



Hardness Relationship Scales



ROCKWELL STANDARD			ROCKWELL SUPERFICIAL			VICKERS	KNOOP	BRINELL HBS 10mm Standard Ball, 3000kgf	BRINELL HBW 10mm Standard Carbide, 3000kgf
HRC 150kg	HRA 60kg	HRD 100kg	HR15N 15kg	HR30N 30kg	HR45N 45kg	HV	HK ≥500g		
68.0	85.6	76.9	93.2	84.4	75.4	940	920	-	-
67.0	85.0	76.1	92.9	83.6	74.2	900	895	-	-
66.0	84.5	75.4	92.5	82.8	73.3	865	870	-	-
65.0	83.9	74.5	92.2	81.9	72.0	832	846	-	(739)
64.0	83.4	73.8	91.8	81.1	71.0	800	822	-	(722)
63.0	82.8	73.0	91.4	80.1	69.9	772	799	-	(705)
62.0	82.3	72.2	91.1	79.3	68.8	746	776	-	(688)
61.0	81.8	71.5	90.7	78.4	67.7	720	754	-	(670)
60.0	81.2	70.7	90.2	77.5	66.6	697	732	-	(654)
59.0	80.7	69.9	89.8	76.6	65.5	674	710	-	634
58.0	80.1	69.2	89.3	75.7	64.3	653	690	-	615
57.0	79.6	68.5	88.9	74.8	63.2	633	670	-	595
56.0	79.0	67.7	88.3	73.9	62.0	613	650	-	577
55.0	78.5	66.9	87.9	73.0	60.9	595	630	-	560
54.0	78.0	66.1	87.4	72.0	59.8	577	612	-	543
53.0	77.4	65.4	86.9	71.2	58.6	560	594	-	525
52.0	76.8	64.6	86.4	70.2	57.4	544	576	(500)	512
51.0	76.3	63.8	85.9	69.4	56.1	528	558	(487)	496
50.0	75.9	63.1	85.5	68.5	55.0	513	542	(475)	481
49.0	75.2	62.1	85.0	67.6	53.8	498	526	(464)	469
48.0	74.7	61.4	84.5	66.7	52.5	484	510	451	455
47.0	74.1	60.8	83.9	65.8	51.4	471	495	442	443
46.0	73.6	60.0	83.5	64.8	50.3	458	480	432	432
45.0	73.1	59.2	83.0	64.0	49.0	446	466	421	421

*Values follow ASTM E 140-12 Table 1 for non-austenitic steels.

Approximate Hardness Conversion Numbers

ROCKWELL STANDARD			ROCKWELL SUPERFICIAL			VICKERS	KNOOP	BRINELL HBS 10mm Standard Ball, 3000kgf	BRINELL HBW 10mm Standard Carbide, 3000kgf
HRC 150kg	HRA 60kg	HRD 100kg	HR15N 15kg	HR30N 30kg	HR45N 45kg	HV	HK ≥500g		
44.0	72.5	58.5	82.5	63.1	47.8	434	452	409	409
43.0	72.0	57.7	82.0	62.2	46.7	423	438	400	400
42.0	71.5	56.9	81.5	61.3	45.5	412	426	390	390
41.0	70.9	56.2	80.9	60.4	44.3	402	414	381	381
40.0	70.4	55.4	80.4	59.5	43.1	392	402	371	371
39.0	69.9	54.6	79.9	58.6	41.9	382	391	362	362
38.0	69.4	53.8	79.4	57.7	40.8	372	380	353	353
37.0	68.9	53.1	78.8	56.8	39.6	363	370	344	344
36.0	68.4	52.3	78.3	55.9	38.4	354	360	336	336
35.0	67.9	51.5	77.7	55.0	37.2	345	351	327	327
34.0	67.4	50.8	77.2	54.2	36.1	336	342	319	319
33.0	66.8	50.0	76.6	53.3	34.9	327	334	311	311
32.0	66.3	49.2	76.1	52.1	33.7	318	326	301	301
31.0	65.8	48.4	75.6	51.3	32.5	310	318	294	294
30.0	65.3	47.7	75.0	50.4	31.3	302	311	286	286
29.0	64.8	47.0	74.5	49.5	30.1	294	304	279	279
28.0	64.3	46.1	73.9	48.6	28.9	286	297	271	271
27.0	63.8	45.2	73.3	47.7	27.8	279	290	264	264
26.0	63.3	44.6	72.8	46.8	26.7	272	284	258	258
25.0	62.8	43.8	72.2	45.9	25.5	266	278	253	253
24.0	62.4	43.1	71.6	45.0	24.3	260	272	247	247
23.0	62.0	42.1	71.0	44.0	23.1	254	266	243	243
22.0	61.5	41.6	70.5	43.2	22.0	248	261	237	237
21.0	61.0	40.9	69.9	42.3	20.7	243	256	231	231
20.0	60.5	40.1	69.4	41.5	19.6	238	251	226	226

*Values follow ASTM E 140-12 Table 1 for non-austenitic steels.



