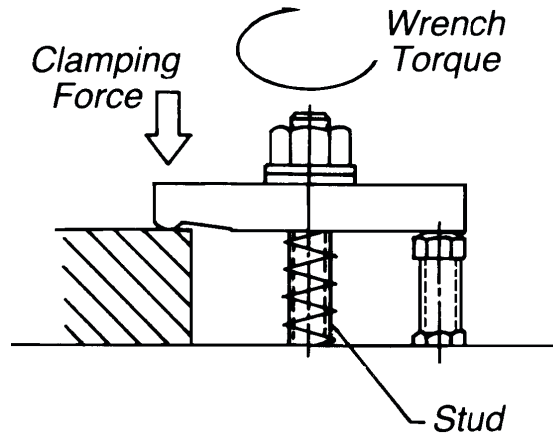


The indicated feature's axis must be located within the specified tolerance zone from its true theoretical position, correctly oriented relative to the designated datum plane or axis.

TYPICAL SURFACE FINISHES PRODUCED BY VARIOUS PRODUCTION METHODS



CLAMPING FORCE OF STANDARD CLAMP STRAPS



USA

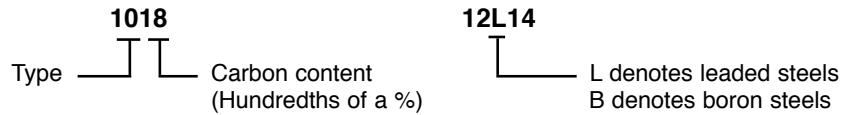
Stud Size	Recommended Torque* (ft.-lbs.)	Clamping Force (lbs.)	Tensile Force in Stud (lbs.)
#10-32	2	300	600
1/4-20	4	500	1000
5/16-18	9	900	1800
3/8-16	16	1300	2600
1/2-13	38	2300	4600
5/8-11	77	3700	7400
3/4-10	138	5500	11000
7/8-9	222	7600	15200
1-8	333	10000	20000

METRIC

M6	4	500	1000
M8	9	900	1800
M10	20	1500	3000
M12	35	2200	4400
M16	84	4000	8000
M20	165	6300	12600
M24	283	9000	18000

*Clean, dry clamping stud torqued to approximately 33% of its 100,000 psi yield strength (2:1 lever ratio).

AISI/SAE NUMBERING SYSTEM FOR CARBON AND ALLOY STEELS



Carbon Steels	10XX	Plain Carbon, Mn 1.00% max
	11XX	Resulfurized Free Machining
	12XX	Resulfurized/Rephosphorized Free Machining
	15XX	Plain Carbon, Mn 1.00-1.65%
Manganese Steel	13XX	Mn 1.75%
Nickel Steels	23XX	Ni 3.50%
	25XX	Ni 5.00%
Nickel-Chromium Steels	31XX	Ni 1.25%, Cr .65-.80%
	32XX	Ni 1.75%, Cr 1.07%
	33XX	Ni 3.50%, Cr 1.50-1.57%
	34XX	Ni 3.00%, Cr .77%
Molybdenum Steels	40XX	Mo .20-.25%
	44XX	Mo .40-.52%
Chromium-Molybdenum Steels	41XX	Cr .50-.95%, Mo .12-.30%
Nickel-Chromium-Molybdenum Steels	43XX	Ni 1.82%, Cr .50-.80%, Mo .25%
	47XX	Ni 1.05%, Cr .45%, Mo .20-.35%
Nickel-Molybdenum Steels	46XX	Ni .85-1.82%, Mo .20-.25%
	48XX	Ni 3.50%, Mo .25%
Chromium Steels	50XX	Cr .27-.65%
	51XX	Cr .80-1.05%
	50XXX	Cr .50%, C 1.00% min
	51XXX	Cr 1.02%, C 1.00% min
	52XXX	Cr 1.45%, C 1.00% min
Chromium-Vanadium Steels	61XX	Cr .60-.95%, V .10-.15%
Tungsten-Chromium Steels	72XX	W 1.75%, Cr .75%
Nickel-Chromium-Molybdenum Steels	81XX	Ni .30%, Cr .40%, Mo .12%
	86XX	Ni .55%, Cr .50%, Mo .20%
	87XX	Ni .55%, Cr .50%, Mo .25%
	88XX	Ni .55%, Cr .50%, Mo .35%
Silicon-Manganese Steels	92XX	Si 1.40-2.00%, Mn .65-.85%, Cr 0-.65%
Nickel-Chromium-Molybdenum Steels	93XX	Ni 3.25%, Cr 1.20%, Mo .12%
	94XX	Ni .45%, Cr .40%, Mo .12%
	97XX	Ni .55%, Cr .20%, Mo .20%
	98XX	Ni 1.00%, Cr .80%, Mo .25%

MACHINABILITY COMPARISON*

Carbon Steels:

1015.....	72%	1137	72%
1018.....	78%	1141	70%
1020.....	72%	1141 Annealed	81%
1022.....	78%	1144	76%
1030.....	70%	1144 Annealed	85%
1040.....	64%	1144 Stressproof.....	83%
1042.....	64%	1212	100%
1050.....	54%	1213	136%
1095.....	42%	12L14	170%
1117	91%	1215	136%

Alloy Steels:

2355 Annealed	70%	4620	66%
4130 Annealed	72%	4820 Annealed	49%
4140 Annealed	66%	52100 Annealed	40%
4142 Annealed	66%	6150 Annealed	60%
41L42 Annealed	77%	8620	66%
4150 Annealed	60%	86L20	77%
4340 Annealed	57%	9310 Annealed	51%

Stainless Steels and Super Alloys:

302 Annealed	45%	420 Annealed	45%
303 Annealed	78%	430 Annealed	54%
304 Annealed	45%	431 Annealed	45%
316 Annealed	45%	440A.....	45%
321 Annealed	36%	15-5PH Condition A	48%
347 Annealed	36%	17-4PH Condition A	48%
410 Annealed	54%	A286 Aged	33%
416 Annealed	110%	Hastelloy X.....	19%

Tool Steels:

A-2.....	42%	M-2	39%
A-6.....	33%	O-1	42%
D-2	27%	O-2	42%
D-3	27%		

Gray Cast Iron:

ASTM Class 20 Annealed.....	73%	ASTM Class 40	48%
ASTM Class 25	55%	ASTM Class 45	36%
ASTM Class 30	48%	ASTM Class 50	36%
ASTM Class 35	48%		

Nodular Iron:

60-40-18 Annealed	61%	80-55-06.....	39%
65-45-12 Annealed	61%		

Aluminum and Magnesium Alloys:

Aluminum, Cold Drawn.....	360%	Magnesium, Cold Drawn	480%
Aluminum, Cast	450%	Magnesium, Cast.....	480%
Aluminum, Die Cast.....	76%		

* Relative machining speed based on 1212 as 100%. All figures are based on cold-drawn bars in as-drawn condition, except where noted.

APPROXIMATE HARDNESS CONVERSIONS FOR STEEL

Rockwell		Rockwell Superficial				Brinell		Vickers	Shore	Approximate Tensile Strength (psi)				
A	B	C	D	E	F	15-N 15 kg Brale	30-N 30 kg Brale	45-N 45 kg Brale	30-T 30 kg 16" Ball	3000 kg 10mm Ball Steel*	500 kg 10mm Ball Steel	136° Diamond Pyramid	Sclero- scope	
86.5	—	70	78.5	—	—	94.0	86.0	77.6	—	—	—	1076	101	—
86.0	—	69	77.7	—	—	93.5	85.0	76.5	—	—	—	1044	99	—
85.6	—	68	76.9	—	—	93.2	84.4	75.4	—	—	—	940	97	—
85.0	—	67	76.1	—	—	92.9	83.6	74.2	—	—	—	900	95	—
84.5	—	66	75.4	—	—	92.5	82.8	73.2	—	—	—	865	92	—
83.9	—	65	74.5	—	—	92.2	81.9	72.0	—	739	—	832	91	—
83.4	—	64	73.8	—	—	91.8	81.1	71.0	—	722	—	800	88	—
82.8	—	63	73.0	—	—	91.4	80.1	69.9	—	705	—	772	87	—
82.3	—	62	72.2	—	—	91.1	79.3	68.8	—	688	—	746	85	—
81.8	—	61	71.5	—	—	90.7	78.4	67.7	—	670	—	720	83	—
81.2	—	60	70.7	—	—	90.2	77.5	66.6	—	654	—	697	81	320,000
80.7	—	59	69.9	—	—	89.8	76.6	65.5	—	634	—	674	80	310,000
80.1	—	58	69.2	—	—	89.3	75.7	64.3	—	615	—	653	78	300,000
79.6	—	57	68.5	—	—	88.9	74.8	63.2	—	595	—	633	76	290,000
79.0	—	56	67.7	—	—	88.3	73.9	62.0	—	577	—	613	75	282,000
78.5	120	55	66.9	—	—	87.9	73.0	60.9	—	560	—	595	74	274,000
78.0	120	54	66.1	—	—	87.4	72.0	59.8	—	543	—	577	72	266,000
77.4	119	53	65.4	—	—	86.9	71.2	58.6	—	525	—	560	71	257,000
76.8	119	52	64.6	—	—	86.4	70.2	57.4	—	500	—	544	69	245,000
76.3	118	51	63.8	—	—	85.9	69.4	56.1	—	487	—	528	68	239,000
75.9	117	50	63.1	—	—	85.5	68.5	55.0	—	475	—	513	67	233,000
75.2	117	49	62.1	—	—	85.0	67.6	53.8	—	464	—	498	66	227,000
74.7	116	48	61.4	—	—	84.5	66.7	52.5	—	451	—	484	64	221,000
74.1	116	47	60.8	—	—	83.9	65.8	51.4	—	442	—	471	63	217,000
73.6	115	46	60.0	—	—	83.5	64.8	50.3	—	432	—	458	62	212,000

*Brinell hardness values above 500 are listed for a 10mm carbide ball instead of a steel ball.

