

NATURAL HAVERSINES

$\backslash ^{\circ}$	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	$^{\circ} / ^{\circ}$
0	.00000	.00008	.00030	.00069	.00122	.00190	.00274	.00373	.00487	.00616	.00760	.00919	.01093	.01281	.01485	.01704	.01937	.02185	.02447	.02724	60
1	.00000	.00008	.00031	.00069	.00123	.00192	.00275	.00374	.00489	.00618	.00762	.00921	.01096	.01285	.01489	.01707	.01941	.02189	.02452	.02729	59
2	.00000	.00008	.00031	.00070	.00124	.00193	.00277	.00376	.00491	.00620	.00765	.00924	.01099	.01288	.01492	.01711	.01945	.02193	.02456	.02734	58
3	.00000	.00008	.00032	.00071	.00125	.00194	.00278	.00378	.00493	.00622	.00767	.00927	.01102	.01291	.01496	.01715	.01949	.02208	.02461	.02738	57
4	.00000	.00009	.00033	.00072	.00126	.00195	.00280	.00380	.00495	.00625	.00770	.00930	.01105	.01295	.01499	.01719	.01953	.02219	.02465	.02743	56
5	.00000	.00009	.00033	.00072	.00127	.00197	.00282	.00382	.00497	.00627	.00772	.00933	.01108	.01298	.01503	.01723	.01957	.02206	.02470	.02748	55
6	.00000	.00009	.00034	.00073	.00128	.00198	.00283	.00383	.00499	.00629	.00775	.00935	.01111	.01301	.01506	.01726	.01961	.02210	.02474	.02753	54
7	.00000	.00009	.00034	.00074	.00129	.00199	.00285	.00385	.00501	.00632	.00777	.00938	.01114	.01305	.01510	.01730	.01965	.02215	.02479	.02757	53
8	.00000	.00010	.00035	.00075	.00130	.00201	.00286	.00387	.00503	.00634	.00780	.00941	.01117	.01308	.01513	.01734	.01969	.02219	.02483	.02762	52
9	.00000	.00010	.00035	.00076	.00131	.00202	.00288	.00389	.00505	.00636	.00783	.00944	.01120	.01311	.01517	.01738	.01973	.02223	.02488	.02767	51
10	.00000	.00010	.00036	.00076	.00132	.00203	.00289	.00391	.00507	.00639	.00785	.00947	.01123	.01314	.01521	.01742	.01977	.02227	.02492	.02772	50
11	.00000	.00011	.00036	.00077	.00133	.00204	.00291	.00392	.00509	.00641	.00788	.00949	.01126	.01318	.01524	.01745	.01981	.02232	.02497	.02776	49
12	.00000	.00011	.00037	.00078	.00134	.00206	.00292	.00394	.00511	.00643	.00790	.00952	.01129	.01321	.01528	.01749	.01985	.02236	.02501	.02781	48
13	.00000	.00011	.00037	.00079	.00135	.00207	.00294	.00396	.00513	.00646	.00793	.00955	.01132	.01324	.01531	.01753	.01989	.02240	.02506	.02786	47
14	.00000	.00012	.00038	.00080	.00136	.00208	.00296	.00398	.00515	.00648	.00795	.00958	.01135	.01328	.01535	.01757	.01993	.02245	.02510	.02791	46
15	.00000	.00012	.00039	.00080	.00137	.00210	.00297	.00400	.00517	.00650	.00798	.00961	.01138	.01331	.01538	.01761	.01998	.02249	.02515	.02796	45
16	.00001	.00012	.00039	.00081	.00139	.00211	.00299	.00402	.00520	.00653	.00801	.00964	.01142	.01334	.01542	.01764	.02002	.02253	.02520	.02800	44
17	.00001	.00013	.00040	.00082	.00140	.00212	.00300	.00403	.00522	.00655	.00803	.00966	.01145	.01338	.01546	.01768	.02006	.02258	.02524	.02805	43
