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11 january 2021

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1 Introduction

Edward Sang (1805–1890) was probably the greatest calculator of logarithms of the 19th century [4, 12, 13, 14, 26, 33]. Sang spent 40 years computing tables of logarithms and trigonometric functions, with the assistance from his daughters Flora (1838-1925) and Jane (1834-1878). The result fills about 50 manuscript volumes, plus a number of transfer duplicates, which are kept at Edinburgh University Library and at the National Library of Scotland, Edinburgh. I have reconstructed a number of these tables and an overview of the tables and reconstructions can be found in a separate guide [37].

Sang's purpose was in particular to provide fundamental tables, including for the decimal division of the quadrant. In 1890 [4, p. 189], he wrote that

In addition to the results being accurate to a degree far beyond what can ever be needed in practical matters, [the collection of computations] contains what no work of the kind has contained before, a complete and clear record of all the steps by which those results were reached. Thus we are enabled at once to verify, or if necessary, to correct the record, so making it a standard for all time.

For these reasons it is proposed that the entire collection be acquired by, and preserved in, some official library, so as to be accessible to all interested in such matters; so that future computers may be enabled to extend the work without the need of recomputing what has been already done; and also so that those extracts which are judged to be expedient may be published.

2 Sines

In the second half of the 1870s, Sang worked on the construction of a canon of sines [38]. This canon was built in three stages. First, Sang computed the sines at intervals of $25'$. Then he constructed a second table at intervals of $5'$. These two tables are found in volume K40. Finally, Sang constructed a canon of sines at $1'$ intervals (volumes K41 and K42) [47].

In a summary of his works drawn in 1890 [4], Sang writes this

In the compilation of the trigonometrical canon the same precautions were taken for securing the accuracy of the results. In the usual way, by means of the extraction of the square root, the quadrant was divided into ten equal parts, and the sines of these computed to thirty-three, for thirty places. These again were bisected thrice, thus giving the sine of each eightieth part of the quadrant; all the steps of the process being recorded.

The quinquesection of these parts was effected by help of the method of the solution of equations of all orders, published by me in 1829; and the computation of the multiples of those parts was effected by the use of the usual formula for second differences. A table of the multiples of 2 ver $.00^{\circ}25'$ was made to facilitate the work, and the sines, first differences, and second differences were recorded in such a way as to enable one instantly to examine

the accuracy. The same method of quinquection was again repeated, and the computation of the canon to each fifth minute was effected by help of a table of one thousand multiples of $2 \text{ ver } .00^\circ 05'$, the record being given to thirty-three places, the verification being examined at every fifth place. In this work there is no likelihood of a single error having escaped notice.

For the third time this method of quinquection was applied in order to obtain the sines of arcs to a single minute. A table of one thousand multiples of $2 \text{ ver } .00^\circ 01'$ was computed to thirty-three places, but in the actual canon it was judged proper to curtail these, and the calculations were restricted to eighteen decimals on the scroll paper. In the actual canon as transcribed, only fifteen places are given. In all cases the function, its first difference, and its second difference are given in position ready for instantaneous examination; and the whole is expected to be free of error excepting in the rare cases where the rejected figures are 500 — these cases being duly noted.

Sang also describes the present volume K40/1 which contains the canon of sines at intervals of $25'$:

This is the record of all the articulate steps in the calculation, to 33 places, of the sines of arcs differing by the 2000th part of the quadrant.

By the extraction of the square root and repeated bisections, the quadrant was divided into 80 parts, and the sines of the multiples of $01^\circ 25'$ were computed.

Thereafter the sines and cosines of $00^\circ 25'$ and of $01^\circ 25'$ were got by the direct resolution of the appropriate equations of the fifth degree, and were compared with those which had been got in computing the recurring functions of submultiples of π , the steps of which are copied into this record.

By help of 100 multiples of $2 \text{ ver } .25'$, and of 1000 multiples of $2 \text{ ver } .5'$, a table of sines of arcs differing by $25'$, and thereafter one of arcs differing by $5'$, were computed on the actual pages.

Although these have the appearance of being interpolations, they are truly independent computations, the use of the preceding work preventing mistakes, as well as the accumulation of the minute errors, due to the rejection of figures beyond the 33rd place.

The second part of volume K40 is reproduced separately [46].

The current table spans 41 pages, with 10 sines and differences per page. A comparison of a number of samples with my reconstruction suggests that the sines in Sang's table (given to 30 places) are usually correct, and are occasionally off by one unit of the 30th place. For instance, in the excerpt given in figure 1, the sine of $50^\circ 75'$ is off by one unit. A closer examination of that excerpt reveals that the differences are not computed from the values given, and that the values in Sang's table are actually rounded values from a table to 33 places, as explained by Sang above. The values in the second part of volume K40 are instead actually given to 33 places.

Computation of Sines.

30.							
5000	.70710	67811	86547	52440	08443	62105	
	+ 277	13424	68742	80458	70168	45204	
	- 1	09471	98827	73159	81056	99087	
5025	.70987	81236	55290	32898	78612	07308	
	+ 276	03952	69915	07298	89111	46167	
	- 1	09897	67537	56489	89855	64333	
5050	.71263	85189	25205	40197	67723	53475	
	+ 274	94055	02377	50808	99255	81833	
	+ 1	10321	66771	58778	21701	45676	
5075	.71538	79244	27582	91006	66979	35309	
	+ 273	83733	35605	92030	77554	39158	
	- 1	10743	95875	95160	86817	86051	
5100	.71812	62977	63188	83037	44533	71466	
	+ 272	72989	39729	96869	90736	50107	
	- 1	11164	54199	43134	93458	71159	
5125	.72085	35967	02918	79907	95270	21573	
	+ 271	61824	85530	53734	97277	78948	
	- 1	11583	41093	43562	74863	82926	
5150	.72356	97791	88449	33642	32548	00521	
	+ 270	50241	44437	10172	22413	96021	
	- 1	12000	55912	01672	10072	73508	
5175	.72627	48033	32886	43814	54961	96542	
	+ 269	38240	88525	08500	12341	22513	
	- 1	12415	98011	88052	37054	15311	
5200	.72896	86276	21411	52314	67303	19055	
	+ 268	25824	90513	20447	75287	07202	
	- 1	12829	66752	39646	56615	11272	
5225	.73165	12099	11924	72762	42590	26257	
	+ 267	12995	23760	80801	18671	95930	
	- 1	13241	61495	60739	25559	80683	

Figure 1: Excerpt from Sang's table of sines to 25'. (Courtesy Edinburgh University Library)

References

The following list covers the most important references¹ related to Sang’s table. Not all items of this list are mentioned in the text, and the sources which have not been seen are marked so. I have added notes about the contents of the articles in certain cases.

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¹**Note on the titles of the works:** Original titles come with many idiosyncrasies and features (line splitting, size, fonts, etc.) which can often not be reproduced in a list of references. It has therefore seemed pointless to capitalize works according to conventions which not only have no relation with the original work, but also do not restore the title entirely. In the following list of references, most title words (except in German) will therefore be left uncapitalized. The names of the authors have also been homogenized and initials expanded, as much as possible.

The reader should keep in mind that this list is not meant as a facsimile of the original works. The original style information could no doubt have been added as a note, but I have not done it here.

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c	Sine					
00 00'	.00000	00000	00000	00000	00000	00000
	+	392	69807	23806	00049	31549 27769
	-		605	58900	66707	96774 10494
00 25	.00392	69807	23806	00049	31549	27769
	+	392	69201	64905	33341	34775 17275
	-		1211	16867	44099	61485 53561
00 50	.00785	39008	88711	33390	66324	45044
	+	392	67990	48037	89241	73289 63714
	-		1816	72966	44298	79950 19162
00 75	.01178	06999	36749	22632	39614	08758
	+	392	66173	75071	44942	93339 44552
	-		2422	26263	82309	71520 18624
01 00	.01570	73173	11820	67575	32953	53310
	+	392	63751	48807	62633	21819 25928
	-		3027	75825	77457	00299 65302
01 25	.01963	36924	60628	30208	54772	79238
	+	392	60723	72981	85176	21519 60626
	-		3633	20718	54825	79697 88774
01 50	.02355	97648	33610	15384	76292	39864
	+	392	57090	52263	30350	41821 71852
	-		4238	60008	46701	68099 09750
01 75	.02748	54738	85873	45735	18114	11716
	+	392	52851	92254	83648	73722 62102
	-		4843	92761	94010	53428 16544
02 00	.03141	07590	78128	29383	91836	73818
	+	392	48007	99492	89638	20294 45558
	-		5449	18045	47758	24392 01136
02 25	.03533	55598	77621	19022	12131	19376
	+	392	42558	81447	41879	95902 44422
	-		6054	34925	70470	26176 33297

