

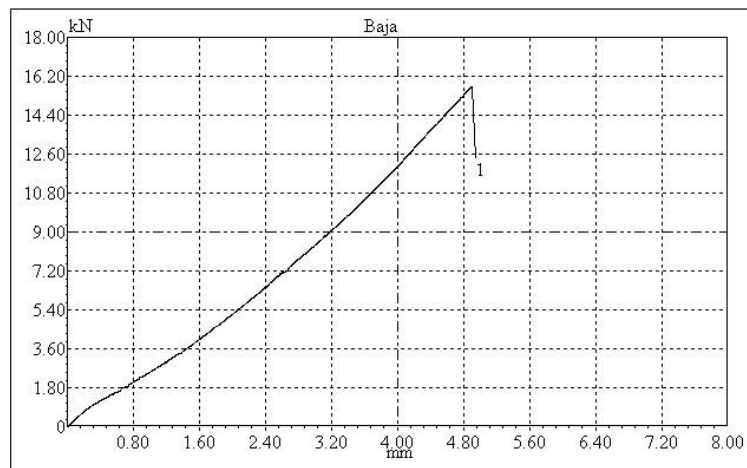
LAMPIRAN

PENGUJIAN TARIK

1. PU 50 MPa

LABORATORIUM JURUSAN TEKNIK MESIN
UNIVERSITAS MUHAMMADIYAH YOGYAKARTA

FW	Test date	Area mm ²	Yield point kN	Max. Load kN	Break kN
Al-SS	2007-01	116.899	7.863	15.726	12.391

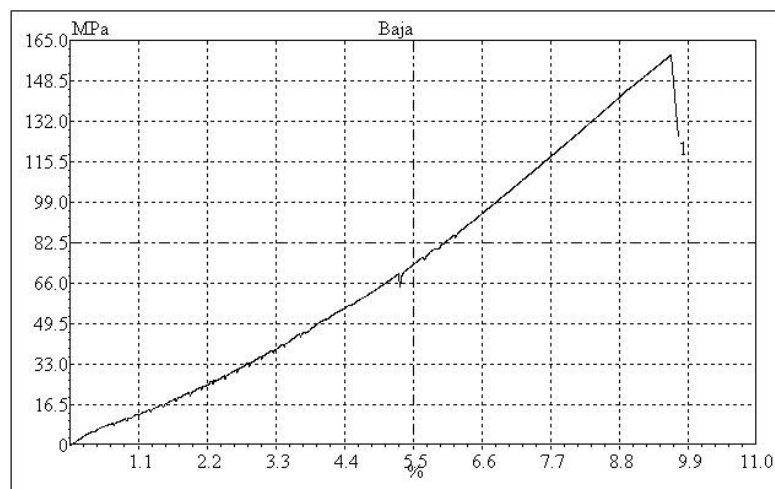


Yogyakarta, 04 April 2017

2. PU 60 MPa

LABORATORIUM JURUSAN TEKNIK MESIN
UNIVERSITAS MUHAMMADIYAH YOGYAKARTA

FW	Test date	Area mm ²	Yield point kN	Max. Load kN	Break kN
AI-SS	2007-01	134.782	10.756	21.449	16.942