18	.00001	.00013	.00040	.00083	.00141	.00214	.00302	.00405	.00524	.00657	.00806	.00969	.01148	.01341	.01549	.01772	.02010	.02262	.02529	.02810	42
19	.00001	.00013	.00041	.00084	.00142	.00215	.00304	.00407	.00526	.00660	.00808	.00972	.01151	.01344	.01553	.01776	.02014	.02266	.02533	.02815	41
20	.00001	.00014	.00041	.00085	.00143	.00216	.00305	.00409	.00528	.00662	.00811	.00975	.01154	.01348	.01556	.01780	.02018	.02271	.02538	.02820	40
21	.00001	.00014	.00042	.00085	.00144	.00218	.00307	.00411	.00530	.00664	.00814	.00978	.01157	.01351	.01560	.01784	.02022	.02275	.02542	.02824	39
22	.00001	.00014	.00043	.00086	.00145	.00219	.00308	.00413	.00532	.00667	.00816	.00981	.01160	.01354	.01564	.01788	.02026	.02279	.02547	.02829	38
23	.00001	.00015	.00043	.00087	.00146	.00221	.00310	.00415	.00534	.00669	.00819	.00984	.01163	.01358	.01567	.01791	.02030	.02284	.02552	.02834	37
24	.00001	.00015	.00044	.00088	.00147	.00222	.00312	.00416	.00536	.00671	.00821	.00986	.01166	.01361	.01571	.01795	.02034	.02288	.02556	.02839	36
25	.00001	.00015	.00044	.00089	.00148	.00223	.00313	.00418	.00539	.00674	.00824	.00989	.01170	.01365	.01574	.01799	.02038	.02292	.02561	.02844	35
26	.00001	.00016	.00045	.00090	.00150	.00225	.00315	.00420	.00541	.00676	.00827	.00992	.01173	.01368	.01578	.01803	.02043	.02297	.02566	.02849	34
27	.00002	.00016	.00046	.00091	.00151	.00226	.00316	.00422	.00543	.00679	.00829	.00995	.01176	.01371	.01582	.01807	.02047	.02301	.02570	.02853	33
28	.00002	.00016	.00046	.00091	.00152	.00227	.00318	.00424	.00545	.00681	.00832	.00998	.01179	.01375	.01585	.01811	.02051	.02305	.02575	.02858	32
29	.00002	.00017	.00047	.00092	.00153	.00229	.00320	.00426	.00547	.00683	.00835	.01001	.01182	.01378	.01589	.01815	.02055	.02310	.02579	.02863	31
30	.00002	.00017	.00048	.00093	.00154	.00230	.00321	.00428	.00549	.00686	.00837	.01004	.01185	.01382	.01593	.01818	.02059	.02314	.02584	.02868	30
31	.00002	.00018	.00048	.00094	.00155	.00232	.00323	.00430	.00551	.00688	.00840	.01007	.01188	.01385	.01596	.01822	.02063	.02319	.02588	.02873	29
32	.00002	.00018	.00049	.00095	.00156	.00233	.00325	.00432	.00554	.00691	.00843	.01010	.01192	.01388	.01600	.01826	.02067	.02323	.02593	.02878	28
33	.00002	.00018	.00050	.00096	.00158	.00234	.00326	.00433	.00556	.00693	.00845	.01012	.01195	.01392	.01604	.01830	.02071	.02327	.02598	.02883	27
34	.00002	.00019	.00050	.00097	.00159	.00236	.00328	.00435	.00558	.00695	.00848	.01015	.01198	.01395	.01607	.01834	.02076	.02332	.02602	.02887	26
35	.00003	.00019	.00051	.00098	.00160	.00237	.00330	.00437	.00560	.00698	.00851	.01018	.01201	.01399	.01611	.01838	.02080	.02336	.02607	.02892	25
36	.00003	.00019	.00051	.00099	.00161	.00239	.00331	.00439	.00562	.00700	.00853	.01021	.01204	.01402	.01615	.01842	.02084	.02340	.02612	.02897	24