c	Sine					
02 50'	.03925	98157	59068	60902	08033	63798
	+ 392	36504	46521	71409	69726	11125
	—	6659	42469	37630	98377	75358
02 75	.04318	34662	05590	32311	77759	74923
	+ 392	29845	04052	33778	71348	35767
	—	7264	39743	39122	92951	67449
03 00	.04710	64507	09642	66090	49108	10690
	+ 392	22580	64308	94655	78396	68318
	—	7869	25814	80665	69956	44001
03 25	.05102	87087	73951	60746	27504	79008
	+ 392	14711	38494	13990	08440	24317
	—	8473	99750	85254	68874	76414
03 50	.05495	01799	12445	74736	35945	03325
	+ 392	06237	38743	28735	39565	47903
	—	9078	60618	94599	53293	74565
03 75	.05887	08036	51189	03471	75510	51228
	+ 391	97158	78124	34135	86271	73338
	—	9683	07486	70562	26725	20809
04 00	.06279	05195	29313	37607	61782	24566
	+ 391	87475	70637	63573	59546	52529
	—	10287	39421	96595	17348	54757
04 25	.06670	92670	99951	01181	21328	77095
	+ 391	77188	31215	66978	42197	97772
	—	10891	55492	79178	29458	74901
04 50	.07062	69859	31166	68159	63526	74867
	+ 391	66296	75722	87800	12739	22871
	—	11495	54767	49256	59402	74615
04 75	.07454	36156	06889	55959	76265	97738
	+ 391	54801	20955	38543	53336	48256
	—	12099	36314	63676	73787	84774

c	Sine					
05 00'	.07845	90957	27844	94503	29602	45994
	+ 391	42701	84640	74866	79548	63482
	−	12702	99203	06623	47746	53390
05 25	.08237	33659	12485	69370	09151	09476
	+ 391	29998	85437	68243	31802	10092
	−	13306	42501	91055	61042	54341
05 50	.08628	63657	97923	37613	40953	19568
	+ 391	16692	42935	77187	70759	55751
	−	13909	65280	60141	49803	82184
05 75	.09019	80350	40859	14801	11712	75319
	+ 391	02782	77655	17046	20955	73567
	−	14512	66608	88694	11668	58564
06 00	.09410	83133	18514	31847	32668	48886
	+ 390	88270	11046	28352	09287	15003
	−	15115	45556	84605	62131	47483
06 25	.09801	71403	29560	60199	41955	63889
	+ 390	73154	65489	43746	47155	67520
	−	15718	01194	90281	39877	52064
06 50	.10192	44557	95050	03945	89111	31409
	+ 390	57436	64294	53465	07278	15456
	−	16320	32593	84073	58892	43982
06 75	.10583	01994	59344	57410	96389	46865
	+ 390	41116	31700	69391	48385	71474
	−	16922	38824	81714	05138	58888
07 00	.10973	43110	91045	26802	44775	18339
	+ 390	24193	92875	87677	43247	12586
	−	17524	18959	37746	75586	76671
07 25	.11363	67304	83921	14479	88022	30925
	+ 390	06669	73916	49930	67660	35915
	−	18125	72069	46959	57394	94185

c	Sine					
07 50'	.11753	73974	57837	64410	55682	66840
	+ 389	88544	01847	02971	10265	41730
	−	18726	97227	45815	45025	90483
07 75	.12143	62518	59684	67381	65948	08570
	+ 389	69817	04619	57155	65239	51247
	−	19327	93506	13882	93096	80236
08 00	.12533	32335	64304	24537	31187	59817
	+ 389	50489	11113	43272	72142	71011
	−	19928	59978	75266	02754	50144
08 25	.12922	82824	75417	67810	03330	30828
	+ 389	30560	51134	68006	69388	20867
	−	20528	95719	00033	39371	75703
08 50	.13312	13385	26552	35816	72718	51695
	+ 389	10031	55415	67973	30016	45164
	−	21128	99801	05646	79360	21467
08 75	.13701	23416	81968	03790	02734	96859
	+ 388	88902	55614	62326	50656	23697
	−	21728	71299	58388	83897	37469
09 00	.14090	12319	37582	66116	53391	20556
	+ 388	67173	84315	03937	66758	86228
	−	22328	09289	74789	97365	76949
09 25	.14478	79493	21897	70054	20150	06784
	+ 388	44845	75025	29147	69393	09279
	−	22927	12847	23054	68303	76796
09 50	.14867	24338	96922	99201	89543	16063
	+ 388	21918	62178	06093	01089	32483
	−	23525	81048	24486	90668	61562
09 75	.15255	46257	59101	05294	90632	48546
	+ 387	98392	81129	81606	10420	70921
	−	24124	12969	54914	63213	54725

c	Sine					
10 00'	.15643	44650	40230	86901	01053	19467
	+ 387	74268	68160	26691	47207	16196
	−	24722	07688	46113	64782	07320
10 25	.16031	18919	08391	13592	48260	35663
	+ 387	49546	60471	80577	82425	08876
	−	25319	64282	87230	43323	83509
10 50	.16418	68465	68862	94170	30685	44539
	+ 387	24226	96188	93347	39101	25367
	−	25916	81831	26204	16437	75916
10 75	.16805	92692	65051	87517	69786	69906
	+ 386	98310	14357	67143	22663	49451
	−	26513	59412	71187	81249	59847
11 00	.17192	91002	79409	54660	92450	19357
	+ 386	71796	54944	95955	41413	89604
	−	27109	96106	91968	31432	35404
11 25	.17579	62799	34354	50616	33864	08961
	+ 386	44686	58838	03987	09981	54200
	−	27705	90994	21385	79179	49677
11 50	.17966	07485	93192	54603	43845	63161
	+ 386	16980	67843	82601	30802	04523
	−	28301	43155	56751	79942	37760
11 75	.18352	24466	61036	37204	74647	67684
	+ 385	88679	24688	25849	50859	66763
	−	28896	51672	61266	57744	71337
12 00	.18738	13145	85724	63054	25507	34447
	+ 385	59782	73015	64582	93114	95426
	−	29491	15627	65435	28888	56822
12 25	.19123	72928	58740	27637	18622	29873
	+ 385	30291	57387	99147	64226	38604
	−	30085	34103	68483	21867	81824

c	Sine					
12 50'	.19509	03220	16128	26784	82848	68477
	+ 385	00206	23284	30664	42358	56780
	−	30679	06184	39769	91306	68692
12 75	.19894	03426	39412	57449	25207	25257
	+ 384	69527	17099	90894	51051	88088
	−	31272	30954	20202	23742	57368
13 00	.20278	72953	56512	48343	76259	13345
	+ 384	38254	86145	70692	27309	30720
	−	31865	07498	23646	33074	06559
13 25	.20663	11208	42658	19036	03568	44065
	+ 384	06389	78647	47045	94235	24161
	−	32457	34902	38338	43496	72343
13 50	.21047	17598	21305	66081	97803	68226
	+ 383	73932	43745	08707	50738	51818
	−	33049	12253	28294	57750	96919
13 75	.21430	91530	65050	74789	48542	20044
	+ 383	40883	31491	80412	92987	54899
	−	33640	38638	34719	08508	17000
14 00	.21814	32413	96542	55202	41529	74943
	+ 383	07242	92853	45693	84479	37899
	−	34231	13145	77411	90722	81561
14 25	.22197	39656	89396	00896	26009	12842
	+ 382	73011	79707	68281	93756	56338
	−	34821	34864	56174	72780	52311
14 50	.22580	12668	69103	69178	19765	69180
	+ 382	38190	44843	12107	20976	04027
	−	35411	02884	52215	84273	47031
14 75	.22962	50859	13946	81285	40741	73207
	+ 382	02779	41958	59891	36702	56996
	−	36000	16296	29553	78236	76307

c	Sine					
15 00'	.23344	53638	55905	41176	77444	30203
	+ 381	66779	25662	30337	58465	80689
	−	36588	74191	36419	65681	17696
15 25	.23726	20417	81567	71514	35910	10892
	+ 381	30190	51470	93917	92784	62993
	−	37176	75662	06658	20259	68323
15 50	.24107	50608	33038	65432	28694	73885
	+ 380	93013	75808	87259	72524	94670
	−	37764	19801	61127	50907	17218
15 75	.24488	43622	08847	52692	01219	68555
	+ 380	55249	56007	26132	21617	77452
	−	38351	05704	09097	40294	82214
16 00	.24868	98871	64854	78824	22837	46007
	+ 380	16898	50303	17034	81322	95238
	−	38937	32464	49646	46942	63249
16 25	.25249	15770	15157	95859	04160	41245
	+ 379	77961	17838	67388	34380	31989
	−	39522	99178	73057	68835	74149
16 50	.25628	93731	32996	63247	38540	73234
	+ 379	38438	18659	94330	65544	57840
	−	40108	04943	62212	66392	28442
16 75	.26008	32169	51656	57578	04085	31074
	+ 378	98330	13716	32117	99152	29398
	−	40692	48856	93984	42632	71871
17 00	.26387	30499	65372	89696	03237	60472
	+ 378	57637	64859	38133	56519	57527
	−	41276	30017	40628	78402	74231
17 25	.26765	88137	30232	27829	59757	17999
	+ 378	16361	34841	97504	78116	83296
	−	41859	47524	71174	20504	16887

