~~Designation:D4651–93 (Reapproved 2003)~~ Designation: D 4651 – 08

Standard Specification for Isobutane Thermophysical Property Tables[1]

This standard is issued under the fixed designation D 4651; 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.

1. Scope

~~1.1The isobutane thermophysical property tables are for use in the calculation of the pressure-volume-temperature (PVT), thermodynamic, and transport properties of isobutane for process design and operations. Tables are provided for gaseous and liquid isobutane at temperatures between 135 and 600K at pressures to 35 MPa. These tables were developed by the National Institute of Standards and Technology (formerly the National Bureau of Standards) upon culmination of four years of effort in acquiring available physical properties data, performing experimental measurements, and in formulating these tables for use in thermal computations.~~

1.1 The thermophysical property tables for isobutane are for use in the calculation of the pressure-volume-temperature (PVT), thermodynamic, and transport properties of isobutane for process design and operations. Tables are provided for gaseous and liquid isobutane at temperatures between 120 and 570 K at pressures to 20 MPa. One table provides properties at the conditions of liquid-vapor equilibrium (saturation properties). The other table provides properties at selected *T*, *p* points for the equilibrium phase at those conditions. The tables were developed by the National Institute of Standards and Technology from a Standard Reference Database product REFPROP, version 8.0.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

2. ~~Sponsorship~~

~~2.1The preparation of the tables and supporting work was done by the National Institute of Standards and Technology (NIST) under the sponsorship of the Gas Research Institute, the American Gas Association, and the Standard Reference Data Program of NIST.~~

~~3.~~Applicability

~~3.1These~~2.1 These tables apply directly only to pure gaseous ~~and liquid~~ isobutane. However, it is expected that they ~~will~~may find substantial use in mathematical models and tables for the thermophysical properties of mixtures containing ~~isobutane, such as natural gas.~~ isobutane.

~~4.~~3. Tables

~~4.1These thermophysical property tables are:~~

~~4.1.1~~

3.1 These thermophysical property tables are:

3.1.1 *Thermophysical Properties of Coexisting Gaseous and Liquid Isobutane*~~, in SI units (Table in Appendix H, pp. 722–724).~~

~~4.1.2*Thermophysical Properties of Isobutane*, along isobars, in SI units (Table in Appendix H, pp. 725–757).[3]~~

~~4.2These tables were produced by equations from a computer package. "NIST Thermophysical Properties of Fluids Database 12" (also designated MIPROPS) of the Standard Reference Data Program of NIST. A wide selection of units (SI units, engineering units, chemical units) are available with this program.~~

~~5.~~, in SI units. See Table 1.

3.1.2 *Thermophysical Properties of Isobutane Along Isobars*, in SI units. See Table 2.

3.2 The tabulated thermophysical properties are:

ρ, molar density ($mol \cdot l^{-1}$)

H, molar enthalpy ($J \cdot mol^{-1}$)

S, molar entropy ($J \cdot K^{-1} \cdot mol^{-1}$)

[1] This ~~practice~~specification is under the jurisdiction of ASTM Committee D03 on Gaseous Fuels and is the direct responsibility of Subcommittee D03.08 on Thermophysical Properties .

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TABLE 1 Thermophysical Properties of Coexisting Gaseous and Liquid Isobutane

