Phone: STerling 3-4100

INDEPENDENT TRACKING COORDINATION PROGRAM

824 Connecticut Avenue
Washington 6, D. C.

July 20, 1964

Dr. Thomas L. K. Smull
Director
Office of Research Grants and Contracts
National Aeronautics and Space Administration
Washington, D.C. 20546

Re: Research Grant NsG 35-60

Dear Dr. Smull:

Our last regular report was forwarded to you under date of April 20, 1964 and covered the period from 1 November 1963 to March 31, 1964.

Enclosed please find report covering activities for the period 1 April through 30 June, 1964.

[redacted]

Respectfully,

Norton Goodwin
Program Director

Enclosures:
Exhibits A through H

UNPUBLISHED PRELIMINARY DA

[redacted]

REPORTS CONTROL No. 2

Society of Photographic Scientists and Engineers

INDEPENDENT TRACKING COORDINATION PROGRAM -

SUMMARY OF PROGRESS AND REPORT OF ACTIVITIES - 1 April to 30 June, 1964

I. TRACKING and ACQUISITION DATA

A. Observations and Reports of Fix

1. PHOTOTRACK observations have been received at SPACON during the period, as follows:

60 091	6	64 004A	13
63 047A	8	64 005A	4
63 053A	2		

2. According to summary reports received at this office, a number of visual reports of fix have been supplied to independent research programs on satellites. At the present time the majority of such reports are not being relayed to SPACON.

3. During the period, the following observations have been received from independent tracking sources overseas and forwarded to Goddard Space Flight Center:

60 091	15	63 038B	1
60 053	2	038C	1
61 Alpha 1	2	043A	1
62 A Ypsi	4	053A	1
62 Kappa 1	5	055B	1
62 B Kappa 1	3	64 001A	2
63 03A	5	004A	35
63 04A	2	006A	3
63 14A	2	010A	1
63 27A	4	010B	1
63 30A	3	011A	8
64 028B	4		

B. Acquisition Data

1. Mean Orbital Elements

Reports of Fix are of primary interest to individuals or centers conducting orbit studies on the particular satellites on which data is given Individual observerations are of little use in satellite acquisition. Mean orbital elements are the result of an analysis of a series of fixes and are of use to anyone wishing to acquire a satellite for observation purposes. An important element of the long-range goals of the Independent Tracking Coordination Program has been to develop sources of acquisition data of this type, not only from official tracking agencies but also from competent individuals and groups.

- Continued on page 2

B. 1. (cont.)

Heretofore, the primary sources of mean orbital data, other than the principal tracking centers, have been individuals with extraordinary interests and/or computer resources, such as W. P. Overbeck, Director of the Savannah River Laboratories and Herman Michielsen, Senior Staff Scientist, Lockheed Missiles and Space Company. During the quarter, the ITCP received for the first time sets of mean orbital data which were based on independent analysis of independent observations carried out by a team of individuals with limited computer resources and no background training in orbit analysis of this kind. These results were reported in our Announcement Card issued 18 June 1964, copy of which is enclosed as Exhibit B.

It will be noted that the mean orbital elements supplied by Gregory Roberts and Arthur Arnold were based solely on observations made at Durban, South Africa. The data obtained by Roberts and Arnold are of use to anyone in the world having an interest in acquiring 1963-14A or 1962 Kappa I during a period from 30 to 60 days after issue. The analytical procedures were carried out with the aid of a desk calculator, following methods suggested in W. P. Overbeck's, "A Letter to Gregory Roberts", which has been published as part of the ITCP Program.

In the case of the more stable satellites, ways for describing the orbit and mean motion in terms of "gear ratio elements" have been developed. "Gear ratio elements"simplify long-term analysis of mean satellite motion. They also supply data in a form which permits acquisition of the more stable satellites from one to two years after the epoch of the elements. They will be described in bulletins to be issued during the next quarter.

2. Daily Sattellite Ephemerides

An alternative method for communicating acquisition data of particular interest in the shorter-lived or more erratic satellites is the daily satellite ephemeris. Such an ephemeris, giving predicted orbital arguments for 00h G.M.T. for each day of a 50-day period on six satellites was issued during the period. It is typical of the kind of daily ephemeris that has been proposed for routine preparation at Goddard Space Flight Center, and was, in this instance, prepared by W. P. Overbeck. A copy of the Daily Ephemerides is attached hereto as Exhibit C. Ephemeris data on three of the satellites (58 001A, 59 001A and 59 007A) were based on Smithsonian Astrophysical Observatory mean orbital data. Data on the remaining three (60 006A, 60 013B, and 63 047A) were based on observations made by W. P. Overbeck. The ephemeris contained on its reverse side tables of eccentricity functions for the current value of eccentricity of each of the satellites listed on the obverse side. True anomaly (PRV) and radius ratio (RAD) were given as functionsof mean anomaly (PRM). These elements were issued on April 5, 1964 in conjunction with a bulletin on "Work Sheets for Conversion of Satellite Data to Rationalized Orbital Elements"(Exhibit D). Further details are given in Section V of this Report.

- continued on Page 3

II. Support of Inflation Studies.

There were no satellite inflations during the quarter. To date, none of the photographic records showing traces of ECHO II (1964 004A) that have come to our attention give evidence of apparent brightness fluctuations attributable to surface anomalies of the structure. Arrangements have been made to keep the satellite under photographic surveillance to determine when and if brightness fluctuations of this type become evident.

III. Satellite Trackers' Handbook.

Satellite tracking techniques and methods for orbit analysis continue to develop at such a pace as to make it undesirable at this point to attempt to "freeze" the material into the form of a handbook. Advances in tracking methods, graphic forms and worksheets, and suggested procedures continue to be issued in bulletin form. The individual bulletins are related to one another and to the present literature through common systems of notation and terminology, and also through adherence to and systematic development of decimal notation for describing angles, as well as times of events.

IV. Rationalized Tables of Trigonometric Functions

During the quarter copies of "SEVEN PLACE COSINES, SINES AND TANGENTS FOR EVERY TENTH MICROTURN" were distributed to addressees and participants in the Independent Tracking Coordination Program. A copy of these tables of trigonometric functions with rationalized arguments is attached hereto as EXHIBIT F. The availability of these tables vastly simplifies desk calculator tracking methods.

V. Derivation of Rationalized Orbital Elements from Daily Satellite Ephemerides, SATOR Code Messages, and NORAD/SPADATS "4-line" Elements.

Rationalized orbital elements present data on the motion of an artificial earth satellite in an optimum form for making predictions. The derivation of rationalized orbital elements from data in other standard formats is routine. In ITCP Bulletin of 5 April, 1964, examples are given of the derivation of rationalized orbital elements from a variety of sources (Exhibit D). Computation work sheets to be used as guides for obtaining rationalized orbital elements from a daily ephemeris were provided, sample copy of which is enclosed herewith - Work Sheet A - and is marked Exhibit D-1. Work Sheet B for obtaining rationalized orbital elements from modified orbital elements is attached hereto and is marked EXhibit D-2. A copy of Work Sheet C for conversion of NORAD/SPADATS "4-line elements" to rationalized orbital elements is attached hereto also and is marked Exhibit D-3 Work Sheet C (Exhibit D-3) provides for derivation of PRM_1 (first time derivative of mean anomaly) from the anomalistic period which is given in such elements to the nearest hundredth of a minute only. An improved Work Sheet permitting derivation of mean motion values to higher precision from the "Semi-Major Axis" values given in NORAD/SPADATS "4-line" elements is in preparation and will be issued when a conversion table has been computed and is available.

VI. Rules for Advancing the Epoch of Rationalized Orbital Elements and Other Aids to Precise Computation.

Rationalized orbital elements may be routinely advanced to a subsequent epoch without loss of precision. Rules for computing rationalized orbital elements for a new epoch are described in ITCP Bulletin of 7 April, 1964, (EXHIBIT E) which gives an example of the necessary computations in work sheet form. Copies of blank Work Sheet C were supplied with the Bulletin (EXHIBIT E-1).

ITCP Bulletin of 7 April also gives rules for error-free combination of polar angles and for obtaining the negative of an angle. Drafting aids to make accurate overlays, including a table for locating arc centers on ITCP Chart #532 are supplied. The same bulletin briefly discusses the availability of circular slide rules for five significant figures, the relative merits of used desk calculators, and the availability of hand calculators which permit computation to eight significant figures.

VII. Digital Computer Program for Station Predictions (ZAYIN).

The methods of prediction, observation and analysis which have been consistently recommended by the Independent Tracking Coordination Program have been based on obtaining fixes at or near the time of local culmination. This is the instant when an artificial earth satellite transits the meridian from the mean orbit pole through the observer's station. For radio observers, this instant is practically undistinguishable from the instant of doppler inflection. Satellite observations at local culmination permit dealing with the effects of the earth's pear shape (third zonal harmonic) in a particularly efficient way and limit the problem of passing from mean to true anomaly in making a prediction. From a computation point-of-view, a method which requires conversion from true to mean anomaly is much more efficient.

A method for predicting positions of artificial earth satellites at the point of local culmination for desk calculator was described in detail in "A Letter to Gregory Roberts". These methods have been refined into a digital computer program of great efficiency by W. P. Overbeck, and described in a Bulletin dated May 14, 1964 entitled, "ZAYIN: A Computer Program For Predicting Positions of Artificial Satellites at the Point of Local Culmination", (EXHIBIT G), copy of which is attached hereto. ZAYIN uses rationalized orbital elements as input and accomplishes rejection of unobservable or inacceptable passes with a minimum of non-productive computation. ZAYIN computes the apparent positions of artificial earth satellites at the point of culmination. It is designed for use by the optical observer who wishes to make the type of observation that is most useful in the determination of orbital characteristics. It examines all revolutions of the satellite which occur between any two selected dates. It rejects those passes which are below the horizon, which occur while the observer is in daylight or for which the point of culmination is inside the Earth's shadow. For passes that are not rejected, it prints out predictions in both alt-azimuth form and in celestial coordinates, together with other data that is useful in setting the observing instrument or in adjusting the predictions when observation indicates that this is necessary. A number of observatories, including the Dominion

- continued on page 5

Observatory, Ottawa, Canada, are now using ZAYIN as a means for satisfying requirements for station predictions on visually observable passes on artificial earth satellites. Copies of the program in deck form are being made available.

VIII. Long-term Tracking Techniques for Stable Satellites.

In the case of the more stable satellites, tracking procedures and orbit analysis can be greatly simplified by expressing the motion of the orbit and of perigee as functionsof mean motion, rather than as functions of time. Element sets of this kind have been named "Gear Ratio Elements" by W. P. Overbeck, who is largely responsibile for their development. ITCP Bulletin of June 11, 1964 reproduces Overbeck's paper entitled, "Gear Ratio Orbital Elements for Tracking Artificial Earth Satellites". (EXHIBIT H)

An important aspect of gear ratio elements is that they offer a technique for orbit analysis which permits the casual observer to become an authoritative source of long-range acquisition data on stable satellites. It also permits the improvement of mean orbital data currently being supplied by the official tracking agencies so as to be useful for satellite acquisition over extended periods of time.

One of the prime objectives in the Independent Tracking Coordination Program has been to reduce the amount of data on a given satellite required for acquisition by an independent observer and to reduce the frequency of communications on a specific satellite required for such purposes. It appears that the gear ratio type of data package permits use of a smaller data package at less frequent intervals than any that have been advanced so far. Although particularly appropriate for the longer-lived satellites, gear ratio elements convey the essential information required for the shorter-lived satellites and may, therefore, be of interest for general adoption for the exchange of satellite acquisition information.

IX. Requirements for a Passive Geodetic Satellite.

The above topic was discussed by a panel on April 27, 1964 at the 1964 International Conference of the Society of Photographic Scientists and Engineers held in New York City. Copies of the final program of the Conference were furnished as EXHIBIT M to Report of April 20, 1964. It is anticipated that J. Hewitt's paper, "A 24-in. f/1 Schmidt System for Precision Measurement of Satellite Positions" will appear in the forthcoming issue of PHOTOGRAPHIC SCIENCE AND ENGINEERING, the SPSE Journal.

X. Matrix Methods

At the same meeting on April 27, 1964, Mr. Norton Goodwin, Director of ITCP read a paper entitled, "Apparent Place Determination of Photographic Star Images". A number of requests for preprints of this paper have been received to date. It is anticipated that the subject matter will appear in an ITCP Bulletin in the near future.

- continued on Page 6

XI. Announcements and Bulletins

A. Summary of Post Card Announcements on Radio-transmitting Satellites Distributed during Period 1 April - 30 June, 1964

Date	No. Dist.	Identity of Satellites		
4/8	691	64 004A	62 060A	63 054A
		64 005A	63 024A	64 003A
4/23	321	64 004A	62 060A	58 002B
		64 005A	64 001B	64 015A
5/7	321	64 004A	62 060A	63 024A
		64 005A	63 038C	63 049C
5/21	678	64 004A	62 060A	64 006B
		64 010A	63 024A	62 015A
6/5	318	64 004A	64 006B	63 054A
		62 060A	63 024A	62 015A
6/18	627	64 006B	64 010A	64 015A
		63 024A	63 054A	62 015A
		63 014A	62 010A	60 009A
		64 004A	64 005A	63 053A

B. Summary of Post Card Announcements on Brighter Satellites

4/2	465	64 004A	64 005A	63 053A
		60 009A	61 004A	58 001A
4/11	478	64 004A		
16	465	60 009A	61 004A	60 009A
		63 047A	63 053A	58 001A
5/1	463	64 009A	60 006A	58 001A
		64 005A	63 053A	60 009B
5/15	463	60 009A	60 006A	58 001A
		64 005A	63 053A	60 009B
5/29	467	64 004A	64 005A	58 001A
		60 009A	63 053A	60 009B
6/11	465	64 006B	64 004A	60 009A
		64 005A	60 006A	63 053A
6/25	465	60 009A	64 005A	60 009B
		58 001A	62 015A	59 007A

END OF REPORT

EXHIBITS ATTACHED TO THIS REPORT :

A. Financial Report, Quarter ending 30 June, 1964 (Forms 1030-1031)

B. Modified Orbital Announcement Card dated June 18, 1964 giving acquisition data supplied by independent observers in Durban, South Africa.

C. Daily Ephemerides on Six Satellites with Eccentricity Tables, issued April 5, 1964

D. Bulletin dated April 5, 1964 describing in detail Computation Work Sheets for Conversion of Satellite Data to Rationalized Orbital Elements

D(1) Work Sheet A: For Obtaining Rationalized Orbital Elements from Rationalized Daily Ephemerides

D(2) Work Sheet B: Rational Orbital Elements from Modified Orbital Elements

D(3) Work Sheet C: Conversion of NORAD-SPADATS "4-line" Elements to R.O.E.

E. Bulletin of April 7, 1964 containing Rules and information on Advancing the Epoch and Drafting Aids to Making Accurate Overlays

E(1) Work Sheet D: For Advancing the Epoch of Rationalized Orbital Elements

F. Tables of Trigonometric Functions: "SEVEN PLACE COSINES, SINES AND TANGENTS FOR EVERY TENTH MICROTURN"

G. Bulletin dated Mary 14, 1964: ZAYIN: A Computer Program for Predicting Positions of Artificial Satellites at the Point of Local Culmination.

H. Bulletin dated June 11, 1964: "Gear Ratio" Elements for Tracking Artificial Earth Satellites.

EXHIBIT B

MODIFIED ORBITAL ELEMENTS 1[illegible] Jun

BRIGHT						
OBJECT	64 006B	64 010A	64 015A	63 024A	63 054A	62 015A
NAME	Elek 2	Cosmos 25	Ariel 2	Tiros 7	Tiros 8	Ariel
SOURCE	Norad	Norad	GSFC	Norad	Norad	GSFC
EPOCH of	14 Jun	16 Jun	15 Jun	13 Jun	13 Jun	12 Jun
perigee	01H	08H	00H	16H	14H	18H
(UT)	14M64	56M53	49M10	53M36	33M38	39M96
INCLIN.	60A20	49A02	51A66	58A23	58A50	53A86
NODE W.	350A16	323A52	010A61	113A60	250A74	091A29
MPD = 1D	-04M24	-25M23	-20M06	-18M74	-17M97	-19M43
PERIGEE	073A30	276A21	020A66	144A25	350A03	282A06
change/P	+A017	+A303	+A214	+A093	+A086	+A172
A. PERIOD	156M386	91M434	101M195	97M439	99M370	100M551
change/P	-M00000	-M00031	-M00009	-M00001	-M00001	-M00001
ECCEN.	U82847	U01347	U07331	U00256	U00235	U05417
P. RADIUS	4326#0	4121#5	4142#2	4347#2	4405#3	4209#7
freq. X6/S	19T430 19T540	90T022	136T447	136T233	136T233	136T406
REMARKS	90T225			136T921	136T924	
R. A. NODE	290A87	075A27	265A00	041A77	229A53	089A82

MODIFIED ORBITAL ELEMENTS 18 Jun

BRIGHT	-28.8	-26,-30	-4	+3	-8,-20	-16,-28
OBJECT	63 014A	62 010A	60 009A	64 004A	64 005A	63 053A
NAME	Atl.Agena	Midas 5	Echo 1	Echo 2	Saturn 5	Expl 19
SOURCE	Durban*	Durban*	Norad	SAO	SAO	SAO
EPOCH of	19 Jun	19 Jun	13 Jun	20 Jun	20 Jun	20 Jun
perigee	00H	10H	09H	01H	02H	01H
(UT)	17M346	45M045	38M15	45M66	05M79	10M28
INCLIN.	87A310	86A705	47A30	81A47	31A45	78A62
NODE W.	080A316	060A070	009A93	014A22	338A94	024A61
MPD = 1D	-04M3164	-04M5056	-17M15	-07M18	-29M78	-07M78
PERIGEE	292A181	116A440	061A89	135A79	135A65	161A05
change/P	-A11702	-A13042	+A255	-A13272	+A66797	-A15244
A. PERIOD	166M4257	152M9816	114M328	108M714	94M237	115M594
change/P	-M00000	-M00000	-M00030	-M00010	-M00033	-M00019
ECCEN.	U00660	U02906	U05459	U02347	U03343	U11288
P. RADIUS	6180#87	5716#51	4584#2	4579#3	4118#8	4333#6
freq. X6/S	Tumbling	Tumbling		136T020		
REMARKS	very slow	per.13 sec.		136T170		
R. A. NODE	191A1843	008A9299	036A34	280A32	320A64	261A06

*Elements supplied by Gregory Roberts and Arthur Arnold, 62 Dragonwyck, 7 St. Georges Street, Durban, South Africa.