c	Sine						
17 50'	.27144	04498	65074	25334	37874	01295	
	+	377	74501	87317	26330	57612	66409
	-		42442	00479	52810	20590	39054
17 75	.27521	79000	52391	51664	95486	67704	
	+	377	32059	86837	73520	37022	27355
	-		43023	87983	52274	22685	36056
18 00	.27899	11060	39229	25185	32508	95059	
	+	376	89035	98854	21246	14336	91299
	-		43605	09139	37236	97187	36321
18 25	.28276	00096	38083	46431	46845	86358	
	+	376	45430	89714	84009	17149	54978
	-		44185	63050	77686	19221	20496
18 50	.28652	45527	27798	30440	63995	41336	
	+	376	01245	26664	06322	97928	34482
	-		44765	48822	47308	89204	86110
18 75	.29028	46772	54462	36763	61923	75818	
	+	375	56479	77841	59014	08723	48372
	-		45344	65560	24871	93499	04678
19 00	.29404	03252	32303	95777	70647	24190	
	+	375	11135	12281	34142	15224	43694
	-		45923	12370	95601	03010	64537
19 25	.29779	14387	44585	29919	85871	67884	
	+	374	65211	99910	38541	12213	79157
	-		46500	88362	52558	07623	42763
19 50	.30153	79599	44495	68460	98085	47041	
	+	374	18711	11547	85983	04590	36394
	-		47077	92643	98016	84332	02646
19 75	.30527	98310	56043	54444	02675	83435	
	+	373	71633	18903	87966	20258	33748
	-		47654	24325	44836	96957	69595

c	Sine					
20 00'	.30901	69943	74947	42410	22934	17183
	+ 373	23978	94578	43129	23300	64153
	−	48229	82518	17836	25326	98168
20 25	.31274	93922	69525	85539	46234	81336
	+ 372	75749	12060	25292	97973	65985
	−	48804	66334	55161	21797	05828
20 50	.31647	69671	81586	10832	44208	47321
	+ 372	26944	45725	70131	76176	60157
	−	49378	74888	09655	93014	15311
20 75	.32019	96616	27311	80964	20385	07478
	+ 371	77565	70837	60475	83162	44846
	−	49952	07293	50229	04794	17000
21 00	.32391	74181	98149	41440	03547	52324
	+ 371	27613	63544	10246	78368	27846
	−	50524	62666	63219	08017	35479
21 25	.32763	01795	61693	51686	81915	80170
	+ 370	77089	00877	47027	70350	92367
	−	51096	40124	53757	83431	60446
21 50	.33133	78884	62570	98714	52266	72537
	+ 370	25992	60752	93269	86919	31921
	−	51667	38785	47132	03261	81412
21 75	.33504	04877	23323	91984	39186	04458
	+ 369	74325	21967	46137	83657	50509
	−	52237	57768	90143	07525	48172
22 00	.33873	79202	45291	38122	22843	54967
	+ 369	22087	64198	55994	76132	02337
	−	52806	96195	52464	92957	64713
22 25	.34243	01290	09489	94116	98975	57304
	+ 368	69280	68003	03529	83174	37624
	−	53375	53187	28000	12451	13285

c	Sine					
22 50'	.34611	70570	77492	97646	82149	94928
	+ 368	15905	14815	75529	70723	24339
	—	53943	27867	36233	82920	97466
22 75	.34979	86475	92308	73176	52873	19267
	+ 367	61961	86948	39295	87802	26873
	—	54510	19360	23585	99504	88592
23 00	.35347	48437	79257	12472	40675	46140
	+ 367	07451	67588	15709	88297	38281
	—	55076	26791	64761	54014	58512
23 25	.35714	55889	46845	28182	28972	84421
	+ 366	52375	40796	50948	34282	79769
	—	55641	49288	64098	55555	83495
23 50	.36081	08264	87641	79130	63255	64190
	+ 365	96733	91507	86849	78726	96274
	—	56205	85979	56914	51238	09245
23 75	.36447	04998	79149	65980	41982	60464
	+ 365	40528	05528	29935	27488	87029
	—	56769	35994	10850	44897	75224
24 00	.36812	45526	84677	95915	69471	47493
	+ 364	83758	69534	19084	82591	11805
	—	57331	98463	27213	11762	07964
24 25	.37177	29285	54212	15000	52062	59298
	+ 364	26426	71070	91871	70829	03841
	—	57893	72519	42315	06984	07794
24 50	.37541	55712	25283	06872	22891	63139
	+ 363	68532	98551	49556	63844	96047
	—	58454	57296	28812	65981	71203
24 75	.37905	24245	23834	56428	86736	59186
	+ 363	10078	41255	20743	97863	24844
	—	59014	51928	97041	94518	12188

c	Sine					
25 00'	.38268	34323	65089	77172	84599	84030
	+ 362	51063	89326	23702	03345	12656
	−	59573	55553	96352	46462	70158
25 25	.38630	85387	54416	00874	87944	96686
	+ 361	91490	33772	27349	56882	42498
	−	60131	67309	16438	87176	19357
25 50	.38992	76877	88188	28224	44827	39184
	+ 361	31358	66463	10910	69706	23141
	−	60688	86333	88670	40466	25446
25 75	.39354	08236	54651	39135	14533	62325
	+ 360	70669	80129	22240	29239	97695
	−	61245	11768	87418	17063	28544
26 00	.39714	78906	34780	61375	43773	60020
	+ 360	09424	68360	34822	12176	69151
	−	61800	42756	31380	22569	69007
26 25	.40074	88331	03140	96197	55950	29171
	+ 359	47624	25604	03441	89607	00144
	−	62354	78439	84904	42839	12340
26 50	.40434	35955	28744	99639	45557	29315
	+ 358	85269	47164	18537	46767	87804
	−	62908	17964	59309	04745	72747
26 75	.40793	21224	75909	18176	92325	17119
	+ 358	22361	29199	59228	42022	15057
	−	63460	60477	14201	10306	81345
27 00	.41151	43586	05108	77405	34347	32176
	+ 357	58900	68722	45027	31715	33712
	−	64012	05125	58792	42125	94478
27 25	.41509	02486	73831	22432	66062	65888
	+ 356	94888	63596	86234	89589	39234
	−	64562	51059	53213	38126	90267

c	Sine					
27 50'	.41865	97375	37428	08667	55652	05122
	+ 356	30326	12537	33021	51462	48967
	−	65111	97430	09824	33552	57311
27 75	.42222	27701	49965	41689	07114	54089
	+ 355	65214	15107	23197	17909	91656
	−	65660	43389	94524	68206	38342
28 00	.42577	92915	65072	64886	25024	45745
	+ 354	99553	71717	28672	49703	53314
	−	66207	88093	28059	56917	53667
28 25	.42932	92469	36789	93558	74727	99059
	+ 354	33345	83624	00612	92785	99647
	−	66754	30695	87324	21214	94439
28 50	.43287	25815	20413	94171	67513	98706
	+ 353	66591	52928	13288	71571	05208
	−	67299	70355	06665	80198	43841
28 75	.43640	92406	73342	07460	39085	03914
	+ 352	99291	82573	06622	91372	61367
	−	67844	06229	79182	98599	55931
29 00	.43993	91698	55915	14083	30457	65281
	+ 352	31447	76343	27439	92773	05436
	−	68387	37480	58022	90027	96021
29 25	.44346	23146	32258	41523	23230	70717
	+ 351	63060	38862	69417	02745	09415
	−	68929	63269	57675	73403	24204
29 50	.44697	86206	71121	10940	25975	80132
	+ 350	94130	75593	11741	29341	85211
	−	69470	82760	55266	80575	84196
29 75	.45048	80337	46714	22681	55317	65343
	+ 350	24659	92832	56474	48766	01015
	−	70010	95118	91846	13144	43324

