

## METRIC CONVERSIONS

Metric conversions are making life more difficult for the mechanic. In addition to doubling the number of tools required, metric-dimensioned nuts and bolts are used alongside English components in many new vehicles. The mechanic has to decide which tool to use, slowing down the job. The tool problem can be solved by trial and error, but some metric conversions aren't so simple.

Converting temperature, lengths or volumes requires a calculator and conversion charts, or else a very nimble mind. Conversion charts are only part of the answer though, because they don't help you "think" metric, or "visualize" what you are converting. The following examples are intended to help you "see" metric sizes:

### LENGTH

Meters are the standard unit of length in the metric system. The smaller units are 10ths (decimeter), 100ths (centimeter), and 1000ths (millimeter) of a meter. These common examples might help you to visualize the metric units:

- \* A meter is slightly longer than a yard (about 40 inches).
- \* An aspirin tablet is about one centimeter across (.4 inches).
- \* A millimeter is about the thickness of a dime.

### VOLUME

Cubic meters and centimeters are used to measure volume, just as we normally think of cubic feet and inches. Liquid volume measurements include the liter and milliliter, like the English quarts or ounces.

- \* One teaspoon is about 5 cubic centimeters.
- \* A liter is about one quart.
- \* A liter is about 61 cubic inches.

### WEIGHT

The metric weight system is based on the gram, with the most common unit being the kilogram (1000 grams). Our comparable units are ounces and pounds:

- \* A kilogram is about 2.2 pounds.
- \* An ounce is about 28 grams.

### TORQUE

Torque is somewhat complicated. The term describes the amount of effort exerted to turn something. A chosen unit of weight or force is applied to a lever of standard length. The resulting leverage is called torque. In our standard system, we use the weight of one pound applied to a lever a foot long—resulting in the unit called a foot-pound. A smaller unit is the inch-pound (the lever is one inch long). Metric units include the meter kilogram (lever one meter long with a kilogram of weight applied) and the Newton-meter (lever one meter long with force of one Newton applied). Some conversions are:

- \* A meter kilogram is about 7.2 foot pounds.
- \* A Newton-meter is about 1.4 foot pounds.
- \* A centimeter kilogram (cmkg) is equal to .9 inch pounds.

## PRESSURE

Pressure is another complicated measurement. Pressure is described as a force or weight applied to a given area. Our common unit is pounds per square inch. Metric units can be expressed in several ways. One is the kilogram per square centimeter ( $\text{kg}/\text{cm}^2$ ). Another unit of pressure is the Pascal (force of one Newton on an area of one square meter), which equals about 4 ounces on a square yard. Since this is a very small amount of pressure, we usually see the kiloPascal, or kPa (1000 Pascals). Another common automotive term for pressure is the bar (used by German manufacturers), which equals 10 Pascals. Thoroughly confused? Try the examples below:

- \* Atmospheric pressure at sea level is about 14.7 psi.
- \* Atmospheric pressure at sea level is about 1 bar.
- \* Atmospheric pressure at sea level is about 1  $\text{kg}/\text{cm}^2$ .
- \* One pound per square inch is about 7 kPa.

If all of these examples leave you still confused, then just use the conversion chart that follows. If you think these examples over for a while, you will begin to see the relationships between the two systems of measurement. The result will be more ease in using both English and metric units!

## QUICK CONVERSION FACTORS

Unit	To	Unit	Multiply By
<b>LENGTH</b>			
Millimeters .....	Inches .....		.04
Inches .....	Millimeters .....		25.4
Meters .....	Feet .....		3.3
Feet .....	Meters .....		.3
Kilometers .....	Miles .....		.6
Miles .....	Kilometers .....		1.6
<b>VOLUME</b>			
Cubic Centimeters .....	Cubic Inches .....		.06
Cubic Inches .....	Cubic Centimeters .....		16.4
Liters .....	Cubic Inches .....		.61
Cubic Inches .....	Liters .....		.016
Liters .....	Quarts .....		1.05
Quarts .....	Liters .....		.95
Liters .....	Pints .....		2.1
Pints .....	Liters .....		.47
Liters .....	Ounces .....		33.8
Ounces .....	Liters .....		.03
<b>WEIGHT</b>			
Grams .....	Ounces .....		.035
Ounces .....	Grams .....		28.3
Kilograms .....	Pounds .....		2.2
Pounds .....	Kilograms .....		.14
<b>TORQUE</b>			
Centimeter Kilograms .....	Inch Pounds .....		.87
Inch Pounds .....	Centimeter Kilograms .....		1.2
Meter Kilograms .....	Foot Pounds .....		7.2
Foot Pounds .....	Meter Kilograms .....		.14
Newton Meters .....	Inch Pounds .....		8.8
Inch Pounds .....	Newton Meters .....		.11
Newton Meters .....	Foot Pounds .....		.74
Foot Pounds .....	Newton Meters .....		1.4
<b>PRESSURE</b>			
Kilograms/Square Centimeter .....	Pounds/Square Inch .....		14.2
Pounds/Square Inch .....	Kilograms/Square Centimeter .....		.07
Bar .....	Pounds/Square Inch .....		14.5
Pounds/Square Inch .....	Bar .....		.07
Atmosphere .....	Pounds/Square Inch .....		14.7
Pounds/Square Inch .....	Atmosphere .....		.07
<b>TEMPERATURE</b>			
Celsius Degrees .....	Fahrenheit Degrees .....		$(C^{\circ} \times 1.8) + 32$
Fahrenheit Degrees .....	Celsius Degrees .....		$(F^{\circ} - 32) \times .56$