T K	P MPa	ρ $mol \cdot l^{-1}$	H $J \cdot mol^{-1}$	S $J \cdot mol^{-1} \cdot K^{-1}$	C_v $J \cdot mol^{-1} \cdot K^{-1}$	C_p $J \cdot mol^{-1} \cdot K^{-1}$	c $m \cdot s^{-1}$	η $\mu Pa \cdot s$	λ $mW \cdot m^{-1} \cdot K^{-1}$
114	2.455E-08	12.733	-23331	110.20	68.27	98.21	1997.4	8618	157.88
114	2.455E-08	2.59E-08	4595.2	355.17	42.89	51.20	139.53	2.855	2.287
118	6.643E-08	12.668	-22937	113.60	68.75	98.94	1962.5	6774	157.1
118	6.643E-08	6.771E-08	4802.2	348.68	43.96	52.28	141.68	2.960	2.512
122	1.673E-07	12.603	-22540	116.91	69.25	99.68	1928.5	5441	156.3
122	1.673E-07	1.65E-07	5013.4	342.75	45.02	53.34	143.79	3.066	2.741
126	3.952E-07	12.538	-22140	120.14	69.75	100.43	1895.5	4451	155.4
126	3.952E-07	3.773E-07	5228.8	337.35	46.06	54.38	145.87	3.171	2.974
130	8.806E-07	12.473	-21736	123.29	70.26	101.18	1863.4	3698	154.4
130	8.806E-07	8.147E-07	5448.4	332.40	47.09	55.40	147.92	3.276	3.211
134	1.861E-06	12.408	-21330	126.36	70.75	101.93	1832.2	3115	153.3
134	1.861E-06	1.67E-06	5672.0	327.87	48.09	56.41	149.94	3.381	3.453
138	3.748E-06	12.343	-20921	129.37	71.25	102.68	1801.7	2656	152.9
138	3.748E-06	3.267E-06	5899.6	323.72	49.09	57.40	151.94	3.486	3.699
142	7.225E-06	12.278	-20509	132.32	71.74	103.42	1772.0	2289	151.0
142	7.225E-06	6.12E-06	6131.1	319.92	50.06	58.38	153.90	3.591	3.948
146	1.338E-05	12.213	-20094	135.20	72.23	104.16	1742.9	1991	149.7
146	1.338E-05	1.102E-05	6366.5	316.43	51.03	59.34	155.84	3.695	4.202
150	2.388E-05	12.147	-19675	138.03	72.72	104.89	1714.4	1748	148.4
150	2.388E-05	1.915E-05	6605.6	313.23	51.98	60.30	157.76	3.799	4.461
154	4.121E-05	12.082	-19254	140.80	73.21	105.63	1686.4	1546	147.1
154	4.121E-05	3.219E-05	6848.5	310.30	52.93	61.25	159.65	3.903	4.723
158	6.893E-05	12.016	-18830	143.51	73.70	106.36	1658.9	1377	145.7
158	6.893E-05	5.248E-05	7095.1	307.60	53.87	62.19	161.51	4.007	4.989
162	0.000112	11.951	-18403	146.18	74.19	107.10	1631.8	1234	144.2
162	0.000112	8.319E-05	7345.3	305.12	54.80	63.12	163.35	4.110	5.260
166	0.0001773	11.885	-17974	148.80	74.68	107.83	1605.0	1113	142.7
166	0.0001773	0.0001285	7599.0	302.85	55.73	64.05	165.16	4.214	5.534
170	0.0002739	11.819	-17541	151.38	75.18	108.57	1578.6	1008	141.2
170	0.0002739	0.0001938	7856.2	300.77	56.65	64.99	166.95	4.317	5.813
174	0.0004134	11.752	-17105	153.91	75.68	109.32	1552.6	918.4	139.7
174	0.0004134	0.000286	8116.8	298.87	57.58	65.92	168.70	4.420	6.095
178	0.0006111	11.686	-16666	156.41	76.20	110.07	1526.8	840.0	138.1
178	0.0006111	0.0004133	8380.8	297.12	58.50	66.85	170.43	4.522	6.382
182	0.0008856	11.619	-16224	158.86	76.72	110.83	1501.3	771.3	136.5
182	0.0008856	0.0005859	8648.1	295.52	59.43	67.79	172.13	4.624	6.672
186	0.0012602	11.552	-15780	161.28	77.25	111.60	1476.0	710.8	134.9
186	0.0012602	0.0008161	8918.6	294.06	60.36	68.74	173.80	4.726	6.967
190	0.0017628	11.485	-15332	163.66	77.79	112.37	1450.9	657.2	133.2
190	0.0017628	0.0011181	9192.1	292.73	61.29	69.69	175.44	4.828	7.265
194	0.002427	11.418	-14880	166.01	78.35	113.16	1426.1	609.5	131.6
194	0.002427	0.0015085	9468.7	291.52	62.23	70.65	177.05	4.929	7.567
198	0.0032918	11.350	-14426	168.33	78.91	113.96	1401.4	566.8	129.9
198	0.0032918	0.0020061	9748.2	290.42	63.18	71.63	178.61	5.029	7.873
202	0.0044031	11.282	-13969	170.62	79.49	114.78	1376.9	528.5	128.2
202	0.0044031	0.0026324	10031	289.42	64.14	72.62	180.14	5.130	8.183
206	0.005813	11.213	-13508	172.87	80.08	115.61	1352.6	493.8	126.5
206	0.005813	0.0034111	10316	288.52	65.10	73.62	181.63	5.230	8.496