c	Sine					
30 00'	.45399	04997	39546	79156	04083	66358
	+ 349	54648	97713	64628	35621	57691
	—	70549	99511	73675	46481	16347
30 25	.45748	59646	37260	43784	39705	24049
	+ 348	84098	98201	90952	89140	41344
	—	71087	95107	73512	78979	95529
30 50	.46097	43745	35462	34737	28845	65393
	+ 348	13011	03094	17440	10160	45815
	—	71624	81077	31894	24547	02352
30 75	.46445	56756	38556	52177	39006	11208
	+ 347	41386	22016	85545	85613	43463
	—	72160	56592	58413	46356	72229
31 00	.46792	98142	60573	37723	24619	54671
	+ 346	69225	65424	27132	39256	71234
	—	72695	20827	32998	29899	82463
31 25	.47139	67368	25997	64855	63876	25905
	+ 345	96530	44596	94134	09356	88771
	—	73228	72957	07184	93355	35883
31 50	.47485	63898	70594	58989	73233	14676
	+ 345	23301	71639	86949	16001	52888
	—	73761	12159	05389	33321	17580
31 75	.47830	87200	42234	45938	89234	67564
	+ 344	49540	59480	81559	82680	35308
	—	74292	37612	26176	03942	50281
32 00	.48175	36741	01715	27498	71915	02872
	+ 343	75248	21868	55383	78737	85027
	—	74822	48497	43524	27481	85087
32 25	.48519	11989	23583	82882	50652	87899
	+ 343	00425	73371	11859	51255	99940
	—	75351	43997	08091	34377	78369

c	Sine					
32 50'	.48862	12414	96954	94742	01908	87839
	+ 342	25074	29374	03768	16878	21571
	−	75879	23295	48473	30844	22850
32 75	.49204	37489	26328	98510	18787	09410
	+ 341	49195	06078	55294	86033	98721
	−	76405	85578	72462	92066	21068
33 00	.49545	86684	32407	53805	04821	08131
	+ 340	72789	20499	82831	93967	77653
	−	76931	30034	68304	79052	12440
33 25	.49886	59473	52907	36636	98788	85784
	+ 339	95857	90465	14527	14915	65213
	−	77455	55853	05947	77206	91589
33 50	.50226	55331	43372	51164	13704	50997
	+ 339	18402	34612	08579	37708	73624
	−	77978	62225	38294	54694	84379
33 75	.50565	73733	77984	59743	51413	24621
	+ 338	40423	72386	70284	83013	89245
	−	78500	48345	02448	38664	80538
34 00	.50904	14157	50371	30028	34427	13866
	+ 337	61923	24041	67836	44349	08707
	−	79021	13407	20957	07415	56640
34 25	.51241	76080	74412	97864	78776	22573
	+ 336	82902	10634	46879	36933	52067
	−	79540	56609	03053	96582	61355
34 50	.51578	58982	85047	44744	15709	74640
	+ 336	03361	54025	43825	40350	90712
	−	80058	77149	45896	17432	75886
34 75	.51914	62344	39072	88569	56060	65352
	+ 335	23302	76875	97929	22918	14826
	−	80575	74229	35799	85357	06439

c	Sine					
35 00'	.52249	85647	15948	86498	78978	80178
	+ 334	42727	02646	62129	37561	08387
	−	81091	47051	49472	56657	12542
35 25	.52584	28374	18595	48628	16539	88565
	+ 333	61635	55595	12656	80903	95845
	−	81605	94820	55242	71724	24813
35 50	.52917	90009	74190	61284	97443	84410
	+ 332	80029	60774	57414	09179	71032
	−	82119	16743	14286	02715	58606
35 75	.53250	70039	34965	18699	06623	55442
	+ 331	97910	44031	43128	06464	12426
	−	82631	12027	81849	03835	85644
36 00	.53582	67949	78996	61827	13087	67868
	+ 331	15279	32003	61279	02628	26782
	−	83141	79885	08469	62337	84345
36 25	.53913	83229	11000	23106	15715	94650
	+ 330	32137	52118	52809	40290	42437
	−	83651	19527	41194	48359	51148
36 50	.54244	15366	63118	75915	56006	37087
	+ 329	48486	32591	11614	91930	91289
	−	84159	30169	24793	61720	19472
36 75	.54573	63852	95709	87530	47937	28376
	+ 328	64327	02421	86821	30210	71817
	−	84666	11027	02971	73803	00380
37 00	.54902	28179	98131	74351	78148	00193
	+ 327	79660	91394	83849	56407	71437
	−	85171	61319	19576	62655	29118
37 25	.55230	07840	89526	58201	34555	71630
	+ 326	94489	30075	64272	93752	42319
	−	85675	80266	19804	39443	74939

c	Sine					
37 50'	.55557	02330	19602	22474	28308	13949
	+ 326	08813	49809	44468	54308	67380
	—	86178	67090	51401	64405	47400
37 75	.55883	11143	69411	66942	82616	81329
	+ 325	22634	82718	93066	89903	19980
	—	86680	21016	65864	50441	11380
38 00	.56208	33778	52130	60009	72520	01309
	+ 324	35954	61702	27202	39462	08600
	—	87180	41271	19634	52501	04556
38 25	.56532	69733	13832	87212	11982	09909
	+ 323	48774	20431	07567	86961	04044
	—	87679	27082	75291	40920	35744
38 50	.56856	18507	34263	94779	98943	13953
	+ 322	61094	93348	32276	46040	68300
	—	88176	77682	02742	56863	29886
38 75	.57178	79602	27612	27056	44983	82253
	+ 321	72918	15666	29533	89177	38414
	—	88672	92301	80409	48042	75642
39 00	.57500	52520	43278	56590	34161	20667
	+ 320	84245	23364	49124	41134	62772
	—	89167	70176	96410	82885	24623
39 25	.57821	36765	66643	05714	75295	83439
	+ 319	95077	53187	52713	58249	38149
	—	89661	10544	49742	41316	87246
39 50	.58141	31843	19830	58428	33545	21588
	+ 319	05416	42643	02971	16932	50903
	—	90153	12643	51453	80350	68755
39 75	.58460	37259	62473	61399	50477	72491
	+ 318	15263	29999	51517	36581	82148
	—	90643	75715	25821	72660	90540

c	Sine					
40 00'	.58778	52522	92473	12916	87059	54639
	+ 317	24619	54284	25695	63920	91608
	−	91132	99003	11520	16334	46184
40 25	.59095	77142	46757	38612	50980	46247
	+ 316	33486	55281	14175	47586	45424
	−	91620	81752	62787	13995	48690
40 50	.59412	10629	02038	52787	98566	91671
	+ 315	41865	73528	51388	33590	96734
	−	92107	23211	50588	19503	35242
40 75	.59727	52494	75567	04176	32157	88405
	+ 314	49758	50317	00800	14087	61492
	−	92592	22629	63776	50430	08562
41 00	.60042	02253	25884	04976	46245	49897
	+ 313	57166	27687	37023	63657	52930
	−	93075	79259	10249	64528	09164
41 25	.60355	59419	53571	42000	09903	02827
	+ 312	64090	48428	26773	99129	43766
	−	93557	92354	18102	98404	31186
41 50	.60668	23510	01999	68774	09032	46593
	+ 311	70532	56074	08671	00725	12580
	−	94038	61171	36779	66622	15234
41 75	.60979	94042	58073	77445	09757	59173
	+ 310	76493	94902	71891	34102	97346
	−	94517	84969	38217	19457	75417
42 00	.61290	70536	52976	49336	43860	56519
	+ 309	81976	09933	33674	14645	21929
	−	94995	63009	17990	57542	44131
42 25	.61600	52512	62909	83010	58505	78448
	+ 308	86980	46924	15683	57102	77798
	−	95471	94553	96452	01628	47265

c	Sine					
42 50'	.61909	39493	09833	98694	15608	56246
	+ 307	91508	52370	19231	55474	30533
	−	95946	78869	19867	15720	54351
42 75	.62217	31001	62204	17925	71082	86779
	+ 306	95561	73500	99364	39753	76182
	−	96420	15222	61547	81820	82741
43 00	.62524	26563	35705	17290	10836	62961
	+ 305	99141	58278	37816	57932	93441
	−	96892	02884	22981	24540	72142
43 25	.62830	25704	93983	55106	68769	56402
	+ 305	02249	55394	14835	33392	21299
	−	97362	41126	34955	83837	85775
43 50	.63135	27954	49377	69942	02161	77701
	+ 304	04887	14267	79879	49554	35524
	−	97831	29223	58683	34142	37073
43 75	.63439	32841	63645	49821	51716	13225
	+ 303	07055	85044	21196	15411	98451
	−	98298	66452	86917	48141	86185
44 00	.63742	39897	48689	71017	67128	11676
	+ 302	08757	18591	34278	67270	12266
	−	98764	52093	45069	03499	98398
44 25	.64044	48654	67281	05296	34398	23942
	+ 301	09992	66497	89209	63770	13868
	−	99228	85426	92317	30789	07454
44 50	.64345	58647	33778	94505	98168	37810
	+ 300	10763	81070	96892	32981	06414
	−	99691	65737	22718	00922	79744
44 75	.64645	69411	14849	91398	31149	44224
	+ 299	11072	15333	74174	32058	26670
	− 1	00152	92310	66307	50380	31629