APPROXIMATE HARDNESS CONVERSIONS FOR STEEL

Rockwell		Rockwell Superficial				Brinell		Vickers		Shore		Approximate Tensile Strength (psi)		
A	B	C	D	E	F	15-N	30-N	45-N	30-T	3000 kg 10mm Ball Steel	500 kg 10mm Ball Steel	136° Diamond Pyramid	Sclero-scope	
60 kg Brate	100 kg 1/16" Ball	150 kg Brate	100 kg Brate	100 kg 1/8" Ball	60 kg 1/16" Ball	15 kg Brate	30 kg Brate	45 kg Brate	30 kg 1/16" Ball					
73.1	115	45	59.2	—	—	83.0	64.0	49.0	—	421	—	446	60	206,000
72.5	114	44	58.5	—	—	82.5	63.1	47.8	—	409	—	434	58	200,000
72.0	113	43	57.7	—	—	82.0	62.2	46.7	—	400	—	423	57	196,000
71.5	113	42	56.9	—	—	81.5	61.3	45.5	—	390	—	412	56	191,000
70.9	112	41	56.2	—	—	80.9	60.4	44.3	—	381	—	402	55	187,000
70.4	112	40	55.4	—	—	80.4	59.5	43.1	—	371	—	392	54	182,000
69.9	111	39	54.6	—	—	79.9	58.6	41.9	—	362	—	382	52	177,000
69.4	110	38	53.8	—	—	79.4	57.7	40.8	—	353	—	372	51	173,000
68.9	110	37	53.1	—	—	78.8	56.8	39.6	—	344	—	363	50	169,000
68.4	109	36	52.3	—	—	78.3	55.9	38.4	—	336	—	354	49	165,000
67.9	109	35	51.5	—	—	77.7	55.0	37.2	—	327	—	345	48	160,000
67.4	108	34	50.8	—	—	77.2	54.2	36.1	—	319	—	336	47	156,000
66.8	108	33	50.0	—	—	76.6	53.3	34.9	—	311	—	327	46	152,000
66.3	107	32	49.2	—	—	76.1	52.1	33.7	—	301	—	318	44	147,000
65.8	106	31	48.4	—	—	75.6	51.3	32.5	—	294	—	310	43	144,000
65.3	105	30	47.7	—	—	75.0	50.4	31.3	—	286	—	302	42	140,000
64.7	104	29	47.0	—	—	74.5	49.5	30.1	—	279	—	294	41	137,000
64.3	104	28	46.1	—	—	73.9	48.6	28.9	—	271	—	286	41	133,000
63.8	103	27	45.2	—	—	73.3	47.7	27.8	—	264	—	279	40	129,000
63.3	103	26	44.6	—	—	72.8	46.8	26.7	—	258	—	272	39	126,000
62.8	102	25	43.8	—	—	72.2	45.9	25.5	—	253	—	266	38	124,000
62.4	101	24	43.1	—	—	71.6	45.0	24.3	—	247	—	260	37	121,000
62.0	100	23	42.1	—	—	71.0	44.0	23.1	82.0	240	201	254	36	118,000
61.5	99	22	41.6	—	—	70.5	43.2	22.0	81.5	234	195	248	35	115,000
61.0	98	21	40.9	—	—	69.9	42.3	20.7	81.0	228	189	243	35	112,000

APPROXIMATE HARDNESS CONVERSIONS FOR STEEL

Rockwell		Rockwell			Rockwell Superficial			Brinell		Vickers	Shore	Approximate Tensile Strength (psi)		
A	B	C	D	E	F	15-N	30-N	45-N	30-T	3000 kg 10mm Ball Steel	500 kg 10mm Ball Steel	136° Diamond Pyramid	Sclero-scope	
60 kg Brale	100 kg 1/16" Ball	150 kg Brale	100 kg Brale	100 kg 1/8" Ball	60 kg 1/16" Ball	15 kg Brale	30 kg Brale	45 kg Brale	30 kg 1/16" Ball					
60.5	97	20	40.1	—	—	69.4	41.5	19.6	80.5	222	184	238	34	109,000
59.0	96	18	—	—	—	—	—	—	80.0	216	179	230	33	106,000
58.0	95	16	—	—	—	—	—	—	79.0	210	175	222	32	103,000
57.5	94	15	—	—	—	—	—	—	78.5	205	171	213	31	100,000
57.0	93	13	—	—	—	—	—	—	78.0	200	167	208	30	98,000
56.5	92	12	—	—	—	—	—	—	77.5	195	163	204	29	96,000
56.0	91	10	—	—	—	—	—	—	77.0	190	160	196	28	93,000
55.5	90	9	—	—	—	—	—	—	76.0	185	157	192	27	91,000
55.0	89	8	—	—	—	—	—	—	75.5	180	154	188	26	88,000
54.0	88	7	—	—	—	—	—	—	75.0	176	151	184	26	86,000
53.5	87	6	—	—	—	—	—	—	74.5	172	148	180	26	84,000
53.0	86	5	—	—	—	—	—	—	74.0	169	145	176	25	83,000
52.5	85	4	—	—	—	—	—	—	73.5	165	142	173	25	81,000
52.0	84	3	—	—	—	—	—	—	73.0	162	140	170	25	79,000
51.0	83	2	—	—	—	—	—	—	72.0	159	137	166	24	78,000
50.5	82	1	—	—	—	—	—	—	71.5	156	135	163	24	76,000
50.0	81	0	—	—	—	—	—	—	71.0	153	133	160	24	75,000
49.5	80	—	—	—	—	—	—	—	70.0	150	130	—	—	73,000
49.0	79	—	—	—	—	—	—	—	69.5	147	128	—	—	—
48.5	78	—	—	—	—	—	—	—	69.0	144	126	—	—	—
48.0	77	—	—	—	—	—	—	—	68.0	141	124	—	—	—
47.0	76	—	—	—	—	—	—	—	67.5	139	122	—	—	—
46.5	75	—	—	—	99.5	—	—	—	67.0	137	120	—	—	—
46.0	74	—	—	—	99.0	—	—	—	66.0	135	118	—	—	—
45.5	73	—	—	—	98.5	—	—	—	65.5	132	116	—	—	—

APPROXIMATE HARDNESS CONVERSIONS FOR STEEL

Rockwell		Rockwell Superficial				Brinell		Vickers	Shore	Approximate Tensile Strength (psi)				
A 60 kg Brale	B 100 kg 1/16" Ball	C 150 kg Brale	D 100 kg Brale	E 100 kg 1/8" Ball	F 60 kg 1/16" Ball	15-N 15 kg Brale	30-N 30 kg Brale	45-N 45 kg Brale	30-T 30 kg 1/16" Ball	3000 kg 10mm Ball Steel	500 kg 10mm Ball Steel	136° Diamond Pyramid	Sclero-scope	
45.0	72	—	—	—	98.0	—	—	—	65.0	130	114	—	—	—
44.5	71	—	—	100.0	97.5	—	—	—	64.2	127	112	—	—	—
44.0	70	—	—	99.5	97.0	—	—	—	63.5	125	110	—	—	—
43.5	69	—	—	99.0	96.0	—	—	—	62.8	123	109	—	—	—
43.0	68	—	—	98.0	95.5	—	—	—	62.0	121	107	—	—	—
42.5	67	—	—	97.5	95.0	—	—	—	61.4	119	106	—	—	—
42.0	66	—	—	97.0	94.5	—	—	—	60.5	117	104	—	—	—
41.8	65	—	—	96.0	94.0	—	—	—	60.1	116	102	—	—	—
41.5	64	—	—	95.5	93.5	—	—	—	59.5	114	101	—	—	—
41.0	63	—	—	95.0	93.0	—	—	—	58.7	112	99	—	—	—
40.5	62	—	—	94.5	92.0	—	—	—	58.0	110	98	—	—	—
40.0	61	—	—	93.5	91.5	—	—	—	57.3	108	96	—	—	—
39.5	60	—	—	93.0	91.0	—	—	—	56.5	107	95	—	—	—
39.0	59	—	—	92.5	90.5	—	—	—	55.9	106	94	—	—	—
38.5	58	—	—	92.0	90.0	—	—	—	55.0	104	92	—	—	—
38.0	57	—	—	91.0	89.5	—	—	—	54.6	102	91	—	—	—
37.8	56	—	—	90.5	89.0	—	—	—	54.0	101	90	—	—	—
37.5	55	—	—	90.0	88.0	—	—	—	53.2	99	89	—	—	—
37.0	54	—	—	89.5	87.5	—	—	—	52.5	—	87	—	—	—
36.5	53	—	—	89.0	87.0	—	—	—	51.8	—	86	—	—	—
36.0	52	—	—	88.0	86.5	—	—	—	51.0	—	85	—	—	—
35.5	51	—	—	87.5	86.0	—	—	—	50.4	—	84	—	—	—
35.0	50	—	—	87.0	85.5	—	—	—	49.5	—	83	—	—	—
34.8	49	—	—	86.5	85.0	—	—	—	49.1	—	82	—	—	—
34.5	48	—	—	85.5	84.5	—	—	—	48.5	—	81	—	—	—