TABLE 1 *Continued*

T K	P MPa	ρ mol·l^{-1}	H J·mol^{-1}	S J·mol^{-1}·K^{-1}	C_v J·mol^{-1}·K^{-1}	C_p J·mol^{-1}·K^{-1}	c m·s^{-1}	η µPa·s	λ mW·m^{-1}·K^{-1}
210	0.0075808	11.145	-13043	175.11	80.69	116.46	1328.4	462.4	124.8
210	0.0075808	0.0043687	10603	287.71	66.08	74.64	183.08	5.329	8.813
214	0.0097734	11.075	-12576	177.31	81.31	117.32	1304.4	433.9	123.1
214	0.0097734	0.0055342	10893	286.98	67.06	75.68	184.48	5.428	9.133
218	0.012465	11.006	-12105	179.49	81.95	118.20	1280.5	407.9	121.4
218	0.012465	0.006939	11186	286.33	68.06	76.74	185.83	5.527	9.457
222	0.015736	10.936	-11630	181.65	82.60	119.10	1256.7	384.1	119.7
222	0.015736	0.0086174	11481	285.75	69.07	77.82	187.12	5.625	9.784
226	0.019678	10.865	-11151	183.78	83.26	120.02	1233.0	362.2	118.0
226	0.019678	0.010606	11778	285.24	70.10	78.93	188.37	5.723	10.12
230	0.024387	10.794	-10669	185.89	83.94	120.96	1209.5	342.1	116.3
230	0.024387	0.012943	12077	284.79	71.14	80.06	189.56	5.821	10.45
234	0.029967	10.723	-10183	187.99	84.64	121.92	1186.1	323.6	114.6
234	0.029967	0.015671	12377	284.40	72.19	81.21	190.68	5.918	10.79
238	0.03653	10.651	-9693.1	190.06	85.35	122.90	1162.8	306.4	112.9
238	0.03653	0.018834	12680	284.07	73.26	82.39	191.75	6.015	11.13
242	0.044196	10.578	-9199.1	192.12	86.08	123.91	1139.6	290.5	111.3
242	0.044196	0.022477	12984	283.78	74.34	83.60	192.74	6.112	11.47
246	0.053092	10.505	-8700.9	194.15	86.82	124.94	1116.4	275.8	109.6
246	0.053092	0.026651	13290	283.55	75.44	84.83	193.67	6.208	11.82
250	0.06335	10.431	-8198.5	196.18	87.58	126.00	1093.4	262.0	107.9
250	0.06335	0.031405	13597	283.36	76.55	86.10	194.52	6.304	12.17
254	0.075109	10.357	-7691.7	198.18	88.35	127.08	1070.4	249.2	106.3
254	0.075109	0.036794	13905	283.21	77.68	87.40	195.30	6.401	12.53
258	0.088516	10.281	-7180.5	200.18	89.14	128.19	1047.5	237.3	104.7
258	0.088516	0.042874	14214	283.10	78.82	88.73	196.00	6.497	12.89
262	0.10372	10.205	-6664.7	202.15	89.94	129.33	1024.7	226.1	103.0
262	0.10372	0.049705	14525	283.03	79.98	90.10	196.62	6.594	13.26
266	0.12089	10.128	-6144.2	204.12	90.76	130.50	1002.0	215.7	101.4
266	0.12089	0.057348	14836	282.99	81.15	91.50	197.15	6.690	13.62
270	0.14017	10.051	-5618.9	206.07	91.59	131.70	979.29	205.9	99.87
270	0.14017	0.065869	15147	282.98	82.34	92.94	197.59	6.787	14.00
274	0.16174	9.9721	-5088.6	208.01	92.44	132.94	956.65	196.6	98.30
274	0.16174	0.075336	15459	283.01	83.54	94.42	197.94	6.885	14.38
278	0.18577	9.8925	-4553.3	209.94	93.29	134.21	934.06	188.0	96.75
278	0.18577	0.085821	15772	283.06	84.76	95.94	198.20	6.983	14.77
282	0.21243	9.8118	-4012.7	211.87	94.17	135.52	911.50	179.8	95.22
282	0.21243	0.0974	16084	283.13	85.99	97.51	198.35	7.082	15.16
286	0.24192	9.7300	-3466.7	213.78	95.05	136.87	888.97	172.1	93.72
286	0.24192	0.11015	16397	283.23	87.24	99.13	198.41	7.183	15.56
290	0.2744	9.6470	-2915.2	215.68	95.95	138.26	866.47	164.8	92.23
290	0.2744	0.12417	16709	283.35	88.50	100.79	198.35	7.284	15.97
294	0.31008	9.5628	-2358	217.58	96.86	139.70	843.98	157.9	90.76
294	0.31008	0.13954	17021	283.49	89.78	102.51	198.19	7.388	16.38
298	0.34914	9.4773	-1794.9	219.46	97.78	141.18	821.50	151.4	89.32
298	0.34914	0.15635	17332	283.65	91.07	104.29	197.92	7.492	16.81
302	0.39177	9.3902	-1225.8	221.35	98.71	142.72	799.01	145.2	87.89
302	0.39177	0.17472	17643	283.82	92.38	106.13	197.52	7.600	17.24