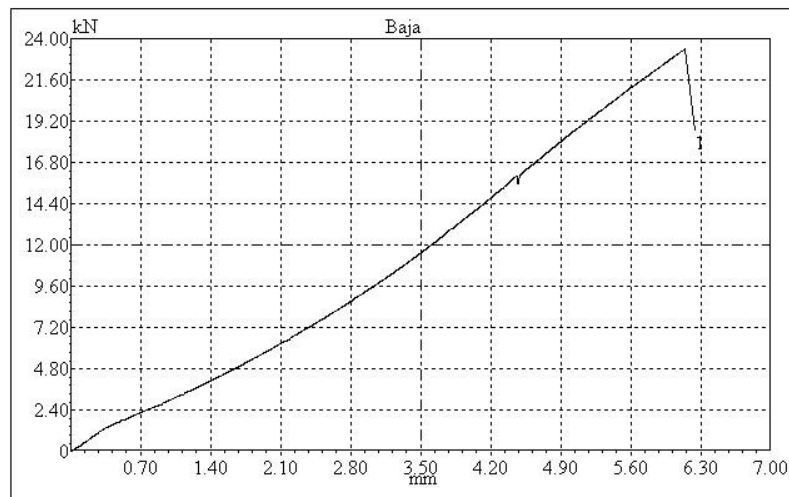


Yogyakarta, 04 April 2017

3. PU 70 MPa

LABORATORIUM JURUSAN TEKNIK MESIN
UNIVERSITAS MUHAMMADIYAH YOGYAKARTA

FW	Test date	Area mm ²	Yield point kN	Max. Load kN	Break kN
AI-SS	2007-01	132.732	12.946	23.399	18.648

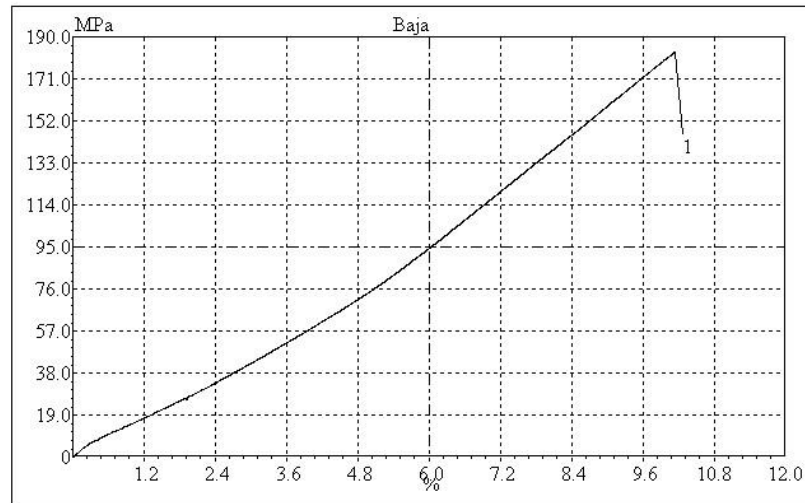


Yogyakarta, 04 April 2017

4. PU 80 MPa

LABORATORIUM JURUSAN TEKNIK MESIN
UNIVERSITAS MUHAMMADIYAH YOGYAKARTA

FW	Test date	Area mm ²	Yield point kN	Max. Load kN	Break kN
Al-SS	2007-01	134.782	19.968	24.707	19.654



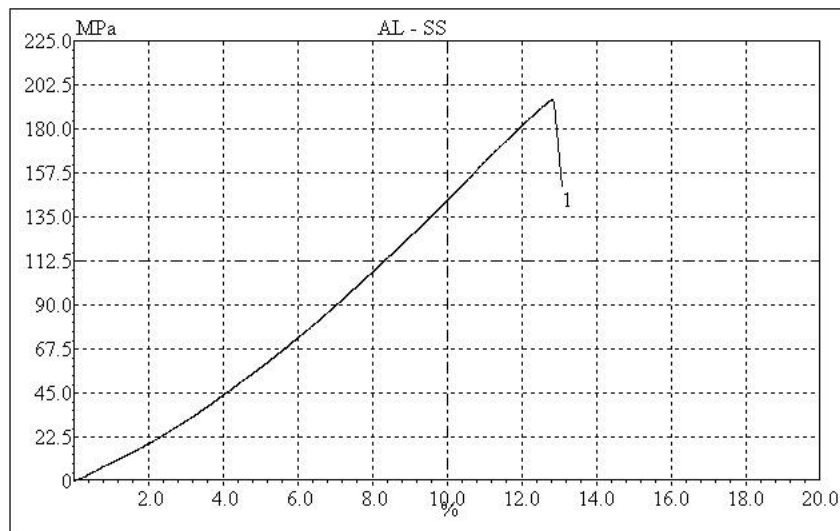
Yogyakarta, 04 April 2017

5. PU 90 MPa

LABORATORIUM JURUSAN TEKNIK MESIN
UNIVERSITAS MUHAMMADIYAH YOGYAKARTA

AL - SS

Test date	Area mm ²	Yield point kN	Max. Load kN	Break kN
2007-01	132.732	25.869	25.874	19.922