37	.00003	.00020	.00052	.00100	.00162	.00240	.00333	.00441	.00564	.00703	.00856	.01024	.01207	.01405	.01618	.01846	.02088	.02345	.02616	.02902	23
38	.00003	.00020	.00053	.00100	.00163	.00241	.00335	.00443	.00567	.00705	.00859	.01027	.01211	.01409	.01622	.01850	.02092	.02349	.02621	.02907	22
39	.00003	.00021	.00053	.00101	.00165	.00243	.00336	.00445	.00569	.00707	.00861	.01030	.01214	.01412	.01626	.01854	.02096	.02354	.02626	.02912	21
40	.00003	.00021	.00054	.00102	.00166	.00244	.00338	.00447	.00571	.00710	.00864	.01033	.01217	.01416	.01629	.01858	.02101	.02358	.02630	.02917	20
41	.00004	.00022	.00055	.00103	.00167	.00246	.00340	.00449	.00573	.00712	.00867	.01036	.01220	.01419	.01633	.01861	.02105	.02363	.02635	.02922	19
42	.00004	.00022	.00056	.00104	.00168	.00247	.00341	.00451	.00575	.00715	.00869	.01039	.01223	.01423	.01637	.01865	.02109	.02367	.02639	.02926	18
43	.00004	.00022	.00056	.00105	.00169	.00249	.00343	.00453	.00578	.00717	.00872	.01042	.01226	.01426	.01640	.01869	.02113	.02371	.02644	.02931	17
44	.00004	.00023	.00057	.00106	.00171	.00250	.00345	.00455	.00580	.00720	.00875	.01045	.01230	.01429	.01644	.01873	.02117	.02376	.02649	.02936	16
45	.00004	.00023	.00058	.00107	.00172	.00252	.00347	.00457	.00582	.00722	.00877	.01048	.01233	.01433	.01648	.01877	.02121	.02380	.02653	.02941	15
46	.00004	.00024	.00058	.00108	.00173	.00253	.00348	.00459	.00584	.00725	.00880	.01051	.01236	.01436	.01651	.01881	.02126	.02385	.02658	.02946	14
47	.00005	.00024	.00059	.00109	.00174	.00254	.00350	.00461	.00586	.00727	.00883	.01054	.01239	.01440	.01655	.01885	.02130	.02389	.02663	.02951	13
48	.00005	.00025	.00060	.00110	.00175	.00256	.00352	.00463	.00589	.00730	.00886	.01057	.01243	.01443	.01659	.01889	.02134	.02394	.02668	.02956	12
49	.00005	.00025	.00060	.00111	.00177	.00257	.00353	.00465	.00591	.00732	.00888	.01060	.01246	.01447	.01663	.01893	.02138	.02398	.02672	.02961	11
50	.00005	.00026	.00061	.00112	.00178	.00259	.00355	.00467	.00593	.00735	.00891	.01063	.01249	.01450	.01666	.01897	.02142	.02402	.02677	.02966	10
51	.00006	.00026	.00062	.00113	.00179	.00260	.00357	.00469	.00595	.00737	.00894	.01066	.01252	.01454	.01670	.01901	.02147	.02407	.02682	.02971	9
52	.00006	.00027	.00063	.00114	.00180	.00262	.00359	.00471	.00598	.00740	.00897	.01069	.01255	.01457	.01674	.01905	.02151	.02411	.02686	.02976	8
53	.00006	.00027	.00063	.00115	.00181	.00263	.00360	.00473	.00600	.00742	.00899	.01072	.01259	.01461	.01677	.01909	.02155	.02416	.02691	.02981	7
54	.00006	.00027	.00064	.00116	.00183	.00265	.00362														

NATURAL HAVERSINES

° \ ' \ "	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	° / '
0	.96985	.97276	.97553	.97815	.98063	.98296	.98515	.98719	.98907	.99081	.99240	.99384	.99513	.99627	.99726	.99810	.99878	.99931	.99970	.99992	60