# Torque & Drill Conversion Chart

## TORQUE CONVERSIONS FOOT POUNDS TO NEWTON METERS

Ft. Lbs.	N·m	Ft. Lbs.	N·m	Ft. Lbs.	N·m	Ft. Lbs.	N·m
1	1.35	26	35	51	69	76	103
2	2.71	27	36	52	70	77	104
3	4.06	28	37	53	71	78	105
4	5.42	29	39	54	73	79	107
5	6.77	30	40	55	74	80	108
6	8.13	31	42	56	75	81	109
7	9.49	32	43	57	77	82	111
8	10	33	44	58	78	83	112
9	12	34	46	59	79	84	113
10	13	35	47	60	81	85	115
11	14	36	48	61	82	86	116
12	16	37	50	62	84	87	118
13	17	38	51	63	85	88	119
14	18	39	52	64	86	89	120
15	20	40	54	65	88	90	122
16	21	41	55	66	89	91	123
17	23	42	56	67	90	92	124
18	24	43	58	68	92	93	126
19	25	44	59	69	93	94	127
20	27	45	61	70	94	95	128
21	28	46	62	71	96	96	130
22	29	47	63	72	97	97	131
23	30	48	65	73	98	98	132
24	31	49	66	74	100	99	134
25	33	50	67	75	101	100	135

## DRILL SIZE & IDENTIFICATION

Drill Diam.	Drill Size	Drill Diam.	Drill Size	Drill Diam.	Drill Size	Drill Diam.	Drill Size
.413"	Z	.2280"	1	.1440"	27	.0550"	54
.404"	Y	.2210"	2	.1405"	28	.0520"	55
.397"	X	.2130"	3	.1360"	29	.0465"	56
.386"	W	.2090"	4	.1285"	30	.0430"	57
.377"	V	.2055"	5	.1200"	31	.0420"	58
.368"	U	.2040"	6	.1160"	32	.0410"	59
.358"	T	.2010"	7	.1130"	33	.0400"	60
.348"	S	.1990"	8	.1110"	34	.0390"	61
.339"	R	.1960"	9	.1100"	35	.0380"	62
.332"	Q	.1935"	10	.1065"	36	.0370"	63
.323"	P	.1910"	11	.1040"	37	.0360"	64
.316"	O	.1890"	12	.1015"	38	.0350"	65
.302"	N	.1850"	13	.0995"	39	.0330"	66
.295"	M	.1820"	14	.0980"	40	.0320"	67
.290"	L	.1800"	15	.0960"	41	.0310"	68
.281"	K	.1770"	16	.0935"	42	.0292"	69
.277"	J	.1730"	17	.0890"	43	.0280"	70
.272"	I	.1695"	18	.0860"	44	.0260"	71
.266"	H	.1660"	19	.0820"	45	.0250"	72
.261"	G	.1610"	20	.0810"	46	.0240"	73
.257"	F	.1590"	21	.0785"	47	.0225"	74
.250"	E	.1570"	22	.0760"	48	.0210"	75
.246"	D	.1540"	23	.0730"	49	.0200"	76
.242"	C	.1520"	24	.0700"	50	.0180"	77
.238"	B	.1495"	25	.0670"	51	.0160"	78
.234"	A	.1470"	26	.0635"	52	.0145"	79
				.0595"	53	.0135"	80