APPROXIMATE HARDNESS CONVERSIONS FOR STEEL

Rockwell		Rockwell Superficial				Brinell		Vickers	Shore	Approximate Tensile Strength (psi)				
A	B	C	D	E	F	15-N	30-N	45-N	30-T	3000 kg 10mm Ball Steel	500 kg 10mm Ball Steel	136° Diamond Pyramid	Sclero-scope	
60 kg Brale	100 kg 1/16" Ball	150 kg Brale	100 kg Brale	100 kg 1/8" Ball	60 kg 1/16" Ball	15 kg Brale	30 kg Brale	45 kg Brale	30 kg 1/16" Ball					
34.0	47	—	—	85.0	84.0	—	—	—	47.7	—	80	—	—	—
33.5	46	—	—	84.5	83.0	—	—	—	47.0	—	79	—	—	—
33.0	45	—	—	84.0	82.5	—	—	—	46.2	—	79	—	—	—
32.5	44	—	—	83.5	82.0	—	—	—	45.5	—	78	—	—	—
32.0	43	—	—	82.5	81.5	—	—	—	44.8	—	77	—	—	—
31.5	42	—	—	82.0	81.0	—	—	—	44.0	—	76	—	—	—
31.0	41	—	—	81.5	80.5	—	—	—	43.4	—	75	—	—	—
30.8	40	—	—	81.0	79.5	—	—	—	43.0	—	74	—	—	—
30.5	39	—	—	80.0	79.0	—	—	—	42.1	—	74	—	—	—
30.0	38	—	—	79.5	78.5	—	—	—	41.5	—	73	—	—	—
29.5	37	—	—	79.0	78.0	—	—	—	40.7	—	72	—	—	—
29.0	36	—	—	78.5	77.5	—	—	—	40.0	—	71	—	—	—
28.5	35	—	—	78.0	77.0	—	—	—	39.3	—	71	—	—	—
28.0	34	—	—	77.0	76.5	—	—	—	38.5	—	70	—	—	—
27.8	33	—	—	76.5	75.5	—	—	—	37.9	—	69	—	—	—
27.5	32	—	—	76.0	75.0	—	—	—	37.5	—	68	—	—	—
27.0	31	—	—	75.5	74.5	—	—	—	36.6	—	68	—	—	—
26.5	30	—	—	75.0	74.0	—	—	—	36.0	—	67	—	—	—
26.0	29	—	—	74.0	73.5	—	—	—	35.2	—	66	—	—	—
25.5	28	—	—	73.5	73.0	—	—	—	34.5	—	66	—	—	—
25.0	27	—	—	73.0	72.5	—	—	—	33.8	—	65	—	—	—
24.5	26	—	—	72.5	72.0	—	—	—	33.1	—	65	—	—	—
24.2	25	—	—	72.0	71.0	—	—	—	32.4	—	64	—	—	—
24.0	24	—	—	71.0	70.5	—	—	—	32.0	—	64	—	—	—
23.5	23	—	—	70.5	70.0	—	—	—	31.1	—	63	—	—	—

APPROXIMATE HARDNESS CONVERSIONS FOR STEEL

Rockwell		Rockwell Superficial				Brinell		Vickers	Shore	Approximate Tensile Strength (psi)				
A 60 kg Brale	B 100 kg 1/16" Ball	C 150 kg Brale	D 100 kg Brale	E 100 kg 1/8" Ball	F 60 kg 1/16" Ball	15-N 15 kg Brale	30-N 30 kg Brale	45-N 45 kg Brale	30-T 30 kg 1/16" Ball	3000 kg 10mm Ball Steel	500 kg 10mm Ball Steel	136° Diamond Pyramid	Sclero- scope	
23.0	22	—	—	70.0	69.5	—	—	—	30.4	—	63	—	—	—
22.5	21	—	—	69.5	69.0	—	—	—	29.7	—	62	—	—	—
22.0	20	—	—	68.5	68.5	—	—	—	29.0	—	62	—	—	—
21.5	19	—	—	68.0	68.0	—	—	—	28.1	—	61	—	—	—
21.2	18	—	—	67.5	67.0	—	—	—	27.4	—	61	—	—	—
21.0	17	—	—	67.0	66.5	—	—	—	26.7	—	60	—	—	—
20.5	16	—	—	66.5	66.0	—	—	—	26.0	—	60	—	—	—
20.0	15	—	—	65.5	65.5	—	—	—	25.3	—	59	—	—	—
—	14	—	—	65.0	65.0	—	—	—	24.6	—	59	—	—	—
—	13	—	—	64.5	64.5	—	—	—	23.9	—	58	—	—	—
—	12	—	—	64.0	64.0	—	—	—	23.5	—	58	—	—	—
—	11	—	—	63.5	63.5	—	—	—	22.6	—	57	—	—	—
—	10	—	—	62.5	63.0	—	—	—	21.9	—	57	—	—	—
—	9	—	—	62.0	62.0	—	—	—	21.2	—	56	—	—	—
—	8	—	—	61.5	61.5	—	—	—	20.5	—	56	—	—	—
—	7	—	—	61.0	61.0	—	—	—	19.8	—	56	—	—	—
—	6	—	—	60.5	60.5	—	—	—	19.1	—	55	—	—	—
—	5	—	—	60.0	60.0	—	—	—	18.4	—	55	—	—	—
—	4	—	—	59.0	59.5	—	—	—	18.0	—	55	—	—	—
—	3	—	—	58.5	59.0	—	—	—	17.1	—	54	—	—	—
—	2	—	—	58.0	58.0	—	—	—	16.4	—	54	—	—	—
—	1	—	—	57.5	57.5	—	—	—	15.7	—	53	—	—	—
—	0	—	—	57.0	57.0	—	—	—	15.0	—	53	—	—	—

Hardness values in italics are beyond the normal range of that scale and are listed for reference only.



SINGLE-ACTING BALL LOCK PINS

Precision ground locating pin. Press button to insert or remove. Positive locking until released by pressing button. Available in four handle styles. Two locking balls standard, with four balls available for greater pull-out strength. 3/16 to 1" diameters standard. Available in alloy or stainless steel.

DOUBLE-ACTING BALL LOCK PINS

Similar to a single-acting pin, except you release by pulling or pushing the handle. Positive locking. Choice of three handle styles. Available with drive-out option (internal spindle extends beyond the shank end). This feature lets you remove a pin under shear loading by tapping the shank end with a hammer.

ADJUSTABLE BALL LOCK PINS

Single-acting ball lock pin with adjustable grip length (1/2-inch range). Adjust grip by turning handle, then lock with the knurled locknut. Available in three handle styles.

DETENT PINS

Economical locating pin. Locking balls are spring loaded, not positive locking. Simply push pin to insert, pull to remove. 3/16 to 1" diameters standard. Available in alloy or stainless steel.

EXPANDING PINS

Precision alignment pin. Diameter expands up to .006 inches by moving handle. Positive cam action expands split bushings to lock pin in place.

LIFTING PINS

Single-acting ball lock pin with one-piece body and four balls for high tension loads. Sturdy forged shackle for heavy lifting.

METRIC PREFIXES

Prefix	Symbol	Multiplier
tera	T	1,000,000,000,000
giga	G	1,000,000,000
mega	M	1,000,000
kilo	k	1,000
hecto	h	100
deka	da	10
		1
deci	d	.1
centi	c	.01
milli	m	.001
micro	μ	.000001
nano	n	.000000001
pico	p	.000000000001

CONVERSION FACTORS

Multiply	By	To Obtain
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A

A	1	Amperes
Abcoulombs	2.998×10^{10}	Statcoulombs
Acre-feet	43,560	Cubic feet
Acre-feet	1233.49	Cubic meters
Acre-feet	325,851	Gallons
Acres	.4047	Hectares
Acres	43,560	Square feet
Acres	4,047	Square meters
Acres	.001562	Square miles
Acres	4,840	Square yards
Ampere-hours	3,600	Coulombs
Ampere-hours	.03731	Faradays
Ampere-turns	1.257	Gilberts
Angstrom unit	3.937×10^{-9}	Inches
Angstrom unit	10^{-10}	Meters
Ares	.02471	Acres
Ares	100	Sq. meters
Astronomical units	1.495×10^8	Kilometers
Atmospheres	1.01325	Bars
Atmospheres	76.0	Cm. of mercury
Atmospheres	33.90	Feet of water
Atmospheres	29.92	Inches of mercury
Atmospheres	10,333	Kilograms/sq. meter
Atmospheres	101.325	KiloPascals
Atmospheres	101,325	Pascals
Atmospheres	14.70	Pounds/sq. inch
Atmospheres	1.058	Tons/sq. foot

B

Bags (cement)	94	Pounds
Barrels (cement)	376	Pounds
Barrels (dry)	7056	Cubic inches
Barrels (dry)	105.0	Quarts (dry)
Barrels (liquid)	31.5	Gallons
Barrels (oil)	42	Gallons
Bars	.9869	Atmospheres
Bars	1,000,000	Dynes/sq. centimeter
Bars	10,200	Kilograms/sq. meter
Bars	100	KiloPascals
Bars	750.0	Millimeters of mercury
Bars	100,000	Pascals
Bars	14.50	Pounds/sq. inch

Multiply	By	To Obtain
Baryls	1	Dynes/sq. centimeter
Board feet	144	Cubic inches
Bolts (US Cloth)	40	Yards
B.T.U.	1.055x10 ¹⁰	Ergs
B.T.U.	778.2	Foot-pounds
B.T.U.	252.2	Gram calories
B.T.U.	3.930x10 ⁻⁴	Horsepower-hours
B.T.U.	1,055	Joules
B.T.U.	.2522	Kilocalories
B.T.U.	107.6	Kilogram-meters
B.T.U.	2.931x10 ⁻⁴	Kilowatt-hours
B.T.U.	10.409	Liter-Atmospheres
B.T.U./hour	.2162	Foot-pounds/second
B.T.U./hour	.0700	Gram-calories/second
B.T.U./hour	3.930x10 ⁻⁴	Horsepower
B.T.U./hour	.2931	Watts
B.T.U./minute	12.97	Foot-pounds/second
B.T.U./minute	.02358	Horsepower
B.T.U./minute	.01758	Kilowatts
B.T.U./minute	17.58	Watts
B.T.U./sq. foot/minute	.1221	Watts/sq. inch
Buckets (British, Dry)	18.18	Liters
Bushels	1.2445	Cu. feet
Bushels	2150.4	Cu. inches
Bushels	.03524	Cu. meters
Bushels	35.24	Liters
Bushels	4	Pecks
Bushels	64	Pints (dry)
Bushels	32	Quarts (dry)

C

C	1	Coulombs
Calories (gram)	.003966	B.T.U.
Calories (gram)	.001	Calories (kilogram)
Calories (gram)	41,840,000	Ergs
Calories (gram)	.001	Food calories
Calories (gram)	3.0860	Foot-pounds
Calories (gram)	1.559x10 ⁻⁶	Horsepower-hours
Calories (gram)	.001	Kilocalories
Calories (gram)	1.162x10 ⁻⁶	Kilowatt-hours
Calories (kilogram)	3.966	B.T.U.
Calories (kilogram)	1,000	Calories (gram)
Calories (kilogram)	1	Food calories
Calories (kilogram)	3,086	Foot-pounds
Calories (kilogram)	.001559	Horsepower-hours
Calories (kilogram)	4,184	Joules
Calories (kilogram)	1	Kilocalories