DAILY SATELLITE EPHEMERIDES

	58001A SAO 38471			59001A SAO 38471			59007A SAO 38471			60006A WPO 38466			60013B WPO 38442			63047A WPO 38468		
	NGR.09223CG 637.9			NGR.09132CG1358.4			NGR.09260CG1595.3			NGR.09174CG 16.7			NGR.07848CG 145.9			NGR.08433CG 651.3		
JNL	CP 7358.1 13T			CP 8299.1 11T			CP 8492.4 11T			CP 6862.3 15T			CP 7443.8 13T			CP 7502.8 13T		
38K	RNT	NRP	PRM	RNT	NRP	PRM	RNT	NRP	PRM	RNT	NRP	PRM	RNT	NRP	PRM	RNT	NRP	PRM
490	.03150	.17290	.11714	.57393	.62860	.41004	.28622	.67181	.44787	.26293	.12637	.63320	.66478	.59058	.68906	.11806	.86189	.41656
491	.04848	.19417	.87293	.58645	.64330	.89005	.29809	.68541	.53852	.28364	.15331	.90152	.68175	.61382	.40203	.13456	.88358	.77111
492	.06545	.21543	.62901	.59897	.65800	.37006	.30996	.69900	.62917	.30436	.18026	.16986	.69871	.63706	.91500	.15105	.90527	.12567
493	.08243	.23669	.38537	.61148	.67270	.85008	.32183	.71260	.71983	.32507	.20721	.43822	.71568	.66030	.42797	.16754	.92695	.48023
494	.09940	.25795	.14202	.62400	.68740	.33010	.33370	.72620	.81050	.34579	.23415	.70658	.73265	.68354	.94095	.18403	.94864	.83480
495	.11638	.27922	.89895	.63651	.70210	.81013	.34557	.73979	.90118	.36651	.26110	.97496	.74961	.70678	.45392	.20052	.97032	.18937
496	.13335	.30048	.65617	.64903	.71680	.29017	.35744	.75339	.99186	.38722	.28805	.24336	.76658	.73002	.96689	.21700	.99201	.54393
497	.15033	.32174	.41368	.66154	.73150	.77020	.36931	.76698	.08255	.40794	.31499	.51176	.78354	.75326	.47987	.23349	.01370	.89853
498	.16730	.34301	.17147	.67406	.74620	.25025	.38118	.78058	.17325	.42866	.34194	.78018	.80051	.77650	.99284	.24998	.03538	.25311
499	.18428	.36427	.92955	.68658	.76090	.73029	.39305	.79418	.26396	.44937	.36888	.04862	.81747	.79974	.50582	.26647	.05707	.60770
500	.20125	.38554	.68792	.69909	.77560	.21035	.40492	.80777	.35467	.47009	.39583	.31706	.83444	.82298	.01879	.28296	.07876	.96230
501	.21823	.40680	.44657	.71161	.79030	.69040	.41679	.82137	.44539	.49080	.42278	.58552	.85140	.84622	.53176	.29944	.10044	.31690
502	.23521	.42807	.20551	.72412	.80500	.17047	.42866	.83497	.53612	.51152	.44972	.85399	.86837	.86945	.04474	.31593	.12213	.67151
503	.25219	.44934	.96473	.73664	.81970	.65053	.44053	.84856	.62686	.53224	.47667	.12248	.88534	.89269	.55772	.33242	.14382	.02612
504	.26916	.47060	.72424	.74916	.83440	.13061	.45240	.86216	.71760	.55295	.50361	.39098	.90230	.91593	.07069	.34891	.16550	.38073
505	.28614	.49187	.48403	.76167	.84910	.61068	.46427	.87576	.80836	.57367	.53056	.65949	.91927	.93917	.58367	.36540	.18719	.73535
506	.30312	.51314	.24411	.77419	.86380	.09076	.47614	.88935	.89912	.59439	.55751	.92802	.93623	.96241	.09664	.38189	.20888	.08997
507	.32010	.53441	.00448	.78670	.87850	.57085	.48801	.90295	.98988	.61510	.58445	.19656	.95320	.98565	.60962	.39837	.23056	.44460
508	.33708	.55567	.76513	.79922	.89320	.05094	.49988	.91655	.08066	.63582	.61140	.46511	.97016	.00889	.12260	.41486	.25225	.79924
509	.35406	.57694	.52607	.81174	.90790	.53104	.51175	.93014	.17144	.65654	.63835	.73368	.98713	.03213	.63557	.43135	.27394	.15388
510	.37104	.59821	.28730	.82425	.92260	.01114	.52362	.94374	.26223	.67725	.66529	.00226	.00409	.05537	.14855	.44784	.29562	.50852
511	.38802	.61948	.04881	.83677	.93730	.49125	.53549	.95734	.35303	.69797	.69224	.27085	.02106	.07861	.66153	.46433	.31731	.86317
512	.40500	.64075	.81060	.84928	.95201	.97136	.54736	.97093	.44384	.71869	.71919	.53945	.03802	.10185	.17451	.48082	.33900	.21782
513	.42198	.66203	.57269	.86180	.96671	.45148	.55923	.98453	.53465	.73940	.74613	.80807	.05499	.12509	.68748	.49730	.36068	.57248
514	.43896	.68330	.33506	.87432	.98141	.93160	.57110	.99812	.62547	.76012	.77308	.07670	.07196	.14833	.20046	.51379	.38237	.92714
515	.45594	.70457	.09771	.88683	.99611	.41172	.58297	.01172	.71630	.78083	.80003	.34535	.08892	.17157	.71344	.53028	.40406	.28181
516	.47292	.72584	.86065	.89935	.01081	.89185	.59484	.02532	.80713	.80155	.82697	.61401	.10589	.19481	.22642	.54677	.42574	.63648
517	.48990	.74711	.62388	.91186	.02551	.37199	.60671	.03891	.89798	.82227	.85392	.88268	.12285	.21804	.73940	.56326	.44743	.99116
518	.50688	.76839	.38739	.92438	.04021	.85213	.61858	.05251	.98883	.84298	.88086	.15137	.13982	.24128	.25238	.57974	.46911	.34584
519	.52386	.78966	.15119	.93690	.05491	.33228	.63045	.06611	.07969	.86370	.90781	.42007	.15678	.26452	.76536	.59623	.49080	.70053
520	.54085	.81093	.91527	.94941	.06961	.81243	.64232	.07970	.17055	.88442	.93476	.68878	.17375	.28776	.27834	.61272	.51249	.05522
521	.55783	.83221	.67964	.96193	.08431	.29258	.65419	.09330	.26143	.90513	.96170	.95750	.19071	.31100	.79132	.62921	.53417	.40991
522	.57481	.85348	.44430	.97444	.09901	.77274	.66606	.10690	.35231	.92585	.98865	.22624	.20768	.33424	.30430	.64570	.55586	.76462
523	.59180	.87476	.20924	.98696	.11371	.25291	.67793	.12049	.44320	.94657	.01560	.49499	.22465	.35748	.81728	.66219	.57755	.11932
524	.60878	.89603	.97447	.99948	.12841	.73308	.68980	.13409	.53410	.96728	.04255	.76376	.24161	.38072	.33026	.67867	.59923	.47403
525	.62576	.91731	.73999	.01199	.14311	.21325	.70167	.14769	.62500	.98800	.06949	.03254	.25858	.40396	.84324	.69516	.62092	.82875
526	.64275	.93859	.50579	.02451	.15781	.69343	.71354	.16128	.71591	.00872	.09644	.30133	.27554	.42720	.35622	.71165	.64261	.18347
527	.65973	.95986	.27187	.03702	.17251	.17362	.72541	.17488	.80683	.02943	.12339	.57014	.29251	.45044	.86920	.72814	.66429	.53819
528	.67672	.98114	.03825	.04954	.18721	.65381	.73728	.18848	.89776	.05015	.15033	.83895	.30947	.47368	.38218	.74463	.68598	.89292
529	.69370	.00242	.80491	.06206	.20191	.13400	.74915	.20207	.98870	.07087	.17728	.10779	.32644	.49692	.89516	.76112	.70767	.24766
530	.71069	.02370	.57185	.07457	.21661	.61420	.76102	.21567	.07964	.09158	.20423	.37663	.34340	.52016	.40815	.77760	.72936	.60240
531	.72767	.04498	.33908	.08709	.23131	.09440	.77289	.22927	.17059	.11230	.23117	.64549	.36037	.54339	.92113	.79409	.75104	.95714
532	.74466	.06626	.10660	.09960	.24601	.57461	.78476	.24286	.26155	.13302	.25812	.91436	.37733	.56663	.43411	.81058	.77273	.31189
533	.76164	.08754	.87440	.11212	.26071	.05483	.79663	.25646	.35251	.15373	.28507	.18325	.39430	.58987	.94709	.82707	.79442	.66664
534	.77863	.10882	.64249	.12464	.27541	.53505	.80850	.27006	.44349	.17445	.31201	.45215	.41127	.61311	.46008	.84356	.81610	.02140
535	.79562	.13010	.41086	.13715	.29011	.01527	.82037	.28365	.53447	.19517	.33896	.72106	.42823	.63635	.97306	.86005	.83779	.37616
536	.81261	.15138	.17952	.14967	.30481	.49550	.83224	.29725	.62546	.21589	.36591	.98998	.44520	.65959	.48604	.87653	.85948	.73093
537	.82959	.17266	.94847	.16218	.31951	.97573	.84411	.31085	.71645	.23660	.39285	.25892	.46216	.68283	.99903	.89302	.88116	.08571
538	.84658	.19394	.71770	.17470	.33422	.45597	.85598	.32445	.80745	.25732	.41980	.52787	.47913	.70607	.51201	.90951	.90285	.44048
539	.86357	.21523	.48722	.18722	.34892	.93622	.86785	.33804	.89847	.27804	.44675	.79684	.49609	.72931	.02500	.92600	.92454	.79527
540	.8[illegible]6	.23651	.25703	.19973	.36362	.41646	.87972	.35164	.98[illegible]	.29875	.47370	.06581	.51306	.75255	.53798	.94249	.94622	.15005

EXHIBIT D-1

WORK SHEET A: For Obtaining Rationalized Orbital Elements from Rationalized Daily Ephemerides

No. - - NGR = $\overset{t}{.}$ CG = . km CP = . km

CG/CP = . Whole turns in PRM per day = $\overset{t}{.}0$

@ JNL = $\overset{d}{.}$: TNR = $\overset{t}{.}$ NRP = $\overset{t}{.}$ PRM = $\overset{t}{.}$

-(@ JNL = $\overset{d}{.}$: TNR = $\overset{t}{.}$ NRP = $\overset{t}{.}$ PRM = $\overset{t}{.}$)

ΔJNL = $\overset{d}{.}$ ΔTNR = $\overset{t}{.}$ ΔNRP = $\overset{t}{.}$ ΔPRM = $\overset{t}{.}$

divide each item by above value of ΔJNL

TNR_1 = $\overset{t}{.}$ NRP_1 = $\overset{t}{.}$ PRM_1 = $\overset{t}{.}$

WORK SHEET A: For Obtaining Rationalized Orbital Elements from Rationalized Daily Ephemerides

No. - - NGR = $\overset{t}{.}$ CG = . km CP = . km

CG/CP = . Whole turns in PRM per day = $\overset{t}{.}0$

@ JNL = $\overset{d}{.}$: TNR = $\overset{t}{.}$ NRP = $\overset{t}{.}$ PRM = $\overset{t}{.}$

-(@ JNL = $\overset{d}{.}$: TNR = $\overset{t}{.}$ NRP = $\overset{t}{.}$ PRM = $\overset{t}{.}$)

ΔJNL = $\overset{d}{.}$ ΔTNR = $\overset{t}{.}$ ΔNRP = $\overset{t}{.}$ ΔPRM = $\overset{t}{.}$

divide each item by above value of ΔJNL

TNR_1 = $\overset{t}{.}$ NRP_1 = $\overset{t}{.}$ PRM_1 = $\overset{t}{.}$

WORK SHEET A: For Obtaining Rationalized Orbital Elements from Rationalized Daily Ephemerides

No. - - NGR = $\overset{t}{.}$ CG = . km CP = . km

CG/CP = . Whole turns in PRM per day = $\overset{t}{.}0$

@ JNL = $\overset{d}{.}$: TNR = $\overset{t}{.}$ NRP = $\overset{t}{.}$ PRM = $\overset{t}{.}$

-(@ JNL = $\overset{d}{.}$: TNR = $\overset{t}{.}$ NRP = $\overset{t}{.}$ PRM = $\overset{t}{.}$)

ΔJNL = $\overset{d}{.}$ ΔTNR = $\overset{t}{.}$ ΔNRP = $\overset{t}{.}$ ΔPRM = $\overset{t}{.}$

divide each item by above value of ΔJNL

TNR_1 = $\overset{t}{.}$ NRP_1 = $\overset{t}{.}$ PRM_1 = $\overset{t}{.}$

Additional copies available from: ITCP, 824 Conn. Ave., Wash., D.C. 20006.

WORK SHEET A: For Obtaining Rationalized Orbital Elements from Rationalized Daily Ephemerides

No. - - NGR = $^{t}.$ CG = . km CP = . km

CG/CP = . Whole turns in PRM per day = $^{t}.0$

@ JNL = $^{d}.$: TNR = $^{t}.$ NRP = $^{t}.$ PRM = $^{t}.$

-(@ JNL = $^{d}.$: TNR = $^{t}.$ NRP = $^{t}.$ PRM = $^{t}.$)

ΔJNL = $^{d}.$ ΔTNR = $^{t}.$ ΔNRP = $^{t}.$ ΔPRM = $^{t}.$

divide each item by above value of ΔJNL

TNR_1 = $^{t}.$ NRP_1 = $^{t}.$ PRM_1 = $^{t}.$

WORK SHEET A: For Obtaining Rationalized Orbital Elements from Rationalized Daily Ephemerides

No. - - NGR = $^{t}.$ CG = . km CP = . km

CG/CP = . Whole turns in PRM per day = $^{t}.0$

@ JNL = $^{d}.$: TNR = $^{t}.$ NRP = $^{t}.$ PRM = $^{t}.$

-(@ JNL = $^{d}.$: TNR = $^{t}.$ NRP = $^{t}.$ PRM = $^{t}.$)

ΔJNL = $^{d}.$ ΔTNR = $^{t}.$ ΔNRP = $^{t}.$ ΔPRM = $^{t}.$

divide each item by above value of ΔJNL

TNR_1 = $^{t}.$ NRP_1 = $^{t}.$ PRM_1 = $^{t}.$

WORK SHEET A: For Obtaining Rationalized Orbital Elements from Rationalized Daily Ephemerides

No. - - NGR = $^{t}.$ CG = . km CP = . km

CG/CP = . Whole turns in PRM per day = $^{t}.0$

@ JNL = $^{d}.$: TNR = $^{t}.$ NRP = $^{t}.$ PRM = $^{t}.$

-(@ JNL = $^{d}.$: TNR = $^{t}.$ NRP = $^{t}.$ PRM = $^{t}.$)

ΔJNL = $^{d}.$ ΔTNR = $^{t}.$ ΔNRP = $^{t}.$ ΔPRM = $^{t}.$

divide each item by above value of ΔJNL

TNR_1 = $^{t}.$ NRP_1 = $^{t}.$ PRM_1 = $^{t}.$

EXHIBIT D-2

WORKSHEET B: Rationalized Orbital Elements from Modified Orbital Elements (items in square brackets are line No.'s of items listed in M.O.E.'s)

No.	= [1]	- -		#0
JNE	= epoch: from [4] = day mo. yr, obtain mjd +([5]/24 = h/24h/day +([6]/1440 = $\overset{m}{.}$ /1440m/day 	= $\overset{d}{.}$000000 = $\overset{d}{.}$) = $\overset{d}{.}$) = $\overset{d}{.}$		#1
NGR	= inclination = [7]/360°/t = $\overset{\circ}{.}$ /360°/t	= $\overset{t}{.}$		#2
CG/CP	= eccentricity = [14]	= .		#3
CP	= semi-major axis = [15] (1.60935 km/sm)/(1.000000 - #3) = (. sm) (1.60935 km/sm)/(0.)	= .	km	#4
CG	= semi-major axis times eccentricity = (#3)(#4)	= .	km	#5
TNR_0	= mean time of orbit pole at epoch TNL_0 = fractional part of #1 -(ANL_0 = [8]/360°/t = $\overset{\circ}{.}$ /360°/t = TNA_0 -(TNA TNR_0	 = $\overset{t}{.}$ = $\overset{t}{.}$) = $\overset{t}{.}$ = $\overset{t}{.}$250000) = $\overset{t}{.}$		#9
TNR_1	= 1st time derivative of mean time of orbit pole = [9]/1440 = $\overset{m}{.}$ /1440m/t	= $\overset{t}{.}$	(ENL)	#11
	Argument of perigee at epoch (from ascending node) = (#10)/360°/t = $\overset{\circ}{.}$ /360°/t	= $\overset{t}{.}$		#12
NRP_0	= argument of perigee at epoch (from north point of orbit) = (#12) - $\overset{t}{.}$250000	= $\overset{t}{.}$		#13
NRP_1	= 1st time derivative of argument of perigee = (#16)[11]/360 = (#16)($\overset{\circ}{.}$ /360°/t) = ($\overset{t}{.}$)($\overset{t}{.}$)	= $\overset{t}{.}$	(ENL)	#14
PRM_0	= mean anomaly at epoch	= $\overset{t}{.}$000000		#15
PRM_1	= 1st time derivative of mean anomaly = 1440m/[12] = 1440m/ $\overset{m}{.}$ /t	= $\overset{t}{.}$	(ENL)	#16
PRM_2	= $\frac{1}{2}$ 2nd time derivative of mean anomaly = $-(\#16)^3[13]/2880$ = -(.)($\overset{m}{.}$)/2880 = . /2880	= $\overset{t}{.}$	$(ENL)^2$	#17

Additional copies available from: ITCP, 824 Conn. Ave., Wash., D.C. 20006.

WORKSHEET B: Rationalized Orbital Elements from Modified Orbital Elements

(items in square brackets are line No.'s of items listed in M.O.E!s)

No.	= [1]	- -	#0
JNE	= epoch: from [4] = day mo. yr, obtain mjd	= $\overset{d}{.}000000$	
	+([5]/24 = h/24h/day	= $\overset{d}{.}$)	
	+([6]/1440 = $\overset{m}{.}$ /1440m/day	= $\overset{d}{.}$)	
		= $\overset{d}{.}$	#1
NGR	= inclination = [7]/360°/t = $\overset{o}{.}$ /360°/t	= $\overset{t}{.}$	#2
CG/CP	= eccentricity = [14]	= .	#3
CP	= semi-major axis = [15] (1.60935 km/sm)/(1.000000 - #3) = (. sm) (1.60935 km/sm)/(0.)	= . km	#4
CG	= semi-major axis times eccentricity = (#3)(#4)	= . km	#5
TNR_0	= mean time of orbit pole at epoch		
	TNL_0 = fractional part of #1	= $\overset{t}{.}$	
	-(ANL_0 = [8]/360°/t = $\overset{o}{.}$ / 360°/t	= $\overset{t}{.}$)	
	= TNA_0	= $\overset{t}{.}$	
	-(TNA	= $\overset{t}{.}250000$)	
	TNR_0	= $\overset{t}{.}$	#0
TNR_1	= 1st time derivative of mean time of orbit pole = [9]/1440 = $\overset{m}{.}$ /1440m/t	= $\overset{t}{.}$ (ENL)	#11
	Argument of perigee at epoch (from ascending node) = (#10)/360°/t = $\overset{o}{.}$ /360°/t	= $\overset{t}{.}$	#12
NRP_0	= argument of perigee at epoch (from north point of orbit) = (#12) - $\overset{t}{.}250000$	= $\overset{t}{.}$	#13
NRP_1	= 1st time derivative of argument of perigee = (#16)[11]/360 = (#16)($\overset{o}{.}$ /360°/t) = ($\overset{t}{.}$)($\overset{t}{.}$)	= $\overset{t}{.}$ (ENL)	#14
PRM_0	= mean anomaly at epoch	= $\overset{t}{.}000000$	#15
PRM_1	= 1st time derivative of mean anomaly = 1440m/[12] = 1440m/ $\overset{m}{.}$ /t	= $\overset{t}{.}$ (ENL)	#16
PRM_2	= $\frac{1}{2}$ 2nd time derivative of mean anomaly = $-(\#16)^3[13]/2880$ = -(.)($\overset{m}{.}$)/2880 = . /2880	= $\overset{t}{.}$ $(ENL)^2$	#17

EXHIBIT D-3

WORKSHEET C: Conversion of NORAD-SPADATS "4-line Elements" to R.O.E.

(items in square brackets are line No. and item No. of items in NORAD elements)

No.	= [0,3]	= - -	#0
JNE	= epoch = [1,3]	= $\overset{d}{.}$	#1
NGR	= inclination = [2,3]/360°/t = $\overset{\circ}{.}$ /360°/t	= $\overset{t}{.}$	#2
CG/CP	= eccentricity = [2,6]	= .	#3
CP	= semi-major axis = [1,4](a) = . (6378.17 km)	= . km	#4
CG	= semi-major axis times eccentricity = (#3)(#4)	= . km	#5
QNT_o	= celestial longitude of midnight from pole of ecliptic at epoch = $\overset{t}{.}540608 + \overset{t}{.}002738($ #1 - $38400\overset{d}{.}000000)$ = $\overset{t}{.}540608 + \overset{t}{.}002738(\quad \overset{d}{.} \quad)$ = $\overset{t}{.}540608 + \overset{t}{.}$	= $\overset{t}{.}$	#6
QNT_1	= 1st time derivative of longitude of mean midnight	= $\overset{t}{.}0027379093$(ENL)	#7
TNR_o	= mean time of the orbit pole at epoch		
	QNR_o = [2,5]/360°/t = $\overset{\circ}{.}$ /360°/t	= $\overset{t}{.}$	#8
	$-QNT_o$ = #6	= $\overset{t}{.}$	
	= TNR_o	= $\overset{t}{.}$	#9
TNR_1	= 1st time derivative of mean time of orbit pole		
	QNR_1 = [3,5]/360°t = $\overset{\circ}{.}$ /360°/t	= $\overset{t}{.}$ (ENL)	#10
	-(QNT_1	= $\overset{t}{.}002738$(ENL)	
	= TNR_1	= $\overset{t}{.}$ (ENL)	#11
	Argument of perigee at epoch (from ascending node) = [2,4]/360°/t = $\overset{\circ}{.}$ /360°/t	= $\overset{t}{.}$	#12
NRP_o	= Argument of perigee at epoch (from north point of orbit) = #12 - $\overset{t}{.}250000$	= $\overset{t}{.}$	#13
NRP_1	= 1st time derivative of argument of perigee = [3,4]/360°/t = $\overset{\circ}{.}$ /360°/t	= $\overset{t}{.}$ (ENL)	#14
PRM_o	= mean anomaly at epoch = [3,3]/360°/t = $\overset{\circ}{.}$ /360°/t	= $\overset{t}{.}$	
	- (#12	= $\overset{t}{.}$)	
	- ((*)(#8) (*)=(-1) if #2>$\overset{t}{.}25$	= $\overset{t}{.}$)	
		= $\overset{t}{.}$	#15
PRM_1	= 1st time derivative of mean anomaly = 1440/[2,7] = 1440m/ $\overset{m}{.}$ /t	= $\overset{t}{.}$ (ENL)	#16
PRM_2	= ½ 2nd time derivative of mean anomaly = $-(\#16)^2[3,7]/2880$ = -(.)(.)/2880 = . /2880	= $\overset{t}{.}$ $(ENL)^2$	#17

WORKSHEET C: Conversion of NORAD-SPADATS "4-line Elements" to R.O.E.
(items in square brackets are line No. and item No. of items in NORAD elements)

No. = [0,3] = - - #0

JNE = epoch = [1,3] = ^{d}. #1

NGR = inclination = [2,3]/360°/t = ^{o}. /360°/t = ^{t}. #2

CG/CP = eccentricity = [2,6] = . #3

CP = semi-major axis = [1,4](a) = . (6378.17 km) = . km #4

CG = semi-major axis times eccentricity = (#3)(#4) = . km #5

QNT$_o$ = celestial longitude of midnight from pole of ecliptic at epoch
= ^{t}.540608 + ^{t}.002738(#1 - 38400^{d}.000000)
= ^{t}.540608 + ^{t}.002738(^{d}.)
= ^{t}.540608 + ^{t}. = ^{t}. #6

QNT$_1$ = 1st time derivative of longitude of mean midnight = ^{t}.0027379093(ENL) #7

TNR$_o$ = mean time of the orbit pole at epoch
QNR$_o$ = [2,5]/360°/t = ^{o}. /360°/t = ^{t}. #8
-QNT$_o$ = #6 = ^{t}.
=TNR$_o$ = ^{t}. #9

TNR$_1$ = 1st time derivative of mean time of orbit pole
QNR$_1$ = [3,5]/360°t = ^{o}. /360°/t = ^{t}. (ENL) #1
-(QNT$_1$ = ^{t}.002738(ENL)
= TNR$_1$ = ^{t}. (ENL) #1

Argument of perigee at epoch (from ascending node)
= [2,4]/360°/t = ^{o}. /360°/t = ^{t}. #1

NRP$_o$ = Argument of perigee at epoch (from north point of orbit)
= #12 - ^{t}.250000 = ^{t}. #1

NRP$_1$ = 1st time derivative of argument of perigee
= [3,4]/360°/t = ^{o}. /360°/t = ^{t}. (ENL) #1

PRM$_o$ = mean anomaly at epoch = [3,3]/360°/t = ^{o}. /360°/t = ^{t}.
- (#12 = ^{t}.)
- ((*)(#8) (*)=(-1) if #2>^{t}.25 = ^{t}.)
= ^{t}. #1

PRM$_1$ = 1st time derivative of mean anomaly = 1440/[2,7]
= 1440m/ ^{m}. /t = ^{t}. (ENL) #1

PRM$_2$ = $\frac{1}{2}$ 2nd time derivative of mean anomaly = $-(\#16)^2[3,7]/2880$
= -(.)(.)/2880 = . /2880 = ^{t}. (ENL)^2 #1

Additional copies available from: ITCP, 824 Conn. Ave., Wash., D.C. 20006.