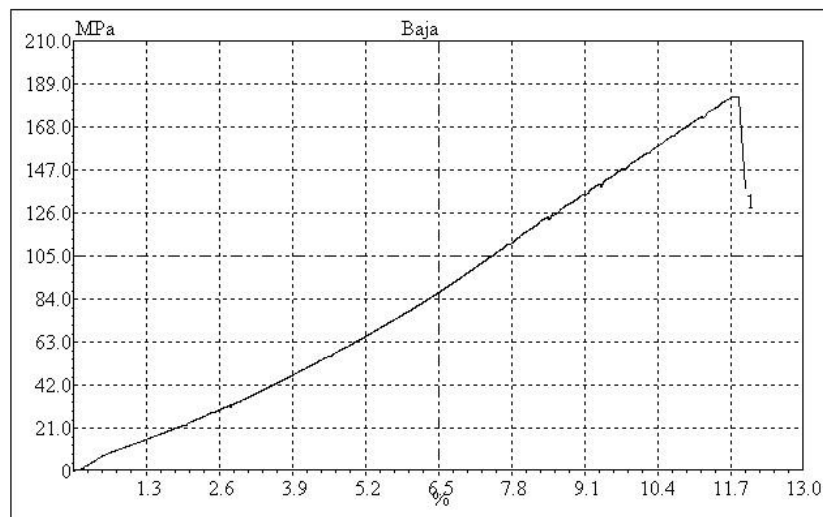


Yogyakarta, 20 April 2017

6. PU 100 MPa

LABORATORIUM JURUSAN TEKNIK MESIN
UNIVERSITAS MUHAMMADIYAH YOGYAKARTA

FW	Test date	Area mm ²	Yield point kN	Max. Load kN	Break kN
Al-SS	2007-01	126.677	14.025	23.192	17.410

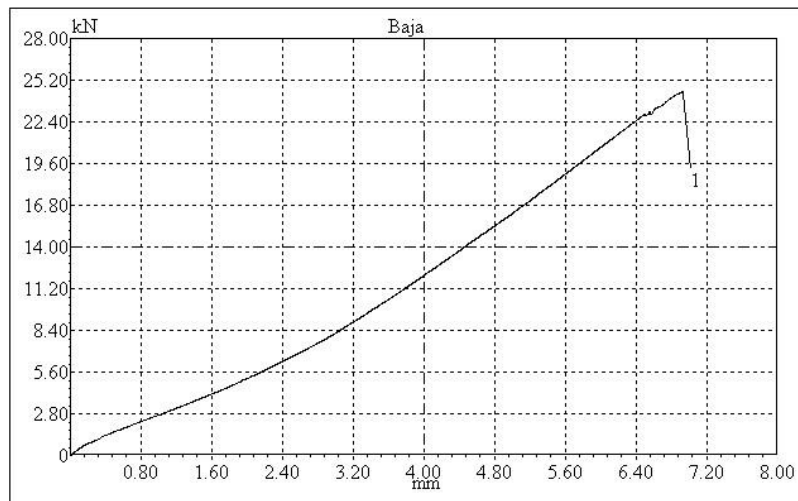


Yogyakarta, 04 April 2017

7. PU 110 MPa

LABORATORIUM JURUSAN TEKNIK MESIN
UNIVERSITAS MUHAMMADIYAH YOGYAKARTA

FW	Test date	Area mm ²	Yield point kN	Max. Load kN	Break kN
Al-SS	2007-01	128.680	12.757	24.424	19.238