Multiply	By	To Obtain
Calories (kilogram)	426.8	Kilogram-meters
Calories (kilogram)	.001162	Kilowatt-hours
Candela/sq. centimeter	3.142	Lamberts
Candela/sq. inch	.4869	Lamberts
Candela/sq. meter	.0003142	Lamberts
Carats	3.086	Grains
Centares (Centiares)	1	Square meters
Centigrams	.01	Grams
Centiliters	.01	Liters
Centimeter-dynes	.00102	Centimeter-grams
Centimeter-dynes	1.020×10^{-8}	Meter-kilograms
Centimeter-dynes	7.376×10^{-8}	Pound-feet
Centimeter-grams	980.7	Centimeter-dynes
Centimeter-grams	10^{-5}	Meter-kilograms
Centimeter-grams	7.233×10^{-5}	Pound-feet
Centimeters	.03281	Feet
Centimeters	.3937	Inches
Centimeters	.01	Meters
Centimeters	10	Millimeters
Centimeters	393.7	Mils
Centimeters of mercury	.01316	Atmospheres
Centimeters of mercury	.4461	Feet of water
Centimeters of mercury	136.0	Kilograms/sq. meter
Centimeters of mercury	27.85	Pounds/sq. foot
Centimeters of mercury	.1934	Pounds/sq. inch
Centimeters/second	1.969	Feet/minute
Centimeters/second	.03281	Feet/second
Centimeters/second	.036	Kilometers/hour
Centimeters/second	.6	Meters/minute
Centimeters/second	.02237	Miles/hour
Centimeters/second	3.728×10^{-4}	Miles/minute
Centimeters/sec./sec.	.03281	Feet/sec./sec.
Centipoise	1	Millipascal-seconds
Centipoise	.001	Pascal-seconds
Centistokes	10^{-6}	Sq. meters/second
Centistokes	1	Sq. millimeters/second
Chains	792	Inches
Chains	20.12	Meters
Chains	22	Yards
Circular mils	5.067×10^{-6}	Sq. centimeters
Circular mils	7.854×10^{-7}	Sq. inches
Circular mils	.7854	Sq. mils
Circumference	6.2832	Radians
Cord feet	16	Cu. feet
Cords	8	Cord feet
Coulombs	1.036×10^{-5}	Faradays
Coulombs	2.998×10^9	Statcoulombs
Coulombs/sq. centimeter	64.52	Coulombs/sq. inch

Multiply	By	To Obtain
Coulombs/sq. inch	.1550	Coulombs/sq. cm
Cubic centimeters	3.531×10^{-5}	Cubic feet
Cubic centimeters	.06102	Cubic inches
Cubic centimeters	.000001	Cubic meters
Cubic centimeters	1.308×10^{-6}	Cubic yards
Cubic centimeters	2.642×10^{-4}	Gallons
Cubic centimeters	.001	Liters
Cubic centimeters	.002113	Pints (liquid)
Cubic centimeters	.001057	Quarts (liquid)
Cubic feet	.8036	Bushels (dry)
Cubic feet	28,320	Cubic centimeters
Cubic feet	1728	Cubic inches
Cubic feet	.02832	Cubic meters
Cubic feet	.03704	Cubic yards
Cubic feet	7.48052	Gallons
Cubic feet	28.32	Liters
Cubic feet	59.84	Pints (liquid)
Cubic feet	62.43	Pounds of water
Cubic feet	29.92	Quarts (liquid)
Cubic feet/minute	472.0	Cu. centimeters/second
Cubic feet/minute	.1247	Gallons/second
Cubic feet/minute	.4720	Liters/second
Cubic feet/minute	62.43	Pounds of water/minute
Cubic feet/second	.646317	Millions of gallons/day
Cubic feet/second	448.831	Gallons/minute
Cubic inches	16.39	Cubic centimeters
Cubic inches	5.787×10^{-4}	Cubic feet
Cubic inches	1.639×10^{-5}	Cubic meters
Cubic inches	2.143×10^{-5}	Cubic yards
Cubic inches	.004329	Gallons
Cubic inches	.01639	Liters
Cubic inches	106,100	Mil-feet
Cubic inches	.03463	Pints (liquid)
Cubic inches	.01732	Quarts (liquid)
Cubic meters	28.38	Bushels (dry)
Cubic meters	1,000,000	Cubic centimeters
Cubic meters	35.31	Cubic feet
Cubic meters	61,023	Cubic inches
Cubic meters	1.308	Cubic yards
Cubic meters	264.2	Gallons
Cubic meters	1000	Liters
Cubic meters	2113	Pints (liquid)
Cubic meters	1057	Quarts (liquid)
Cubic yards	764,600	Cubic centimeters
Cubic yards	27	Cubic feet
Cubic yards	46,656	Cubic inches

Multiply	By	To Obtain
Cubic yards	.7646	Cubic meters
Cubic yards	202.0	Gallons
Cubic yards	764.6	Liters
Cubic yards	1616	Pints (liquid)
Cubic yards	807.9	Quarts (liquid)
Cubic yards/minute	.45	Cubic feet/second
Cubic yards/minute	3.367	Gallons/second
Cubic yards/minute	12.74	Liters/second
Cycles/second	1	Hertz

D

Days	86,400	Seconds
Decigrams	.1	Grams
Deciliters	.1	Liters
Decimeters	.1	Meters
Degrees (angle)	60	Minutes
Degrees (angle)	.01111	Quadrants
Degrees (angle)	.01745	Radians
Degrees (angle)	3600	Seconds
Degrees (Celsius)	$(^{\circ}\text{C} \times 9/5) + 32$	Degrees (Fahrenheit)
Degrees (Celsius)	$^{\circ}\text{C} + 273.15$	Degrees (Kelvin)
Degrees (Fahrenheit)	$(^{\circ}\text{F} - 32) \times 5/9$	Degrees (Celsius)
Degrees (Fahrenheit)	$^{\circ}\text{F} + 459.67$	Degrees (Rankine)
Degrees (Kelvin)	$^{\circ}\text{K} - 273.15$	Degrees (Celsius)
Degrees (Rankine)	$^{\circ}\text{R} - 459.67$	Degrees (Fahrenheit)
Degrees/second (angle)	.01745	Radians/second
Degrees/second (angle)	.1667	Revolutions/minute
Degrees/second (angle)	.002778	Revolutions/second
Dekagrams	10	Grams
Dekaliters	10	Liters
Dekameters	10	Meters
Drams	27.34375	Grains
Drams	1.771845	Grams
Drams	.0625	Ounces
Drams (troy)	.1371429	Ounces
Drams (troy)	.125	Ounces (troy)
Dyne-centimeters	1	Ergs
Dynes	1	Gram-cm./sec ²
Dynes	10 ⁻⁷	Joules/centimeter
Dynes	1.020x10 ⁻⁶	Kilograms
Dynes	10 ⁻⁵	Newtons
Dynes	7.233x10 ⁻⁵	Poundals
Dynes	2.248x10 ⁻⁶	Pounds
Dynes/centimeter	.01	Ergs/sq. millimeter
Dynes/sq. centimeter	9.869x10 ⁻⁷	Atmospheres
Dynes/sq. centimeter	10 ⁻⁶	Bars

Multiply	By	To Obtain
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E

Em (Pica)	.4233	Centimeters
Em (Pica)	.167	Inches
Ergs	9.478×10^{-11}	B.T.U.
Ergs	2.390×10^{-8}	Calories (gram)
Ergs	1	Dyne-centimeters
Ergs	7.376×10^{-8}	Foot-pounds
Ergs	.00102	Gram-centimeters
Ergs	3.725×10^{-14}	Horsepower-hours
Ergs	10^{-7}	Joules
Ergs	2.390×10^{-11}	Kilocalories
Ergs	1.020×10^{-8}	Kilogram-meters
Ergs	2.778×10^{-14}	Kilowatt-hrs.
Ergs	2.778×10^{-11}	Watt-hours
Ergs/second	5.688×10^{-9}	B.T.U./minute
Ergs/second	1	Dyne-cm./sec.
Ergs/second	4.427×10^{-6}	Foot-pounds/minute
Ergs/second	7.3756×10^{-8}	Foot-pounds/second
Ergs/second	1.341×10^{-10}	Horsepower
Ergs/second	1.433×10^{-9}	Kilocalories/minute

F

F	1	Farads
Faradays	26.80	Ampere-hours
Faradays	96,490	Coulombs
Faradays/sec.	96,490	Amperes
Farads	1,000,000	Microfarads
Fathoms	1.8288	Meters
Fathoms	6	Feet
Feet	30.48	Centimeters
Feet	12	Inches
Feet	3.048×10^{-4}	Kilometers
Feet	.3048	Meters
Feet	1.894×10^{-4}	Miles
Feet	1.645×10^{-4}	Miles (nautical)
Feet	304.8	Millimeters
Feet	.3333	Yards
Feet of water	.02950	Atmospheres
Feet of water	.8826	Inches of mercury
Feet of water	.03048	Kilograms/sq. cm.
Feet of water	304.8	Kilograms/sq. meter
Feet of water	62.43	Pounds/sq. foot
Feet of water	.4335	Pounds/sq. inch
Feet/minute	.5080	Centimeters/second
Feet/minute	.01667	Feet/second
Feet/minute	.01829	Kilometers/hour

Multiply	By	To Obtain
Feet/minute	.3048	Meters/minute
Feet/minute	.01136	Miles/hour
Feet/second	30.48	Centimeters/second
Feet/second	1.097	Kilometers/hour
Feet/second	.5921	Knots
Feet/second	18.29	Meters/minute
Feet/second	.6818	Miles/hour
Feet/second	.01136	Miles/minute
Feet/sec./sec.	30.48	Centimeters/sec./sec.
Feet/sec./sec.	.3048	Meters/sec./sec.
Feet/sec./sec.	1.097	Kilometers/hr./sec.
Feet/sec./sec.	.6818	Miles/hour/sec.
Foot candles	10.764	Lumens/sq. meter
Footlamberts	3.426	Candela/square meter
Foot-pounds	.001285	B.T.U.
Foot-pounds	13,560,000	Ergs
Foot-pounds	.3240	Gram calories
Foot-pounds	5.051×10^{-7}	Horsepower-hours
Foot-pounds	1.356	Joules
Foot-pounds	3.240×10^{-4}	Kilocalories
Foot-pounds	.1383	Kilogram-meters
Foot-pounds	3.766×10^{-7}	Kilowatt-hours
Foot-pounds	1.356	Newton-meters
Foot-pounds/minute	.001285	B.T.U./minute
Foot-pounds/minute	.01667	Foot-pounds/sec.
Foot-pounds/minute	3.030×10^{-5}	Horsepower
Foot-pounds/minute	3.240×10^{-4}	Kilocalories/minute
Foot-pounds/minute	2.260×10^{-5}	Kilowatts
Foot-pounds/second	.07710	B.T.U./minute
Foot-pounds/second	4.6262	B.T.U./hour
Foot-pounds/second	.001818	Horsepower
Foot-pounds/second	.01944	Kilocalories/minute
Foot-pounds/second	.001356	Kilowatts
Furlongs	660	Feet
Furlongs	.125	Miles
Furlongs	40	Rods