EXHIBIT D

Phone: STerling 3-4100

INDEPENDENT TRACKING COORDINATION PROGRAM
824 Connecticut Avenue
Washington 6, D. C.

BULLETIN

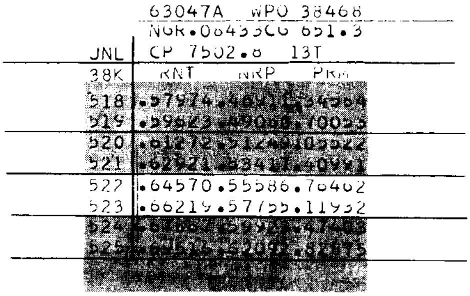
April 5, 1964

WORK SHEETS FOR CONVERSION OF SATELLITE DATA TO RATIONALIZED ORBITAL ELEMENTS

COMPUTATION WORK SHEETS which may be used as guides for obtaining rationalized orbital elements from various sources are discussed below. Blank copies are supplied herewith. Additional work sheets may be obtained from this office upon request. Please specify which work sheets are required.

Rationalized Orbital Elements from Daily Ephemeris: Example

Given



```
      63047A  WPO 38468
      NGR.08433CG 651.3
JNL | CP 7502.8  13T
38K | RNT    NRP    PRM
518 |.57974.[illegible]
519 |.59623.[illegible]
520 |.61272.[illegible]
521 |.62921.[illegible]
522 |.64570.55586.76462
523 |.66219.57755.11932
524 |[illegible]
525 |[illegible]
```

(Extract from Daily Ephemerides supplied by W. P. Overbeck 3 April 1964.)

WORK SHEET A: For Obtaining Rationalized Orbital Elements from Rationalized Daily Ephemerides

No. 63-047-01 NGR = $\overset{t}{.}08433$ CG = 651.3 km CP = 7502.8 km

CG/CP = .086812 Whole turns in PRM per day = $13\overset{t}{.}0$

@ JNL = $38523\overset{d}{.}000000$: TNR = - $\overset{t}{.}66219$ NRP = $\overset{t}{.}57755$ PRM = $\overset{t}{.}11932$

-(@ JNL = $38522\overset{d}{.}000000$: TNR = - $\overset{t}{.}64570$ NRP = $\overset{t}{.}55586$ PRM = $\overset{t}{.}76462$)

ΔJNL = $1\overset{d}{.}000000$ ΔTNR = - $\overset{t}{.}01649$ ΔNRP = $\overset{t}{.}02169$ ΔPRM = $13\overset{t}{.}35470$

divide each item by above value of ΔJNL

TNR_1 = - $\overset{t}{.}01649$ NRP_1 = $\overset{t}{.}02169$ PRM_1 = $13\overset{t}{.}35470$

Decoding SATOR Messages: Description of Code

SATOR (Modified Orbital Elements for Prediction Purposes)

Code word: SATOR

Symbolic form:

```
SATOR   aabbc    deeff    ggggZ    hhhhX    NOWES    iiiii
jkkkk   ARPER    11111    mnnnX    PERIOD   ooooo
ppppp   ECCEN    qqqqq    PERRA    rrrrr    RAFRE
sssss   (sssss repeated as necessary)       RADEG    ttttt
```

Key:

aa = last two digits of year satellite launched
bb = Greek letter designation, 01 = Alpha, 02 = Beta, etc.
c = component
d = reference time (epoch): last digit of numerical notation for month; i.e. 1 = January or November, 2 = February or December, 3 = March, etc.
ee = reference time (epoch): date
ff = reference time (epoch): hour
gggg = reference time (epoch): minutes and hundredths of minutes
Z = Universal time, Greenwich Mean Time
hhhh = inclination in degrees and hundredths of degrees. If the orbit inclination is negative (satellite fired westward) group is preceded by NEGAT
X = always an X
NOWES = sub-indicator for geographical longitude of northbound node west of Greenwich at reference time
iiiii = longitude of northbound node in degrees and hundredths of degrees
j = 1 if plus: when the "prime sweep interval" is one day plus a certain number of minutes
2 if minus: when the "prime sweep interval" is one day minus a certain number of minutes
This is equivalent to saying that the same portion of the orbit plane will reappear at the same location a certain number of minutes earlier each day.
kkkk = number of minutes and hundredths of minutes by which "prime sweep interval" differs from one day or 1440 minutes. This is another way of expressing the relative "westward motion" of the orbit plane.
ARPER = sub-indicator (argument of perigee) angular distance of perigee from node at reference time. For modified orbital elements, this is also the position of the satellite in the ellipse at reference time (mean anomaly at epoch is always equal to zero in this system)
11111 = angular distance of perigee and satellite from northbound node, measured in the direction of satellite travel in degrees and hundredths of degrees
m = 1 for plus, if perigee moves in the same direction as satellite travel
2 for minus, if perigee moves in the direction opposite to satellite travel
nnn = average decimal fraction of a degree which perigee moves per period, measured in thousandths of a degree
X = always an X
PERIOD = sub-indicator for perigee-to-perigee period (anomalistic period)

ooooo = perigee-to-perigee period (anomalistic period) in minutes and thousandths of a minute. If first two digits are less than 85 it should be understood that 100 should be added in order to arrive at the correct period (period cannot be less than about 88 minutes). Should the period be greater than 185 minutes a special notation will be made in the message.
ppppp = average per period change in perigee-to-perigee period, measured as a decimal fraction in one hundred thousandths of a minute
ECCEN = sub-indicator for eccentricity
ggggg = eccentricity, measured as a decimal fraction in one hundred thousandths
PERRA = sub-indicator for radial distance of satellite from center of earth at perigee
rrrrr = radial distance of satellite from center of earth at perigee, measured in miles and tenths of miles
RAFRE = sub-indicator for radio frequencies currently being transmitted from satellite
sssss = radio frequency in megacycles and hundredths of megacycles
RADEG = sub-indicator for right ascension of the ascending node expressed in degrees and hundredths of degrees in order that this message may also serve the needs of those who prefer traditional orbital elements (Note that this sub-indicator and the following code group represent a revision of the code appearing in the Fifth Supplement to the Draft Manual)
ttttt = degrees and hundredths of degrees of right ascension (Note that right ascension is given in degrees and hundredths of degrees rather than hours and minutes)

(From Satellite Report #7, National Academy of Sciences, National Research Council, p. 49-50)

Decoding SATOR Messages: Example

Given the following SATOR code message:

```
PART IV.
 SATOR   6354A    32716    5450Z    5850X    NOWES
 29152   21798    ARPER    24051    1086X    PERIOD
 99369   00001    ECCEN    00268    PERRA    44038
 RAFRE   36.20    00000    RADEG    14726
```

(From Bulletin 9 1963-54A 716 Part IV, from NASA Goddard Space Flight Center.
Data Source NORAD)

Modified Orbital Elements from above SATOR code message:

←See Code MODIFIED ORBITAL ELEMENTS 02 Apr

							Line No.
BRIGHT	+3	-4	-8,-20	-8,-24	-16,-28	-28,[illegible]	0
OBJECT	64 004A	63-054A	64 005A	61 004A	63 053A	58 00[illegible]	1
NAME	Echo 2	Tiros 8	Saturn 5	Expl 9	Expl 19	Expl [illegible]	2
SOURCE	Norad	Norad	Norad	SAO	SAO	SAO	3
EPOCH of	28 Mar	27 Mar	29 Mar	04 Apr	28 Mar	04 Apr	4
perigee	02H	16H	12H	00H	00H	01H	5
(UT)	09M28	54M50	07M97	17M46	37M97	05M[illegible]	6
INCLIN.	81A46	58A50	31A44	38A94	78A60	33A[illegible]	7
NODE W.	228A85	291A52	223A70	032A71	212A35	292[illegible]	8
MPD = 1D	-07M19	-17M98	-29M56	-24M77	-07M78	-2[illegible]	9
PERIGEE	329A37	240A51	013A13	095A79	327A03	14[illegible]	10
change/P	-A186	+A086	[illegible]	+A46752	-A15533	+[illegible]	11
A. PERIOD	108M853	99M369	[illegible]	[illegible]M340	115M711	10[illegible]	12
change/P	-M00009	-M00001	[illegible]	[illegible]	-M00010	[illegible]	13
ECCEN.	U02377	U00268	[illegible]	[illegible]	U11238	[illegible]	14
P. RADIUS	4580#1	4403#8	[illegible]	[illegible]	[illegible]	41[illegible]	15
freq. X6/S	136T020	136T233	[illegible]	[illegible]	[illegible]	[illegible]	16
REMARKS	136T170	136T924	[illegible]	[illegible]	[illegible]	[illegible]	17
R. A. NODE	349A00	147A26	146A21	[illegible]A33	[illegible]A42	[illegible]	18

Rationalized Orbital Elements from Modified Orbital Elements: Example

Given above Modified Orbital Elements:

WORKSHEET B: Rationalized Orbital Elements from Modified Orbital Elements
(items in square brackets are line No.'s of items listed in M.O.E!s)

No. = [1] 63-054-01 #0

JNE = epoch: from [4] = 27 day 03 mo. 1964 yr, obtain mjd = $38481^{d}.000000$
+([5]/24 = 16h/24h/day = $^{d}.666667)$
+([6]/1440 = $54^{m}.50$/1440m/day = $^{d}.037847)$
= $38481^{d}.704514$ #1

NGR = inclination = [7]/360°/t = 58°.50 /360°/t = $^{t}.162500$ #2

CG/CP = eccentricity = [14] = .00268 #3

CP = semi-major axis = [15] (1.60935 km/sm)/(1.000000 - #3)
= (4403.8 sm) (1.60935 km/sm)/(0.99732) = 7106.30 km #4

CG = semi-major axis times eccentricity = (#3)(#4) = 19.04 km #5

TNR_0 = mean time of orbit pole at epoch
TNL_0 = fractional part of #1 = $^{t}.704514$
-(ANL_0 = [8]/360°/t = 291°.52 / 360°/t = $^{t}.809778)$
= TNA_0 = $^{t}.394736$
-(TNA = $^{t}.250000)$
TNR_0 = $^{t}.644736$ #9

TNR_1 = 1st time derivative of mean time of orbit pole
= [9]/1440 = $-17^{m}.98$/1440m/t = - $^{t}.012486$(ENL) #11
Argument of perigee at epoch (from ascending node)
= (#10)/360°/t = 240°.51/360°/t = $^{t}.668083$ #12

NRP_0 = argument of perigee at epoch (from north point of orbit)
= (#12) - $^{t}.250000$ = $^{t}.418083$ #13

NRP_1 = 1st time derivative of argument of perigee = (#16)[11]/360
= (#16)(0°.086/360°/t) = (14.4914)($^{t}.0002389$) = $^{t}.003462$(ENL) #14

PRM_0 = mean anomaly at epoch = $^{t}.000000$ #15

PRM_1 = 1st time derivative of mean anomaly = 1440m/[12]
= 1440m/ $99^{m}.369$/t = $14^{t}.49144$ (ENL) #16

PRM_2 = $\frac{1}{2}$ 2nd time derivative of mean anomaly = $-(\#16)^3[13]/2880$
= -(3043.2)($-^{m}.00001$)/2880 = .030432/2880 = $^{t}.106\text{-}4$ $(ENL)^2$ #17

Rationalized Orbital Elements from NORAD-SPADATS "4-line" Elements: Example

Given:

```
(((((
0  716  009 1963-54A           US   64 03 27   9 03 28 261
1  716  009 38481.72737050 01.11416577 -.953515-06 -.240759-10 178
2  716  009 058.4979 240.5085 147.2553 .0026835 0099.36 000721 179
3  716  009 147.0132  01.2459 -03.5655 -.853-06 -.127-3 001411 136
)))))
```

(From Element sets for NASA issued 29 March 64, Data Source NORAD)

WORKSHEET C: Conversion of NORAD-SPADATS "4-line Elements" to R.O.E.
(items in square brackets are line No. and item No. of items in NORAD elements)

No.	= [0,3]		= [illegible]	#0
JNE	= epoch = [1,3]		= $\overset{d}{.}$ [illegible]	#1
NGR	= inclination = [2,3]/360°/t	= $\overset{o}{.}$ [illegible] /360°/t	= $\overset{t}{.}$ [illegible]	#2
CG/CP	= eccentricity = [2,6]		= . [illegible]	#3
CP	= semi-major axis = [1,4](a)	= . [illegible] (6378.17 km)	= [illegible] . [illegible] km	#4
CG	= semi-major axis times eccentricity = (#3)(#4)		= [illegible] . [illegible] km	#5
QNT_0	= celestial longitude of midnight from pole of ecliptic at epoch			
	= $\overset{t}{.}540608 + \overset{t}{.}002738(\#1 - 38400\overset{d}{.}000000)$			
	= $\overset{t}{.}540608 + \overset{t}{.}002738($ $\overset{d}{.}$ [illegible])			
	= $\overset{t}{.}540608 + \overset{t}{.}$ [illegible]		= $\overset{t}{.}$ [illegible]	#6
QNT_1	= 1st time derivative of longitude of mean midnight		= $\overset{t}{.}0027379093$(ENL)	#7
TNR_0	= mean time of the orbit pole at epoch			
	QNR_0 – [2,5]/360°/t	= $\overset{o}{.}$ [illegible] /360°/t	= $\overset{t}{.}$ [illegible]	#8
	$-QNT_0$ = #6		= $\overset{t}{.}$ [illegible])	
	$=TNR_0$		= $\overset{t}{.}$ [illegible]	#9
TNR_1	= 1st time derivative of mean time of orbit pole			
	QNR_1 = [3,5]/360°t	= – $\overset{o}{.}$ [illegible] /360°/t	= – $\overset{t}{.}$ [illegible] (ENL)	#10
	$-(QNT_1$		= $\overset{t}{.}002738$(ENL)	
	$= TNR_1$		= – $\overset{t}{.}$ [illegible] (ENL)	#11
	Argument of perigee at epoch (from ascending node) = [2,4]/360°/t	= $\overset{o}{.}$ [illegible] /360°/t	= $\overset{t}{.}$ [illegible]	#12
NRP_0	= Argument of perigee at epoch (from north point of orbit) = #12 – $\overset{t}{.}250000$		= $\overset{t}{.}$ [illegible]	#13
NRP_1	= 1st time derivative of argument of perigee = [3,4]/360°/t	= $\overset{o}{.}$ [illegible] /360°/t	= $\overset{t}{.}$ [illegible] (ENL)	#14
PRM_0	= mean anomaly at epoch = [3,3]/360°/t	= $\overset{o}{.}$ [illegible] /360°/t	= $\overset{t}{.}$ [illegible]	
		– (#12	= $\overset{t}{.}$ [illegible])	
		– ((*)(#8) (*)=(-1) if #2>$\overset{t}{.}25$	= $\overset{t}{.}$ [illegible])	
			= $\overset{t}{.}$ [illegible]	#15
PRM_1	= 1st time derivative of mean anomaly = 1440/[2,7]			
	= 1440m/ $\overset{m}{.}$ [illegible] /t		= $\overset{t}{.}$ [illegible] (ENL)	#16
PRM_2	= ½ 2nd time derivative of mean anomaly = $-(\#16)^2[3,7]/2880$			
	= –([illegible])([illegible])/2880	= . [illegible] /2880	= $\overset{t}{.}$ [illegible] $(ENL)^2$	#17

DRAFTING AIDS TO MAKING ACCURATE OVERLAYS

In ITCP Bulletin of January 15, 1964 (1. 11) mention was made of an

> "inexpensive yardstick compass such as #978 of Eugene Dietzgen Co., 2425 Sheffield, Chicago, Illinois 60614, which could be purchased for less than $15 and which is useful in preparing accurate overlays for meridional stereographic nets."

Our attention has been drawn to the Keuffel and Esser Mark 1 Beam Compass, Item No. 55-1806, which is also available at less than $15. It is available at most drafting and surveying supply houses and is distributed by Keuffel and Esser, Hoboken, New Jersey. Three 8" beams are supplied with this unit and additional beams are available.

ACCURATE LOCI for the centers of arcs to be swung with a beam compass can rapidly be found with the table given below. Distances in millimeters from the net center are given.

Location of Arc Centers for Preparing Accurate Overlays of Mean Orbit Plane and of Observer's Parallel

On ITCP Chart #532

ORBIT PLANE ARC CENTER			OBSERVER CIRCLE CENTER		
NGR (turns)	Center On X Axis (mm)	NGR (turns)	NGO (turns)	Center On Y Axis (mm)	NGO (turns)
.00	00.0	.50	.00	160.3	.50
.01	10.1	.49	.01	160.6	.49
.02	20.3	.48	.02	161.6	.48
.03	30.6	.47	.03	163.2	.47
.04	41.2	.46	.04	165.5	.46
.05	52.1	.45	.05	168.5	.45
.06	63.5	.44	.06	172.4	.44
.07	75.4	.43	.07	177.2	.43
.08	88.1	.42	.08	182.9	.42
.09	101.7	.41	.09	189.9	.41
.10	116.5	.40	.10	198.1	.40
.11	132.6	.39	.11	208.0	.39
.12	150.5	.38	.12	219.9	.38
.13	170.7	.37	.13	234.2	.37
.14	193.8	.36	.14	251.5	.36
.15	220.6	.35	.15	272.7	.35
.16	252.6	.34	.16	299.2	.34
.17	291.6	.33	.17	332.7	.33
.18	340.7	.32	.18	376.5	.32
.19	404.9	.31	.19	435.5	.31
.20	493.4	.30	.20	518.7	.30
.21	624.3	.29	.21	644.6	.29
.22	840.3	.28	.22	855.5	.28
.23	1268.9	.27	.23	1279.0	.27
.24	2547.9	.26	.24	2552.9	.26
.25	-----	.25	.25	-----	.25

ACUARC RULER

It is obvious from the above table that many of the arcs of circles which one would like to draw on a stereographic net overlay are too large for beam compasses of practical radius. The ACUARC ruler is a flexible template that can be adjusted to approximate curves of any radius from about 7" to infinity. It is extremely useful in fitting arcs of circles through three or four points plotted on a net overlay. It is sold by many drafting and mapping supply houses and is manufactured by Hoyle Engineering Company, Barstow, California, U.S.A. The list price is $10.00.

SLIDE-RULE MULTIPLICATION AND DIVISION TO FIVE SIGNIFICANT FIGURES

The Atlas slide rule is an ingenious device for multiplying and dividing to five significant figures. In addition to a circular scale around the periphery of the disc, the slide rule contains a spiral scale of 25 coils occupying most of the face of the slide rule, which is about 21 cm in diameter. For those who do not have access to a desk calculator or a hand calculator, such as the CURTA described below, the Atlas Slide Rule will prove a very useful aid to computation. It is distributed by Eugene Dietzgen Co., 2425 Sheffield, Chicago, Illinois, 60614, U.S.A., and is available from most drafting and surveying supply houses. It is listed as Dietzgen Part No. 1797A at a $13.50 list price.