c	Sine					
45 00'	.64944	80483	30183	65572	63207	70894
	+ 298	10919	23023	07866	81677	95041
	− 1	00612	64435	90203	42519	10353
45 25	.65242	91402	53206	73439	44885	65935
	+ 297	10306	58587	17663	39158	84688
	− 1	01070	81403	99701	63279	10541
45 50	.65540	01709	11793	91102	84044	50623
	+ 296	09235	77183	17961	75879	74147
	− 1	01527	42508	39369	49586	61815
45 75	.65836	10944	88977	09064	59924	24770
	+ 295	07708	34674	78592	26293	12332
	− 1	01982	47044	94135	48771	89730
46 00	.66131	18653	23651	87656	86217	37102
	+ 294	05725	87629	84456	77521	22602
	− 1	02435	94311	90375	07320	20970
46 25	.66425	24379	11281	72113	63738	59704
	+ 293	03289	93317	94081	70201	01632
	− 1	02887	83609	96992	87281	75679
46 50	.66718	27669	04599	66195	33939	61336
	+ 292	00402	09707	97088	82919	25953
	− 1	03338	14242	26501	08671	63744
46 75	.67010	28071	14307	63284	16858	87289
	+ 290	97063	95465	70587	74247	62209
	− 1	03786	85514	36094	16196	78689
47 00	.67301	25135	09773	33871	91106	49498
	+ 289	93277	09951	34493	58050	83520
	− 1	04233	96734	28719	68652	62297
47 25	.67591	18412	19724	68365	49157	33018
	+ 288	89043	13217	05773	89398	21223
	− 1	04679	47212	54145	49337	94729

c	Sine						
47 50'	.67880	07455	32941	74139	38555	54241	
	+	287	84363	66004	51628	40060	26494
	-	1	05123	36262	10022	95842	49607
47 75	.68167	91818	98946	25767	78615	80735	
	+	286	79240	29742	41605	44217	76887
	-	1	05565	63198	42946	47567	40269
48 00	.68454	71059	28688	67373	22833	57622	
	+	285	73674	66543	98658	96650	36618
	-	1	06006	27339	49509	09344	73076
48 25	.68740	44733	95232	66032	19483	94240	
	+	284	67668	39204	49149	87305	63542
	-	1	06445	28005	77354	29528	15629
48 50	.69025	12402	34437	15182	06789	57782	
	+	283	61223	11198	71795	57777	47913
	-	1	06882	64520	26223	90932	82148
48 75	.69308	73625	45635	86977	64567	05695	
	+	282	54340	46678	45571	66844	65765
	-	1	07318	36208	49002	13008	35609
49 00	.69591	27965	92314	32549	31411	71460	
	+	281	47022	10469	96569	53836	30156
	-	1	07752	42398	52755	63635	05393
49 25	.69872	74988	02784	29118	85248	01616	
	+	280	39269	68071	43813	90201	24763
	-	1	08184	82420	99769	78939	21515
49 50	.70153	14257	70855	72932	75449	26379	
	+	279	31084	85650	44044	11262	03248
	-	1	08615	55609	08580	89529	70770
49 75	.70432	45342	56506	16976	86711	29627	
	+	278	22469	30041	35463	21732	32478
	-	1	09044	61298	55004	51563	87275

c	Sine					
50 00'	.70710	67811	86547	52440	08443	62105
	+ 277	13424	68742	80458	70168	45203
	− 1	09471	98827	73159	81056	99036
50 25	.70987	81236	55290	32898	78612	07308
	+ 276	03952	69915	07298	89111	46167
	− 1	09897	67537	56489	89855	64334
50 50	.71263	85189	25205	40197	67723	53475
	+ 274	94055	02377	50808	99255	81833
	− 1	10321	66771	58778	21701	45675
50 75	.71538	79244	27582	91006	66979	35308
	+ 273	83733	35605	92030	77554	36158
	− 1	10743	95875	95160	86817	86051
51 00	.71812	62977	63188	83037	44533	71466
	+ 272	72989	39729	96869	90736	50107
	− 1	11164	54199	43134	93458	71159
51 25	.72085	35967	02918	79907	35270	21573
	+ 271	61824	85530	53734	97277	78948
	− 1	11583	41093	43562	74863	82927
51 50	.72356	97791	88449	33642	32548	00521
	+ 270	50241	44437	10172	22413	96021
	− 1	12000	55912	01672	10072	73507
51 75	.72627	48033	32886	43814	54961	96542
	+ 269	38240	88525	08500	12341	22514
	− 1	12415	98011	88052	37054	15312
52 00	.72896	86274	21411	52314	67303	19056
	+ 268	25824	90513	20447	75287	07202
	− 1	12829	66752	39646	56615	11273
52 25	.73165	12099	11924	72762	42590	26258
	+ 267	12995	23760	80801	18671	95929
	− 1	13241	61495	60739	25559	80682

c	Sine						
52 50'	.73432	25094	35685	53563	61262	22187	
	+	265	99753	62265	20061	93112	15247
	-	1	13651	81606	23940	37574	69299
52 75	.73698	24847	97950	73625	54374	37434	
	+	264	86101	80658	96121	55537	45948
	-	1	14060	26451	71164	90322	68234
53 00	.73963	10949	78609	69747	09911	83382	
	+	263	72041	54207	24956	65214	77714
	-	1	14466	95402	14608	37235	64263
53 25	.74226	82991	32816	94703	75126	61096	
	+	262	57574	58805	10348	27979	13451
	-	1	14871	87830	37718	22500	84583
53 50	.74489	40565	91622	05052	03105	74547	
	+	261	42702	70974	72630	05478	28868
	-	1	15275	03111	96160	97743	41923
53 75	.74750	83268	62596	77682	08584	03415	
	+	260	27427	67862	76469	07734	86945
	-	1	15676	40625	18785	18913	30816
54 00	.75011	10696	30459	54151	16318	90360	
	+	259	11751	27237	57683	88821	56129
	-	1	16075	99751	08580	21891	73452
54 25	.75270	22447	57697	11835	05140	46489	
	+	257	95675	27486	49103	66929	82677
	-	1	16473	79873	43630	75338	62913
54 50	.75528	18122	85183	60938	72070	29166	
	+	256	79201	47613	05472	91591	19764
	-	1	16869	80378	78067	09309	03849
54 75	.75784	97324	32796	66411	63661	48930	
	+	255	62331	67234	27405	82282	15915
	-	1	17264	00656	43011	18173	04587

c	Sine					
55 00'	.76040	59656	00030	93817	45943	64845
	+	254	45067	66577	84394	64109 11328
	-	1	17656	40098	47518	36380 31325
55 25	.76295	04723	66608	78212	10052	76173
	+	253	27411	26479	36876	27728 80003
	-	1	18046	98099	79514	85616 93748
55 50	.76548	32134	93088	15088	37781	56176
	+	252	09364	28379	57361	42111 86255
	-	1	18435	74058	06730	91908 92290
55 75	.76800	41499	21467	72449	79893	42431
	+	250	90928	54321	50630	50202 93965
	-	1	18822	67373	77629	71233 20603
56 00	.77051	32427	75789	23080	30096	36396
	+	249	72105	86947	73000	78969 73362
	-	1	19207	77450	22331	82203 82061
56 25	.77301	04533	62736	96081	09066	09758
	+	248	52898	09497	50668	96765 91301
	-	1	19591	03693	53535	44407 46864
56 50	.77549	57431	72234	46750	05832	01059
	+	247	33307	05803	97133	52358 44437
	-	1	19972	45512	67432	20969 46069
56 75	.77796	90738	78038	43883	58190	45496
	+	246	13334	60291	29701	31388 98368
	-	1	20352	02319	44618	63937 70891
57 00	.78043	04073	38329	73584	89579	43864
	+	244	92982	57971	85082	67451 27477
	-	1	20729	73528	51003	21079 19870
57 25	.78287	97055	96301	58667	57030	71341
	+	243	72252	84443	34079	46372 07607
	-	1	21105	58557	38709	02690 12699

c	Sine						
57 50'	.78531	69308	80744	92747	03402	78948	
	+	242	51147	25885	95370	43681	94908
	-	1	21479	56826	46972	07027	68245
57 75	.78774	20456	06630	88117	47084	73856	
	+	241	29667	69059	48398	36654	26663
	-	1	21851	67759	03035	02978	24755
58 00	.79015	50123	75690	36515	83739	00519	
	+	240	07816	01300	45363	33676	01908
	-	1	22221	90781	23036	68583	63141
58 25	.79255	57939	76990	81879	17415	02427	
	+	238	85594	10519	22326	65092	38767
	-	1	22590	25322	12896	84053	79128
58 50	.79494	43533	87510	04205	82507	41194	
	+	237	63003	85197	09429	81038	59639
	-	1	22956	70813	69196	77901	37112
58 75	.79732	06537	72707	13635	63546	00833	
	+	236	40047	14383	40233	03137	22527
	-	1	23321	26690	80055	24840	27674
59 00	.79968	46584	87090	53868	66683	23360	
	+	235	16725	87692	60177	78296	94853
	-	1	23683	92391	25999	94097	41945
59 25	.80203	63310	74783	14046	44980	18213	
	+	233	93041	95301	34177	84199	52908
	-	1	24044	67355	80834	46793	69409
59 50	.80437	56352	70084	48224	29179	71121	
	+	232	68997	27945	53343	37405	83499
	-	1	24403	51028	12500	81057	20936
59 75	.80670	25349	98030	01567	66585	54620	
	+	231	44593	76917	40842	56348	62563
	-	1	24760	42854	83937	23538	76569