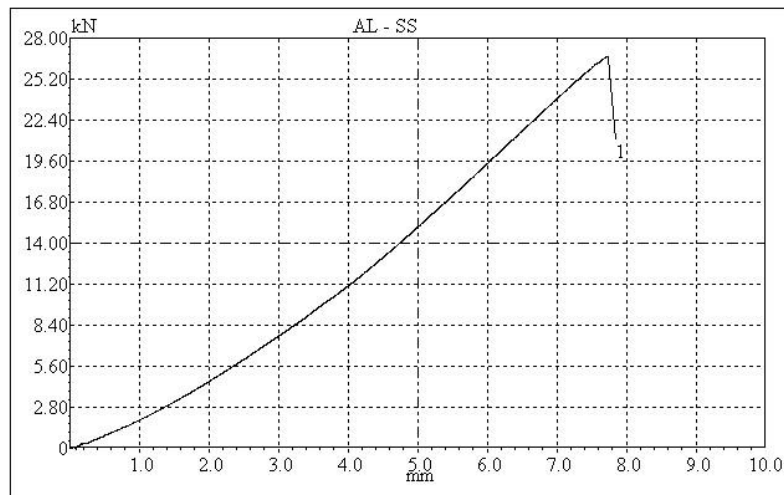


Yogyakarta, 04 April 2017

8. PU 120 MPaLABORATORIUM JURUSAN TEKNIK MESIN
UNIVERSITAS MUHAMMADIYAH YOGYAKARTA

AL - SS

Test date	Area mm ²	Yield point kN	Max. Load kN	Break kN
2007-01	132.732	26.269	26.726	21.079

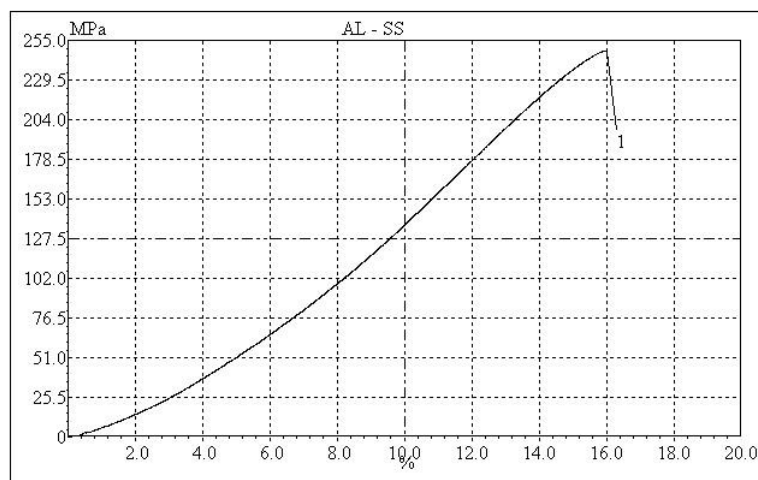


Yogyakarta, 20 April 2017

9. PU 130 MPaLABORATORIUM JURUSAN TEKNIK MESIN
UNIVERSITAS MUHAMMADIYAH YOGYAKARTA

AL - SS

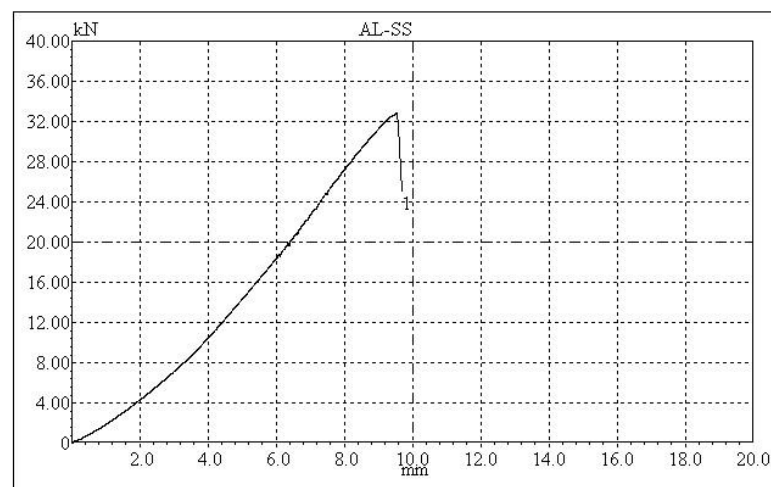
Test date	Area mm ²	Yield point kN	Max. Load kN	Break kN
2007-01	132.732	32.954	32.955	26.170



Yogyakarta, 20 April 2017

10. PU 140 MPaLABORATORIUM JURUSAN TEKNIK MESIN
UNIVERSITAS MUHAMMADIYAH YOGYAKARTAFW
SS-AL


Test date	Area mm ²	Yield point kN	Max. Load kN	Break kN
2007-01	141.026	18.227	32.841	25.017