USED DESK CALCULATORS

Greater than 5-place accuracy requires access to a desk calculator or at least a hand calculator. Used and/or reconditioned desk calculators with automatic division features and sufficient register dials to compute to 8 significant figures are available through most stationery and office supply sales outlets, including those of the larger department stores (e.g. Macy's in New York City). In general, a used desk calculator with few features, but in good condition, will prove to be a better buy than a used desk calculator in fair condition with many special features at the same price.

CURTA HAND CALCULATOR

The CURTA hand calculator, while not as convenient as a good electric-powered desk calculator, can be used to solve problems to 8 significant figures. One version with more limited registers is offered but is not considered to be as good a buy. These items are not toys, they are precision equipment and command a substantial price - about $165. They are available through some of the larger stationery stores and are listed in the Montgomery Ward catalog under Automobile Rally Accessories.

Exhibit G

Phone: STerling 3-4100

INDEPENDENT TRACKING COORDINATION PROGRAM

824 Connecticut Avenue
Washington 6, D. C.

BULLETIN

ZAYIN: A COMPUTER PROGRAM FOR PREDICTING POSITIONS OF ARTIFICIAL SATELLITES AT THE POINT OF LOCAL CULMINATION

W. P. Overbeck

May 14, 1964

Introduction

This paper describes an automatic prediction program, ZAYIN, which computes the apparent positions of artificial earth satellites at the point of local culmination. It is designed for use by the optical observer who wishes to make the type of observation that is most useful in the determination of orbital characteristics. It examines all revolutions of the satellite which occur between any two selected dates. It rejects those passes which are below the horizon, which occur while the observer is in daylight or for which the point of culmination is inside the Earth's shadow. For passes that are not rejected, it prints out predictions in both alt-azimuth form and in celestial coordinates, together with other data that is useful in setting the observing instrument or in adjusting the predictions when observation indicates that this is necessary.

ZAYIN uses Rationalized Orbital Elements as input. These were initially described in an ITCP publication, "A Letter to Gregory Roberts", and have been further discussed in subsequent ITCP Bulletins. A Bulletin of April 5, 1964, tells how to derive such elements from the information available from a variety of sources. The output of ZAYIN is also, primarily, in rationalized format and is arranged to facilitate mailing of predictions from a central computing facility to distant observing stations.

ZAYIN is one of a group of programs which, together, comprise a complete data processing system for satellite tracking, including such functions as; computation of perturbations, preparation of tabular aids for desk calculator computation and the reduction and analysis of observations. The data card format and the subroutines used in ZAYIN are designed to be applicable to all programs in this system.

The unique feature of ZAYIN is that it accomplishes its rejection of unacceptable passes, with a minimum of non-productive computation, in the coordinate system of the orbit pole, rather than that of the Earth's North Pole. A fast subroutine for coordinate transformation, POLO, makes it possible to do this expeditiously. ZAYIN also includes an "internal counter" system that permits the program to make its own decisions as to whether certain steps in the computation are necessary.

Symbols, Units and Fortran Names

With few exceptions, the Fortran names used in ZAYIN are derived from the three-letter symbols which have been consistently used in the ITCP reference material. To maintain this consistency, we will use the same three-letter symbols in the ensuing description of ZAYIN, even though they differ from the Fortran names. It is believed that the reader can learn to recognize the differences without confusion. Where it is necessary to use Fortran names in the discussion, they will be underlined and will also include the Fortran convention of writing the letter "O" with a slash, as "Ø", to distinguish it from the numeral, zero.

The Fortran names require a fourth, prefix letter to differentiate between fixed-point and floating-point variables. We have given this prefix letter an added significance as follows:

I The letter "I" is used to designate the integral portion of a number. For example, the mean anomaly, PRM, may include both full and fractional turns, as in PRM = 1179.283492 In this case, the name, IPRM, would have the value, 1179, representing only the full turns.

A The fractional portion of a number such as that above, would have the prefix "A". In the above example, APRM would have the value, .283492 In ZAYIN, names that begin with "A", such as APRM, ANGR, ANRP, etc., represent the amplitude of the angle that is represented by the last three letters in the name.

S The prefix "S" will represent the sine of an angle. Thus, when the angle is named ANGR its sine will be named SNGR.

C Similarly, "C" designates the cosine, so that CNGR is the cosine of ANGR.

D The prefix "D" designates a difference or a derivative. Such a name will usually require further definition.

The units of angular measure in ZAYIN are decimal turns; units of time are decimal days and units of distance are kilometers. Throughout the program and subroutines, the letter "Z" always represents the constant, 2 pi, needed as a conversion factor between turns and radians wherever the standard trigonometric Library Functions are used.

Input

The input data for ZAYIN is arranged on a series of punched cards as described below. For each card, we give the full 72 column format, in which blank spaces are indicated by the letter "b". The field assigned to each Fortran variable is underlined. The numbers used in these examples correspond to an actual case and, in a succeeding description of the output, the same case is used so that the numbers may be directly compared.

Control Card

```
b38475b38535bbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbb
 JNL1  JNL2
```

This card gives the Modified Julian Dates, JNL, for starting, JNL1, and ending, JNL2, of the series of predictions.

C Card

```
0.157250b-0.227057b6372.07bbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbØVERBECKbbbb
 ANGØ      ALNØ      GØ                                                IDEN IDEN1
```

The C card gives the observer's position, including his polar distance, NGO, his longitude, LNO, and his radius, GO, from the Earth's center. It also provides 46 spaces for alphanumeric data that may be needed for identification or as an aid in addressing and mailing predictions. This information is transferred from input to output in blocks of 5 characters, such as IDEN and IDEN1. As written, ZAYIN transfers only two such blocks but it may be easily changed to transfer more information.

A Card

```
38466.02459357b.091739b06862.26b0016.75b21157.572844b15.26800111.665E-05
 JNE    AJNE     ANGR     CP       CG    IPRMO APRMO   APRM1      APRM2
```

This card contains a portion of the orbital elements for one satellite and includes all of the information needed in calculating the principal perturbations of its motion. Thus, for some programs, this is the only card needed. The first item is the epoch of the elements, JNE, divided into an integral portion, JNE, and a fractional portion, AJNE. (The "I" prefix is not used for the integral portion because the letter "J" already defines it as a fixed point variable.) The next three items include the inclination, NGR, the semimajor axis, CP, and the displacement of the orbit center, CG. The remaining items are coefficients of the equation for the mean anomaly, PRM, which, with the above values, would be written:

$$PRM = 21157.572844 + 15.26800111(ENL) + .665E\text{-}05(ENL)^2$$

For some programs, the second term coefficient, APRM1, is split into integral and fractional portions but ZAYIN does not require this.

B Card

```
-.766253b-.02071577b-.783E-08b+.480335b+.02694540b+.117E-07b.00E-05-3.53
  ATNRO     ATNR1     ATNR2     ANRPO     ANRP1     ANRP2     RGW    GD
```

The B card contains the remaining orbital element data, starting with coefficients for the two equations:

$$TNR = -\ 0.766253 - 0.02071577(ENL) - .783E\text{-}08(ENL)^2$$

$$NRP = +\ 0.480335 + 0.02694540(ENL) + .117E\text{-}07(ENL)^2$$

It also includes the values necessary in correcting for the effects of the Earth's pear shape; RGW, which happens to be insignificant for this case, and GD.

The full stack of data cards for a run of ZAYIN starts with the Control Card and C Card and may then include any number of pairs of A and B Cards, one pair for each satellite for which predictions are desired. A single blank card is then added at the end of the stack.

TABLE I, EXAMPLE OF OUTPUT OF ZAYIN

```
      OVERBECK           38466.024594 CP= 6862.26 CG=  16.75
                           NGR=.091739 RGW=0.       GD=-3.53

                           21157.572844 15.26800108 0.665E-05
                           NRP 0.480335  0.02694540 0.117E-07
  JNL1=38475               TNR-0.766253 -0.02071577-0.783E-08

     JNL      QNX     RA      NOR     NRO     GV      ONX    DMDT    SLAN
     UT       NGX    DECL     OGX     RGO     PRM     NXR    DRGX    COGS  I/J K/L M/N
  481.44057 .10950 20 37.7 .09244 .84110 6844.6 .1324 14.546 .3235  49   0   1
   10 34 25 .36707 -42.145 .24241 .19763 .94563 .1060 -1.445 .2133  42   0  91

  482.42134 .09208 20 12.6 .09210 .84190 6845.7 .1315 14.545 .3207   8   0   1
   10  6 43 .36679 -42.045 .24180 .19812 .92012 .1054 -1.454 .2785   5   0 105

  483.40210 .07461 19 47.4 .09176 .84270 6847.1 .1306 14.544 .3178   8   0   1
    9 39  1 .36647 -41.930 .24113 .19861 .89460 .1048 -1.462 .3652   5   0 119

  485.43245 .04856 19  9.9 .06420 .89732 6846.3 .0687 14.506 .1541  16   2   1
   10 22 43 .33300 -29.880 .18736 .22728 .89451 .0617 -2.171 .2141  10   0 148

  486.41321 .03092 18 44.5 .06372 .89816 6848.1 .0676 14.505 .1523   8   1   1
    9 55  1 .33184 -29.464 .18594 .22763 .86901 .0610 -2.182 .2983   4   0 162

  489.42455 .99409 17 51.5 .02774 .95721 6849.3 .0112 14.458 .0754  24   6   1
   10 11 20 .22148  10.267 .06504 .24523 .84699 .0235 -1.959 .2386  12   0 205

  490.40530 .97699 17 26.9 .02717 .95809 6851.6 .0106 14.457 .0754   8   2   1
    9 43 38 .21936  11.029 .06287 .24538 .82151 .0231 -1.921 .3162   3   0 219

  493.41679 .98389 17 36.8 .98726 .01955 6853.4 .9978 14.447 .0711  24   9   1
   10  0 10 .18254  24.285 .02537 .24821 .80186 .9883  0.959 .2571   9   0 262

  494.39754 .96715 17 12.7 .98668 .02044 6856.0 .9976 14.446 .0715   8   3   1
    9 32 27 .18341  23.971 .02625 .24813 .77634 .9878  0.997 .3328   2   0 276
```

```
496.42818 .96335 17   7.2 .94919 .07982 6856.0 .9576 14.483 .1109  16   8   1
 10 16 34 .29900 -17.639 .14741 .23587 .78101 .9557  2.412 .1824   4   0 305

497.40893 .94601 16 42.2 .94868 .08067 6858.6 .9568 14.483 .1124   8   4   1
  9 48 51 .30008 -18.029 .14866 .23559 .75544 .9551  2.402 .2658   1   0 319

505.04729 .69688 10 43.5 .05456 .91391 6871.6 .0484 14.485 .1223  64  38   1
  1  8  5 .30734 -20.642 .15704 .23373 .38154 .0485 -2.342 .2662   6   0 428

508.05863 .67179 10   7.4 .01704 .97384 6869.5 .0038 14.445 .0739  24  12   1
  1 24 25 .19001  21.595 .03293 .24758 .36026 .0153 -1.232 .2949   6   0 471

509.03936 .65497  9 43.2 .01647 .97471 6867.3 .0035 14.445 .0735   8   3   1
  0 56 40 .18893  21.984 .03184 .24768 .33463 .0148 -1.198 .1973   2   0 485

511.07006 .68062 10 20.1 .97707 .03530 6867.9 .9929 14.449 .0754  16   6   1
  1 40 52 .20490  16.235 .04808 .24643 .34052 .9801  1.624 .3323   6   0 514

512.05079 .66363  9 55.6 .97651 .03616 6865.5 .9925 14.450 .0753   8   2   1
  1 13  8 .20670  15.589 .04991 .24630 .31490 .9797  1.665 .2414   3   0 528

515.06207 .63124  9   9.0 .93990 .09554 6863.9 .9406 14.496 .1396  24   6   1
  1 29 22 .32216 -25.977 .17431 .23019 .29308 .9444  2.251 .2886  12   0 571

516.04280 .61358  8 43.6 .93942 .09635 6861.2 .9395 14.497 .1411   8   1   1
  1  1 37 .32357 -26.487 .17597 .22987 .26746 .9437  2.243 .1930   4   0 585

518.07311 .58656  8   4.6 .91088 .15127 6862.1 .8766 14.539 .2966  16   2   1
  1 45 16 .36362 -40.903 .23559 .20228 .26766 .9002  1.526 .3231  10   0 614

519.05383 .56898  7 39.3 .91054 .15204 6859.4 .8756 14.540 .2992   8   0   1
  1 17 31 .36406 -41.061 .23638 .20182 .24200 .8995  1.518 .2343   5   0 628

534.40009 .16480 21 57.3 .07184 .88352 6875.2 .0832 14.512 .1894 127   1   2
  9 36  7 .34310 -33.515 .20162 .22107 .56102 .0720 -1.962 .2118  90   0 847
```

Output

An example of the output of ZAYIN, obtained with the above input data, is shown in Table I. The table will extend through as many pages as are needed to reach the ending date, JNL2. For each satellite, a fresh page is started. The format is arranged so that the most important data is to the left of the vertical line, where the sheet can be trimmed to fit the standard 6½" mailing envelope. The alphanumeric identification data is printed at the upper left, where it will match a transparent window in the envelope.

The input orbital element data is reproduced at the upper right. Here, it may be seen that, in transferring the coefficient, APRM1, as a single, floating-point number, we lose the identity of the last digit. This is not important to ZAYIN.

Immediately below the identification, we print the starting date, JNL1. The purpose of this is to eliminate need for printing the first two digits in the succeeding table of predictions.

Each prediction occupies two lines and the numbers are arranged in pairs, upper and lower, which correspond to the upper and lower column headings. In most cases, the numbers in each pair have a functional relationship as indicated in the following discussion:

JNL UT	Both numbers represent the predicted time of culmination transit. The upper is expressed as the integral and fractional Modified Julian Date (with the first two digits removed) and the lower is the Universal Time in hours, minutes and seconds.
QNX NGX	This is the predicted apparent position in rationalized celestial coordinates, including the polar angle, QNX, and polar distance, NGX.
RA DECL	This is the same predicted position as above but is expressed in star chart coordinates of Right Ascension and Declination for the epoch of the prediction. For precise work, these must be corrected for precession of the coordinate system from the epoch of the charts.
NOR OGX	This is equivalent to an alt-azimuth prediction for the point of culmination but is expressed in rationalized coordinates with the observer's geocentric zenith (obtained by projection from G through O) as the pole. NOR is the polar angle of the orbit pole and OGX is the zenith distance. These values are not corrected for effects of atmospheric refraction.
NRO RGO	These represent the coordinates of the observer relative to the orbit pole. They are of interest to the observer who wishes to select those observations which will be most useful in determining the location of the orbit pole.
GV PRM	These numbers give the radius and mean anomaly of the satellite at the point of culmination. They are useful in selecting the most meaningful observations. They may be used in combination with other data to determine brightness and apparent rates of motion.

ONX NXR	These values are used in setting an instrument that employs an equatorial mounting. ONX corresponds to the "local hour angle" of the point of culmination and NXR determines the apparent "bearing angle" or direction of travel of the satellite, as viewed in celestial coordinates.
DMDT DRGX	DMDT is the rate of change of mean anomaly of the satellite, with respect to time, at the point of culmination. DRGX is the rate at which the angle, RGX, changes with respect to time. These values may be used in setting the proper rate of motion for a camera which, like the Baker-Nunn camera, follows the motion of the satellite. They may also be used in calculating corrections which should be applied to the predicted positions when the predicted timing is found to be in error.
SLAN COGS	SLAN is a Fortran variable that corresponds to the ratio of slant range to radius. Multiplied by GV, it gives the slant range and aids the observer in estimating brightness. COGS is the cosine of the angle, OGS, between the observer and the Earth's shadow center. For predictions that fall in the twilight zone, it is useful in estimating darkness of the sky so that the observer can decide whether observation of a faint satellite is feasible.

The remaining three columns contain numbers that are not related to the prediction. However, they are pertinent to a later discussion of the performance of the computer program. As described below, they indicate what the program has done in the interval between predictions.

I/J	I represents the number of passes rejected, after the preceeding prediction, because they were below the observer's horizon. J represents the number rejected because they occurred while the observer was in daylight, even though they were above the horizon.
K/L	K represents the number of passes rejected because the culmination point was inside the Earth's shadow although they were above the horizon and occurred while the observer was in darkness. L represents passes that were not rejected but which had to be returned for more precise computation because the estimated mean anomaly was substantiall different from that predicted by the equation for mean anomaly, PRM.
M/N	M is the number of returns for recomputation needed in refining the prediction to six-digit precision. N is the total number of synodic revolutions tested, up to the current prediction and including previous predictions. It is a cumulative count so that, as indicated by the final entry, the entire table involves the examination of 847 synodic revolutions, plus a few more that would have occurred between the final prediction and the ending date, JNL2.

In discussion of the Main Program, we will again refer to these counts to explain how they control the routing of the computation and how they provide a measure of the performance of the program.

Subroutines

The following discussion represents a functional description of each of the subroutines, starting with an example of the necessary CALL statement. Internal detail of some of these subroutines is given in separate Appendices. In each CALL statement, the underlined arguments are the "input" arguments, whose values must be supplied by the Main Program. The remaining arguments are the output arguments, for which values are supplied by the subroutine.

CALL FRACT (A, ARNØ)

FRACT is a very brief subroutine that usually preceeds an entry into POLO or other subroutines and operations that involve trigonometric functions. It extracts the fractional portion of a decimal number and expresses it in the range from $-0^{t}.5$ to $+0^{t}.5$ In ZAYIN, the input argument for FRACT usually has a temporary name, such as A or B. The CALL statement defines the permanent name for storage (in this case, it is ARNØ). As an example of the operation of this subroutine, we might start with the number:

$$A = 2412.849236$$

FRACT would extract the fractional portion, .849236, and, because this is outside the required range, it would subtract 1.0 to obtain - 0.150764, which would be returned to the Main Program as the value for ARNØ. Use of this subroutine permits us to combine several angles without concern as to whether or not they accumulate to more than a full revolution.

CALL PØLØ (ANGØ, SNGØ, CNGØ, ANGR, SNGR, CNGR, ARNØ, SRNØ, CRNØ, ARGØ, SRGØ, CRGØ, AØRN, SØRN, CØRN, ANØR, SNØR, CNØR)

POLO is the "workhorse" of ZAYIN, solving all problems in spherical trigonometry through coordinate transformation. The three underlined input arguments are supplied by the Main Program and POLO supplies the remaining 15 arguments. The chart on page 8 gives the rules for naming the arguments for POLO and also helps to explain what POLO does. The above CALL statement represents a case in which we wish to transform the coordinates of an observer, O, from the Earth's North pole, N, to the orbit pole, R, with the Earth's center, G, as the center of both coordinate systems. Examining the definitions given in the upper right portion of the chart, it may be seen that this requires the following substitutions:

3 = Ø   1 = N   2 = R   0 = G

These substitutions are then made in the list of "Call Names" given in the lower portion of the chart to obtain the arguments as listed above in the CALL statement. The order of letters obtained from this substitution automatically defines the direction of measurement of each polar angle. The subroutine contains its own switching system to route each computation through the shortest path. A complete description, flow diagram and Fortran listing for POLO are included in an ITCP Bulletin of November 19, 1962, on "Fortran Programs for Preparation of Tabular Aids to Satellite Tracking".

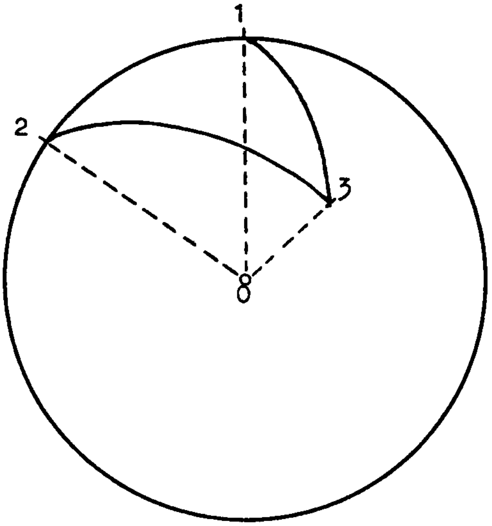
CALL SHADØ (JNL, AJNL, ANGS, ATNS, AQNT)

SHADO also requires FRACT and POLO as internal subroutines. From a given input date, for which the integral portion is JNL and the fractional portion is AJNL, SHADO computes the Earth's true anomaly and transforms it from the pole of the ecliptic, Q, to the North pole, N, providing the coordinates of the Earth's shadow center, NGS and TNS. It also supplies the fractional value of the Tropical Year, QNT. Details of SHADO are given in Appendix B. An understanding of the problem with which it deals can be obtained from an ITCP Bulletin of March 28, 1964, on "Time as a Measure of Direction in Space".

CALL KEPLR (APRV, CP, CG, APRM, DPRM, RADR, DRAD)

KEPLR contains Kepler's equations and computes the mean anomaly, PRM, and the ratio of radius to semimajor axis, RADR, from given input values of the true anomaly, PRV, and eccentricity, as derived from CG and CP. It also computes the rate of change of mean anomaly, DPRM, and rate of change of radius ratio, DRAD, per unit change in true anomaly.