G

g's (gravity)	32.174	feet/sec/sec
g's (gravity)	9.806650	meters/sec/sec
Gallons	3785	Cubic centimeters
Gallons	.1337	Cubic feet
Gallons	231.0	Cubic inches
Gallons	.003785	Cubic meters
Gallons	.004951	Cubic yards
Gallons	.83267	Gallons (Imperial)
Gallons	3.785	Liters

Multiply	By	To Obtain
Gallons	8	Pints (liquid)
Gallons	8.3453	Pounds of water
Gallons	4	Quarts (liquid)
Gallons (Imperial)	1.20095	Gallons
Gallons/minute	8.0208	Cubic feet/hour
Gallons/minute	.002228	Cubic feet/second
Gallons/minute	.06308	Liters/sec.
Gallons/minute	6.0086	Tons of water/24 hrs.
Gausses	6.452	Lines/sq. inch
Gausses	10^{-8}	Teslas
Gausses	10^{-8}	Webers/sq. cm.
Gausses	6.452×10^{-8}	Webers/sq. in.
Gausses	10^{-4}	Webers/sq. meter
Gilberts	.7958	Ampere-turns
Gilberts/centimeter	.7958	Ampere-turns/cm.
Gilberts/centimeter	2.021	Ampere-turns/inch
Gilberts/centimeter	79.58	Ampere-turns/meter
Gills	.1183	Liters
Gills	.25	Pints (liquid)
Gills (British)	142.07	Cu. centimeters
Grade percentage	.9001	Degrees
Grains	.0365714	Drams
Grains	.06480	Grams
Grains	.002083	Ounces (troy)
Grains	.04167	Pennyweights (troy)
Grains (troy)	1	Grains
Grains/gallon	17.118	Parts/million
Grains/gallon	142.86	Pounds/million gallons
Grains/Imp. gallon	14.254	Parts/million
Gram-centimeters	9.295×10^{-8}	B.T.U.
Gram-centimeters	980.7	Ergs
Gram-centimeters	2.344×10^{-8}	Kilocalories
Gram-centimeters	10^{-5}	Kilogram-meters
Gram-centimeters/sec. ²	1	Dynes
Grams	980.7	Dynes
Grams	15.43	Grains
Grams	.001	Kilograms
Grams	1000	Milligrams
Grams	.03527	Ounces
Grams	.03215	Ounces (troy)
Grams	.07093	Poundals
Grams	.002205	Pounds
Grams/centimeter	.005600	Pounds/inch
Grams/cu. centimeter	62.43	Pounds/cubic foot
Grams/cu. centimeter	.03613	Pounds/cubic inch
Grams/liter	58.417	Grains/gallon
Grams/liter	8.345	Pounds/1000 gallons
Grams/liter	.062427	Pounds/cubic foot

Multiply	By	To Obtain
Grams/liter	1000	Parts/million
Grams/sq. centimeter	2.0481	Pounds/sq. foot

H

H	1	Henries
Hands	4	Inches
Hectares	2.471	Acres
Hectares	10,000	Square meters
Hectares	107,600	Square feet
Hectograms	100	Grams
Hectoliters	100	Liters
Hectometers	100	Meters
Hectowatts	100	Watts
Hertz	1	Cycles/second
Hogsheads	8.42184	Cubic feet
Hogsheads	63	Gallons
Hogsheads (British)	10.114	Cubic feet
Horsepower	42.41	B.T.U./minute
Horsepower	33,000	Foot-pounds/min.
Horsepower	550	Foot-pounds/sec.
Horsepower	1.014	Horsepower (metric)
Horsepower	10.69	Kilocalories/minute
Horsepower	.7457	Kilowatts
Horsepower	745.7	Watts
Horsepower (boiler)	33,479	B.T.U./hour
Horsepower (boiler)	9.803	Kilowatts
Horsepower (metric)	.9863	Horsepower
Horsepower-hours	2544	B.T.U.
Horsepower-hours	641,600	Calories (gram)
Horsepower-hours	2.685x10 ¹³	Ergs
Horsepower-hours	1,980,000	Foot-pounds
Horsepower-hours	2,684,520	Joules
Horsepower-hours	641.6	Kilocalories
Horsepower-hours	273,700	Kilogram-meters
Horsepower-hours	.7457	Kilowatt-hours
Hundredweights	1600	Ounces
Hundredweights	100	Pounds
Hundredweights	.05	Tons
Hundredweights	.0446429	Tons (long)
Hundredweights	.0453592	Tons (metric)
Hundredweights (long)	112	Pounds
Hundredweights (long)	.05	Tons (long)

I

Inches	2.54	Centimeters
Inches	.0254	Meters

Multiply	By	To Obtain
Inches	25.4	Millimeters
Inches	1,000	Mils
Inches	.02778	Yards
Inches of mercury	.03342	Atmospheres
Inches of mercury	1.133	Feet of water
Inches of mercury	.03453	Kilograms/sq. cm.
Inches of mercury	345.3	Kilograms/sq. meter
Inches of mercury	70.73	Pounds/sq. foot
Inches of mercury	.4912	Pounds/sq. inch
Inches of water	.002458	Atmospheres
Inches of water	.07355	Inches of mercury
Inches of water	25.40	Kilograms/sq. meter
Inches of water	.5781	Ounces/sq. inch
Inches of water	5.202	Pounds/sq. foot
Inches of water	.03613	Pounds/sq. inch

J

J	1	Joules
Joules	9.478×10^{-4}	B.T.U.
Joules	10,000,000	Ergs
Joules	.7376	Foot-pounds
Joules	3.725×10^{-7}	Horsepower-hours
Joules	2.390×10^{-4}	Kilocalories
Joules	.1020	Kilogram-meters
Joules	2.778×10^{-7}	Kilowatt-hours
Joules	1	Newton-meters
Joules	2.778×10^{-4}	Watt-hours

K

Kilocalories	3.966	B.T.U.
Kilocalories	1	Food calories
Kilocalories	3086	Foot-pounds
Kilocalories	1000	Gram calories
Kilocalories	.001559	Horsepower-hours
Kilocalories	4,184	Joules
Kilocalories	1	Kilogram calories
Kilocalories	426.9	Kilogram-meters
Kilocalories	4.184	Kilojoules
Kilocalories	.001162	Kilowatt-hours
Kilocalories/minute	51.43	Foot-pounds/second
Kilocalories/minute	.09351	Horsepower
Kilocalories/minute	.06973	Kilowatts
Kilogram-meters	7.231	Foot-pounds
Kilogram-meters/sec. ²	1	Newtons
Kilograms	1000	Grams
Kilograms	70.93	Poundals

Multiply	By	To Obtain
Kilograms	2.205	Pounds
Kilograms	.001102	Tons
Kilograms/cu. meter	.001	Grams/cu. centimeter
Kilograms/cu. meter	.06243	Pounds/cu. foot
Kilograms/cu. meter	3.613×10^{-5}	Pounds/cu. inch
Kilograms/meter	.6720	Pounds/foot
Kilograms/sq. cm.	.9678	Atmospheres
Kilograms/sq. cm.	980,665	Dynes
Kilograms/sq. cm.	32.81	Feet of water
Kilograms/sq. cm.	28.96	Inches of mercury
Kilograms/sq. cm.	2,048	Pounds/sq. foot
Kilograms/sq. cm.	14.22	Pounds/sq. inch
Kilograms/sq. meter	9.678×10^{-5}	Atmospheres
Kilograms/sq. meter	9.807×10^{-5}	Bars
Kilograms/sq. meter	.003281	Feet of water
Kilograms/sq. meter	.002896	Inches of mercury
Kilograms/sq. meter	.2048	Pounds/sq. foot
Kilograms/sq. meter	.001422	Pounds/sq. inch
Kilograms/sq. millimeter	1,000,000	Kilograms/sq. meter
Kilolines	1000	Maxwells
Kiloliters	1000	Liters
Kilometers	100,000	Centimeters
Kilometers	3281	Feet
Kilometers	1000	Meters
Kilometers	.6214	Miles
Kilometers	1094	Yards
Kilometers/hour	27.78	Centimeters/second
Kilometers/hour	54.68	Feet/minute
Kilometers/hour	.9113	Feet/second
Kilometers/hour	.5396	Knots
Kilometers/hour	16.67	Meters/minute
Kilometers/hour	.6214	Miles/hour
Kilometers/hr./sec.	27.78	Centimeters/sec./sec.
Kilometers/hr./sec.	.9113	Feet/sec./sec.
Kilometers/hr./sec.	.2778	Meters/sec./sec.
Kilometers/liter	2.352	Miles/gallon
KiloNewtons	224.8	Pounds
KiloPascals	.1450	Pounds/sq. inch
Kilowatt-hours	3412	B.T.U.
Kilowatt-hours	3.600×10^{13}	Ergs
Kilowatt-hours	2,655,000	Foot-pounds
Kilowatt-hours	1.341	Horsepower-hours
Kilowatt-hours	3,600,000	Joules
Kilowatt-hours	860.4	Kilocalories
Kilowatt-hours	367,100	Kilogram-meters
Kilowatts	56.87	B.T.U./minute
Kilowatts	44,250	Foot-pounds/minute
Kilowatts	737.6	Foot-pounds/second