Yogyakarta, 7 April 2017

HASIL PENGUJIAN KEKERASAN

1. PU 130 MPa



LABORATORIUM BAHAN TEKNIK
DEPARTEMEN TEKNIK MESIN SEKOLAH VOKASI
UNIVERSITAS GADJAH MADA

HASIL PENGUJIAN KEKERASAN
No. 079 / P.Kkr / BT.DTM / 2017

Spesimen Friction Welding (Aluminium-Stainless steel)

No	Kode	Jarak dr sambungan	d ₁ (µm)	d ₂ (µm)	d rata-rata (µm)	Kekerasan (VHN)	
1	4	Aluminium	10.0 mm	67.0	65.0	66.00	85.1
			1.5 mm	82.0	86.0	84.00	52.6
			0.5 mm	86.0	82.0	84.00	52.6
		SS	0.5 mm	40.0	39.0	39.50	237.7
			1.5 mm	40.0	39.0	39.50	237.7
			10.0 mm	40.0	38.0	39.00	243.8

Keterangan :

- Menggunakan metode uji Vickers dengan pembebanan 200 gf
- Satuan pengukuran diagonal jejak indentor dalam µm
- Pengujian dilakukan pada tanggal 10 Juli 2017

Yogyakarta, 10 Juli 2017
Staf Laboratorium Bahan Teknik

Pengujian & Analisa Material

Lab. Bahan Teknik
Departemen Teknik Mesin
Sekolah Vokasi UMY

Lembar asli, tidak untuk digandakan

Kampus : Jl. Grafika 2A Yogyakarta 55281 Telpn : (0274) 747632, 548637, 6492269. Fax. (0274) 546400
E-mail: lab.bahanteknik@yahoo.co.id

2. PU 50 MPa



LABORATORIUM BAHAN TEKNIK
PROGRAM DIPLOMA TEKNIK MESIN
HASIL PENGUJIAN KEKERASAN
UNIVERSITAS PADJADJARAN
No. 101/P.K.01/BJ.DTM/2017

Spesimen Friction Welding (Aluminium-Stainless steel)

No	Variasi	Jarak dr sambungan	d ₁ (μ m)	d ₂ (μ m)	d _{rata-rata} (μ m)	Kekerasan (VHN)	
1	50 MPa	Aluminium	0.5 mm	71.0	74.0	72.50	70.6
		1.0 mm	71.0	72.5	71.75	72.0	
		1.5 mm	70.0	72.0	71.00	73.6	
		2.0 mm	70.5	71.0	70.75	74.1	
		2.5 mm	68.5	70.0	69.25	77.3	
	SS	<i>tidak diuji</i>					

Keterangan :

1. Menggunakan metode uji Vikers dengan pembebanan 200 gf
2. Satuan pengukuran diagonal jejak indentor dalam μ m
3. Pengujian dilakukan pada tanggal 24 Juli 2017

Yogyakarta, 24 Juli 2017
 Staf Laboratorium Bahan Teknik



Lembar asli, tidak untuk digandakan



Designation: E 92 - 82 (Reapproved 1997)¹

AMERICAN SOCIETY FOR TESTING AND MATERIALS
1901 Race Street, West Conshohocken, PA 19380
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Standard Test Method for Vickers Hardness of Metallic Materials¹

This standard is issued under the fixed designation E 92; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense. Consult the DoD Index of Specifications and Standards for the specific year of issue which has been adopted by the Department of Defense.

¹Note—Section 27 was added editorially in October 1997.

1. Scope

1.1 This test method covers the determination of the Vickers hardness of metallic materials, using applied loads of 1 kgf to 120 kgf,² the verification of Vickers hardness testing machines (Part B), and the calibration of standardized hardness test blocks (Part C). Two general classes of standard tests are recognized:

1.1.1 *Verification, Laboratory, or Reference Tests*, where a high degree of accuracy is required.

1.1.2 *Routine Tests*, where a somewhat lower degree of accuracy is permissible.