Naming of Variables used as Arguments in POLO



Definitions:

3 A point whose coordinates are to be transformed.

1 Pole of coordinate system in which coordinates of 3 are known.

2 Pole of coordinate system in which coordinates of 3 are desired.

0 Common center of both coordinate systems.

Note: All angles must be expressed in decimal revolutions (turns) and in the range from - 0.5 to + 0.5

Call Name	Dummy Name	Description:
A103	A	Polar distance of point 3 from pole 1
S103	B	Sine of polar distance, 103
C103	C	Cosine of polar distance, 103
A102	D	Polar distance of pole 2 from pole 1
S102	E	Sine of polar distance, 102
C102	F	Cosine of polar distance, 102
A213	G	Polar angle of point 3 from pole 2, measured about pole 1
S213	H	Sine of polar angle, 213
C213	O	Cosine of polar angle, 213
A203	P	Polar distance of point 3 from pole 2
S203	Q	Sine of polar distance, 203
C203	R	Cosine of polar distance, 203
A321	S	Polar angle of pole 1 from point 3, measured about pole 2
S321	T	Sine of polar angle, 321
C321	U	Cosine of polar angle, 321
A132	V	Polar angle of pole 2 from pole 1, measured about point 3
S132	W	Sine of polar angle, 132
C132	X	Cosine of polar angle, 132

Note: The underlined variables; A103, A102 and A213 represent the input data, which must be supplied from the main program. All other values are computed by POLO. In the CALL statement, the variables must be listed in the above order.

Main Program

The following description is based on the Flow Diagram of Figure 1 but also requires reference to the Fortran statement list in Table II. Numbers in the Flow Diagram boxes correspond to the statement numbers. Although the program is a continuously flowing sequence of operations, it is written in six "Parts", each of which completes a major portion of the logic. Within each Part, the statements are numbered consecutively.

PART I reads the input data and establishes the output format. It also establishes the control pattern as that of a "one station - many satellite" program, predicting for any number of satellites in one computer run but for only one observing location. Minor changes in this part of the program will convert it to a "one satellite - many station" or "many satellite - many station" program.

As written, ZAYIN starts by reading the Control Card and C Card (statements 10 - 13) to find the range of prediction dates and the observer's location. It then reads the A Card for the first satellite. As indicated in the Flow Diagram, the program returns to this point for additional satellites and, if there are none, it is routed to the END through statement 16.

Continuing with a given satellite, ZAYIN reads the B Card (statements 17 and 18) and then proceeds to print the headings for the output table of predictions (statements 19 - 32).

PART II establishes initial values of program variables and the value of one constant, Z, (statement 40).

The independent variable in ZAYIN is ENL, the time elapsed since the epoch of the orbital elements. Its initial value is determined (statements 41 and 42) from the starting date, JNL1. Statement 43 then finds the maximum value, ENLM, from the ending date, JNL2.

The average interval between times of local culmination is equal to the "synodic period", SYNP. This is the reciprocal of the mean rate of revolution of the satellite relative to the observer, measured in turns per day. Statement 44 adds all of the rates involved: APRM1, the mean anomalistic motion of the satellite; ANRP1, the motion of the perigee; ATNR1, the motion of the orbit pole and - 1.0/day for the motion of the observer. Statement 45 then find the reciprocal to define the value of SYNP.

The internal counters; I, J, K, L, M and N, are all set to zero in this part of the program. The necessary statements are placed in an order that depends on the points at which various return loops are to enter.

One of the time-saving features of ZAYIN is that it computes the coordinates of the Earth's shadow center no more frequently than necessary, once at the start of the program and once as a part of the completion of each prediction. The initial values are supplied, in statements 48 and 49, for the starting date, JNL1.

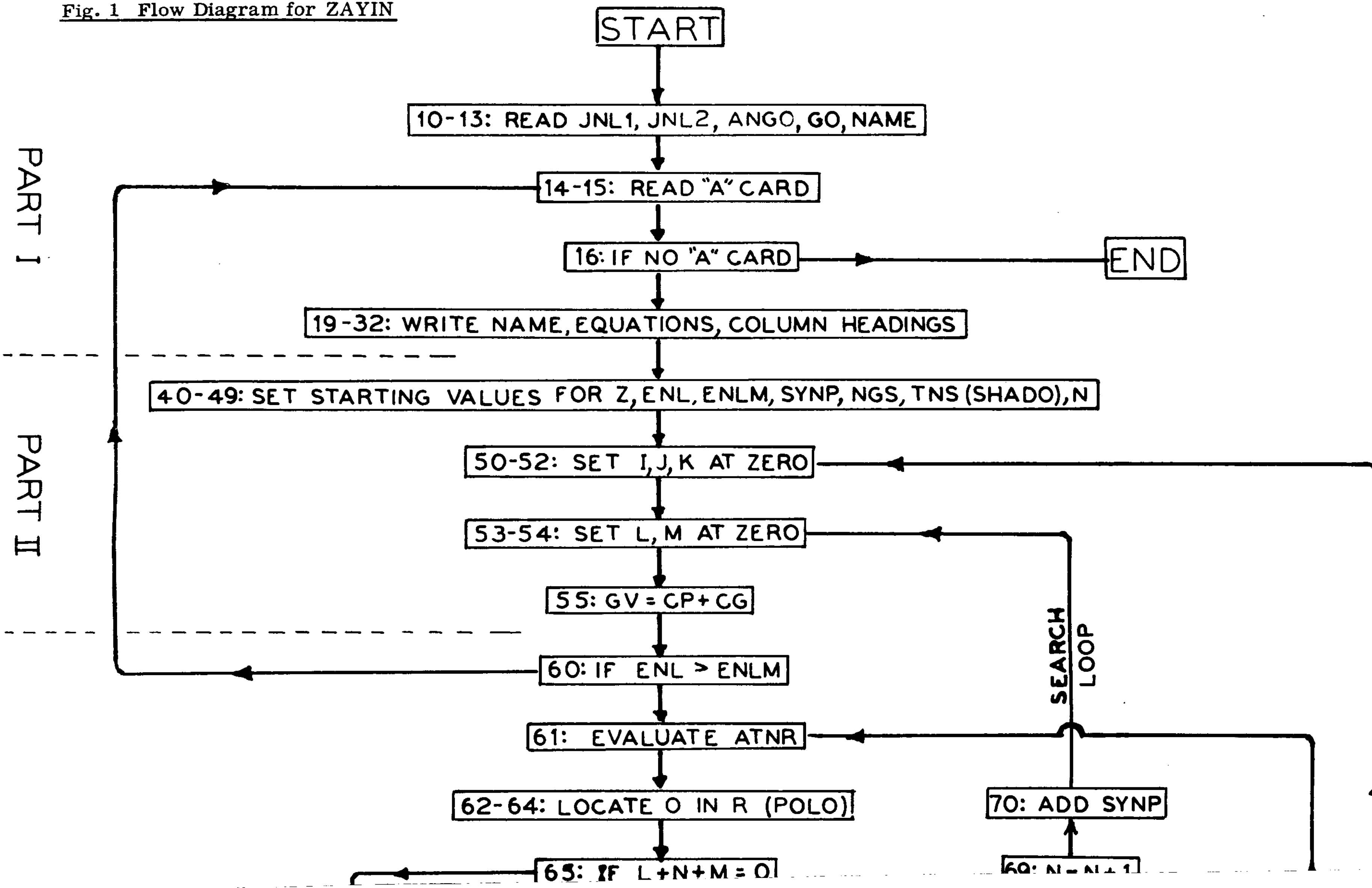
Considerable time is saved in ZAYIN by rejecting "impossible" passes prior to a final computation of the satellite radius, GV. Statement 55 allows the program to start with the initial assumption that the satellite is at its apogee radius, CP + CG.

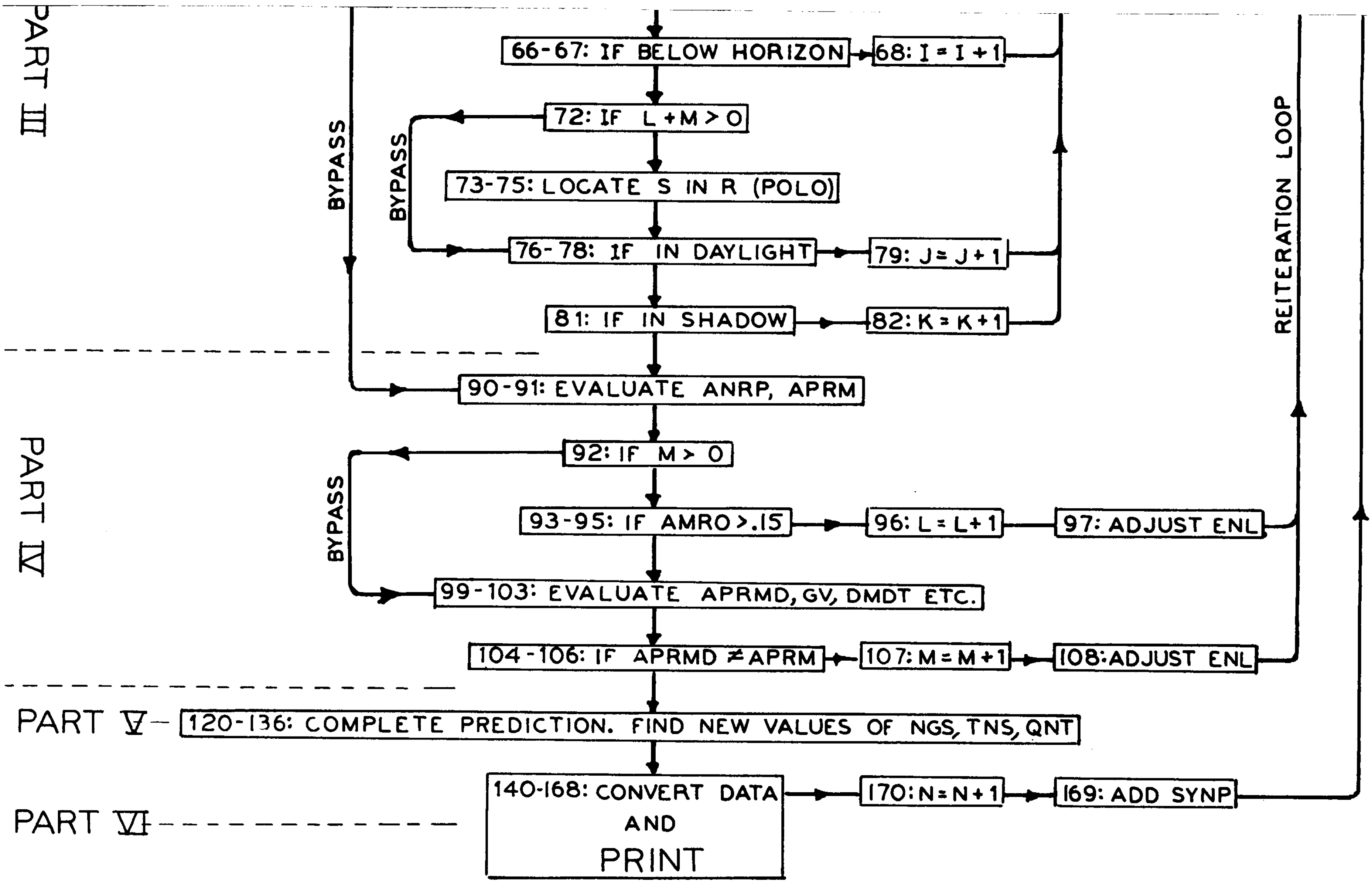
FORTRAN Listing for ZAYIN Main Program Parts I and II

```
C            ZAYIN
C            PART I
   10 READ 11,JNL1,JNL2
   11 FØRMAT(2I6)
   12 READ 13,ANGØ,ALNØ,GØ,IDEN,IDEN1
   13 FØRMAT(F8.6,F10.6,F8.2,34X,2A5)
   14 READ 15,JNE,AJNE,ANGR,CP,CG,IPRM,APRMO,APRM1, APRM2
   15 FØRMAT(I5,F9.8,F8.6,F9.2,F8.2,I6,F7.6,F12.8,E8.3)
   16 IF(JNE)172,172,17
   17 READ 18,ATNRO,ATNR1,ATNR2,ANRPO,ANRP1,ANRP2,RGW,GD
   18 FØRMAT(F8.6,F11.8,E10.3,F9.6,F11.8,E10.3,E8.2,F5.2)
   19 WRITE ØUTPUT TAPE 6,20,IDEN,IDEN1,JNE,AJNE,CP,CG
   20 FØRMAT(1H1,5X,2A5,7X,I5,F7.6,4H CP=,F8.2,4H CG=,F7.2)
   21 WRITE ØUTPUT TAPE 6,22,ANGR,RGW,GD
   22 FØRMAT(25X,4HNGR=,F7.6,5H RGW=,E8.2,4H GD=,F5.2//)
   23 WRITE ØUTPUT TAPE 6,24,IPRM,APRMO,APRM1,APRM2
   24 FØRMAT(25X,I5,F7.6,F12.8,E10.3)
   25 WRITE ØUTPUT TAPE 6,26,ANRPO,ANRP1,ANRP2
   26 FØRMAT(25X,3HNRP,F9.6,F12.8,E10.3)
   27 WRITE ØUTPUT TAPE 6,28,JNL1,ATNRO,ATNR1,ATNR2
   28 FØRMAT(2X,5HJNL1 =,I5,13X,3HTNR,F9.6,F12.8,E10.3//)
   29 WRITE ØUTPUT TAPE 6,30
   30 FØRMAT(4X,61HJNL      QNX      RA      NØR      NRØ      GV      ØNX     DMD
     1T    SLAN)
   31 WRITE ØUTPUT TAPE 6,32
   32 FØRMAT(5X,72HUT      NGX     DECL      ØGX      RGØ      PRM      NXR     DRGX
     1    CØGS I/J K/L M/N)


C            PART II
   40 Z=6.28318531
   41 A=JNL1-AJNE
   42 ENL=A+AJNE
   43 ENLM=JNL2-JNE
   44 A=APRM1+ANRP1+ATNR1-1.
   45 SYNP=1./A
   47 N=0
   48 AJNL=0.
   49 CALL SHADØ(JNL1,AJNL,ANGS,ATNS,AQNT)
   50 I=0
   51 J=0
   52 K=0
   53 L=0
   54 M=0
   55 GV=CP+CG
```

Fig. 1 Flow Diagram for ZAYIN



PART III
66-67: IF BELOW HORIZON
68: I = I + 1
72: IF L + M > O
73-75: LOCATE S IN R (POLO)
76-78: IF IN DAYLIGHT
79: J = J + 1
81: IF IN SHADOW
82: K = K + 1
BYPASS
BYPASS
REITERATION LOOP
PART IV
90-91: EVALUATE ANRP, APRM
92: IF M > O
BYPASS
93-95: IF AMRO >.15
96: L = L + 1
97: ADJUST ENL
99-103: EVALUATE APRMD, GV, DMDT ETC.
104-106: IF APRMD ≠ APRM
107: M = M + 1
108: ADJUST ENL
PART V
120-136: COMPLETE PREDICTION. FIND NEW VALUES OF NGS, TNS, QNT
PART VI
140-168: CONVERT DATA AND PRINT
170: N = N + 1
169: ADD SYNP

PART III starts with statement 60, which sends ZAYIN back for another satellite if ENL exceeds the maximum value, ENLM. It then includes the principal components of a "search loop", which searches for acceptable passes. The action of this loop can be better understood with the aid of a preliminary review of the geometry for the general situation, Figure 2, and for the rejection criteria, Figure 3.

Figure 2 is a view of the Earth from the direction of the orbit pole, R. The orbit then lies in the plane of the paper and its inclination is represented by the polar distance, NGR, of the Earth's North pole, N, from the orbit pole. In this view, the observer's circular path is tilted and his relationship to the orbit is described by the direction coordinates, NRO and RGO, and his radius, GO.

In Figure 3(a), it may be seen that, if the sine of the angle, RGO, is greater than GO/GV, the satellite will be above the observer's horizon. For preliminary screening, we can apply this criterion without knowing whether the satellite is actually at the point, V, and without knowing its exact radius, GV. To avoid unnecessary rejections, we can assume that GV has its maximum value, CP + CG.

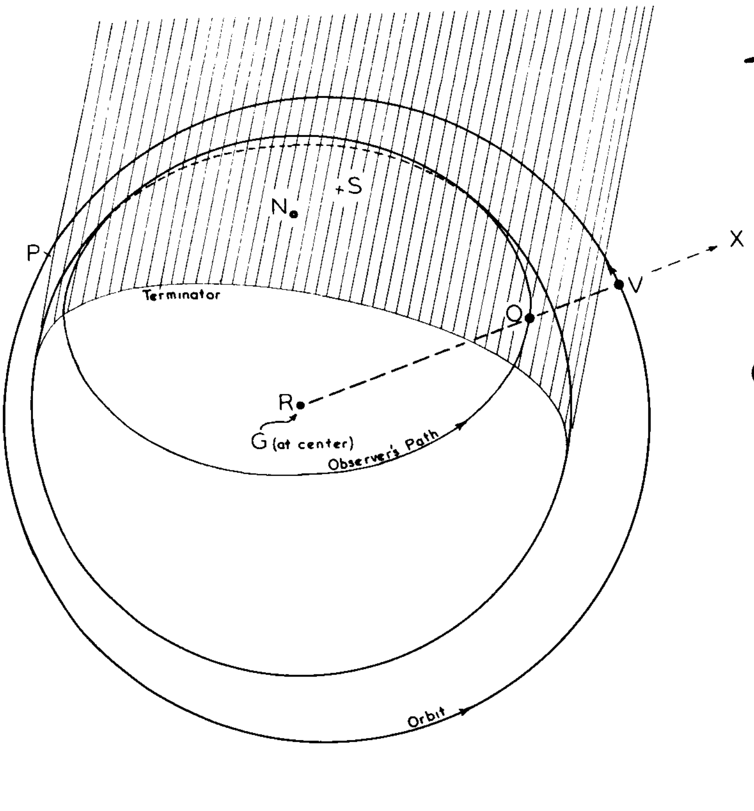


Fig. 2. Requirements for Optical Observation at the Point of Local Culmination

In this diagram, the Earth is visible from the orbit pole, R, and the Earth's center, G, is the center of the coordinate system. The orbit is in the plane of the paper and its inclination is represented by the polar distance, NGR, of the Earth's North Pole, N. The polar angle, NRO, of the observer, O, must equal the polar angle, NRV, of the satellite, V. For successful optical observation, the observer's polar distance, RGO, must be such that the satellite will be above his horizon (see Fig. 3(a)). The position of the Earth's shadow center, S, must be such that the observer is on the shadowed side of the terminator (see Fig. 3(b)) and the satellite is outside the cylindrical region defined by the Earth's shadow (see Fig. 3(c)).

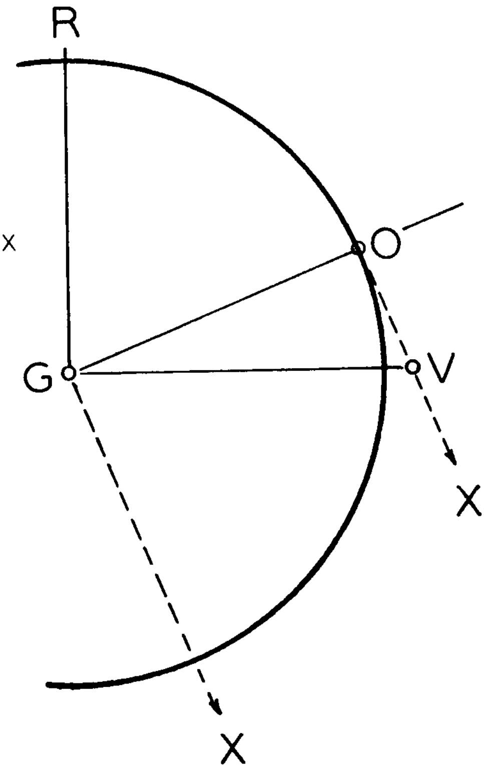


Fig. 3 (a) Criterion for Rejection

For the limiting case, the satellite, V, is on the horizon of the observer, O. The angle, OVG, is equal to the angle, RGO, and the sine of either OVG or RGO is GO/GV. Thus, if the sine of RGO is less than GO/GV, the satellite will be below the observer's horizon.

Returning to Figure 2, the position of the Earth's shadow center, S, may be defined by the direction coordinates, NRS and RGS. The question as to whether the observer is in daylight depends on the angle, SGO.

As illustrated in Figure 3(b), the cosine of SGO must be positive and, if we wish to insure that the observer is well inside the twilight zone, we can specify a minimum value. As written, ZAYIN requires that the observer be at least $0^{t}.028$ away from the "terminator", or edge of the shadow. This criterion is independent of the exact location of the satellite.

Looking, again, at Figure 2, it may be seen that the coordinates of the satellite would be: NRV, RGV and GV. RGV is always equal to $0^{t}.25$. At the point of culmination, NRV will be equal to NRO and, again, we may assume that GV has the maximum value, CP + CG.

As shown in Figure 3(c), the satellite must be outside the cylinder defined by the Earth's shadow, regardless of whether the angle, SGV, is greater or less than $0^{t}.25$. This requires that the sine of SGV be greater than GO/GV. Again, the assumption that GV = CP + CG is one that avoids unnecessary rejections.