TABLE 1 *Continued*

T K	P MPa	ρ $mol \cdot l^{-1}$	H $J \cdot mol^{-1}$	S $J \cdot mol^{-1} \cdot K^{-1}$	C_v $J \cdot mol^{-1} \cdot K^{-1}$	C_p $J \cdot mol^{-1} \cdot K^{-1}$	c $m \cdot s^{-1}$	η $\mu Pa \cdot s$	λ $mW \cdot m^{-1} \cdot K^{-1}$
306	0.43819	9.3017	-650.4	223.22	99.66	144.32	776.50	139.3	86.49
306	0.43819	0.19476	17952	284.01	93.70	108.04	197.01	7.709	17.69
310	0.48858	9.2114	-68.6	225.09	100.62	145.98	753.97	133.6	85.12
310	0.48858	0.21659	18259	284.22	95.03	110.03	196.37	7.822	18.15
314	0.54317	9.1194	519.9	226.96	101.59	147.71	731.40	128.3	83.76
314	0.54317	0.24034	18565	284.43	96.38	112.10	195.59	7.938	18.63
318	0.60215	9.0255	1115.4	228.83	102.57	149.52	708.78	123.2	82.44
318	0.60215	0.26617	18870	284.66	97.75	114.27	194.68	8.057	19.12
322	0.66573	8.9295	1718	230.69	103.56	151.42	686.10	118.2	81.13
322	0.66573	0.29422	19171	284.89	99.13	116.54	193.62	8.181	19.63
326	0.73415	8.8312	2328.2	232.55	104.57	153.41	663.33	113.5	79.85
326	0.73415	0.3247	19470	285.13	100.51	118.93	192.41	8.310	20.16
330	0.80761	8.7304	2946.1	234.40	105.59	155.52	640.46	109.0	78.60
330	0.80761	0.35779	19766	285.37	101.91	121.44	191.05	8.445	20.71
334	0.88635	8.6270	3572.3	236.26	106.63	157.75	617.48	104.6	77.36
334	0.88635	0.39372	20058	285.62	103.31	124.10	189.52	8.586	21.29
338	0.97059	8.5206	4207.0	238.12	107.68	160.13	594.36	100.4	76.16
338	0.97059	0.43277	20345	285.87	104.71	126.93	187.82	8.735	21.89
342	1.0606	8.4109	4850.8	239.98	108.74	162.69	571.08	96.38	74.97
342	1.0606	0.47521	20627	286.11	106.11	129.97	185.94	8.893	22.53
346	1.1565	8.2977	5504.1	241.85	109.83	165.44	547.62	92.43	73.81
346	1.1565	0.5214	20903	286.36	107.52	133.26	183.86	9.061	23.21
350	1.2587	8.1805	6167.6	243.72	110.93	168.44	523.94	88.59	72.68
350	1.2587	0.57173	21172	286.59	108.95	136.89	181.59	9.241	23.93
354	1.3674	8.0588	6842.0	245.60	112.06	171.73	500.02	84.84	71.57
354	1.3674	0.62668	21433	286.82	110.41	140.94	179.11	9.44	24.70
358	1.4829	7.9321	7528.1	247.49	113.21	175.38	475.82	81.18	70.48
358	1.4829	0.68681	21684	287.03	111.93	145.55	176.40	9.645	25.53
362	1.6054	7.7996	8226.8	249.38	114.39	179.48	451.29	77.58	69.42
362	1.6054	0.7528	21924	287.22	113.53	150.87	173.45	9.875	26.43
366	1.7352	7.6606	8939.5	251.30	115.60	184.15	426.38	74.03	68.37
366	1.7352	0.82548	22152	287.39	115.23	157.11	170.25	10.13	27.41
370	1.8727	7.5139	9667.7	253.22	116.86	189.58	401.01	70.53	67.36
370	1.8727	0.90588	22364	287.54	117.03	164.55	166.77	10.41	28.50
374	2.0181	7.358	10413	255.18	118.17	196.03	375.12	67.04	66.36
374	2.0181	0.99533	22559	287.65	118.96	173.60	163.00	10.72	29.71
378	2.1718	7.1913	11179	257.16	119.54	203.88	348.59	63.54	65.40
378	2.1718	1.0956	22732	287.72	121.02	184.89	158.90	11.08	31.09
382	2.3343	7.0111	11968	259.17	121.01	213.80	321.32	60.03	64.46
382	2.3343	1.2090	22878	287.73	123.23	199.43	154.46	11.49	32.68
386	2.5058	6.8138	12785	261.24	122.62	226.90	293.15	56.45	63.58
386	2.5058	1.3389	22991	287.68	125.63	218.98	149.63	11.97	34.55
390	2.6869	6.5941	13638	263.36	124.42	245.34	263.93	52.77	62.76
390	2.6869	1.4904	23060	287.52	128.27	246.92	144.37	12.55	36.83
394	2.8782	6.3430	14539	265.59	126.52	273.75	233.42	48.92	62.09
394	2.8782	1.6716	23068	287.23	131.24	290.57	138.63	13.26	39.74
398	3.0802	6.0444	15510	267.96	129.14	324.44	201.26	44.76	61.76
398	3.0802	1.8978	22982	286.73	134.75	369.40	132.32	14.18	43.73

TABLE 1 *Continued*

T K	*P* MPa	ρ mol·l⁻¹	*H* J·mol⁻¹	*S* J·mol⁻¹·K⁻¹	C_v J·mol⁻¹·K⁻¹	C_p J·mol⁻¹·K⁻¹	*c* m·s⁻¹	η μPa·s	λ mW·m⁻¹·K⁻¹
402	3.294	5.6611	16603	270.60	132.80	444.47	166.79	40.03	62.50
402	3.294	2.2035	22733	285.85	139.26	557.25	125.27	15.48	50.08
406	3.521	5.0501	18021	274.00	139.62	1125.70	128.12	33.65	69.00
406	3.521	2.7246	22042	283.91	146.50	1601.40	116.78	17.90	66.35
407	3.580	4.7629	18568	275.32	143.30	2459.70	116.97	31.07	77.26
407	3.580	2.9844	21611	282.79	149.68	3556.20	113.83	19.21	81.05