1.2 This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. Referenced Documents

2.1 ASTM Standards:

- E 4 Practices for Force Verification of Testing Machines³
- E 140 Hardness Conversion Tables for Metals (Relationship Between Brinell Hardness, Vickers Hardness, Rockwell Hardness, Rockwell Superficial Hardness, Knoop Hardness, and Scleroscope Hardness)³
- E 384 Test Method for Microhardness of Materials³

3. Terminology

3.1 *Vickers hardness number, HV*—a number related to the applied load and the surface area of the permanent impression made by a square-based pyramidal diamond indenter having included face angles of 136° (see Fig. 1 and Table 1), computed from the equation:

$$HV = 1P \sin(a/2) / d^2 = 1.8544 \text{ kgf} / d^2$$

where:

P = load, kgf,

d = mean diagonal of impression, mm, and

a = face angle of diamond = 136°.

3.2 *Vickers hardness test*—an indentation hardness test

using calibrated machines to force a square-based pyramidal diamond indenter having specified face angles, under a predetermined load, into the surface of the material under test and to measure the diagonals of the resulting impression after removal of the load.

3.2.1 Vickers hardness tests are made at test loads of 1 kgf to 120 kgf.

3.2.2 For practical purposes the Vickers hardness number is constant when a square-based diamond pyramid with a face angle of 136° is used with applied loads of 5 kgf and higher. At lower test loads the Vickers hardness may be load-dependent. In Table 2 are given the Vickers hardness numbers for a test load of 1 kgf. For obtaining hardness numbers when other test loads are used, the Vickers hardness number obtained from Table 2 is multiplied by the test load in kilograms-force (Table 3).

NOTE 1—The Vickers hardness number is followed by the symbol HV with a suffix number denoting the load and second suffix number indicating the duration of loading when the latter differs from 10 to 15 s, which is the normal loading time.

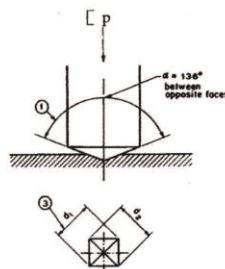


FIG. 1 Vickers Hardness Test (see Table 1)

TABLE 1 Symbols and Designations Associated with Fig. 1

Number	Symbol	Designation
1	---	Angle at the vertex of the pyramidal indenter (136°)
2	P	Test load in kilograms-force
3	d	Arithmetic mean of the two diagonals d and d'

¹ This test method is under the jurisdiction of ASTM Committee E-28 on Mechanical Testing and is the direct responsibility of Subcommittee E28.06 on Indentation Hardness Testing.

Current edition approved July 30, 1982. Published December 1982. Originally published as E 92 - 52 T. Last previous edition E92-72(1977).

² A procedure covering Vickers tests using applied loads of 1 gf to 1000 gf (1 kgf) may be found in Test Method E 384, Test Method for Microhardness of Materials, appearing in the Annual Book of ASTM Standards, Vol 03.01.

³ Annual Book of ASTM Standards, Vol 03.01.

ASTM E 92

Example:
 440 HV 30 = Vickers hardness of 440 measured under a load of 30 kgf applied for 10 to 15 s.
 440 HV 30/20 = Vickers hardness of 440 measured under a load of 30 kgf applied for 20 s.

3.3 verification—checking or testing to assure conformance with the specification.
 3.4 calibration—determination of the values of the significant parameters by comparison with values indicated by a reference instrument or by a set of reference standards.

TABLE 2 Vickers Hardness Numbers
 (Diamond, 136° Face Angle, Load of 1 kgf)