Multiply	By	To Obtain
Kilowatts	1.341	Horsepower
Kilowatts	14.34	Kilocalories/minute
Kilowatts	1000	Watts
Knots	1.689	Feet/second
Knots	1.8532	Kilometers/hr.
Knots	1.151	Miles/hour
Knots	1	Nautical miles/hour

L

Lamberts	.3183	Candela/sq. centimeter
Lamberts	2.054	Candela/sq. inch
Lamberts	3183	Candela/sq. meter
Leagues	3	Miles (nautical)
Light years	9.4609×10^{12}	Kilometers
Light years	5.9×10^{12}	Miles
Lines/sq. centimeter	1	Gausses
Lines/sq. inch	.1550	Gausses
Lines/sq. inch	1.550×10^{-9}	Webers/sq. centimeter
Lines/sq. inch	10^{-8}	Webers/sq. inch
Links (engineer's)	12	Inches
Links (surveyor's)	7.92	Inches
Liters	1000	Cubic centimeters
Liters	.03531	Cubic feet
Liters	61.02	Cubic inches
Liters	.001	Cubic meters
Liters	.001308	Cubic yards
Liters	.2642	Gallons
Liters	1.000	Kilograms of water
Liters	2.113	Pints (liquid)
Liters	1.057	Quarts (liquid)
Liters/minute	5.886×10^{-4}	Cu. feet/second
Liters/minute	.004403	Gallons/second
Lumens	.07958	Spherical candle power
Lumens	.001496	Watts
Lumens/sq. foot	1	Foot-candles
Lumens/sq. foot	10.76	Lumens/sq. meter
Lux	.0929	Foot-candles

M

Maxwells	.001	Kilolines
Maxwells	10^{-8}	Webers
Megajoules	.2778	Kilowatt-hours
Megalines	1,000,000	Maxwells
MegaPascals	145.0	Pounds/sq. inch
Meter-kilograms	98,070,000	Centimeter-dynes
Meter-kilograms	100,000	Centimeter-grams

Multiply	By	To Obtain
Meter-kilograms	7.233	Pound-feet
Meters	100	Centimeters
Meters	3.281	Feet
Meters	39.37	Inches
Meters	.001	Kilometers
Meters	6.214×10^{-4}	Miles
Meters	5.396×10^{-4}	Miles (nautical)
Meters	1000	Millimeters
Meters	1.094	Yards
Meters/minute	1.667	Centimeters/second
Meters/minute	3.281	Feet/minute
Meters/minute	.05468	Feet/second
Meters/minute	.06	Kilometers/hour
Meters/minute	.03238	Knots
Meters/minute	.03728	Miles/hour
Meters/second	196.8	Feet/minute
Meters/second	3.281	Feet/second
Meters/second	3.6	Kilometers/hour
Meters/second	.06	Kilometers/minute
Meters/second	2.237	Miles/hour
Meters/second	.03728	Miles/minute
Meters/sec./sec.	3.281	Feet/sec./sec.
Meters/sec./sec.	3.6	Kilometers/hr./sec.
Meters/sec./sec.	2.237	Miles/hour/sec.
Mhos	1	Siemens
Microfarads	10^{-6}	Farads
Microns	10^{-6}	Meters
Mil-feet	9.425×10^{-6}	Cu. inches
Miles	160,900	Centimeters
Miles	5280	Feet
Miles	63,360	Inches
Miles	1.609	Kilometers
Miles	1,609	Meters
Miles	.8684	Miles (nautical)
Miles	1760	Yards
Miles (nautical)	6,080.27	Feet
Miles (nautical)	1.853	Kilometers
Miles (nautical)	1,853	Meters
Miles (nautical)	1.1516	Miles
Miles (nautical)	2,027	Yards
Miles/gallon	.4251	Kilometers/liter
Miles/hour	44.70	Centimeters/second
Miles/hour	88	Feet/minute
Miles/hour	1.467	Feet/second
Miles/hour	1.609	Kilometers/hour
Miles/hour	.8684	Knots
Miles/hour	26.82	Meters/minute
Miles/hour	.1667	Miles/minute

Multiply	By	To Obtain
Miles/hour/sec.	44.70	Centimeters/sec./sec.
Miles/hour/sec.	1.467	Feet/sec./sec.
Miles/hour/sec.	1.609	Kilometers/hr./sec.
Miles/hour/sec.	.4470	Meters/sec./sec.
Miles/minute	2682	Centimeters/second
Miles/minute	88	Feet/second
Miles/minute	1.609	Kilometers/minute
Miles/minute	60	Miles/hour
Milliers	1000	Kilograms
Milligrams	.01543	Grains
Milligrams	.001	Grams
Milligrams/liter	1	Parts/million
Milliliters	.001	Liters
Millimeters	.1	Centimeters
Millimeters	.03937	Inches
Millimeters	.003281	Feet
Millimeters	39.37	Mils
Millimeters of mercury	.001316	Atmospheres
Millimeters of mercury	.001333	Bars
Millimeters of mercury	.04461	Feet of water
Millimeters of mercury	13.60	Kilograms/sq. meter
Millimeters of mercury	133.3	Pascals
Millimeters of mercury	.01934	Pounds/sq. inch
Millimicrons	10 ⁻⁹	Meters
Million gallons/day	1.54723	Cu. feet/second
Mils	.00254	Centimeters
Mils	.001	Inches
Miner's inches	1.5	Cu. feet/minute
Minims	.061612	Cu. centimeters
Minims (British)	.059192	Cu. centimeters
Minutes (angle)	.01667	Degrees
Minutes (angle)	1.852x10 ⁻⁴	Quadrants
Minutes (angle)	2.909x10 ⁻⁴	Radians
Minutes (angle)	60	Seconds

N

N	1	Newtons
Nepers	8.686	Decibels
Newton-meters	.7376	Foot-pounds
Newton-meters	1	Joules
Newtons	100,000	Dynes
Newtons	.1020	Kilograms
Newtons	1	Kilogram-meters/sec ²
Newtons	.2248	Pounds
Newtons/sq. meter	1	Pascals

Multiply	By	To Obtain
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O

Oersteds	79.58	Amperes/meter
Ounces	16	Drams
Ounces	437.5	Grains
Ounces	28.349527	Grams
Ounces	.9115	Ounces (troy)
Ounces	.0625	Pounds
Ounces	2.790×10^{-5}	Tons (long)
Ounces	2.835×10^{-5}	Tons (metric)
Ounces (fluid)	1.805	Cubic inches
Ounces (fluid)	.02957	Liters
Ounces (troy)	480	Grains
Ounces (troy)	31.103481	Grams
Ounces (troy)	1.09714	Ounces
Ounces (troy)	20	Pennyweights (troy)
Ounces (troy)	.08333	Pounds (troy)
Ounces/sq. inch	.0625	Pounds/sq. inch

P

Pa	1	Pascals
Parts/million	.0584	Grains/gallon
Parts/million	.07016	Grains/Imp. gallon
Parts/million	8.345	Pounds/million gallons
Pascals	9.869×10^{-6}	Atmospheres
Pascals	.00001	Bars
Pascals	1	Newtons/sq. meter
Pascals	1.450×10^{-4}	Pounds/sq. inch
Pecks	.25	Bushels
Pecks	537.605	Cubic inches
Pecks	8.810	Liters
Pecks	8	Quarts (dry)
Pennyweights (troy)	24	Grains
Pennyweights (troy)	1.55517	Grams
Pennyweights (troy)	.05	Ounces (troy)
Pennyweights (troy)	.004167	Pounds (troy)
Pi	1	3.141592654
Picas	.1660	Inches
Pints (dry)	33.60	Cu. inches
Pints (liquid)	473.2	Cu. centimeters
Pints (liquid)	.01671	Cu. feet
Pints (liquid)	28.87	Cu. inches
Pints (liquid)	6.189×10^{-4}	Cu. yards
Pints (liquid)	.125	Gallons
Pints (liquid)	.4732	Liters
Pints (liquid)	.5	Quarts (liquid)
Points	.01384	Inches

Multiply	By	To Obtain
Poise	1	Grams/centimeter-sec.
Pound-feet	13,560,000	Centimeter-dynes
Pound-feet	13,825	Centimeter-grams
Pound-feet	.1383	Meter-kilograms
Poundals	13,826	Dynes
Poundals	14.10	Grams
Poundals	.001383	Joules/centimeter
Poundals	.1383	Joules/meter
Poundals	.01410	Kilograms
Poundals	.1383	Newtons
Poundals	.03108	Pounds
Pounds	256	Drams
Pounds	444,823	Dynes
Pounds	7000	Grains
Pounds	453.59237	Grams
Pounds	.04448	Joules/centimeter
Pounds	.45359237	Kilograms
Pounds	.004448	KiloNewtons
Pounds	4.448	Newtons
Pounds	16	Ounces
Pounds	14.5833	Ounces (troy)
Pounds	32.17	Poundals
Pounds	1.21528	Pounds (troy)
Pounds	.0005	Tons
Pounds (troy)	5760	Grains
Pounds (troy)	373.24177	Grams
Pounds (troy)	13.1657	Ounces
Pounds (troy)	12	Ounces (troy)
Pounds (troy)	240	Pennyweights (troy)
Pounds (troy)	.822857	Pounds
Pounds (troy)	4.1143×10^{-4}	Tons
Pounds (troy)	3.6735×10^{-4}	Tons (long)
Pounds (troy)	3.7324×10^{-4}	Tons (metric)
Pounds of water	.01602	Cubic feet
Pounds of water	27.68	Cubic inches
Pounds of water	.1198	Gallons
Pounds of water/min.	2.670×10^{-4}	Cu. feet/second
Pounds/cubic foot	.01602	Grams/cu. centimeter
Pounds/cubic foot	16.02	Kilograms/cu. meter
Pounds/cubic foot	5.787×10^{-4}	Pounds/cu. inch
Pounds/cubic inch	27.68	Grams/cu. centimeter
Pounds/cubic inch	27,680	Kilograms/cu. meter
Pounds/cubic inch	1728	Pounds/cu. foot
Pounds/foot	1.488	Kilograms/meter
Pounds/inch	178.6	Grams/centimeter
Pounds/sq. foot	.01602	Feet of water
Pounds/sq. foot	4.883	Kilograms/sq. meter
Pounds/sq. foot	.006945	Pounds/sq. inch