1	.96990	.97281	.97557	.97819	.98067	.98300	.98518	.98722	.98910	.99084	.99243	.99387	.99515	.99629	.99728	.99811	.99879	.99932	.99970	.99993	59
2	.96995	.97281	.97562	.97824	.98071	.98304	.98522	.98725	.98913	.99087	.99245	.99389	.99517	.99631	.99729	.99812	.99880	.99933	.99971	.99993	58
3	.97000	.97290	.97566	.97828	.98075	.98308	.98525	.98728	.98916	.99090	.99248	.99391	.99519	.99633	.99731	.99814	.99881	.99934	.99971	.99993	57
4	.97004	.97295	.97571	.97832	.98079	.98311	.98529	.98732	.98919	.99092	.99250	.99393	.99521	.99634	.99732	.99815	.99882	.99934	.99972	.99993	56
5	.97009	.97300	.97575	.97836	.98083	.98315	.98532	.98735	.98922	.99095	.99253	.99396	.99523	.99636	.99734	.99816	.99883	.99935	.99972	.99994	55
6	.97014	.97304	.97580	.97841	.98087	.98319	.98536	.98738	.98925	.99098	.99255	.99398	.99525	.99638	.99735	.99817	.99884	.99936	.99973	.99994	54
7	.97019	.97309	.97584	.97845	.98091	.98323	.98539	.98741	.98928	.99101	.99258	.99400	.99527	.99640	.99737	.99819	.99885	.99937	.99973	.99994	53
8	.97024	.97314	.97589	.97849	.98095	.98326	.98543	.98745	.98931	.99103	.99260	.99402	.99529	.99641	.99738	.99820	.99886	.99937	.99973	.99994	52
9	.97029	.97318	.97593	.97853	.98099	.98330	.98546	.98748	.98934	.99106	.99263	.99405	.99531	.99643	.99740	.99821	.99887	.99938	.99974	.99994	51
10	.97034	.97323	.97598	.97858	.98103	.98334	.98550	.98751	.98937	.99109	.99265	.99407	.99533	.99645	.99741	.99822	.99888	.99939	.99974	.99995	50
11	.97039	.97328	.97602	.97862	.98107	.98337	.98553	.98754	.98940	.99112	.99268	.99409	.99535	.99647	.99743	.99823	.99889	.99940	.99975	.99995	49
12	.97044	.97332	.97606	.97866	.98111	.98341	.98557	.98757	.98943	.99114	.99270	.99411	.99537	.99648	.99744	.99825	.99890	.99940	.99975	.99995	48
13	.97049	.97337	.97611	.97870	.98115	.98345	.98560	.98761	.98946	.99117	.99273	.99414	.99539	.99650	.99746	.99826	.99891	.99941	.99976	.99995	47
14	.97054	.97342	.97615	.97874	.98119	.98349	.98564	.98764	.98949	.99120	.99275	.99416	.99541	.99652	.99747	.99827	.99892	.99942	.99976	.99996	46
15	.97059	.97347	.97620	.97879	.98123	.98352	.98567	.98767	.98952	.99123	.99278	.99418	.99543	.99653	.99748	.99828	.99893	.99942	.99977	.99996	45
16	.97064	.97351	.97624	.97883	.98127	.98356	.98571	.98770	.98955	.99125	.99280	.99420	.99545	.99655	.99750	.99829	.99894	.99943	.99977	.99996	44
17	.97069	.97356	.97629	.97887	.98131	.98360	.98574	.98774	.98958	.99128	.99283	.99422	.99547	.99657	.99751	.99831	.99895	.99944	.99978	.99996	43
18	.97074	.97361	.97633	.97891	.98135	.98363	.98577	.98777	.98961	.99131	.99285	.99425	.99549	.99659	.99753	.99832	.99896	.99944	.99978	.99996	42
19	.97078	.97365	.97637	.97895	.98139	.98367	.98581	.98780	.98964	.99133	.99288	.99427	.99551	.99660	.99754	.99833	.99897	.99945	.99978	.99996	41