C_v, constant volume molar heat capacity (J·K $^{-1}$·mol^{-1})
C_p, constant pressure molar heat capacity (J·K $^{-1}$·mol^{-1})
c, speed of sound (m·s^{-1})
η, viscosity (μPa·s)
λ, thermal conductivity (mW·m^{-1}·K^{-1})

3.3 These tables were produced by equations from a computer package, "NIST Standard Reference Database 23; Reference Fluid Thermodynamic and Transport Properties Database (REFPROP): Version =8.0" A wide selection of units (SI units, engineering units, chemical units) is available with this program.[2]

4. Additional Information

~~5.1These tables were originally published by the American Chemical Society and the American Institute of Physics for the National Institute of Standards and Technology in a comprehensive report titled "Thermophysical Properties of Fluids. II. Methane, Ethane, Propane, Isobutane and Normal Butane." This report also contains the following:~~

~~5.1.1Properties and uncertainties data.~~
~~5.1.2Correlation equations for isobutane.~~
~~5.1.3Description of the research study culminating in the tables.~~
~~5.1.4References to properties data.~~
~~5.1.5Computational methods used.~~

~~[2] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR: D03–1005.~~
[2] Available from Standard Reference Data, National Institute of Standards and Technology (NIST), 100 Bureau Drive, Stop 3460, Gaithersburg, MD 20899.