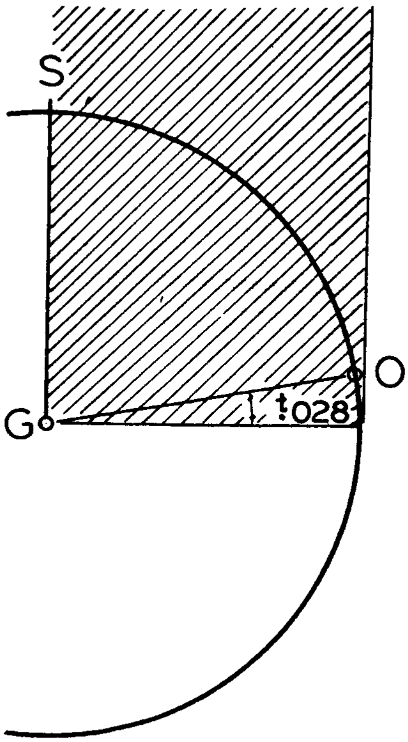


Fig. 3 (b) Criterion for Rejection

If the angle, SGO, is greater than $0^{t}.25$, the observer will be in sunlight. To ensure that his sky is reasonably dark, we require that he be about $0^{t}.028$ away from the edge of the shadow. Thus, if the cosine of SGO is negative, or less than 0.174, the circumstances are considered to be unsatisfactory.

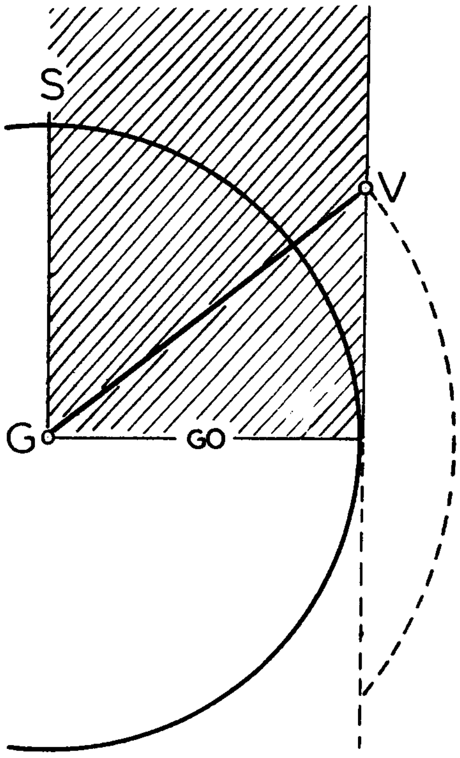


Fig. 3 (c) Criterion for Rejection

If the sine of the angle, SGV, is less than GO/GV, the satellite will be inside the cylinder defined by the Earth's shadow. On the side towards the Sun, it will then be below the horizon for any observer who is inside the shadow. On the side away from the Sun, it will be inside the shadow and will not be illuminated.

Returning to the Flow Diagram and Fortran listing, we should, temporarily, ignore the "bypass" lines at statements 65 and 72 because these are best related to the functions of Part IV of the program. The first task is then to locate the position of the observer, O, in the coordinates of the orbit pole, R. This is done in four steps:

a. Evaluate TNR from the TNR equation (statement 61).

b. Sum the necessary polar angles to find NRO (statement 62).

c. Call FRACT to express NRO in the proper range (statement 63).

d. Call POLO to transform O from N to R (statement 64). This statement is the example that was used in the functional description of POLO, above.

The criterion of Figure 3(a) is then applied in statements 66 and 67. SRG0 - G0/GV is given the name, P0GX, only because its value is useful at a later point in the program. If the pass is rejected (below the horizon), we add 1 to the "I" counter (statement 68). Returning through the search loop, we add 1 to the "N" counter and advance ENL by one synodic period (statements 69 and 70).

For the passes that are above the horizon, we then find the coordinates of the shadow center, S, in the same manner as used above; summing the polar angles (statement 73), placing in the proper range (statement 74) and transforming coordinates (statement 75). Statements 76 and 77 then represent two applications of the Law of Cosines, which are written in an order that economizes on computing time. Written in full, statement 76 would be:

$$\cos SGV = \cos RGS \cos RGV + \sin RGS \sin RGV \cos SRV$$

but RGV is always $0^{t}25$ and, at the point of culmination, SRV will equal SRO so that the equation reduces to:

$$\cos SGV = \sin RGS \cos SRO$$

Similarly, statement 77 could be written in full as:

$$\cos SGO = \cos RGS \cos RGO + \sin RGS \sin RGO \cos SRO$$

Having already evaluated the product, sin RGS cos SRO, we can write:

$$\cos SGO = \cos RGS \cos RGO + \sin RGO \cos SGV$$

The criterion of Figure 3(b) is then applied in statement 78 and, if the pass is rejected (in daylight), we add 1 to the "J" counter (statement 79) and, in returning through the search loop, add 1 to "N" and SYNP to ENL.

For surviving passes, the criterion of Figure 3(c) is applied in statement 81. For those rejected here (in shadow), we add 1 to the "K" counter, 1 to "N" and SYNP to ENL.

Much of the speed of ZAYIN is due to the effectiveness of this search loop. On the average, half of the passes will be rejected because they are below the horizon. (In Table I, there are a total of 480 "I" rejections in the 847 passes examined.) For this reason, the "I" reject path has been kept as short as possible. Of the remaining passes, approximately half (240 in Table I) will occur with the observer in daylight. Thus, the "J" path is just outside the "I" path. For a low-flying satellite, as was selected for our example in Table I, many passes that are otherwise acceptable will lie inside the Earth's shadow (106 in Table I). The fact that ZAYIN rejects these prior to final computation of the satellite position is an important time-saving feature. It should be noted that the assumption that GV = CP + CG is one that is designed to save all possible passes. This leads to some unnecessary computer work in that a few of these may be, later, rejected in Part IV. An alternative assumption would be that the satellite is at perigee radius where GV = CP - CG. Such an assumption would minimize computer work and would select only those passes that are easiest to observe. If ZAYIN were to be used in predicting for a large number of observing stations, such an assumption might be preferred.

FORTRAN Listing for ZAYIN Main Program Part III

```
C
    60 IF(ENL-ENLM)61,61,14
    61 ATNR=ATNRO+ATNR1 *ENL+ATNR2*ENL**2
    62 A=-ATNR+AJNE+ENL+ALNØ
    63 CALL FRACT(A,ARNØ)
    64 CALL PØLØ(ANGØ,SNGØ,CNGØ,ANGR,SNGR,
       CNGR,ARNØ,SRNØ,CRNØ,ARGØ,SRGØ,
       1CRGØ,AØRN,SØRN,CØRN,ANØR,SNØR,CNØR)
     65 IF(L+M+N)90,90,66
     66 PØGX=SRGØ-GØ/GV
     67 IF(PØGX)68,68,72
     68 I=I+1
     69 N=N+1
     70 ENL=ENL+SYNP
     71 GØ TØ 53
     72 IF(L+M)73,73,76
     73 A=ATNS-ATNR
     74 CALL FRACT(A,ARNS)
     75 CALL PØLØ(ANGS,SNGS,CNGS,ANGR,SNGR,
        CNGR,ARNS,SRNS,CRNS,ARGS,SRGS,
        1CRGS,ASRN,SSRN,CSRN,ANSR,SNSR,CNSR)
      76 CSGV=SRGS*CØSF((ASRN-AORN)*Z)
      77 CSGØ=CRGØ*CRGS+SRGØ*CSGV
      78 IF(CSGØ-.173648)79,79,81
      79 J=J+1
      80 GØ TØ 69
      81 IF(SQRTF(1.-CSGV**2)-GØ/GV)82,82,90
      82 K=K+1
      83 GØ TØ 69
```

PART IV is concerned with matching the polar angle, NRV, of the satellite with that of the observer, NRO (see Figure 2). It starts by evaluating NRP (statement 90) and PRM (statement 91) from the orbital element equations. Ignoring the bypass at statement 92, the sum of NRP and PRM is compared with NRO in statements 93, 94 and 95. If there is an appreciable difference (the value, $0\overset{t}{.}15$, was selected arbitrarily), the value of ENL is adjusted according to the formula in statement 97 and, adding 1 to the "L" counter, we return to statement 61 to try again. This returns the case to the search loop to redetermine the coordinates of the observer, O. The pass must again pass the rejection criteria but, this time, it is not necessary to redetermine the coordinates of S, which change rather slowly. Statement 72 permits us to bypass statements 73 through 75.

As indicated by Table I, very few passes are returned through "L". Such returns occur occasionally if the satellite has very high orbital eccentricity. Most cases advance to statements 99, 100 and 101, where we determine the mean anomaly, APRMD, that is equivalent to the polar angle, PRO, between the perigee, P, and observer, O, (see Figure 2). This is done by using PRO as the input value of true anomaly for KEPLR.

Statement 102 is the first determination of the actual radius, GV, and includes a small adjustment, GD cos NRO, for effects of the pear shape.

Statement 103 determines the rate of change, DMDT, of the computed value of mean anomaly as a function of time. It includes effects of motion of the satellite, the perigee, the orbit pole and the observer.

The desired value of mean anomaly, APRMD, is then compared with that predicted by the orbital element equation in statement 91, APRM. This requires three statements; 104, 105 and 106, using FRACT because we are interested in only the fractional portion. If the difference represents more than $0\overset{d}{.}000001$ in timing, we add 1 to the "M" counter, adjust ENL by an amount determined from the difference in mean anomaly and its rate of change, DMDT, and return to statement 61 to try again. The accurate determination of DMDT in statement 103 is an important factor in keeping the number of these returns to a minimum. As indicated in Table I, at least one return through "M" is usually necessary but the count is very rarely higher than 2.

In returning through "M", it is necessary, again, to pass all rejection criteria and, this time, with the correct value of GV. It is here that an occasional pass will be rejected after having progressed all the way through Part IV.

Use of the synodic period, SYNP, as a first approximation from each time of local culmination to the next is valid only after finding one correct time of culmination. This explains the bypass at statement 65, which requires that there must have been at least one adjustment at "L" or "M" or one complete prediction to bring the observer and satellite into "synchronism" before the rejection criteria can be applied.

The bypass at statement 92 insures that the rough adjustment of mean anomaly in statement 97 is applied only once. If this adjustment is made too closely, and if it is permitted to remain in effect, the program can go into a state of sustained recycle when there is a substantial difference between true anomaly and mean anomaly at the culmination point.

On completing Part IV, ZAYIN has fully established the situation shown in Figure 2, with NRV, for the satellite, substantially equal to NRO, for the observer. The observer, satellite and orbit pole are lined up on the same great circle.

FORTRAN Listing for ZAYIN Main Program Part IV

```
C
   90 ANRP=ANRPO+ANRP1*ENL+ANRP2*ENL**2
   91 APRM=APRMO+APRM1*ENL+APRM2*ENL**2
   92 IF(M)93,93,99
   93 A=-APRM-ANRP-AORN
   94 CALL FRACT(A,AMRØ)
   95 IF(ABSF(AMRØ)-.15)99,99,96
   96 L=L+1
   97 ENL=ENL+AMRØ/(APRM1+ANRP1-(1.-ATNR1)*SNGØ*CNØR/SRGØ)
   98 GØ TØ 61
   99 A=-ANRP-AØRN
  100 CALL FRACT(A,APRØ)
  101 CALL KEPLR(APRØ,CP,CG,APRMD,DPRM,RADR,DRAD)
  102 GV=CP*RADR+GD*CØRN
  103 DMDT=APRM1+ANRP1-DPRM*(1.-ATNR1)*SNGØ*CNØR/SRGØ
  104 A=APRMD-APRM
  105 CALL FRACT(A,B)
  106 IF(ABSF(B)-DMDT*.1E-05)120,120,107
  107 M=M+1
  108 ENL=ENL+B/DMDT
  109 GØ TØ 61
```

PART V finishes the prediction after the exact time of culmination has been found in Part IV. The order of the statements in Part V is not as logical as it could be and, although this does not affect the computer, we will discuss them in an order that should be easier for the reader to understand.

The alt-azimuth prediction in column 4 of Table I is already partly completed. The value of NOR has been stored as a part of the coordinate transformation in statement 64. Statement 120 completes the calculation of OGX, which was partially done in statement 66.

The next task is the conversion to celestial coordinates. These are first determined with relation to the orbit pole, R. In Figure 2, it may be seen that NRX is equal to NRO (already determined) and, in Figure 3(a), it may be seen that RGX will be equal to RGO + OGX, as done in statement 121. These coordinates, NRX and RGX, must then be transformed to the N pole, as is done in statement 130, providing values of RNX and NGX. To express the polar angle as QNX, we need a value of QNT, obtained with statements 124 through 129. We make the necessary summation of angles and adjust to the proper range in statements 131 through 134. The call of SHADO, in statement 129 not only provides the required value of QNT but also provides revised values of TNS and NGS for use with the next prediction.

Miscellaneous computations are included in statement 122, which computes the ratio of slant range to radius, <u>SLAN</u>; statement 123, which computes the rate of change of RGX with time; statement 135, which computes the local hour angle, ONX, and statement 136, which simply reverses the sign of ORN so that it can be printed out as NRO.

On completion of Part V, all of the real work of prediction is done and values of 98 variables that are involved in the prediction are in storage. At this point, we can make any decision that we like as to which values we wish to have in the output record.

PART VI is then concerned only with the conversion of data to the particular form desired for the printout of Table I. Statements 140 through 146 convert decimal days to Universal Time in hours, minutes and seconds. Statements 147 through 153 convert the value of QNX to hours and minutes in Right Ascension. Statement 154 converts NGX to degrees of Declination. Statements 154 through 164 cause all negative decimal fractions to be expressed as positive decimal fractions, simply to save space in the output format by eliminating minus signs. Statements 165 through 168 do the printing.

Finally, statement 169 adds one synodic period, statement 170 adds 1 to the "N" count and statement 171 sends ZAYIN back to look for the next observable pass.

Program Performance

ZAYIN has been tested with a variety of satellites, covering the full range of values of inclination and eccentricity. It works equally well for both northern hemisphere and southern hemisphere observing locations. The example used for Table I was chosen to illustrate the performance through a full revolution in TNR, the Local Mean Time of the Orbit Pole, for a low-flying satellite, which makes relatively few observable passes (60 06 A). The nature of the satellite is apparent from the rather large number of passes rejected because they are below the horizon (I) or inside the shadow (K). The only known limitation of the program is that it will not operate dependably if one attempts to predict for a period much beyond 100 days from the epoch of the orbital elements. This is a result of handling the mean motion, PRM1, as a single floating point number, rather than breaking it into integral and fractional parts and using double precision in multiplying it by ENL. The multiplication then results in uncertainty in the sixth decimal digit so that, in attempting to balance to $0\overset{t}{.}000001$, the program can fall into a sustained loop. This is not a serious limitation but the user should be aware of its existence.

Tracing through the rejects, as well as the predictions in Table I, one finds that the entire computation includes:

1261 coordinate transformations using POLO
43 orbital computations using KPLR
22 determinations of the Earth's shadow position with SHADO

plus the computations called for in many cycles through the Main Program. Using the IBM 704, which is now regarded as a slow machine, the entire job, plus printout on magnetic tape, requires about 95 seconds. A faster machine could do it in about 16 seconds. This proves, at least, that there are a great many microseconds in one second.

FORTRAN Listing for ZAYIN Main Program Parts V and VI

```
C          PART V
  120 AØGX=ATANF(CRGØ/PØGX)/Z
  121 ARGX=ARGØ+AØGX
  122 SLAN=ABSF(CRGØ/SINF(AØGX*Z))
  123 DRGX=-(1.-ATNR1)*SNGØ*SNØR/SLAN
  124 A=ENL+AJNE
  125 IB=A
  126 JNL=JNE+IB
  127 B=IB
  128 AJNL=A-B
  129 CALL SHADØ(JNL,AJNL,ANGS,ATNS,AQNT)
  130 CALL PØLØ(ARGX,SRGX,CRGX,ANGR,SNGR,CNGR,AØRN,SØRN,CØRN,ANGX,SNGX,
     1CNGX,ARNX,SRNX,CRNX,ANXR,SNXR,CNXR)
  131 A=AQNT+ATNR+ARNX
  132 CALL FRACT(A,AQNX)
  133 IF(AQNX)134,135,135
  134 AQNX=AQNX+1.
  135 AØNX=-ARNØ+ARNX
  136 ANRØ=-AØRN

C          PART VI
  140 A=24.*AJNL
  141 IUTH=A
  142 B=IUTH
  143 B=60.*(A-B)
  144 IUTM=B
  145 C=IUTM
  146 IUTS=60.*(B-C)
  147 B=AQNX-.25
  148 IF(B)149,150,150
  149 B=B+1.
  150 B=24.*B
  151 IRAH=B
  152 C=IRAH
  153 RAM=60.*(B-C)
  154 DECL=360.*(.25-ANGX)
  155 IF(ANØR)156,157,157
  156 ANØR=ANØR+1.
  157 IF(AØGX)158,159,159
  158 AØGX=AØGX+1.
  159 IF(ANRØ)160,161,161
  160 ANRØ=ANRØ+1.
  161 IF(AØNX)162,163,163
  162 AØNX=AØNX+1.
  163 IF(ANXR)164,165,165
  164 ANXR=ANXR+1.
  165 WRITE ØUTPUT TAPE 6,166,JNL,AJNL,AQNX,IRAH,RAM,ANØR,ANRØ,GV,AØNX,
     1DMDT,SLAN,I,K,M
  166 FØRMAT(1X,I3,F6.5,1X,F6.5,I3,F5.1,1X,F6.5,1X,F6.5,F7.1,1X,F5.4,
     1F7.3,1X,F5.4,3I4)
  167 WRITE ØUTPUT TAPE 6,168,IUTH,IUTM,IUTS,ANGX,DECL,AØGX,ARGØ,APRM,
     1ANXR,DRGX,CSGØ,J,L,N
  168 FØRMAT(1X,3I3,1X,F6.5,F8.3,1X,F6.5,1X,F6.5,1X,F6.5,1X,F5.4,F7.3,
     11X,F5.4,3I4//)
```

(See continuation, above.)

Continuation of PART VI

```
  169 ENL=ENL+SYNP
  170 N=N+1
  171 GØ TØ 50
  172 END FILE 6
      REWIND 6
      STØP 77777
      END(2,0,1,0,1)
```

Appendix A. FORTRAN Listing for FRACT

```
C         FRACT
      SUBRØUTINE FRACT(A,B)
   10 I=A
   11 C=I
   12 D=A-C
   13 IF(ABSF(D)-.5)19,19,14
   14 IF(D)15,19,17
   15 B=1.+D
   16 GØ TØ 20
   17 B=D-1.
   18 GØ TØ 20
   19 B=D
   20 RETURN
```

Comments

"A" is the input argument and may be any decimal number that includes both integral and fractional parts. The output argument, "B", will correspond to the fractional part and, if this is greater than 0.5 in magnitude (statement 13), 1.0 is subtracted (statement 17). Thus, the output argument is always in the range from -0.5 to +0.5. The object deck for FRACT will consist of only two cards.

Appendix B. FORTRAN Listing for SHADO

```
C           SHADØ
      SUBRØUTINE SHADØ(I,A,B,C,D)
   10 G=I-38200
   11 H=G+A
   12 ANQM=0.493026+.273791E-02*H
   13 AQNT=ANQM+0.5
   14 ANQP=0.034201+.13E-06*H
   15 E=ANQM-ANQP
   16 CALL FRACT(E,APQM)
   17 Z=6.28318531
   18 APQM=APQM*Z
   19 APQE=APQM+.01673572*SINF(APQM)+.14004E-03*SINF(2.*APQM)
   20 APQM2=APQE-.01673572*SINF(APQE)
   21 APQE=APQE+(APQM-APQM2)/(1.-.01673572*CØSF(APQE))
   22 F=CØSF(APQE/2.)
   23 IF(F)26,24,26
   24 APQS=.5
   25 GØ TØ 27
   26 APQS=2.*ATANF(1.01687813*SINF(APQE/2.)/F)/Z
   27 E=ANQP+APQS
   28 CALL FRACT(E,ANQS)
   29 AQGN=.06513206
   30 AQGS=.25
   31 CALL PØLØ(AQGS,SQGS,CQGS,AQGN,SQGN,CQGN,ANQS,SNQS,CNQS,B,SNGS,
     1CNGS,ASNQ,SSNQ,CSNQ,AQSN,SQSN,CQSN)
   32 E=-AQNT-ASNQ
   33 CALL FRACT(E,C)
   34 J=AQNT
   35 P=J
   36 D=AQNT-P
      RETURN
```

Discussion

Equations in SHADO use the Modified Julian Date, 38200, as the epoch. Thus, they should be periodically revised. These include statement 12, which computes the Earth's mean polar angle, NQM, and statement 14, which computes the perigee position.

Statement 19 makes a first approximation of the eccentric anomaly, using equation (45) from page 161 of Moulton's "Celestial Mechanics". Statement 20 computes the corresponding mean anomaly. Statement 21 then uses Moulton's equation (47), page 162, to obtain a closer approximation of the eccentric anomaly. For the Earth's orbital eccentricity, this second approximation is sufficient.

SHADO then computes the true anomaly,(statement 26) and then transforms the Earth's position from the pole of the ecliptic, Q, to the North celestial pole, N, using POLO. Statement 29 gives the value used for obliquity of the ecliptic.