c	Sine					
60 00'	.80901	69943	74947	42410	22934	17183
	+ 230	19833	34062	56905	32809	85994
	− 1	25115	42285	53931	66006	56782
60 25	.81131	89777	09009	99315	55744	03177
	+ 228	94717	91777	02973	66803	29212
	− 1	25468	48772	77970	45704	17736
60 50	.81360	84495	00787	02289	22547	32389
	+ 227	69249	43004	25003	21099	11476
	− 1	25819	61772	09082	68162	74457
60 75	.81588	53744	43791	27292	43646	43865
	+ 226	43429	81232	15920	52936	37019
	− 1	26168	80741	98679	71165	61542
61 00	.81814	97174	25023	43212	96582	80884
	+ 225	17261	00490	17240	81770	75477
	− 1	26516	05143	97390	28570	48573
61 25	.82040	14435	25513	60453	78353	56361
	+ 223	90744	95346	19850	53200	26904
	− 1	26861	34442	55890	92701	36998
61 50	.82264	05180	20859	80304	31553	83265
	+ 222	63883	60903	63959	60498	89906
	− 1	27204	68105	25731	74029	76862
61 75	.82486	69063	81763	44263	92052	73171
	+ 221	36678	92798	38227	86469	13044
	− 1	27546	05602	60157	56871	55282
62 00	.82708	05742	74561	82491	78521	86215
	+ 220	09132	87195	78070	29597	57762
	− 1	27885	46408	14924	49833	24121
62 25	.82928	14875	61757	60562	08119	43977
	+ 218	81247	40787	63145	79764	33641
	− 1	28222	89998	49111	69748	51748

c	Sine						
62 50'	.83146	96123	02545	23707	87883	77618	
	+	217	53024	50789	14034	10015	81893
	-	1	28558	35853	25928	57853	03255
62 75	.83364	49147	53334	37741	97899	59511	
	+	216	24466	14935	88105	52162	78638
	-	1	28891	83455	13517	26952	74745
63 00	.83580	73613	68270	25847	50062	38149	
	+	214	95574	31480	74588	25210	03893
	-	1	29223	32289	85750	38348	30683
63 25	.83795	69187	99751	00435	75272	42042	
	+	213	66350	99190	88837	86861	73210
	-	1	29552	81846	23024	07285	18397
63 50	.84009	35538	98941	89273	62134	15252	
	+	212	36798	17344	65813	79576	54813
	-	1	29880	31616	13046	35706	60911
63 75	.84221	72337	16286	55087	41710	70065	
	+	211	06917	85728	52767	43869	93902
	-	1	30205	81094	51620	71093	58276
64 00	.84432	79255	02015	07854	85580	63967	
	+	209	76712	04634	01146	72776	35626
	-	1	30529	29779	43424	90183	58345
64 25	.84642	55967	06649	09001	58356	99593	
	+	208	46182	74854	57721	82592	77281
	-	1	30850	77172	02785	06366	90704
64 50	.84851	02149	81503	66723	40949	76874	
	+	207	15331	97682	54936	76225	86577
	-	1	31170	22776	54444	99566	91898
64 75	.85058	17481	79186	21660	17175	63451	
	+	205	84161	74906	00491	76658	94679
	-	1	31487	66100	34330	67417	86696

c	Sine						
65 00'	.85264	01643	54092	22151	93834	58130	
	+	204	52674	08805	66161	09241	07983
	-	1	31803	06653	90309	96561	28053
65 25	.85468	54317	62897	88313	03075	66113	
	+	203	20871	02151	75851	12679	79930
	-	1	32116	43950	82947	52889	38776
65 50	.85671	75188	65049	64164	15755	46043	
	+	201	88754	58200	92903	59790	41154
	-	1	32427	77507	86254	89571	39534
65 75	.85873	63943	23250	57067	75545	87197	
	+	200	56326	80693	06648	70219	01620
	-	1	32737	06844	88435	71705	91526
66 00	.86074	20270	03943	63716	45764	88817	
	+	199	23589	73848	18212	98513	10094
	-	1	33044	31484	92626	16450	27680
66 25	.86273	43859	77791	81929	44277	98911	
	+	197	90545	42363	25586	82062	82414
	-	1	33349	50954	17630	47484	93203
66 50	.86471	34405	20155	07516	26340	81325	
	+	196	57195	91409	07956	34577	89211
	-	1	33652	64781	98651	62678	65536
66 75	.86667	91601	11564	15472	60918	70536	
	+	195	23543	26627	09304	71899	23675
	-	1	33953	72500	88017	13827	74233
67 00	.86863	15144	38191	24777	32817	94211	
	+	193	89589	54126	21287	58071	49442
	-	1	34252	73646	55899	97349	93873
67 25	.87057	04733	92317	46064	90889	43653	
	+	192	55336	80479	65387	60721	55569
	-	1	34549	67757	91034	54821	37255

c	Sine					
67 50'	.87249	60070	72797	11452	51610	99222
	+ 191	20787	12721	74353	05900	18314
	− 1	34844	54377	01427	82252	31928
67 75	.87440	80857	85518	85805	57511	17536
	+ 189	85942	58344	72925	23647	86386
	− 1	35137	33049	15065	47005	20833
68 00	.87630	66800	43863	58730	81159	03922
	+ 188	50805	25295	57859	76642	65553
	− 1	35428	03322	80613	11265	86956
68 25	.87819	17605	69159	16590	57801	69475
	+ 187	15377	21972	77246	65376	78597
	− 1	35716	64749	68112	60986	63009
68 50	.88006	32982	91131	93837	23178	48072
	+ 185	79660	57223	09134	04390	15588
	− 1	36003	16884	69673	39227	49597
68 75	.88192	12643	48355	02971	27568	63660
	+ 184	43657	40338	39460	65162	65991
	− 1	36287	59286	00158	82829	29821
69 00	.88376	56300	88693	42431	92731	29651
	+ 183	07369	81052	39301	82333	36170
	− 1	36569	91514	97867	61360	33955
69 25	.88559	63670	69745	81733	75064	65821
	+ 181	70799	89537	41434	20973	02215
	− 1	36850	13136	25210	17285	75608
69 50	.88741	34470	59283	23167	96037	68036
	+ 180	33949	76401	16224	03687	26607
	− 1	37128	23717	69380	06316	49837
69 75	.88921	68420	35684	39391	99724	94643
	+ 178	96821	52683	46843	97370	76770
	− 1	37404	22830	43020	36902	54410

c	Sine						
70 00'	.89100	65241	88367	86235	97095	71413	
	+	177	59417	29853	03823	60468	22360
	-	1	37678	10048	84885	07842	68061
70 25	.89278	24659	18220	90059	57563	93773	
	+	176	21739	19804	18938	52625	54299
	-	1	37949	84950	60495	42990	93100
70 50	.89454	46398	38025	08998	10189	48072	
	+	174	83789	34853	58443	09634	61199
	-	1	38219	47116	62791	22047	45820
70 75	.89629	30187	72878	67441	19824	09271	
	+	173	45569	87736	95651	87587	15379
	-	1	38486	96131	12777	06429	54723
71 00	.89802	75757	60615	63093	07411	24650	
	+	172	07082	91605	82874	81157	60656
	-	1	38752	31581	60163	59226	05654
71 25	.89974	82840	52221	45967	88568	85306	
	+	170	68330	60024	22711	21931	55002
	-	1	39015	53058	84003	58246	52846
71 50	.90145	51171	12245	68679	10500	40308	
	+	169	29315	06965	38707	63685	02156
	-	1	39276	60156	93323	01183	96687
71 75	.90314	80486	19211	07386	74185	42464	
	+	167	90038	46808	45384	62501	05469
	-	1	39535	52473	27747	01918	12310
72 00	.90482	70524	66019	52771	36686	47933	
	+	166	50502	94335	17637	60582	93159
	-	1	39792	29608	58120	76993	97679
72 25	.90649	21027	60354	70408	97269	41092	
	+	165	10710	64726	59516	83588	95480
	-	1	40046	91166	87125	21317	96203