TABLE 2 Thermophysical Properties of Isobutane Along Isobars

T K	ρ mol·l^{-1}	*H* J·mol^{-1}	*S* J·mol^{-1}·K^{-1}	C_v J·mol^{-1}·K^{-1}	C_p J·mol^{-1}·K^{-1}	*c* m·s^{-1}	η μPa·s	λ mW·m^{-1}·K^{-1}
				Pressure = 0.1 MPa				
120	12.636	-22732	115.25	69.01	99.31	1945.6	6063	156.7
130	12.474	-21730	123.28	70.26	101.18	1863.7	3702	154.4
140	12.311	-20709	130.84	71.51	103.04	1787.1	2465	151.6
150	12.148	-19669	138.01	72.73	104.89	1714.8	1749	148.5
160	11.985	-18611	144.84	73.95	106.72	1645.7	1304	145.0
170	11.820	-17534	151.37	75.19	108.57	1579.1	1009	141.2
180	11.654	-16439	157.63	76.46	110.44	1514.5	805.3	137.3
190	11.486	-15325	163.65	77.80	112.37	1451.5	657.9	133.3
200	11.317	-14192	169.46	79.21	114.36	1389.7	547.7	129.1
210	11.146	-13038	175.09	80.70	116.44	1329.0	462.9	124.9
220	10.972	-11863	180.56	82.28	118.63	1269.2	396.1	120.6
230	10.796	-10665	185.88	83.95	120.94	1210.1	342.4	116.4
240	10.616	-9443.3	191.08	85.72	123.39	1151.6	298.5	112.1
250	10.432	-8196.6	196.17	87.58	125.99	1093.7	262.2	108.0
260	10.244	-6923.0	201.16	89.54	128.76	1036.2	231.6	103.9
261.07	10.223	-6785.7	201.69	89.76	129.06	1030.1	228.7	103.4
261.07	0.048038	14452	283.04	79.71	89.77	196.48	6.571	13.17
270	0.046232	15263	286.10	81.85	91.69	200.26	6.797	14.03
280	0.044385	16191	289.47	84.33	93.96	204.32	7.048	15.02
290	0.042696	17142	292.81	86.87	96.34	208.25	7.297	16.04
300	0.041143	18118	296.12	89.47	98.80	212.04	7.544	17.08
320	0.038379	20144	302.65	94.79	103.90	219.32	8.032	19.24
340	0.035985	22275	309.11	100.19	109.15	226.26	8.515	21.50
360	0.033886	24511	315.50	105.61	114.45	232.90	8.992	23.86
380	0.032029	26853	321.83	111.00	119.76	239.30	9.463	26.32
400	0.030372	29301	328.11	116.31	125.01	245.50	9.929	28.88
420	0.028882	31853	334.33	121.52	130.16	251.51	10.39	31.54
440	0.027536	34506	340.50	126.61	135.21	257.36	10.85	34.31
460	0.026312	37260	346.62	131.56	140.12	263.07	11.30	37.18
480	0.025194	40110	352.69	136.36	144.89	268.64	11.75	40.16
500	0.024169	43055	358.70	141.01	149.52	274.09	12.20	43.23
520	0.023225	46090	364.65	145.51	154.00	279.42	12.64	46.41