ROCKWELL STANDARD			ROCKWELL SUPERFICIAL			VICKERS	KNOOP	BRINELL
HRB 100kg	HRA 60kg	HRF 60kg	HR15T 15kg	HR30T 30kg	HR45T 45kg	HV	HK ≥500g	HBS 3000kgf
100	61.5	-	93.1	83.1	72.9	240	251	240
99	60.9	-	92.8	82.5	71.9	234	246	234
98	60.2	-	92.5	81.8	70.9	228	241	228
97	59.5	-	92.1	81.1	69.9	222	236	222
96	58.9	-	91.8	80.4	68.9	216	231	216
95	58.3	-	91.5	79.8	67.9	210	226	210
94	57.6	-	91.2	79.1	66.9	205	221	205
93	57.0	-	90.8	78.4	65.9	200	216	200
92	56.4	-	90.5	77.8	64.8	195	211	195
91	55.8	-	90.2	77.1	63.8	190	206	190
90	55.2	-	89.9	76.4	62.8	185	201	185
89	54.6	-	89.5	75.8	61.8	180	196	180
88	54.0	-	89.2	75.1	60.8	176	192	176
87	53.4	-	88.9	74.4	59.8	172	188	172
86	52.8	-	88.6	73.8	58.8	169	184	169
85	52.3	-	88.2	73.1	57.8	165	180	165
84	51.7	-	87.9	72.4	56.8	162	176	162
83	51.1	-	87.6	71.8	55.8	159	173	159
82	50.6	-	87.3	71.1	54.8	156	170	156
81	50.0	-	86.9	70.4	53.8	153	167	153
80	49.5	-	86.6	69.7	52.8	150	164	150
79	48.9	-	86.3	69.1	51.8	147	161	147
78	48.4	-	86.0	68.4	50.8	144	158	144
77	47.9	-	85.6	67.7	49.8	141	155	141
76	47.3	-	85.3	67.1	48.8	139	152	139
75	46.8	99.6	85.0	66.4	47.8	137	150	137
74	46.3	99.1	84.7	65.7	46.8	135	147	135
73	45.8	98.5	84.3	65.1	45.8	132	145	132

*Values follow ASTM E 140-12 Table 2 for non-austenitic steels.

Approximate Hardness Conversion Numbers

ROCKWELL STANDARD			ROCKWELL SUPERFICIAL			VICKERS	KNOOP	BRINELL
HRB 100kg	HRA 60kg	HRF 60kg	HR15T 15kg	HR30T 30kg	HR45T 45kg	HV	HK ≥500g	HBS 3000kgf
72	45.3	98.0	84.0	64.4	44.8	130	143	130
71	44.8	97.4	83.7	63.7	43.8	127	141	127
70	44.3	96.8	83.4	63.1	42.8	125	139	125
69	43.8	96.2	83.0	62.4	41.8	123	137	123
68	43.3	95.6	82.7	61.7	40.8	121	135	121
67	42.8	95.1	82.4	61.0	39.8	119	133	119
66	42.3	94.5	82.1	60.4	38.7	117	131	117
65	41.8	93.9	81.8	59.7	37.7	116	129	116
64	41.4	93.4	81.4	59.0	36.7	114	127	114
63	40.9	92.8	81.1	58.4	35.7	112	125	112
62	40.4	92.2	80.8	57.7	34.7	110	124	110
61	40.0	91.7	80.5	57.0	33.7	108	122	108
60	39.5	91.1	80.1	56.4	32.7	107	120	107
59	39.0	90.5	79.8	55.7	31.7	106	118	106
58	38.6	90.0	79.5	55.0	30.7	104	117	104
57	38.1	89.4	79.2	54.4	29.7	103	115	103
56	37.7	88.8	78.8	53.7	28.7	101	114	101
55	37.2	88.2	78.5	53.0	27.7	100	112	100
54	36.8	87.7	78.2	52.4	26.7	-	111	-
53	36.3	87.1	77.9	51.7	25.7	-	110	-
52	35.9	86.5	77.5	51.0	24.7	-	109	-
51	35.5	86.0	77.2	50.3	23.7	-	108	-
50	35.0	85.4	76.9	49.7	22.0	-	107	-
49	34.6	84.8	76.6	49.0	21.7	-	106	-
48	34.1	84.3	76.2	48.3	20.7	-	105	-
47	33.7	83.7	75.9	47.7	19.7	-	104	-
46	33.3	83.1	75.6	47.0	18.7	-	103	-
45	32.9	82.6	75.3	46.3	17.7	-	102	-

*Values follow ASTM E 140-12 Table 2 for non-austenitic steels.