c	Sine						
72 50'	.90814	31738	25081	29925	80858	36572	
	+	163	70663	73559	72391	62270	99277
	-	1	40299	36755	49887	72122	36492
72 75	.90978	02401	98641	02317	43129	35849	
	+	162	30364	36804	22503	90148	62785
	-	1	40549	65985	14587	60256	21108
73 00	.91140	32766	35445	24821	33277	98634	
	+	160	89814	70819	07916	29892	41677
	-	1	40797	78469	83056	47868	86707
73 25	.91301	22581	06264	32737	63170	40311	
	+	159	49016	92349	24859	82023	54970
	-	1	41043	73826	91373	51560	50011
73 50	.91460	71597	98613	57597	45193	95281	
	+	158	07973	18522	33486	30463	04959
	-	1	41287	51677	10455	50081	47649
73 75	.91618	79571	17135	91083	75657	00240	
	+	156	66685	66845	23030	80381	57310
	-	1	41529	11644	46641	75670	72532
74 00	.91775	46256	83981	14114	56038	57550	
	+	155	25156	55200	76389	04710	84778
	-	1	41768	53356	42273	88131	06043
74 25	.91930	71413	39181	90503	60749	42328	
	+	153	83388	01844	34115	16579	78735
	-	1	42005	76443	76270	30747	42766
74 50	.92084	54801	41026	24618	77329	21063	
	+	152	41382	25400	57844	85832	35969
	-	1	42240	80540	64695	67162	03604
74 75	.92236	96183	66426	82463	63161	57032	
	+	150	99141	44859	93149	18670	32365
	-	1	42473	65284	61324	98328	33631

c	Sine					
75 00'	.92387	95325	11286	75612	81831	89397
	+ 149	56667	79575	31824	20341	98734
	− 1	42704	30316	58202	58673	82744
75 25	.92537	51992	90862	07437	02173	88131
	+ 148	13963	49258	73621	61668	15990
	− 1	42932	75280	86195	90609	70283
75 50	.92685	65956	40120	81058	63842	04121
	+ 146	71030	73977	87425	71058	45707
	− 1	43158	99825	15543	96533	39313
75 75	.92832	36987	14098	68484	34900	49828
	+ 145	27871	74152	71881	74525	06394
	− 1	43383	03600	56400	67478	11980
76 00	.92977	64858	88251	40366	09425	56222
	+ 143	84488	70552	15481	07046	94414
	− 1	43604	86261	59372	87571	64446
76 25	.93121	49347	58803	55847	16472	50636
	+ 142	40883	84290	56108	19475	29968
	− 1	43824	47466	16053	13474	48263
76 50	.93263	90231	43094	11955	35947	80604
	+ 140	97059	36824	40055	06000	81705
	− 1	44041	86875	59547	27975	94704
76 75	.93404	87290	79918	52010	41948	62309
	+ 139	53017	49948	80507	78024	87001
	− 1	44257	04154	64996	66934	49517
77 00	.93544	40308	29867	32518	19973	49310
	+ 138	08760	45794	15511	11090	37484
	− 1	44469	98971	50095	18756	97592
77 25	.93682	49068	75661	48029	31063	86794
	+ 136	64290	46822	65415	92333	39892
	− 1	44680	70997	75600	95619	50725

c	Sine						
77 50'	.93819	13359	22484	13445	23397	26686	
	+	135	19609	75824	89814	96713	89167
	-	1	44889	19908	45842	75640	85923
77 75	.93954	32968	98309	03260	20111	15853	
	+	133	74720	55916	43972	21073	03244
	-	1	45095	45382	09221	15227	37920
78 00	.94088	07689	54225	47232	41184	19097	
	+	132	29625	10534	34751	05845	65324
	-	1	45299	47100	58704	30816	66387
78 25	.94220	37314	64759	81983	47029	84421	
	+	130	84325	63433	76046	75028	98937
	-	1	45501	24749	32318	49255	36650
78 50	.94351	21640	28193	58030	22058	83358	
	+	129	38824	38684	43728	25773	62287
	-	1	45700	78017	13633	26054	72218
78 75	.94480	60464	66878	01758	47832	45645	
	+	127	93123	60667	30094	99718	90069
	-	1	45898	06596	32241	30775	57900
79 00	.94608	53588	27545	31853	47551	35714	
	+	126	47225	54070	97853	68943	32169
	-	1	46093	10182	64232	98802	94198
79 25	.94735	00813	81616	29707	16494	67883	
	+	125	01132	43888	33620	70140	37971
	-	1	46285	88475	32665	48778	26358
79 50	.94860	01946	25504	63327	86635	05854	
	+	123	54846	55413	00955	21362	11613
	-	1	46476	41177	08026	64965	95700
79 75	.94983	56792	80917	64283	07997	17467	
	+	122	08370	14235	92928	56396	15913
	-	1	46664	67994	08693	43838	85840

c	Sine					
80 00'	.95105	65162	95153	57211	64393	33380
	+ 120	61705	46241	84235	12557	30073
	− 1	46850	68636	01385	04175	62636
80 25	.95226	26868	41395	41446	76950	63453
	+ 119	14854	77605	82850	08381	67437
	− 1	47034	42816	01610	59971	34236
80 50	.95345	41723	19001	24296	85332	30890
	+ 117	67820	34789	81239	48410	33201
	− 1	47215	90250	74111	55470	85656
80 75	.95463	09543	53791	05536	33742	64091
	+ 116	20604	44539	07127	92939	47545
	− 1	47395	10660	33298	61642	72201
81 00	.95579	30147	98330	12664	26682	11636
	+ 114	73209	33878	73829	31296	75344
	− 1	47572	03768	43683	33419	86191
81 25	.95694	03357	32208	86493	57978	86980
	+ 113	25637	30110	30145	97876	89153
	− 1	47746	69302	20304	27041	43317
81 50	.95807	28994	62319	16639	55855	76133
	+ 111	77890	60808	09841	70835	45836
	− 1	47919	06992	29147	76838	67316
81 75	.95919	06885	23127	26481	26691	21969
	+ 110	29971	53815	80693	93996	78520
	− 1	48089	16572	87563	30815	85412
82 00	.96029	36856	76943	07175	20688	00489
	+ 108	81882	37242	93130	63180	93108
	− 1	48256	97781	64673	44385	81520
82 25	.96138	18739	14186	00305	83868	93597
	+ 107	33625	39461	28457	18795	11588
	− 1	48422	50359	81778	31627	89753

c	Sine					
82 50'	.96245	52364	53647	28763	02664	05185
	+ 105	85202	89101	46678	87167	21835
	− 1	48585	74052	12754	73444	47468
82 75	.96351	37567	42748	75441	89831	27020
	+ 104	36617	15049	33924	13722	74367
	− 1	48746	68606	84449	82000	64426
83 00	.96455	74184	57798	09366	03554	01387
	+ 102	87870	46442	49474	31722	09941
	− 1	48905	33775	77069	20840	03377
83 25	.96558	62055	04240	58840	35276	11328
	+ 101	38965	12666	72405	10882	06564
	− 1	49061	69314	24559	80078	06473
83 50	.96660	01020	16907	31245	46158	17892
	+ 99	89903	43352	47845	30804	00091
	− 1	49215	74981	14987	06082	42609
83 75	.96759	90923	60259	79090	76962	17983
	+ 98	40687	68371	32858	24721	57482
	− 1	49367	50538	90906	85058	91713
84 00	.96858	31611	28631	11949	01683	75465
	+ 96	91320	17832	41951	39662	65769
	− 1	49516	95753	49731	79969	24349
84 25	.96955	22931	46463	53900	41346	41234
	+ 95	41803	22078	92219	59693	41420
	− 1	49664	10394	44092	20215	78021
84 50	.97050	64734	68542	46120	01039	82654
	+ 93	92139	11684	48127	39477	63399
	− 1	49808	94234	82191	43536	75333
84 75	.97144	56873	80226	94247	40517	46053
	+ 92	42330	17449	65935	95940	88066
	− 1	49951	47051	28155	89563	74047

c	Sine						
85 00'	.97236	99203	97676	60183	36458	34119	
	+	90	92378	70398	37780	06377	14019
	-	1	50091	68624	02379	44501	84680
85 25	.97327	91582	68074	97963	42835	48138	
	+	89	42287	01774	35400	61875	29339
	-	1	50229	58736	81862	36401	37609
85 50	.97417	33869	69849	33364	04710	77477	
	+	87	92057	43037	53538	25473	91730
	-	1	50365	17177	00544	80498	29036
85 75	.97505	25927	12886	86902	30184	69207	
	+	86	41692	25860	52993	44975	62694
	-	1	50498	43735	49634	74109	23159
86 00	.97591	67619	38747	39895	75160	31901	
	+	84	91193	82125	03358	70866	39535
	-	1	50629	38206	77930	40575	36758
86 25	.97676	58813	20872	43254	46026	71436	
	+	83	40564	43918	25428	30291	02777
	-	1	50758	00388	92137	21757	82039
86 50	.97759	99377	64790	68682	76317	74213	
	+	81	89806	43529	33291	08533	20738
	-	1	50884	30083	57179	18595	94026
86 75	.97841	89184	08320	01973	84850	94951	
	+	80	38922	13445	76111	89937	26712
	-	1	51008	27095	96504	79248	19843
87 00	.97922	28106	21765	78085	74788	21663	
	+	78	87913	86349	79607	10689	06869
	-	1	51129	91234	92387	34343	99267
87 25	.98001	16020	08115	57692	85477	28532	
	+	77	36783	95114	87219	76345	07602
	-	1	51249	22312	86219	78883	18378