Appendix C. FORTRAN Listing for KEPLR

```
C          KEPLR
      SUBRØUTINE KEPLR(W,B,C,D,E,F,G)
    9 A=W
   10 H=C/B
   11 Ø=1.-H
   12 P=1.+H
   13 Q=SQRTF(Ø/P)
   14 R=SQRTF(Ø*P)
   15 IF(A)21,16,24
   16 D=0.
   17 F=Ø
   18 E=F*Ø/R
   19 G=0.
      S=1.
   20 GØ TØ 44
   21 S=-1.
   22 A=-A
   23 GØ TØ 25
   24 S=1.
   25 IF(A-.5)34,26,31
   26 D=.5
   27 F=P
   28 E=F*P/R
   29 G=0.
   30 GØ TØ 44
   31 A=1.-A
   32 T=-1.
   33 GØ TØ 35
   34 T=1.
   35 Z=6.28318531
   36 U=A*Z/2.
   37 V=2.*ATANF(Q*SINF(U)/CØSF(U))
   38 D=(V-H*SINF(V))/Z
   39 F=1.-H*CØSF(V)
   40 E=F**2/R
   41 G=S*T*Z*E*H*SINF(2.*U)/R
   42 IF(T)43,44,44
   43 D=1.-D
   44 D=S*D
      RETURN
```

Discussion

KEPLR uses conventional orbital formulae, which are included in statements 37 through 40. The remaining statements are concerned with establishing constants and with the routing of trivial solutions. The input true anomaly, W, may have any value in the range of $- 1^{t}.0$ to $+ 1^{t}.0$.

Phone: STerling 3-4100

Exhibit H

INDEPENDENT TRACKING COORDINATION PROGRAM

824 Connecticut Avenue
Washington 6, D. C.

BULLETIN

June 11, 1964

"Gear Ratio" Orbital Elements for Tracking Artificial Earth Satellites

W. P. Overbeck
June 8, 1964

CONTENTS:

Introduction

The Derivation of Gear Ratio Elements
  a. Basic Orbital Elements
  b. Treatment of Kepler's Laws
  c. Cumulation Effects of Gravitational Perturbations
  d. Acceleration Effects

Comparison of Theoretical Gear Ratios with Those Observed over Long Periods

Applications of Gear Ratio Elements
  a. Use of Gear Ratio Elements to Furnish Rationalized Orbital Elements for Prediction
  b. Use of Gear Ratio Elements in Simplified Satellite Tracking for Casual as well as Meticulous Observers
  c. Use of Gear Ratio Elements to Improve Tracking Agency Data for Long Term Predictions
  d. Gear Ratio Elements for Keeping Track of the ECHO Satellites

Conclusions

INTRODUCTION

One of the main problems facing those who attempt to supply satellite prediction data is the rapid rate at which this data becomes obsolete. The principal reason for this is the erratic nature of the accelerations due to atmospheric drag, solar wind and radiation pressure. There is no way to eliminate this problem completely but there is a way to isolate it and express it in a form such that it can be more easily controlled by the independent observer.

In 1958, I used a tracking method that I called the "gear ratio method", because it treats the components of satellite motion as though they were coupled to one another like the gears in a gear train. I discarded this method because its performance seemed erratic. However, it was particularly useful in its application to long-term extrapolation from each observation to the next. Remembering this particular quality, I resurrected the Gear Ratio

SPSE

Society of Photographic Scientists and Engineers

method for use in a recent effort to track ECHO II through daytime optical observation. The results were surprisingly successful, particularly when the method was coupled with refinements that have been developed during the period since 1958. In its modernized form, the Gear Ratio method is found to have the following advantages:

1. With few exceptions, the characteristics of any satellite that is now in orbit can be expressed in a "permanent" set of Gear Ratio Orbital Elements which can be easily kept up-to-date with no further information other than that derived by the observer from his own observations.

2. With careful measurement by an experienced observer, the Gear Ratio Elements will give very precise prediction over periods as long as 2 to 3 years. Relatively little analytical effort is required in the interpretation of observations.

3. Gear Ratio Elements can also be used and kept up-to-date by a beginner who does not care for precision or who is not equipped for precise measurement. Under such usage, the Gear Ratio Elements do not deteriorate. The effects of measurement error are not cumulative.

The ECHO balloon satellites are the principal exceptions to the above comments in that additional refinements are needed for precise prediction. However, the ability to obtain dependable, though rough, predictions is retained. The Gear Ratio Elements appear to be the best way to provide a long-term, though incomplete, description of the behavior of such satellites.

The following discussion is in two parts. The first of these reviews the background of theory and experimental evidence from which the Gear Ratio Elements are derived. The second part explains a few applications of the Gear Ratio Elements to satellite tracking problems. The discussion assumes that the reader is familiar with other recent publications of the Independent Tracking Coordination Program.

THE DERIVATION OF GEAR RATIO ELEMENTS

a. Basic Orbital Elements

If the Earth were a perfect sphere, if it had no atmosphere and if there were no other nearby massive objects, such as the Sun and Moon, the behavior of an artificial satellite could be permanently described by a set of six numbers, known as the "orbital elements". The nature of these elements is illustrated in Figure 1.

In this diagram, we view the Earth from the direction of the orbit pole, R, so that the orbit lies in the plane of the paper, which also includes the Earth's center, G, (hidden under R). The inclination of the orbit is represented by the polar distance, NGR, between the Earth's North pole, N, and the orbit pole. Its value, expressed in turns, is one of the six elements.

Using the pole of the ecliptic, Q, as a reference direction, the location of R is further defined by the polar angle, QNR, expressed in turns and measured about the North pole. The value of QNR is a second orbital element.

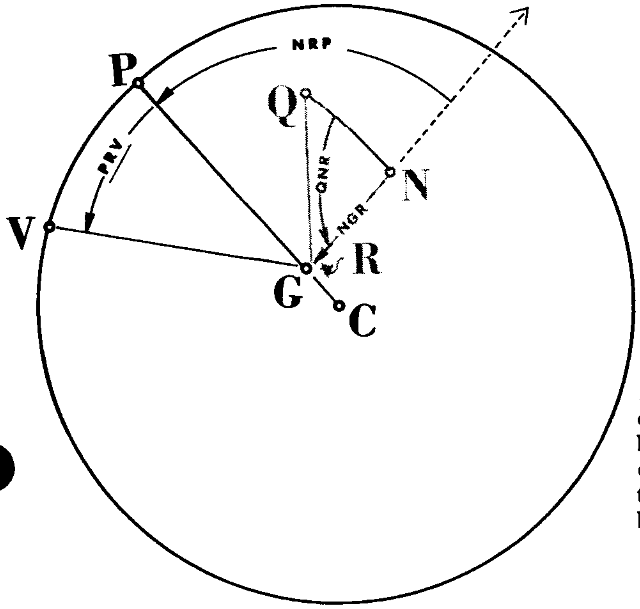
The point in the orbit nearest to the Earth's center is the perigee, P, and its position is defined by a third orbital element, the value of the polar angle, NRP, also measured in turns.

The above three elements define the orientation of the orbit which, according to Kepler's First Law, must then be drawn as an ellipse, with one of its foci at the Earth's center. The size and shape of the ellipse can then be defined in terms of its semimajor axis, CP, and the displacement, CG, of its center from the Earth's center. The value of CP, in kilometers, is a fourth orbital element and the eccentricity, CG/CP, is the fifth.

Finally, if we select an instant at which the satellite is at the perigee, we need supply only one more number, the corresponding epoch, JNE, as a sixth orbital element.

Such economy in description is seldom necessary and it is customary to expand this group of numbers so that we can specify initial positions of the satellite other than at the perigee. A more general situation would be that in which the satellite is at a point, V. This may be defined in terms of a polar angle, PRV, known as the "true anomaly". Kepler's Laws are then used in providing a description of the variation of this angle as a function of time.

Fig. 1. Definition of Orbital Elements:



Points and directions in the plane of the orbit are represented in black and are mapped in the plane of the paper. Points which lie above the plane of the orbit, and the angles between them, are shown in grey.

QNR: The right-handed polar angle measured from the pole of the ecliptic Q, around the North Pole, N, to the mean pole of the orbit, R. This value, together with the Polar distance, NGR, determines the orientation of orbit's coordinate system relative to that in which the observer's position is defined.

NGR: The polar distance from the North Pole, N, measured at the center of its earth, G, to mean orbit pole, R.

NRP: "Argument of perigee from the North point of the orbit" = The right-handed polar angle measured from the North Pole, N, around the mean orbit pole, R, to perigee, P.

P: Perigee, the point in the orbit closest to G, the center of the earth.

V: The center of mass of the satellite.

PRV: "True anomaly" = The right-handed polar angle measured from perigee, P, around the mean orbit pole, R, to the center of mass of the satellite.

C: Center of elliptical orbit

CG: Distance from center of orbit, C, to center of Earth, G.

CP: "Semi-major axis" = Distance from center of orbit, C, to perigee, P.

CG/CP = Eccentricity of orbit.

b. Treatment of Kepler's Laws by Tabulation of Eccentricity Functions

As indicated above, Kepler's First Law defines the orbit as an ellipse, with one focus at the Earth's center. This can be expressed in the equation:

$$\frac{GV}{CP} = \frac{1 - e^2}{1 + e \cos(PRV)} \tag{1}$$

in which e is the eccentricity, CG/CP. The ratio of satellite radius to semi-major axis, GV/CP, is the "radius ratio". For any given value of eccentricity, we can compute values of the radius ratio as a function of true anomaly and can tabulate these, as in the fourth column of Table I. We can also use a derivative of equation (1) to calculate the rates of change of radius ratio, as listed in the fifth column.

With the assumptions made earlier (spherical Earth, no atmosphere, no Sun or Moon), the satellite would continue to travel around its orbit forever, completing each revolution in exactly the same time interval. This can be expressed, according to Kepler's Third Law, in the equation:

$$n^2(CP)^3 = .75402E{+}14 \tag{2}$$

in which n is the "mean motion", in revolutions per day, and CP is measured in kilometers. The constant, .75402E+14 (electronic computer format for $.75402 \times 10^{14}$) applies only to earth satellites and would be different for satellites of other planets.

The true angular motion of the satellite, d(PRV)/dt, will vary from the mean motion, being faster at perigee and slower at apogee. To simplify the description of this motion, it is compared with that of a fictitious object, M, which travels around R at a constant rate, d(PRM)/dt, which is equal to the mean motion, n. Kepler's Second Law permits us to define a "velocity ratio", or ratio of true motion to mean motion, in the equation:

$$\frac{d(PRV)}{d(PRM)} (GV/CP)^2 = \sqrt{1 - e^2} \tag{3}$$

This differential equation can be solved, uniquely, for PRM as a function of PRV. A solution for PRV as a function of PRM requires successive approximations. We have tabulated values of PRM in the second column of Table I and have inverted equation (3) to obtain inverse values of the velocity ratio, as listed in the third column. The entire table is then called a table of "eccentricity functions" because it applies to only one value of eccentricity. Now that we have electronic computers to produce them, it is much more convenient to interpolate in such tables than to use the basic equations.

Such equations, or tables, provide an artifice which permits us to describe the motion of the satellite in the simple time equation:

$$PRM = PRM_0 + PRM_1(ENL) \tag{4}$$

in which PRM_0 is the initial value at any epoch, JNE. PRM_1 is equal to the mean motion, n, and ENL is the elapsed time since epoch. Presumably, one might then determine the value of PRM at any time and then translate to PRV. A table using PRM as the argument would therefore seem more useful. However, such a table is more costly, in terms of computational time and effort. Instead, we use a prediction procedure in which we, first, select a position, PRV. We then translate to PRM and use equation (4) to determine the time.

TABLE I

Mean Anomaly (PRM) and Other Values Tabulated as Functions of True Anomaly (PRV) Where Eccentricity (CG/CP) = .019607

PRV	PRM	$\frac{d(PRM)}{d(PRV)}$	Radius Ratio	$\frac{d(R.R.)}{d(PRV)}$
0.00	0.000000	0.961356	0.980393	0.000000
0.01	0.009614	0.961429	0.980430	0.007438
0.02	0.019229	0.961647	0.980542	0.014851
0.03	0.028847	0.962011	0.980727	0.022211
0.04	0.038470	0.962518	0.980986	0.029494
0.05	0.048098	0.963168	0.981317	0.036674
0.06	0.057734	0.963957	0.981719	0.043724
0.07	0.067378	0.964884	0.982191	0.050621
0.08	0.077032	0.965945	0.982731	0.057339
0.09	0.086697	0.967137	0.983337	0.063853
0.10	0.096375	0.968456	0.984007	0.070140
0.11	0.106066	0.969897	0.984739	0.076177
0.12	0.115773	0.971456	0.985530	0.081940
0.13	0.125496	0.973126	0.986377	0.087407
0.14	0.135236	0.974903	0.987277	0.092557
0.15	0.144994	0.976780	0.988227	0.097370
0.16	0.154772	0.978750	0.989223	0.101824
0.17	0.164570	0.980807	0.990262	0.105903
0.18	0.174388	0.982943	0.991340	0.109588
0.19	0.184229	0.985151	0.992452	0.112863
0.20	0.194092	0.987422	0.993596	0.115712
0.21	0.203977	0.989748	0.994765	0.118122
0.22	0.213887	0.992120	0.995956	0.120080
0.23	0.223820	0.994530	0.997165	0.121576
0.24	0.233777	0.996967	0.998386	0.122600
0.25	0.243759	0.999423	0.999616	0.123146
0.26	0.253766	1.001889	1.000848	0.123206
0.27	0.263797	1.004354	1.002078	0.122777
0.28	0.273853	1.006808	1.003302	0.121858
0.29	0.283933	1.009242	1.004514	0.120448
0.30	0.294038	1.011645	1.005709	0.118551
0.31	0.304166	1.014008	1.006883	0.116169
0.32	0.314318	1.016321	1.008031	0.113309
0.33	0.324492	1.018575	1.009148	0.109981
0.34	0.334689	1.020759	1.010229	0.106195
0.35	0.344907	1.022864	1.011270	0.101964
0.36	0.355146	1.024881	1.012267	0.097302
0.37	0.365404	1.026801	1.013215	0.092228
0.38	0.375682	1.028617	1.014110	0.086761
0.39	0.385976	1.030319	1.014949	0.080922
0.40	0.396288	1.031900	1.015727	0.074735
0.41	0.406614	1.033354	1.016442	0.068225
0.42	0.416954	1.034672	1.017091	0.061418
0.43	0.427307	1.035851	1.017670	0.054344
0.44	0.437671	1.036883	1.018177	0.047032
0.45	0.448044	1.037765	1.018610	0.039514
0.46	0.458426	1.038492	1.018966	0.031822
0.47	0.468813	1.039062	1.019246	0.023990
0.48	0.479206	1.039470	1.019446	0.016053
0.49	0.489602	1.039716	1.019566	0.008044
0.50	0.500000	1.039798	1.019607	0.000000

With the aid of equation (4), we can write what are called "unperturbed orbital elements" as follows, using values for a particular satellite, 1960 Nu 2, to provide a numerical example:

Unperturbed Orbital Elements, 1960 Nu 2

JNE = 38442.028710

NGR = .078483

CP = 7443.85

CG = 145.95

PRM = .654629 + 13.51296031(ENL)

QNR = .804751

NRP = .475764

For such elements, the epoch, JNE, may have any selected value. The meticulous reader may find that, in the above elements, the value of $n^2(CP)^3$ does not agree exactly with equation (2). The above values include corrections for the gravitational perturbations discussed below. However, equation (2) is quite adequate for a first approximation.

c. Cumulative Effects of Gravitational Perturbations

The Earth is not a perfect sphere but resembles, more nearly, an oblate spheroid, having an equatorial radius of 6378.17 km. and polar radius of 6356.79 km. Through observation of artificial satellites, it has also been found that the Earth is slightly pear-shaped, having more mass to the South of the equator than to the North. In addition, its equatorial cross-section is elliptical, with the maximum radius (at about $0\overset{\circ}{.}061$ W) being about 0.17 km. greater than the minimum. In theory, these differences from a spherical figure may be treated as extra masses which exert extra "perturbing" forces on the satellite, giving rise to perturbations in its motion.

The most important perturbations are those that are due to the oblateness. In prediction, these must be considered. However, it is usually possible to neglect effects of the elliptical equator and, except in precise prediction, those of the pear shape. The most noticeable effect of the oblateness is the precession of the orbit pole which, in a manner similar to the precession of a gyroscope, moves in a circular path about the Earth's North pole. This motion can be expressed in an equation:

$$QNR = QNR_0 + QNR_1(ENL) \qquad (5)$$

in which the value of the coefficient, QNR_1, can be approximated from the formula:

$$QNR_1 = -\frac{.66037E+5}{p^2}(PRM_1)\cos(NGR) \qquad (6)$$

in which p is equal to $CP(1 - e^2)$.

For the Gear Ratio Elements, we regard the ratio, QNR_1/PRM_1, as the first of two gear ratios. Motion of the satellite is so coupled to that of the orbit pole that, for each mean revolution of the satellite, the pole is moved by the amount:

$$\frac{\Delta QNR}{\Delta PRM} = \frac{QNR_1}{PRM_1} = - \frac{.66037E+5}{p^2} \cos(NGR) \qquad (7)$$

In equating this to $\Delta QNR/\Delta PRM$, we indicate that it is applicable to large, as well as small changes in PRM.

A second effect of the oblateness is observed as a motion of the perigee so that the polar angle, NRP, may be described by a time equation:

$$NRP = NRP_0 + NRP_1(ENL) \qquad (8)$$

For this equation, an approximate value of NRP_1 may be obtained from:

$$NRP_1 = \frac{.66037E+5}{p^2} (PRM_1) \; (2 - 2.5 \sin^2(NGR)) \qquad (9)$$

The second gear ratio is obtained by dividing equation (9) by equation (6) to obtain:

$$\frac{\Delta NRP}{\Delta QNR} = \frac{NRP_1}{QNR_1} = - \frac{2 - 2.5 \sin^2(NGR)}{\cos(NGR)} \qquad (10)$$

which is also applicable to large, as well as small changes. It should be noted that this ratio depends only on the inclination, NGR.

These equations have been described as yielding "approximate" values and, in the preceeding section, we also indicated that equation (2) gives a first approximation. In "Smithsonian Contributions to Astrophysics", Vol. 6, p 67, Kozai gives more complete formulae than those of equations (2), (6) and (9). We have obtained excellent results by using the Kozai formulae to compute the rates of motion and by deriving the ratios from these rates.

In writing orbital elements to include the effects of oblateness, the normal practice is to express QNR and NRP in terms of time equations, such as equations (5) and (8). However, the Gear Ratio Elements would be written:

JNE = 38442.028710

NGR = .078483

CP = 7443.85

CG = 145.95

$PRM = .654629 + \Delta PRM$

$QNR = .804751 - .001052884(\Delta PRM)$

$NRP = .475764 - 1.6333966(\Delta QNR)$

and we might then supply an auxiliary prediction equation which, at this stage, would be written:

$$\Delta PRM = 13.51296031(ENL)$$

However, it should be noted that the prediction information can be expressed in forms other than the above equation. It can be expressed as a table of values of PRM as a function of time, as a graph or in the form of periodic announcements of observed values.

d. Acceleration Effects

The effects of atmospheric drag and radiation pressure make it necessary to add another term to equation (4) so that it becomes:

$$\mathrm{PRM} = \mathrm{PRM}_0 + \mathrm{PRM}_1(\mathrm{ENL}) + \mathrm{PRM}_2(\mathrm{ENL})^2 \tag{11}$$

in which the acceleration coefficient, PRM_2, is usually of a magnitude that can be most conveniently expressed in microturns per day^2.

When the perigee radius (CP - CG) is about 6900 km. or less, the acceleration will be primarily due to atmospheric drag. PRM_2 will be positive and may range from 10 to 1,000 $\mu t/d^2$ for reasonably long-lived satellites. As a satellite approaches the end of its lifetime, PRM_2 may increase rapidly to values as great as 100,000 $\mu t/d^2$.

If the perigee radius is greater than 6900 km., the effects of radiation pressure become significant and may result in either positive or negative values of PRM_2, generally of the order of $\pm 1\ \mu t/d^2$. The ECHO satellites are a notable exception, being abnormally sensitive to both radiation pressure and atmospheric drag. For these satellites, typical values of PRM_2 might range from - 500 to + 2,000 $\mu t/d^2$.

In any case, the acceleration coefficient is highly variable and can seldom be predicted with an accuracy much better than ± 50%. So, in writing an equation for long-term prediction, we usually use a mean value that has been determined from observations over a substantial period. In addition to yielding the best possible predictions, this value also serves as an indicator of the length of time that the mean anomaly equation remains useful. For example, if we expect the equation to give values of PRM that are accurate to $\pm\ .^{t}01$, its accuracy begins to become questionable when the acceleration term approaches this value or when:

$$\mathrm{ENL} \text{ is equal to or greater than } \sqrt{.01/\mathrm{PRM}_2}$$

The acceleration affects other orbital elements because the mean motion, n, is variable, as indicated by:

$$n = \frac{d(\mathrm{PRM})}{d(\mathrm{ENL})} = \mathrm{PRM}_1 + 2\mathrm{PRM}_2(\mathrm{ENL}) \tag{12}$$

which may be derived from equation (11). As indicated by preceeding formulae, this variation can affect the semimajor axis, the eccentricity and the rates of motion of both orbit pole and perigee.