Multiply	By	To Obtain
Pounds/sq. inch	.06804	Atmospheres
Pounds/sq. inch	.06895	Bars
Pounds/sq. inch	2.307	Feet of water
Pounds/sq. inch	2.036	Inches of mercury
Pounds/sq. inch	703.1	Kilograms/sq. meter
Pounds/sq. inch	6.897	KiloPascals
Pounds/sq. inch	.006897	MegaPascals
Pounds/sq. inch	6897	Pascals

Q

Quadrants (angle)	90	Degrees
Quadrants (angle)	5400	Minutes
Quadrants (angle)	1.571	Radians
Quarts (dry)	67.20	Cubic inches
Quarts (dry)	1.164	Quarts (liquid)
Quarts (liquid)	946.4	Cubic centimeters
Quarts (liquid)	.03342	Cubic feet
Quarts (liquid)	57.75	Cubic inches
Quarts (liquid)	9.464x10 ⁻⁴	Cubic meters
Quarts (liquid)	.25	Gallons
Quarts (liquid)	.9463	Liters
Quarts (liquid)	.8594	Quarts (dry)
Quintals	100	Kilograms
Quintals	220.5	Pounds
Quintals (Argentinean)	101.28	Pounds
Quintals (Brazilian)	129.54	Pounds
Quintals (Peruvian)	101.43	Pounds
Quintals (Chilean)	101.41	Pounds
Quintals (Mexican)	101.47	Pounds
Quires	25	Sheets

R

Radians	57.30	Degrees
Radians	3438	Minutes
Radians	.6366	Quadrants
Radians/second	57.30	Degrees/second
Radians/second	9.549	Revolutions/minute
Radians/second	.1592	Revolutions/second
Radians/sec./sec.	573.0	Revolutions/min./min.
Radians/sec./sec.	.1592	Revolutions/sec./sec
Reams	500	Sheets
Revolutions	360	Degrees
Revolutions	4	Quadrants
Revolutions	6.283	Radians
Revolutions/minute	6	Degrees/second
Revolutions/minute	.1047	Radians/second

Multiply	By	To Obtain
Revolutions/minute	.01667	Revolutions/second
Revolutions/min./min.	.001745	Radians/sec./sec.
Revolutions/min./min.	2.778x10 ⁻⁴	Revolutions/sec./sec.
Revolutions/second	360	Degrees/second
Revolutions/second	6.283	Radians/second
Revolutions/second	60	Revolutions/minute
Revolutions/sec./sec.	6.283	Radians/sec./sec.
Revolutions/sec./sec.	3600	Revolutions/min./min.
Rods	.25	Chains
Rods	16.5	Feet
Rods	5.029	Meters
Rods	5.5	Yards

S

S	1	Siemens
Scruples	20	Grains
Seconds (angle)	2.778x10 ⁻⁴	Degrees
Seconds (angle)	.01667	Minutes
Seconds (angle)	3.087x10 ⁻⁶	Quadrants
Seconds (angle)	4.848x10 ⁻⁶	Radians
Siemens	1	Mhos
Slugs	14.59	Kilograms
Slugs	32.17	Pounds
Square centimeters	197,300	Circular mils
Square centimeters	.001076	Square feet
Square centimeters	.1550	Square inches
Square centimeters	10 ⁻⁴	Square meters
Square centimeters	100	Square millimeters
Square feet	2.296x10 ⁻⁵	Acres
Square feet	929.0	Square centimeters
Square feet	144	Square inches
Square feet	.09290	Square meters
Square feet	3.587x10 ⁻⁸	Square miles
Square feet	.1111	Square yards
Square inches	1,273,000	Circular mils
Square inches	6.452	Square centimeters
Square inches	.006944	Square feet
Square inches	645.2	Square millimeters
Square inches	1,000,000	Square mils
Square kilometers	247.1	Acres
Square kilometers	10,760,000	Square feet
Square kilometers	1,000,000	Square meters
Square kilometers	.3861	Square miles
Square kilometers	1,196,000	Square yards
Square meters	2.471x10 ⁻⁴	Acres
Square meters	10.76	Square feet
Square meters	3.861x10 ⁻⁷	Square miles

Multiply	By	To Obtain
Square meters	1.196	Square yards
Square miles	640	Acres
Square miles	27,878,400	Square feet
Square miles	2.590	Square kilometers
Square miles	3,097,600	Square yards
Square millimeters	1,973	Circular mils
Square millimeters	.01	Square centimeters
Square millimeters	.001550	Square inches
Square mils	1.273	Circular mils
Square yards	2.066×10^{-4}	Acres
Square yards	9	Square feet
Square yards	1,296	Square inches
Square yards	.8361	Square meters
Square yards	3.228×10^{-7}	Square miles
Stokes	.0001	Sq. meters/second

T

T	1	Teslas
Teslas	1	Webers/sq. meter
Therms	105.5	Megajoules
Tonne	1	Ton (metric)
Tons	907.18486	Kilograms
Tons	32,000	Ounces
Tons	29166.66	Ounces (troy)
Tons	2000	Pounds
Tons	2430.56	Pounds (troy)
Tons	.89286	Tons (long)
Tons	.90718	Tons (metric)
Tons (long)	1016	Kilograms
Tons (long)	2240	Pounds
Tons (long)	1.12	Tons
Tons (metric)	1000	Kilograms
Tons (metric)	2205	Pounds
Tons (register)	100	Cubic feet
Tons (refrigeration)	3.517	Kilowatts
Tons of water/24 hrs.	1.3349	Cu. feet/hour
Tons of water/24 hrs.	.16643	Gallons/minute
Tons of water/24 hrs.	83.333	Pounds water/hr.
Torr	.001333	Bars
Torr	133.3	Pascals
Torr	.01934	Pounds/sq. inch

V

V	1	Volts
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Multiply	By	To Obtain
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W

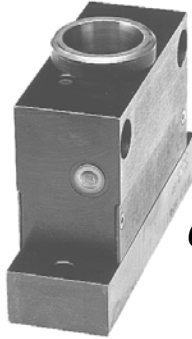
W	1	Watts
Watt-hours	3.412	B.T.U.
Watt-hours	860.4	Calories (gram)
Watt-hours	3.6×10^{10}	Ergs
Watt-hours	2655	Foot-pounds
Watt-hours	.001341	Horsepower-hours
Watt-hours	.8604	Kilocalories
Watt-hours	367.1	Kilogram-meters
Watt-hours	.001	Kilowatt-hours
Watts	3.412	B.T.U./hour
Watts	.05687	B.T.U./minute
Watts	10^7	Ergs/second
Watts	44.25	Foot-pounds/minute
Watts	.7376	Foot-pounds/second
Watts	.001341	Horsepower
Watts	.001360	Horsepower (metric)
Watts	.01434	Kilocalories/minute
Watts	.001	Kilowatts
Wb	1	Webers
Webers	100,000	Kilolines
Webers	10^8	Maxwells
Webers/sq. inch	1.550×10^7	Gausses
Webers/sq. inch	10^8	Lines/sq. inch
Webers/sq. inch	.1550	Webers/sq. centimeter
Webers/sq. inch	1,550	Webers/sq. meter
Webers/sq. meter	10,000	Gausses
Webers/sq. meter	64,520	Lines/sq. inch
Webers/sq. meter	1	Teslas
Webers/sq. meter	.0001	Webers/sq. centimeter
Webers/sq. meter	6.452×10^{-4}	Webers/sq. inch

Y

Yards	91.44	Centimeters
Yards	3	Feet
Yards	36	Inches
Yards	9.114×10^{-4}	Kilometers
Yards	.9144	Meters
Yards	5.682×10^{-4}	Miles
Yards	4.934×10^{-4}	Miles (nautical)



***Setting the pace
in power workholding technology.***



*Collet
Vises*



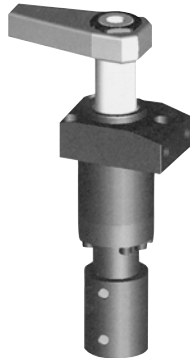
Precision Machine Vises



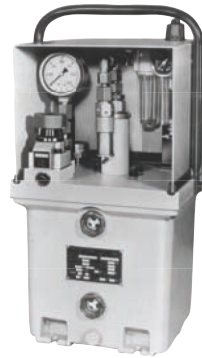
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*Concentric Clamping
Devices*



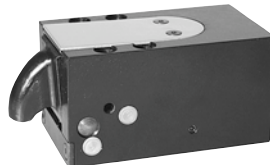
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Power Units



Swing Clamps



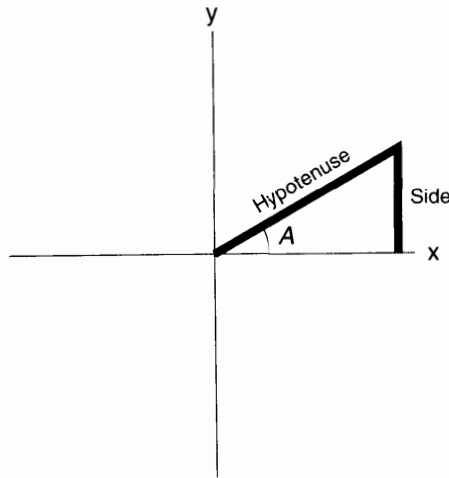
*Extending
Clamps*

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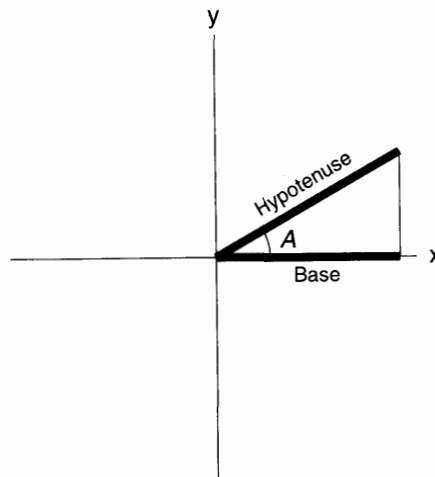
TRIGONOMETRY FUNCTIONS