540	0.022353	49214	370.54	149.87	158.34	284.65	13.07	49.69
560	0.021545	52423	376.38	154.08	162.54	289.78	13.51	53.08
570	0.021163	54059	379.27	156.13	164.58	292.31	13.72	54.81
				Pressure = 1 MPa				
120	12.642	-22672	115.16	69.09	99.28	1947.80	6125	156.9
130	12.480	-21670	123.18	70.34	101.14	1866.30	3738	154.6
140	12.318	-20649	130.75	71.58	103.00	1790.10	2488	151.8
150	12.156	-19610	137.91	72.80	104.84	1718.10	1765	148.7
160	11.993	-18552	144.74	74.02	106.67	1649.40	1315	145.2
170	11.829	-17476	151.26	75.25	108.50	1583.20	1018	141.6
180	11.663	-16382	157.52	76.53	110.37	1519.00	812.5	137.6
190	11.497	-15269	163.53	77.86	112.28	1456.30	663.8	133.6
200	11.329	-14136	169.34	79.27	114.26	1395.00	552.6	129.5
210	11.158	-12983	174.97	80.76	116.33	1334.70	467.2	125.3
220	10.986	-11809	180.43	82.34	118.50	1275.40	399.9	121.0
230	10.811	-10613	185.75	84.01	120.78	1216.80	345.8	116.8
240	10.632	-9393.2	190.94	85.78	123.20	1158.90	301.6	112.6
250	10.450	-8148.6	196.02	87.64	125.76	1101.60	265.0	108.5
260	10.264	-6877.5	201.00	89.60	128.48	1044.70	234.4	104.4
270	10.073	-5578.3	205.91	91.64	131.39	988.22	208.3	100.4
280	9.8753	-4249.0	210.74	93.77	134.50	931.89	186.0	96.54
290	9.6707	-2887.5	215.52	95.98	137.85	875.56	166.7	92.76
300	9.4575	-1491.0	220.25	98.27	141.50	819.00	149.9	89.09
320	8.9965	1420.8	229.64	103.07	150.01	703.88	121.6	82.11
339.34	8.4843	4421.1	238.74	108.03	160.97	586.60	99.07	75.76
339.34	0.44655	20440	285.95	105.18	127.92	187.21	8.787	22.10
340	0.44469	20525	286.20	105.28	127.80	187.76	8.800	22.17
360	0.39823	23064	293.46	109.15	126.93	202.25	9.225	24.47
380	0.36400	25620	300.37	113.65	128.89	214.08	9.673	26.95
400	0.33698	28227	307.05	118.33	132.00	224.30	10.13	29.56
420	0.31474	30904	313.58	123.10	135.73	233.45	10.59	32.28
440	0.29591	33658	319.99	127.87	139.75	241.82	11.04	35.12
460	0.27964	36495	326.29	132.59	143.92	249.58	11.50	38.05
480	0.26537	39415	332.51	137.22	148.11	256.88	11.94	41.09
500	0.25270	42420	338.64	141.74	152.29	263.78	12.39	44.23
520	0.24135	45507	344.69	146.13	156.41	270.37	12.83	47.47
540	0.23109	48676	350.67	150.40	160.46	276.68	13.27	50.81