20	.97083	.97370	.97642	.97899	.98142	.98371	.98584	.98783	.98967	.99136	.99290	.99429	.99553	.99662	.99756	.99834	.99898	.99946	.99979	.99997	40
21	.97088	.97374	.97646	.97904	.98146	.98374	.98588	.98786	.98970	.99139	.99293	.99431	.99555	.99664	.99757	.99835	.99899	.99947	.99979	.99997	39
22	.97093	.97379	.97651	.97908	.98150	.98378	.98591	.98789	.98973	.99141	.99295	.99433	.99557	.99665	.99759	.99837	.99900	.99947	.99980	.99997	38
23	.97098	.97384	.97655	.97912	.98154	.98382	.98595	.98793	.98976	.99144	.99297	.99436	.99559	.99667	.99760	.99838	.99900	.99948	.99980	.99997	37
24	.97103	.97388	.97660	.97916	.98158	.98385	.98598	.98796	.98979	.99147	.99300	.99438	.99561	.99669	.99761	.99839	.99901	.99949	.99981	.99997	36
25	.97108	.97393	.97664	.97920	.98162	.98389	.98601	.98799	.98982	.99149	.99302	.99440	.99563	.99670	.99763	.99840	.99902	.99949	.99981	.99997	35
26	.97113	.97398	.97668	.97924	.98166	.98393	.98605	.98802	.98985	.99152	.99305	.99442	.99565	.99672	.99764	.99841	.99903	.99950	.99981	.99998	34
27	.97117	.97402	.97673	.97929	.98170	.98396	.98608	.98805	.98988	.99155	.99307	.99444	.99567	.99674	.99766	.99842	.99904	.99950	.99982	.99998	33
28	.97122	.97407	.97677	.97933	.98174	.98400	.98612	.98808	.98990	.99157	.99309	.99446	.99568	.99675	.99767	.99844	.99905	.99951	.99982	.99998	32
29	.97127	.97412	.97681	.97937	.98178	.98404	.98615	.98812	.98993	.99160	.99312	.99449	.99570	.99677	.99768	.99845	.99906	.99952	.99982	.99998	31
30	.97132	.97416	.97686	.97941	.98182	.98407	.98618	.98815	.98996	.99163	.99314	.99451	.99572	.99679	.99770	.99846	.99907	.99952	.99983	.99998	30
31	.97137	.97421	.97690	.97945	.98185	.98411	.98622	.98818	.98999	.99165	.99317	.99453	.99574	.99680	.99771	.99847	.99908	.99953	.99983	.99998	29
32	.97142	.97425	.97695	.97949	.98189	.98415	.98625	.98821	.99002	.99168	.99319	.99455	.99576	.99682	.99773	.99848	.99909	.99954	.99984	.99998	28
33	.97147	.97430	.97699	.97953	.98193	.98418	.98629	.98824	.99005	.99171	.99321	.99457	.99578	.99684	.99774	.99849	.99909	.99954	.99984	.99998	27
34	.97151	.97435	.97703	.97957	.98197	.98422	.98632	.98827	.99008	.99173	.99324	.99459	.99580	.99685	.99775	.99850	.99910	.99955	.99984	.99999	26
35	.97156	.97439	.97708	.97962	.98201	.98426	.98635	.98830	.99011	.99176	.99326	.99461	.99582	.99687	.99777	.99852	.99911	.99956	.99985	.99999	25
36	.97161	.97444	.97712	.97966	.98205	.98429	.98639	.98834	.99014	.99179	.99329	.99464	.99584	.99688	.99778	.99853	.99912	.99956	.99985	.99999	24
37	.97166	.97448	.97716	.97970	.98209	.98433	.98642	.98837	.99016	.99181	.99331	.99466	.99585	.99690	.99779	.99854	.99913	.99957	.99985	.99999	23
38	.97171	.97453	.97721	.97974	.98212	.98436	.98646	.98840	.99019	.99184	.99333	.99468	.99587	.99692	.99781	.99855	.99914	.99957	.99986	.99999	22