# English-Metric Conversion Chart

<b>MILLIMETERS TO INCHES</b>							
Conversion Factor — Multiply known millimeter figure by .03937							
MM	Inches	MM	Inches	MM	Inches	MM	Inches
1.....	.039	21.....	.827	41.....	1.614	61.....	2.402
2.....	.079	22.....	.866	42.....	1.654	62.....	2.441
3.....	.118	23.....	.906	43.....	1.693	63.....	2.480
4.....	.157	24.....	.945	44.....	1.732	64.....	2.520
5.....	.197	25.....	.984	45.....	1.772	65.....	2.559
6.....	.236	26.....	1.024	46.....	1.811	66.....	2.598
7.....	.276	27.....	1.063	47.....	1.850	67.....	2.638
8.....	.315	28.....	1.102	48.....	1.890	68.....	2.677
9.....	.354	29.....	1.142	49.....	1.929	69.....	2.717
10.....	.394	30.....	1.181	50.....	1.969	70.....	2.756
11.....	.433	31.....	1.220	51.....	2.008	71.....	2.795
12.....	.472	32.....	1.260	52.....	2.047	72.....	2.835
13.....	.512	33.....	1.299	53.....	2.087	73.....	2.874
14.....	.551	34.....	1.339	54.....	2.126	74.....	2.913
15.....	.591	35.....	1.378	55.....	2.165	75.....	2.953
16.....	.630	36.....	1.417	56.....	2.205	76.....	2.992
17.....	.669	37.....	1.457	57.....	2.244	77.....	3.031
18.....	.709	38.....	1.496	58.....	2.283	78.....	3.071
19.....	.748	39.....	1.535	59.....	2.323	79.....	3.110
20.....	.787	40.....	1.575	60.....	2.362	80.....	3.150
						81.....	3.189
						82.....	3.228
						83.....	3.268
						84.....	3.307
						85.....	3.346
						86.....	3.386
						87.....	3.425
						88.....	3.465
						89.....	3.504
						90.....	3.543
						91.....	3.583
						92.....	3.622
						93.....	3.661
						94.....	3.701
						95.....	3.740
						96.....	3.780
						97.....	3.819
						98.....	3.858
						99.....	3.898
						100.....	3.937

<b>INCHES TO MILLIMETERS</b>							
Conversion Factor — Multiply known inch figure by 25.40							
Inches	MM	Inches	MM	Inches	MM	Inches	MM
.001.....	.025	.040.....	1.016	.340.....	8.636	.640.....	16.256
.002.....	.051	.050.....	1.270	.350.....	8.890	.650.....	16.510
.003.....	.076	.060.....	1.524	.360.....	9.144	.660.....	16.764
.004.....	.102	.070.....	1.778	.370.....	9.398	.670.....	17.018
.005.....	.127	.080.....	2.032	.380.....	9.652	.680.....	17.272
.006.....	.152	.090.....	2.286	.390.....	9.906	.690.....	17.526
.007.....	.178	.100.....	2.540	.400.....	10.160	.700.....	17.780
.008.....	.203	.110.....	2.794	.410.....	10.414	.710.....	18.034
.009.....	.229	.120.....	3.048	.420.....	10.668	.720.....	18.288
.010.....	.254	.130.....	3.302	.430.....	10.922	.730.....	18.542
.011.....	.279	.140.....	3.556	.440.....	11.176	.740.....	18.796
.012.....	.305	.150.....	3.810	.450.....	11.430	.750.....	19.050
.013.....	.330	.160.....	4.064	.460.....	11.684	.760.....	19.304
.014.....	.356	.170.....	4.318	.470.....	11.938	.770.....	19.558
.015.....	.381	.180.....	4.572	.480.....	12.192	.780.....	19.812
.016.....	.406	.190.....	4.826	.490.....	12.446	.790.....	20.066
.017.....	.432	.200.....	5.080	.500.....	12.700	.800.....	20.320
.018.....	.457	.210.....	5.334	.510.....	12.954	.810.....	20.574
.019.....	.483	.220.....	5.588	.520.....	13.208	.820.....	20.828
.020.....	.508	.230.....	5.842	.530.....	13.462	.830.....	21.082
.021.....	.533	.240.....	6.096	.540.....	13.716	.840.....	21.336
.022.....	.559	.250.....	6.350	.550.....	13.970	.850.....	21.590
.023.....	.584	.260.....	6.604	.560.....	14.224	.860.....	21.844
.024.....	.610	.270.....	6.858	.570.....	14.478	.870.....	22.098
.025.....	.635	.280.....	7.112	.580.....	14.732	.880.....	22.352
.026.....	.661	.290.....	7.366	.590.....	14.986	.890.....	22.606
.027.....	.686	.300.....	7.620	.600.....	15.240	.900.....	22.860
.028.....	.711	.310.....	7.874	.610.....	15.494	.910.....	23.114
.029.....	.737	.320.....	8.128	.620.....	15.748	.920.....	23.368
.030.....	.762	.330.....	8.382	.630.....	16.002	.930.....	23.622
						.940.....	23.876
						.950.....	24.130
						.960.....	24.384
						.970.....	24.638
						.980.....	24.892
						.990.....	25.146
						1.000.....	25.400
						2.000.....	50.800
						3.000.....	76.200
						4.000.....	101.600
						5.000.....	127.000