ROCKWELL STANDARD			ROCKWELL SUPERFICIAL			VICKERS	KNOOP	BRINELL
HRB 100kg	HRA 60kg	HRF 60kg	HR15T 15kg	HR30T 30kg	HR45T 45kg	HV	HK ≥500g	HBS 3000kgf
45	32.9	82.6	75.3	46.3	17.7	-	102	-
44	32.4	82.0	74.9	45.7	16.7	-	101	-
43	32.0	81.4	74.6	45.0	15.7	-	100	-
42	31.6	80.8	74.3	44.3	14.7	-	99	-
41	31.2	80.3	74.0	43.7	13.6	-	98	-
40	30.7	79.7	73.6	43.0	12.6	-	97	-
39	30.3	79.1	73.3	42.3	11.6	-	96	-
38	29.9	78.6	73.0	41.6	10.6	-	95	-
37	29.5	78.0	72.7	41.0	9.6	-	94	-
36	29.1	77.4	72.3	40.3	8.6	-	93	-
35	28.7	76.9	72.0	39.6	7.6	-	92	-
34	28.2	76.3	71.7	39.0	6.6	-	91	-
33	27.8	75.7	71.4	38.3	5.6	-	90	-
32	27.4	75.2	71.0	37.6	4.6	-	89	-
31	27.0	74.6	70.7	37.0	3.6	-	88	-
30	26.6	74.0	70.4	36.3	2.6	-	87	-

*Values follow ASTM E 140-12 Table 2 for non-austenitic steels.

**Conversions for scales using carbide (WC) ball indenter have not yet been developed.



Minimum Thickness Guide

Using the Diamond Indenter
Rockwell & Rockwell Superficial Scale
Minimum Thickness

in	mm	HR15N Hardness Reading	HR30N Hardness Reading	HR45N Hardness Reading	HRA Hardness Reading	HRC Hardness Reading
0.006	0.15	92	...	...	...	...
0.008	0.20	90	...	...	...	...
0.010	0.25	88	...	...	...	...
0.012	0.30	83	82	77	...	...
0.014	0.36	76	78.5	74	...	...
0.016	0.41	68	74	72	86	...
0.018	0.46	...	66	68	84	...
0.020	0.51	...	57	63	82	...
0.022	0.56	...	47	58	79	69
0.024	0.61	...	...	51	76	67
0.026	0.66	...	...	37	71	65
0.028	0.71	...	...	20	67	62
0.030	0.76	...	...	...	60	57
0.032	0.81	...	...	...	...	52
0.034	0.86	...	...	...	...	45
0.036	0.91	...	...	...	...	37
0.038	0.96	...	...	...	...	28
0.040	1.02	...	...	...	...	20

Using the 1/16th" (1.588 mm)
Diameter Ball Indenter
Rockwell & Rockwell Superficial Scale
Minimum Thickness

in	mm	HR15T Hardness Reading	HR30T Hardness Reading	HR45T Hardness Reading	HRF Hardness Reading	HRB Hardness Reading
0.010	0.25	91	93	...	...	...
0.012	0.30	86	78	...	...	...
0.014	0.36	81	62	...	...	...
0.016	0.41	75	44	71	...	...
0.018	0.46	68	24	62	...	...
0.020	0.51	...	...	53	...	...
0.022	0.56	...	...	43	...	...
0.024	0.61	...	...	31	98	94
0.026	0.66	...	...	18	91	87
0.028	0.71	...	...	4	85	80
0.030	0.76	...	...	...	77	71
0.032	0.81	...	...	...	69	62
0.034	0.86	...	...	...	...	52
0.036	0.91	...	...	...	...	40
0.038	0.96	...	...	...	...	28
0.040	1.02	...	...	...	...	...





Corrections to be Added to Rockwell HRC, HRA, and HRD Values Obtained on Convex Cylindrical Surfaces of Various Diameters