c	Sine					
87 50'	.98078	52804	03230	44912	61822	36134
	+	75	85534	72802	00999	97461 89224
	-	1	51366	20145	78804	00328 71717
87 75	.98154	38338	76032	45912	59284	25358
	+	74	34168	52656	22195	97133 17507
	-	1	51480	84553	30634	52446 22060
88 00	.98228	72507	28688	68108	56417	42865
	+	72	82687	68102	91561	44686 95447
	-	1	51593	15358	62176	74453 02041
88 25	.98301	55194	96791	59670	01104	38312
	+	71	31094	52744	29384	70233 93406
	-	1	51703	12388	54139	55047 56887
88 50	.98372	86289	49535	89054	71338	31718
	+	69	79391	40355	75245	15186 36519
	-	1	51810	75473	47742	40898 83874
88 75	.98442	65680	89891	64299	86524	68237
	+	68	27580	64882	27502	74287 52645
	-	1	51916	04447	44976	89183 80633
89 00	.98510	93261	54773	91802	60812	20882
	+	66	75664	60434	82525	85103 72012
	-	1	52018	99148	08862	63769 71911
89 25	.98577	68926	15208	74328	45915	92894
	+	65	23645	61286	73663	21334 00101
	-	1	52119	59416	63697	74646 42291
89 50	.98642	92571	76495	47991	67249	92995
	+	63	71526	01870	09965	46687 57810
	-	1	52217	85097	95303	60222 60921
89 75	.98706	64097	78365	57957	13937	50805
	+	62	19308	16772	14661	86464 96889
	-	1	52313	76040	51264	12108 43638

c	Sine						
90 00'	.98768	83405	95137	72619	00402	47694	
	+	60	66994	40731	63397	74356	53251
	-	1	52407	32096	41159	42015	57355
90 25	.98829	50400	35869	36016	74759	00945	
	+	59	14587	08635	22238	32340	95896
	-	1	52498	53121	36793	90414	32230
90 50	.98888	64987	44504	58255	07099	96841	
	+	57	62088	55513	85444	41926	63666
	-	1	52587	38974	72418	76596	07693
90 75	.98946	27076	00018	43699	49026	60507	
	+	56	09501	16539	13025	65330	55973
	-	1	52673	89519	44948	89798	00094
91 00	.99002	36577	16557	56725	14357	16480	
	+	54	56827	27019	68076	75532	55879
	-	1	52758	04622	14174	21055	41513
91 25	.99056	93404	43577	24801	89889	72359	
	+	53	04069	22397	53902	54477	14366
	-	1	52839	84153	02965	35456	01818
91 50	.99109	97473	65974	78704	44366	86725	
	+	51	51229	38244	50937	19021	12548
	-	1	52919	27985	97473	84478	69035
91 75	.99161	48703	04219	29641	63387	99273	
	+	49	98310	10258	53463	34542	43513
	-	1	52996	35998	47326	58108	26467
92 00	.99211	47013	14477	83104	97930	42786	
	+	48	45313	74260	06136	76434	17046
	-	1	53071	08071	65814	76426	29068
92 25	.99259	92326	88737	89241	74364	59832	
	+	46	92242	66188	40322	00007	87978
	-	1	53143	44090	30077	20386	45846

c	Sine						
92 50'	.99306	84569	54926	29563	74372	47810	
	+	45	39099	22098	10244	79621	42132
	-	1	53213	43942	81278	01492	00003
92 75	.99352	23668	77024	39808	53993	89942	
	+	43	85885	78155	28966	78129	42129
	-	1	53281	07521	24778	70101	03752
93 00	.99396	09554	55179	68775	32123	32071	
	+	42	32604	70634	04188	08028	38377
	-	1	53346	34721	30304	62094	50494
93 25	.99438	42159	25813	72963	40151	70448	
	+	40	79258	35912	73883	45933	87883
	-	1	53409	25442	32105	83649	93105
93 50	.99479	21417	61726	46846	86085	58331	
	+	39	25849	10470	41777	62283	94778
	-	1	53469	79587	29112	33873	03672
93 75	.99518	47266	72196	88624	48369	53109	
	+	37	72379	30883	12665	28410	91106
	-	1	53527	97062	85083	65047	76803
94 00	.99556	19646	03080	01289	76780	44215	
	+	36	18851	33820	27581	63363	14303
	-	1	53583	77779	28752	80274	05975
94 25	.99592	38497	36900	28871	40143	58518	
	+	34	65267	56040	98828	83089	08328
	-	1	53637	21650	53964	68271	30023
94 50	.99627	03764	92941	27700	23232	66846	
	+	33	11630	34390	44864	14817	78305
	-	1	53688	28594	19808	75134	14714
94 75	.99660	15395	27331	72564	38050	45151	
	+	31	57942	05796	25055	39683	63591
	-	1	53736	98531	50746	12836	02787

c	Sine					
95 00'	.99691	73337	33127	97619	77734	08742
	+	30	04205	07264	74309	26847 60804
	-	1	53783	31387	36731	04284 34326
95 25	.99721	77542	40392	71929	04581	69546
	+	28	50421	75877	37578	22563 26478
	-	1	53827	27090	33326	64740 08331
95 50	.99750	27964	16270	09507	27144	96024
	+	26	96594	48787	04251	57823 18147
	-	1	53868	85572	61815	19423 25454
95 75	.99777	24558	65057	13758	84968	14171
	+	25	42725	63214	42436	38399 92693
	-	1	53908	06770	09302	57134 21443
96 00	.99802	67284	28271	56195	23368	06864
	+	23	88817	56444	33133	81265 71250
	-	1	53944	90622	28817	19729 70476
96 25	.99826	56101	84715	89329	04633	78114
	+	22	34872	65822	04316	61536 00774
	-	1	53979	37072	39403	27301 07619
96 50	.99848	90974	50537	93645	66169	78888
	+	20	80893	28749	64913	34234 93155
	-	1	54011	46067	26208	38910 89797
96 75	.99869	71867	79287	58559	00404	72043
	+	19	26881	82682	38704	95324 03358
	-	1	54041	17557	40565	48752 85173
97 00	.99888	98749	61969	97263	95728	75401
	+	17	72840	65124	98139	46571 18185
	-	1	54068	51497	00069	17608 51430
97 25	.99906	71590	27094	95403	42299	93586
	+	16	18772	13627	98070	28962 66755
	-	1	54093	47843	88646	39483 34271

c	Sine						
97 50'	.99922	90362	40722	93473	71262	60341	
	+	14	64678	65784	09423	89479	32484
	-	1	54116	06559	56621	43312	88600
97 75	.99937	55041	06507	02897	60741	92825	
	+	13	10562	59224	52802	46166	43884
	-	1	54136	27609	20775	29638	95812
98 00	.99950	65603	65731	55700	06908	36709	
	+	11	56426	31615	32027	16527	48072
	-	1	54154	10961	64399	42164	22267
98 25	.99962	22029	97346	87727	23435	84781	
	+	10	02272	20653	67627	74363	25805
	-	1	54169	56589	37343	74102	35184
98 50	.99972	24302	18000	55354	97799	10586	
	+	8	48102	64064	30284	00260	90621
	-	1	54182	64468	56059	09249	64096
98 75	.99980	72404	82064	85638	98060	01207	
	+	6	93919	99595	74224	91011	26525
	-	1	54193	34579	03633	97712	67539
99 00	.99987	66324	81660	59863	89071	27732	
	+	5	39726	65016	70590	93298	58986
	-	1	54201	66904	29825	66235	36557
99 25	.99993	06051	46677	30454	82369	86718	
	+	3	85524	98112	40765	27063	22429
	-	1	54207	61431	51085	63077	38550
99 50	.99996	91576	44789	71220	09433	09147	
	+	2	31317	36680	89679	63985	83879
	-	1	54211	18151	50579	37404	76905
99 75	.99999	22893	81470	60899	73418	93026	
	+		77106	18529	39100	26581	06974
	-	1	54212	37058	78200	53162	13948

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100 00'	1.00000	00000	00000	00000	00000	00000
	—	77106	18529	39100	26581	06974
	—	1 54211	18151	50579	37404	76905
100 25	.99999	22893	81470	60899	73418	93026