39	.97176	.97458	.97725	.97978	.98216	.98440	.98649	.98843	.99022	.99186	.99336	.99470	.99589	.99693	.99782	.99856	.99915	.99958	.99986	.99999	21
40	.97180	.97462	.97729	.97982	.98220	.98444	.98652	.98846	.99025	.99189	.99338	.99472	.99591	.99695	.99784	.99857	.99915	.99959	.99986	.99999	20
41	.97185	.97467	.97734	.97986	.98224	.98447	.98656	.98849	.99028	.99192	.99340	.99474	.99593	.99696	.99785	.99858	.99916	.99959	.99987	.99999	19
42	.97190	.97471	.97738	.97990	.98228	.98451	.98659	.98852	.99031	.99194	.99343	.99476	.99595	.99698	.99786	.99859	.99917	.99960	.99987	.99999	18
43	.97195	.97476	.97742	.97994	.98232	.98454	.98662	.98855	.99034	.99197	.99345	.99478	.99597	.99700	.99788	.99860	.99918	.99960	.99987	.99999	17
44	.97200	.97480	.97747	.97998	.98236	.98458	.98666	.98858	.99036	.99199	.99347	.99480	.99598	.99701	.99789	.99861	.99919	.99961	.99988	.99999	16
45	.97204	.97485	.97751	.98002	.98239	.98462	.98669	.98862	.99039	.99202	.99350	.99483	.99600	.99703	.99790	.99863	.99920	.99961	.99988	1.00000	15
46	.97209	.97490	.97755	.98007	.98243	.98465	.98672	.98865	.99042	.99205	.99352	.99485	.99602	.99704	.99792	.99864	.99920	.99962	.99988	1.00000	14
47	.97214	.97494	.97760	.98011	.98247	.98469	.98676	.98868	.99045	.99207	.99354	.99487	.99604	.99706	.99793	.99865	.99921	.99963	.99989	1.00000	13
48	.97219	.97499	.97764	.98015	.98251	.98472	.98679	.98871	.99048	.99210	.99357	.99489	.99606	.99708	.99794	.99866	.99922	.99963	.99989	1.00000	12
49	.97224	.97503	.97768	.98019	.98255	.98476	.98682	.98874	.99051	.99212	.99359	.99491	.99608	.99709	.99796	.99867	.99923	.99964	.99989	1.00000	11
50	.97228	.97508	.97773	.98023	.98258	.98479	.98686	.98877	.99053	.99215	.99361	.99493	.99609	.99711	.99797	.99868	.99924	.99964	.99990	1.00000	10
51	.97233	.97512	.97777	.98027	.98262	.98483	.98689	.98880	.99056	.99217	.99364	.99495	.99611	.99712	.99798	.99869	.99924	.99965	.99990	1.00000	9
52	.97238	.97517	.97781	.98031	.98266	.98487	.98692	.98883	.99059	.99220	.99366	.99497	.99613	.99714	.99799	.99870	.99925	.99965	.99990	1.00000	8
53	.97243	.97521	.97785	.98035	.98270	.98490	.98695	.98886	.99062	.99223	.99368	.99499	.99615	.99715	.99801	.99871	.99926	.99966	.99991	1.00000	7
54	.97247	.97526	.97790	.980																	

NATURAL HAVERSINES

INTERPOLATION TABLE

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
0.1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	0.1
0.2	0	0	1	1	1	1	1	2	2	2	2	2	3	3	3	0.2
0.3	0	1	1	1	2	2	2	2	3	3	3	4	4	4	4	0.3
0.4	0	1	1	2	2	2	3	3	4	4	4	5	5	6	6	0.4
0.5	0	1	1	2	3	3	3	4	4	5	5	6	6	7	7	0.5
0.6	1	1	2	2	3	4	4	5	5	6	7	7	8	8	9	0.6
0.7	1	1	2	3	4	4	5	6	6	7	8	8	9	10	10	0.7
0.8	1	2	2	3	4	5	6	6	7	8	9	10	10	11	12	0.8
0.9	1	2	3	4	5	5	6	7	8	9	10	11	12	13	13	0.9