Diagonal of impression, mm	Vickers Hardness Number for Diagonal Measured to 0.0001 mm									
	0.0000	0.0001	0.0002	0.0003	0.0004	0.0005	0.0006	0.0007	0.0008	0.0009
0.005	74 170	71 290	68 590	66 020	63 590	61 300	59 130	57 080	55 120	53 270
0.006	51 510	49 840	48 240	46 720	45 270	43 890	42 570	41 310	40 100	38 950
0.007	37 840	36 750	35 770	34 800	33 850	32 970	32 100	31 280	30 480	29 710
0.008	28 970	28 260	27 580	26 920	26 280	25 670	25 070	24 500	23 950	23 410
0.009	22 890	22 390	21 910	21 440	20 990	20 550	20 120	19 710	19 310	18 920
0.010	18 540	18 180	17 820	17 480	17 140	16 820	16 500	16 200	15 900	15 610
0.011	15 330	15 050	14 780	14 520	14 270	14 020	13 780	13 550	13 320	13 090
0.012	12 380	12 070	12 460	12 250	12 050	11 870	11 690	11 520	11 350	11 140
0.013	10 970	10 810	10 640	10 480	10 330	10 170	10 030	9 880	9 737	9 598
0.014	9 461	9 327	9 196	9 068	8 943	8 820	8 699	8 581	8 466	8 353
0.015	8 242	8 133	8 026	7 922	7 819	7 718	7 620	7 523	7 428	7 335
0.016	7 244	7 154	7 066	6 979	6 895	6 811	6 729	6 649	6 570	6 493
0.017	6 416	6 342	6 268	6 196	6 125	6 055	5 986	5 919	5 853	5 787
0.018	5 723	5 660	5 598	5 537	5 477	5 418	5 360	5 303	5 247	5 191
0.019	5 137	5 083	5 030	4 978	4 927	4 877	4 827	4 778	4 730	4 683
0.020	4 636	4 590	4 545	4 500	4 456	4 413	4 370	4 328	4 286	4 245
0.021	4 205	4 165	4 125	4 087	4 049	4 012	3 975	3 938	3 902	3 866
0.022	3 831	3 797	3 763	3 729	3 696	3 663	3 631	3 599	3 567	3 536
0.023	3 505	3 475	3 445	3 416	3 387	3 358	3 329	3 301	3 274	3 246
0.024	3 219	3 193	3 166	3 140	3 115	3 089	3 064	3 039	3 015	2 991
0.025	2 967	2 943	2 920	2 897	2 874	2 852	2 830	2 808	2 786	2 764
0.026	2 743	2 722	2 701	2 681	2 661	2 641	2 621	2 601	2 582	2 563
0.027	2 544	2 525	2 506	2 488	2 470	2 452	2 434	2 417	2 399	2 382
0.028	2 365	2 348	2 332	2 315	2 299	2 283	2 267	2 251	2 236	2 220
0.029	2 205	2 190	2 175	2 160	2 145	2 131	2 116	2 102	2 088	2 074
0.030	2 060	2 047	2 033	2 020	2 007	1 993	1 980	1 968	1 955	1 942
0.031	1 930	1 917	1 905	1 893	1 881	1 869	1 857	1 845	1 834	1 822
0.032	1 811	1 800	1 788	1 777	1 766	1 756	1 745	1 734	1 724	1 713
0.033	1 703	1 693	1 682	1 672	1 662	1 652	1 643	1 633	1 623	1 614
0.034	1 604	1 595	1 585	1 576	1 567	1 558	1 549	1 540	1 531	1 522
0.035	1 514	1 505	1 497	1 488	1 480	1 471	1 463	1 455	1 447	1 439
0.036	1 431	1 423	1 415	1 407	1 400	1 392	1 384	1 377	1 369	1 362
0.037	1 355	1 347	1 340	1 333	1 326	1 319	1 312	1 305	1 298	1 291
0.038	1 284	1 277	1 271	1 264	1 258	1 251	1 245	1 238	1 232	1 225
0.039	1 219	1 213	1 207	1 201	1 195	1 189	1 183	1 177	1 171	1 166
0.040	1 159	1 153	1 147	1 142	1 136	1 131	1 125	1 119	1 114	1 108
0.041	1 103	1 098	1 092	1 087	1 082	1 077	1 072	1 066	1 061	1 056
0.042	1 051	1 046	1 041	1 036	1 031	1 027	1 022	1 017	1 012	1 008
0.043	1 003	998	994	989	985	980	975	971	967	962
0.044	958	953	949	945	941	936	932	928	924	920
0.045	916	912	908	904	900	896	892	888	884	880
0.046	876	873	869	865	861	858	854	850	847	843
0.047	839	836	832	829	825	822	818	815	812	808
0.048	805	802	798	795	792	788	785	782	779	775
0.049	772	769	766	763	760	757	754	751	748	745
0.050	742	739	736	733	730	727	724	721	719	716
0.051	713	710	707	705	702	699	696	694	691	688
0.052	686	683	681	678	675	673	670	668	665	663
0.053	660	658	655	653	650	648	645	643	641	638
0.054	636	634	631	629	627	624	622	620	617	615