Diameters of Convex Cylindrical Surfaces

Hardness Reading	1/4 in (6.4 mm)	3/8 in (10 mm)	1/2 in (13 mm)	5/8 in (16 mm)	3/4 in (19 mm)	7/8 in (22 mm)	1 in (25 mm)	1 1/4 in (32 mm)	1 1/2 in (38 mm)
20	6.0	4.5	3.5	2.5	2.0	1.5	1.5	1.0	1.0
25	5.5	4.0	3.0	2.5	2.0	1.5	1.0	1.0	1.0
30	5.0	3.5	2.5	2.0	1.5	1.5	1.0	1.0	0.5
35	4.0	3.0	2.0	1.5	1.5	1.0	1.0	0.5	0.5
40	3.5	2.5	2.0	1.5	1.0	1.0	1.0	0.5	0.5
45	3.0	2.0	1.5	1.0	1.0	1.0	0.5	0.5	0.5
50	2.5	2.0	1.5	1.0	1.0	0.5	0.5	0.5	0.5
55	2.0	1.5	1.0	1.0	0.5	0.5	0.5	0.5	0
60	1.5	1.0	1.0	0.5	0.5	0.5	0.5	0	0
65	1.5	1.0	1.0	0.5	0.5	0.5	0.5	0	0
70	1.0	1.0	0.5	0.5	0.5	0.5	0.5	0	0
75	1.0	0.5	0.5	0.5	0.5	0.5	0	0	0
80	0.5	0.5	0.5	0.5	0.5	0	0	0	0
85	0.5	0.5	0.5	0	0	0	0	0	0
90	0.5	0	0	0	0	0	0	0	0



Correction for Convex Cylindrical Surfaces

Corrections to be Added to Rockwell HRB, HRF, and HRG Values Obtained on Convex Cylindrical Surfaces of Various Diameters
Diameters of Convex Cylindrical Surfaces

Hardness Reading	1/4 in (6.4 mm)	3/8 in (10 mm)	1/2 in (13 mm)	5/8 in (16 mm)	3/4 in (19 mm)	7/8 in (22 mm)	1 in (25 mm)
0	12.5	8.5	6.5	5.5	4.5	3.5	3.0
10	12.0	8.0	6.0	5.0	4.0	3.5	3.0
20	11.0	7.5	5.5	4.5	4.0	3.5	3.0
30	10.0	6.5	5.0	4.5	3.5	3.0	2.5
40	9.0	6.0	4.5	4.0	3.0	2.5	2.5
50	8.0	5.5	4.0	3.5	3.0	2.5	2.0
60	7.0	5.0	3.5	3.0	2.5	2.0	2.0
70	6.0	4.0	3.0	2.5	2.0	2.0	1.5
80	5.0	3.5	2.5	2.0	1.5	1.5	1.5
90	4.0	3.0	2.0	1.5	1.5	1.5	1.0
100	3.5	2.5	1.5	1.5	1.0	1.0	0.5





Corrections to be Added to Rockwell Superficial HR15N, HR30N, and HR45N
Values Obtained on Convex Cylindrical Surfaces of Various Diameters
Diameters of Convex Cylindrical Surfaces

Hardness Reading	1/8 in (3.2 mm)	1/4 in (6.4 mm)	3/8 in (10 mm)	1/2 in (13 mm)	3/4 in (19 mm)	1 in (25 mm)
20	6.0	3.0	2.0	1.5	1.5	1.5
25	5.5	3.0	2.0	1.5	1.5	1.0
30	5.5	3.0	2.0	1.5	1.0	1.0
35	5.0	2.5	2.0	1.5	1.0	1.0
40	4.5	2.5	1.5	1.5	1.0	1.0
45	4.0	2.0	1.5	1.0	1.0	1.0
50	3.5	2.0	1.5	1.0	1.0	0.5
55	3.5	2.0	1.5	1.0	0.5	0.5
60	3.0	1.5	1.0	1.0	0.5	0.5
65	2.5	1.5	1.0	0.5	0.5	0.5
70	2.0	1.0	1.0	0.5	0.5	0.5
75	1.5	1	0.5	0.5	0.5	0
80	1	0.5	0.5	0.5	0	0
85	0.5	0.5	0.5	0.5	0	0
90	0	0	0	0	0	0



Correction for Convex Cylindrical Surfaces

Corrections to be Added to Rockwell Superficial HR15T, HR30T, and HR45T Values Obtained on Convex Cylindrical Surfaces of Various Diameters

Diameters of Convex Cylindrical Surfaces

Hardness Reading	1/8 in (3.2 mm)	1/4 in (6.4 mm)	3/8 in (10 mm)	1/2 in (13 mm)	5/8 in (16 mm)	3/4 in (19 mm)	1 in (25 mm)
20	13.0	9.0	6.0	4.5	4.5	3.0	2.0
30	11.5	7.5	5.0	3.5	3.5	2.5	2.0
40	10.0	6.5	4.5	3.5	3.0	2.5	2.0
50	8.5	5.5	4.0	3.0	2.5	2.0	1.5
60	6.5	4.5	3.0	2.5	2.0	1.5	1.5
70	5.0	3.5	2.5	2.0	1.5	1.0	1.0
80	3.0	2.0	1.5	1.5	1.0	1.0	0.5
90	1.5	1.0	1.0	0.5	0.5	0.5	0.5



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