SINE



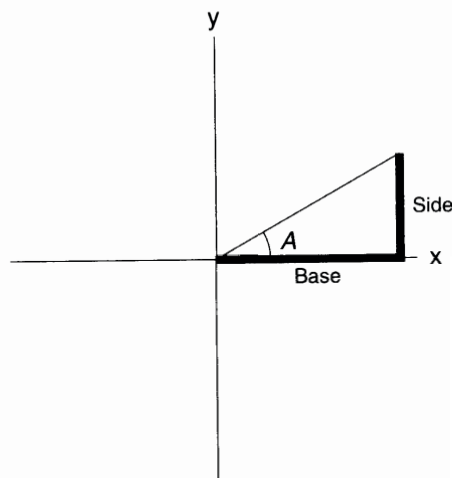
$$\sin A = \frac{\text{Side}}{\text{Hypotenuse}}$$

COSINE



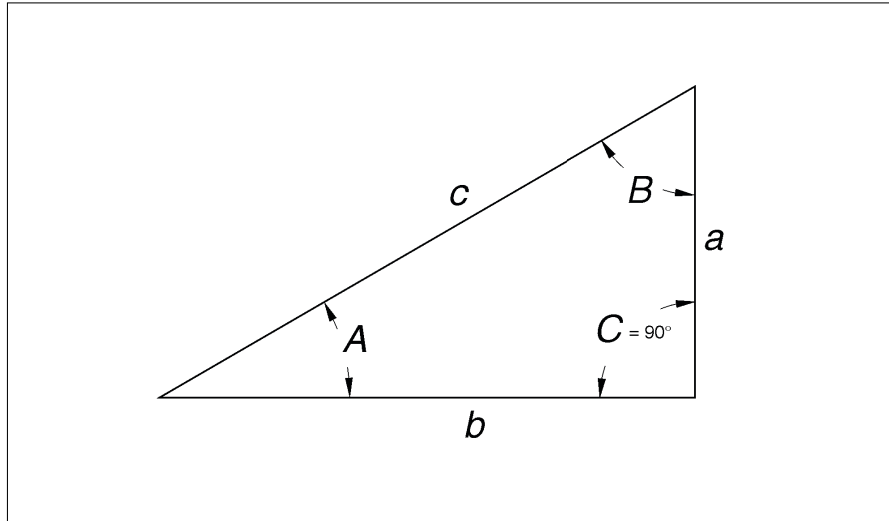
$$\cos A = \frac{\text{Base}}{\text{Hypotenuse}}$$

TANGENT



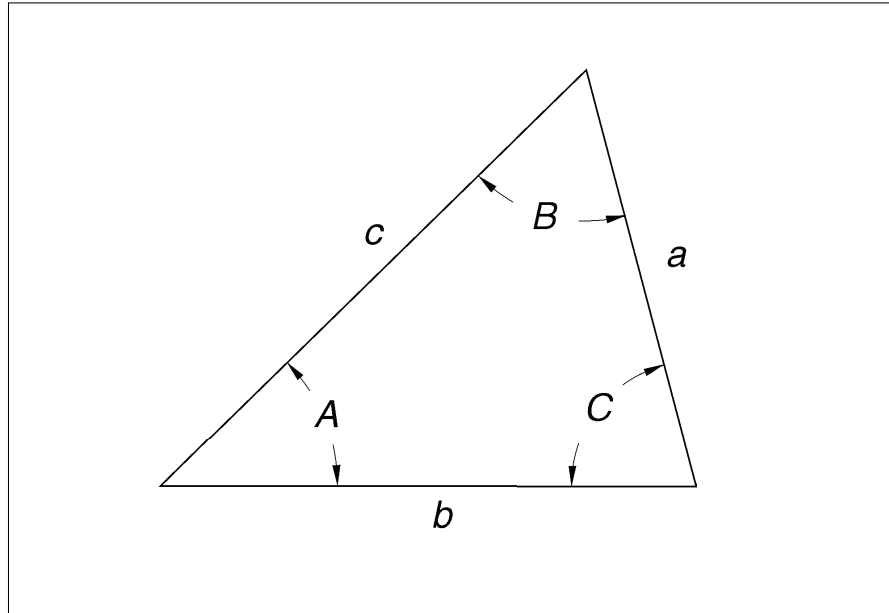
$$\tan A = \frac{\text{Side}}{\text{Base}}$$

RIGHT TRIANGLES



Known Sides and Angles	Unknown Sides and Angles			Area
a and b	$c = \sqrt{a^2 + b^2}$	$A = \arctan \frac{a}{b}$	$B = \arctan \frac{b}{a}$	$\frac{a \times b}{2}$
a and c	$b = \sqrt{c^2 - a^2}$	$A = \arcsin \frac{a}{c}$	$B = \arccos \frac{a}{c}$	$\frac{a \times \sqrt{c^2 - a^2}}{2}$
b and c	$a = \sqrt{c^2 - b^2}$	$A = \arccos \frac{b}{c}$	$B = \arcsin \frac{b}{c}$	$\frac{b \times \sqrt{c^2 - b^2}}{2}$
a and $\angle A$	$b = \frac{a}{\tan A}$	$c = \frac{a}{\sin A}$	$B = 90^\circ - A$	$\frac{a^2}{2 \times \tan A}$
a and $\angle B$	$b = a \times \tan B$	$c = \frac{a}{\cos B}$	$A = 90^\circ - B$	$\frac{a^2 \times \tan B}{2}$
b and $\angle A$	$a = b \times \tan A$	$c = \frac{b}{\cos A}$	$B = 90^\circ - A$	$\frac{b^2 \times \tan A}{2}$
b and $\angle B$	$a = \frac{b}{\tan B}$	$c = \frac{b}{\sin B}$	$A = 90^\circ - B$	$\frac{b^2}{2 \times \tan B}$
c and $\angle A$	$a = c \times \sin A$	$b = c \times \cos A$	$B = 90^\circ - A$	$\frac{c^2 \sin A \cos A}{2}$
c and $\angle B$	$a = c \times \cos B$	$b = c \times \sin B$	$A = 90^\circ - B$	$\frac{c^2 \cos B \sin B}{2}$

OBLIQUE TRIANGLES



Known Sides and Angles	Unknown Sides and Angles			Area
All three sides a, b, c	$A =$ $\arccos \frac{b^2 + c^2 - a^2}{2bc}$	$B =$ $\arcsin \frac{bx \sin A}{a}$	$C =$ $180^\circ - A - B$	$\frac{a \times b \times \sin C}{2}$
Two sides and the angle between them $a, b, \angle C$	$c =$ $\sqrt{a^2 + b^2 - (2ab \cos C)}$	$A =$ $\arctan \frac{a \times \sin C}{b - (a \times \cos C)}$	$B =$ $180^\circ - A - C$	$\frac{a \times b \times \sin C}{2}$
Two sides and the angle opposite one of the sides $a, b, \angle A$ ($\angle B$ less than 90°)	$B =$ $\arcsin \frac{bx \sin A}{a}$	$C =$ $180^\circ - A - B$	$c =$ $\frac{a \times \sin C}{\sin A}$	$\frac{a \times b \times \sin C}{2}$
Two sides and the angle opposite one of the sides $a, b, \angle A$ ($\angle B$ greater than 90°)	$B =$ $180^\circ -$ $\arcsin \frac{bx \sin A}{a}$	$C =$ $180^\circ - A - B$	$c =$ $\frac{a \times \sin C}{\sin A}$	$\frac{a \times b \times \sin C}{2}$
One side and two angles $a, \angle A, \angle B$	$b =$ $\frac{a \times \sin B}{\sin A}$	$C =$ $180^\circ - A - B$	$c =$ $\frac{a \times \sin C}{\sin A}$	$\frac{a \times b \times \sin C}{2}$



DECIMAL EQUIVALENTS

$\frac{1}{64}$	.015625
$\frac{1}{32}$	.03125
$\frac{3}{64}$	.046875
$\frac{1}{16}$	.0625
$\frac{5}{64}$	.078125
$\frac{3}{32}$	.09375
$\frac{7}{64}$	.109375
$\frac{1}{8}$	.125
$\frac{9}{64}$	.140625
$\frac{5}{32}$	.15625
$\frac{11}{64}$	.171875
$\frac{3}{16}$	.1875
$\frac{13}{64}$	.203125
$\frac{7}{32}$	.21875
$\frac{15}{64}$	.234375
$\frac{1}{4}$	.25
$\frac{17}{64}$	.265625
$\frac{9}{32}$	.28125
$\frac{19}{64}$	.296875
$\frac{5}{16}$	.3125
$\frac{21}{64}$	.328125
$\frac{11}{32}$	.34375
$\frac{23}{64}$	.359375
$\frac{3}{8}$	.375
$\frac{25}{64}$	.390625
$\frac{13}{32}$	.40625
$\frac{27}{64}$	.421875
$\frac{7}{16}$	.4375
$\frac{29}{64}$	.453125
$\frac{15}{32}$	.46875
$\frac{31}{64}$	.48375
$\frac{1}{2}$	.5

$\frac{33}{64}$	.515625
$\frac{17}{32}$	.53125
$\frac{35}{64}$	.546875
$\frac{9}{16}$	.5625
$\frac{37}{64}$	.578125
$\frac{19}{32}$	.59375
$\frac{39}{64}$	.609375
$\frac{5}{8}$	.625
$\frac{41}{64}$	.640625
$\frac{21}{32}$	.65625
$\frac{43}{64}$	.671875
$\frac{11}{16}$	.6875
$\frac{45}{64}$	.703125
$\frac{23}{32}$	.71875
$\frac{47}{64}$	.734375
$\frac{3}{4}$	.75
$\frac{49}{64}$	.765625
$\frac{25}{32}$	.78125
$\frac{51}{64}$	.796875
$\frac{13}{16}$	.8125
$\frac{53}{64}$	.828125
$\frac{27}{32}$	.84375
$\frac{55}{64}$	.859375
$\frac{7}{8}$	.875
$\frac{57}{64}$	.890625
$\frac{29}{32}$	.90625
$\frac{59}{64}$	.921875
$\frac{15}{16}$	.9375
$\frac{61}{64}$	.953125
$\frac{31}{32}$	.96875
$\frac{63}{64}$	.984375
1	1.