The resulting rate of change of the semimajor axis is usually quite small so that the effects of acceleration are best treated by occasional recomputation or adjustment according to the equation:

$$\Delta(\mathrm{CP}) = -\frac{2(\mathrm{CP})}{3n}\,\Delta n \tag{13}$$

The theory for estimating relationships between acceleration and eccentricity is rather unsatisfactory, except for after-the-fact analysis. However, in his book, "Satellites and Scientific Research", King-Hele presents some useful formulae which apply to satellites having moderately high acceleration (about .5E-3 or more) and for which the initial eccentricity is between 0.2 and 0.02. Expressed in our symbols, one of these formulae estimates the lifetime, t_L, of the satellite as:

$$t_L = \frac{3\ e_o\ (\mathrm{PRM}_1)}{8\ (\mathrm{PRM}_2)} \text{ (days)} \tag{14}$$

in which e_o is the initial value of eccentricity. The variation of eccentricity with time can then be expressed by:

$$e = e_o\sqrt{1 - (\mathrm{ENL})/t_L} \tag{15}$$

where ENL is the elapsed time since the epoch of the initial value.

For lesser acceleration, corresponding to a perigee radius greater than about 6900 km., the above formulae become meaningless. Experience indicates that one may as well adopt the most convenient assumption; that the eccentricity remains constant until the observations indicate that a change is necessary. (This excludes effects of the pear shape, which we handle through geometric adjustment of predictions and observations, rather than as a cyclic variation in eccentricity.) Again, the ECHO satellites are an important exception in that they undergo large, cyclic variations in eccentricity as a result of radiation pressure.

Theory becomes even less satisfactory in predicting the effects of acceleration on the motion of the orbit pole and perigee. Generally, the theory requires that additional terms, dependent on $(ENL)^2$, be added to equations (5) and (8). However, it is difficult to derive satisfactory values for the necessary coefficients, QNR_2 and NRP_2.

COMPARISON OF THEORETICAL GEAR RATIOS WITH THOSE OBSERVED OVER LONG PERIODS

For the Gear Ratio Elements, we have made two simplifying assumptions. First, the ratio between motion of the orbit pole and mean motion of the satellite is assumed to follow the equation:

$$\frac{\Delta QNR}{\Delta PRM} = A + B(\Delta PRM) \qquad (16)$$

in which A and B are constants to be determined empirically. Second, the ratio between motion of the perigee and that of the pole is assumed to remain a single-valued constant. To test these assumptions, we have studied records for several satellites, with the results indicated in the following Table II.

TABLE II

Study of Observed Gear Ratios

	Perigee	ΔQNR/ΔPRM			Revolutions
Satellite	Radius	A	B	ΔNRP/ΔQNR	Examined
64 005 A	6636.02	-.001193673	-.239E-8	-1.545815	1800
1958 Alpha	6718.51	-.001033630	-.639E-9	-1.493730	15600
1959 Alpha 1	6938.64	-.000851741	negligible	-1.5033958	8700
1959 Eta	6894.33	-.000823397	negligible	-1.4888692	8500
1960 Zeta 1	6844.96	-.001177486	negligible	-1.4988108	22000
63 047 A	6851.30	-.001029629	negligible	-1.5771681	1600
1960 Mu 2	7297.90	-.001052884	negligible	-1.6333966	19000

Values of B less than .1E-12 were considered negligible. In no case was there a significant departure from a single value for ΔQNR/ΔNRP.

These results should not be viewed with surprise because they represent an after-the-fact fit to data that is limited in precision and the implied acceleration effects are not greatly different than those that would be predicted by other means. The only conclusions that we wish to draw are:

1. For satellites having a perigee radius of the order of 6900 km. or more, constant values for both $\Delta QNR/\Delta PRM$ and $\Delta NRP/\Delta QNR$ may be used over periods of time as long as 2 to 3 years.

2. For satellites having a perigee radius less than 6900 km., the ratio, $\Delta NRP/\Delta QNR$, remains constant and the ratio, $\Delta QNR/\Delta PRM$, can be closely approximated as a linear function of ΔPRM.

These conclusions apply to mean rates of motion. Periodic variations due to the pear shape are treated separately.

Obviously, a long period of observation is needed to establish accurately measured values of these ratios. However, we can use the Kozai formulae to calculate initial values and, as indicated by the following Table III, these values are adequate to serve for several hundred revolutions.

TABLE III

Comparison of Observed and Theoretical Gear Ratios

	$\Delta QNR/\Delta PRM$		$\Delta NRP/\Delta QNR$	
Satellite	Observed	Theoretical	Observed	Theoretical
1960 Zeta 1	-.001177486	-.00117730	-1.4988108	-1.4988108
1960 Nu 2	-.001052884	-.00105213	-1.6333974	-1.6334171
63 047 A	-.001029629	-.00102906	-1.5771681	-1.5771675

Thus the final form of the Gear Ratio Elements for 1960 Nu 2 might be written:

$JNE = 38442.028710$

$NGR = .078483$

$CP = 7443.85$

$CG = 145.95$

$PRM = 16624.654629 + \Delta PRM$

This term is shown only to indicate where it is placed, when its value is significant.

$QNR = .804751 - .001052884(\Delta PRM) - 0.0(\Delta PRM)^2$

$NRP = .475674 - 1.6333966(\Delta QNR)$

This differs from the form written previously only in the addition of the integral number of turns, since launching, to PRM_0. This is useful in coordinating different sets of elements that are derived at different times. The auxiliary prediction equation may now be written as:

$$\Delta PRM = 13.51296031(ENL) + .127E\text{-}6(ENL)^2$$

and it must be recognized that the values of CP and CG will require occasional revision.

The usefulness of the Gear Ratio Elements will become more apparent in the following description of various applications. However, at this point, it should be noted that their basic characteristic is that they use PRM as the independent variable, rather than ENL. In essence, the mean anomaly, PRM, is the satellite's measure of time, just as our time, JNL, is based on mean revolutions of the Earth about the Sun. The prediction equation is simply a means of translating between the two systems of time.

APPLICATIONS OF GEAR RATIO ELEMENTS

a. Use of Gear Ratio Elements to Furnish Rationalized Orbital Elements for Prediction

It is possible to make predictions directly from the Gear Ratio Elements. However, to take advantage of other ITCP publications on the subject of prediction, the Gear Ratio Elements can be converted to the normal form of Rationalized Orbital Elements. Using the above 1960 Nu 2 elements as an example, we first add the ΔPRM eqation to PRM_0 to obtain:

$$\text{PRM} = 16624.654629 + 13.51296031(\text{ENL}) + .127\text{E-}6(\text{ENL})^2 \tag{17}$$

The ΔPRM equation is then multiplied by the ΔQNR/ΔPRM ratio and added to QNR_0 to obtain:

$$\text{QNR} = .805751 - .01422758(\text{ENL}) - .134\text{E-}9(\text{ENL})^2 \tag{18}$$

and the ΔQNR portion of this is multiplied by the ΔNRP/ΔQNR ratio and added to NRP_0 to obtain:

$$\text{NRP} = .475764 + .02323928(\text{ENL}) + .218\text{E-}9(\text{ENL})^2 \tag{19}$$

It should be noted, here, that the coefficients of $(\text{ENL})^2$ in equations (18) and (19) are slightly less than we would have derived from a more elaborate, but rather uncertain theory. Evidently, this difference from past practice has little practical significance.

To make equation (18) easier to use, we usually combine it with an equation for QNT. Using methods outlined in previous ITCP Bulletins, the applicable equation would be:

$$\text{QNT} = .655678 + .00273791(\text{ENL}) \tag{20}$$

and, combining with equation (18), we have:

$$\text{TNR} = .149073 - .01696549(\text{ENL}) - .134\text{E-}6(\text{ENL})^2 \tag{21}$$

Equations (17), (19) and (21) are those normally used with the Rationalized Orbital Elements. The values of JNE, NGR, CP and CG can be copied directly from the Gear Ratio Elements to complete the full set of Rationalized Orbital Elements.

b. Use of Gear Ratio Elements in Simplified Satellite Tracking for Casual as well as Meticulous Observers

For tracking, we replace the PRM equation by a "Revolutions Log", a device that was first used in satellite tracking by Arthur S. Leonard. Equation (17) can be expanded into a table of values of PRM, with first and second differences, as shown in Table IV.

TABLE IV

Tentative Revolutions Log for 1960 Nu 2
(based on equation (17), above)

JNL	PRM	1st Diff.	2nd Diff.
38440	16597.240752		.0000254
		135.1296158	
38450	16732.370368		.0000254
		135.1296412	
38460	16867.500009		.0000254
		135.1296666	
38470	17002.629676		.0000254
		135.1296920	
38480	17137.759368		.0000254
		135.1297174	
38490	17272.889085		.0000254
		135.1297428	
38500	17408.018828		.0000254

The usual practice is to write these values in pencil so that they can, later, be erased and replaced by observed values.

Using a 10 day interval, the values in the third column will be 10 times the mean motion, n, and those in the fourth column will be 200 times the acceleration coefficient. As outlined in previous ITCP Bulletins, predictions may be made by interpolation in such a table. Its form is comparable to that of the Daily Satellite Ephemerides.

The prediction procedure involves the calculation of a time, JNL, at which the satellite is expected to appear at a particular position such as the point of local culmination. For this position, we will have calculated a value of PRM. The observation then represents a measurement of the actual time at which the satellite appeared at, or very near this position. As a meticulous observer, I will have measured this time to $\pm\, 0\overset{d}{.}0000001$. I will then use this actual time to recalculate the position and will correct for differences between the calculated and actual point of observation. I will also make corrections for effects of the pear shape and the ellipticity of the equator. All of this is done with the objective of obtaining a measured value of PRM that is accurate to about $\pm\, 0\overset{t}{.}00001$.

Another observer, Mr. X, may either be less meticulous or may lack the means for making precise observations. He may simply use the predicted value of PRM as a measured value to correspond with his measurement of the time. We can assume that his accuracy is $\pm\, 0\overset{d}{.}00001$ in timing and $\pm\, 0\overset{t}{.}001$ in PRM. Let us then assume that Mr. X and I both start tracking 1960 Nu 2, using the above table and the Gear Ratio Elements. For convenience, we will also assume that his location is the same as mine and that he makes each observation at the same time that I do. After about 60 days, our records of observations might compare as shown in Table V.

TABLE V

RECORD OF OBSERVATIONS

Comparing Log of a Meticulous Observer (W.P.O) with Log of a Casual Observer (Mr. X)

JNL	Predicted PRM	W. P. O.		Mr. X	
		PRM	Resid.	PRM	Resid.
38462.40113315	16899.946438	16899.946518	+80	16899.9469	+400
38482.05088329	17165.472894	17165.473397	+503	17165.4732	+300
38484.04727861	17192.450126	17192.450724	+598	17192.4512	+1100
38485.08494712	17206.472112	17206.472747	+635	17206.4728	+700
38486.04369964	17219.427707	17219.428390	+683	17219.4280	+300
38494.02957430	17327.340616	17327.341718	+1102	17327.3416	+1000
38495.06723367	17341.362480	17341.363653	+1173	17341.3642	+1700
38497.06365582	17368.340068	17368.341367	+1299	17368.3410	+900

We can assume that Mr. X's values of JNL will be the same as mine (in the first column) except that they will include only five digits to the right of the decimal.

In the above table, each "residual" column represents the difference between the observed values and the predicted values, which are in the second column. As we proceed, Mr. X and I will both plot these residuals against time, as shown in Figure 2.

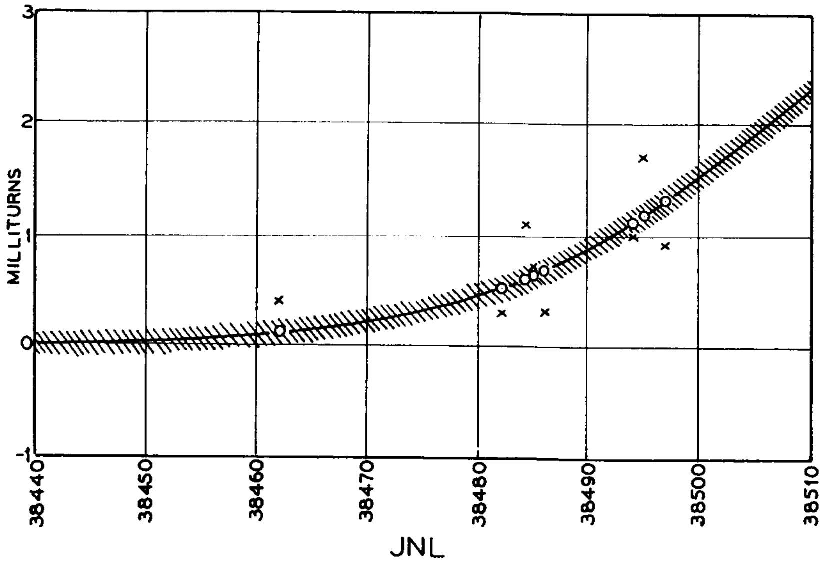


Fig. 2. Plot of residuals in NRM obtained by a meticulous observer (O) as compared with those of a casual observer (X). Data from Table V.

On JNL = 38500, Mr. X and I both decide to review the situation and bring our orbital elements up to date. We both draw a smooth curve through the data points. My curve is represented by the solid line and Mr. X's curve will probably fall somewhere within the shaded area.

Our next step is to correct the values of PRM in the Revolutions Log by amounts equal to the ordinates of this curve for the dates used in the Log. A comparision of the results that we obtain might be as shown in Table VI.

TABLE VI

Corrected Revolutions Logs of Meticulous and Casual Observer Compared

	W. P. O. Log			Mr. X's Log		
JNL	PRM	1st Diff.	2nd	PRM	1st	2nd
38440	16597.240752		.000036	16597.2408		.0000
		135.129626			135.1296	
38450	16732.370378		.000085	16732.3704		.0001
		135.129711			135.1297	
38460	16867.500089		.000068	16867.5001		.0001
		135.129782			135.1298	
38470	17002.629871		.000157	17002.6299		.0001
		135.129939			135.1299	
38480	17137.759810		.000216	17137.7598		.0003
		135.130155			135.1302	
38490	17272.889965		.000228	17272.8900		.0001
		135.130383	---------		135.1303	-------
38500	17408.020348	------------	.000200	17408.0203	----------	.0002
	--------------	135.130583		------------	135.1305	
38510	17543.150931		.000200	17543.1508		.0002
		135.130783			135.1307	
38520	17678.281714			17678.2815		

In both cases, we have extrapolated the table ahead by selecting a mean value for the second difference and adding it in for two more 10 day intervals. Thus, the portion of each Log below the dashed line represents a new "tentative" Log, with which we continue to predict for subsequent observations.

At the same time that we revise the Log, Mr. X and I will both derive new orbital elements and we will assume that we select the date, JNL = 38510. As compared with the previous Gear Ratio Elements, the data that we will work from will be:

Data Required for Revision of Elements

	W. P. O.	Mr. X
JNL	38510.0	38510.0
PRM	17543.150931	17543.1508
ΔPRM	918.496302	918.4962

The new Gear Ratio Elements that we derive will be:

New Gear Ratio Elements Derived from Casual and Meticulous Observations Compared

	W. P. O.	Mr. X
JNE	38510.0	38510.0
NGR	.078483	.078483
CP	7443.46	7443.46
CG	145.95	145.95
PRM	17543.150931 + ΔPRM	17543.1508 + ΔPRM
QNR	.837681 - .001052884(ΔPRM)	.837681 - .001052884(ΔPRM)
NRP	.055373 - 1.63333966(ΔQNR)	.055373 - 1.63333966(ΔQNR)

If I were to write an auxiliary prediction equation, it would be:

$$\Delta PRM = 13.5130683(ENL) + .100E\text{-}5(ENL)^2$$

Whereas Mr. X's prediction equation would be:

$$\Delta PRM = 13.51306(ENL) + .1E\text{-}5(ENL)^2$$

Thus, it may be seen that the main difference between my results and those of Mr. X is that I have more quantitative information as to the acceleration that has taken place and my prediction data will be more accurate in timing. However, the new Gear Ratio Elements that we derive will not be significantly different. Insofar as tracking is concerned, I could have abandoned the satellite for 70 days, leaving it to Mr. X. At the end of that time, I would have found his elements acceptable in recovering it. So, Mr. X easily qualifies as an Independent Satellite Tracker. (We once defined a "tracker" as a man who can keep track of satellites by himself.)

It should be noted that the above example is fictitious in that it was necessary to show a rather sudden increase in acceleration in order to make the residuals large enough to clearly illustrate the method of correction. 1960 Nu 2 would never show such a drastic change. If actual data had been used, the curve of Figure 2 would have been very close to the time axis. I would have made very small corrections, plotting the curve on a larger scale, and Mr. X would have concluded that there was no need to make corrections.

c. Use of Gear Ratio Elements to Improve Tracking Agency Data for Long Term Predictions

In using data issued by the official tracking agencies, one should recognize its limitations. The principal objective of the agency is to provide good short-term prediction. Observations are analyzed in batches to derive the best orbital elements to fit current observations and these are then extrapolated one or two weeks ahead. Before these elements begin to deteriorate, the agency will have a new batch of observations, a new analysis and a fresh set of elements. Thus, there is little reason to aim for long-term accuracy of any one set of elements.

There are a number of methods by which tracking agency data can be "smoothed" to obtain more uniform and better long-term performance. However, in smoothing the data, one should understand which items are likely to be most accurate and which should be regarded with suspicion. First, the rates of motion given for orbit pole and perigee are usually theoretical, rather than measured values. As a result, one sometimes obtains better values by comparing successive sets of elements, rather than by using those stated in the official bulletins. The remaining items are then comparable to those that we have described as "unperturbed" orbital elements and can be discussed, in order of decreasing accuracy, as follows:

JNE	The tracking agencies measure time very precisely so that there need never be any doubt as to the precision of the stated epoch.
CP	The semimajor axis is derived from measurement of the mean motion and this value should always be quite precise.
NGR	The inclination is relatively easy to measure and does not change rapidly. After the first week or two that a satellite is in orbit, tracking agency values for NGR will stabilize to within about ± 30 microturns of the correct value.
QNR	This value is also relatively easy to measure but more observations are needed in finding a correct value. So, the accuracy will generally be about ± 100 microturns for SAO elements and not quite this good for NORAD elements.
CG	This depends on eccentricity and the ability to obtain a good measurement varies with the orientation of the orbit. In prediction elements, the values seem to have a "scatter" of about ± 0.0005.
NRP	The perigee position is the most difficult to measure, particularly if the eccentricity is low. Errors can be of the order of ± 1500 microturns. Tracking agency data will also contain the variations due to the pear shape. For long-term, smoothed elements, we must separate these variations.
PRM	Accuracy in measurement of mean anomaly is affected by the accuracy of the perigee position, which serves as the reference point. It should be realized that, by adding NRP and PRM to obtain NRM, we can usually obtain a more accurate measure of the satellite position because NRM is measured from a fixed reference point.

Table VII then illustrates how we can use the Gear Ratio Elements to improve tracking agency data. In this case, we have used Ephemeris VI data, issued by the Smithsonian Astrophysical Observatory. Once we have established values for the gear ratios, the only data that we need accept from the SAO ephemerides are the values of JNE, NGR and NRM. In effect, we use SAO just as we used Mr. X, to keep track of how many times the satellite goes by and when. Thus, the first two columns of the table are similar to the Revolutions Log, except that, for convenience, we have used the 14 day interval that corresponds to the dates for which the Ephemeris VI is issued.

TABLE VII

Example of Use of Gear Ratio Elements to Improve for Long-Range Predictions From Data on Saturn V (1964 05A) Given in S.A.O. Ephemeris VI Bulletins

Gear Ratio Equations:

$QNR = -.508226 - .0011936733(PRM) - .2389E{-}8(PRM)^2$

$NRP = -.682318 - 1.545815(QNR)$

$\Delta CP = -21.5601 \Delta\Delta PRM$

$t_L = 629$ days

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
JNL	NRM(SAO)	PRM(WPO)	1st Diff.	2nd	QNR(SAO)	QNR(WPO)	1st Diff	2nd µt	NRP(SAO)	NRP(WPO)	1st Diff	2nd µt	ΔCP	CP	e(SAO)	e(WPO)
38423.686866	Launch 0.064122	- 0.039111				-0.508179				0.103233						
38436	187.517261	187.068647		(est.) .139530	-0.731608	-0.731609			0.448611	0.448514					.034811	.034811
			212.872147				-.254398				.393252			6880.550		
38450	400.782660	399.940794		.157855	-0.986042	-0.986007		406	0.845000	0.841866		628	-3.4034		.03413	.034421
			213.030002				-.254804				.393880			6877.147		
38464	614.206542	612.970796		.138971	-1.240833	-1.240811		383	1.230722	1.235746		592	-2.9962		.03548	.034027
			213.168973				-.255187				.394472			6874.150		
38478	827.769987	826.139769		.119074	-1.495900	-1.495998		359	1.628917	1.630218		555	-2.5672		.03390	.033631
			213.288047				-.255546				.395027			6871.583		
38492	1041.453061	1039.427816		.142221	-1.751594	-1.751544		389	2.027361	2.025245		601	-3.0663		.03282	.033225
			213.430268				-.255935				.395628			6868.517		
38506	1255.278957	1252.858084		.100329	-2.007436	-2.007479		338	2.418947	2.420873		523	-2.1631		.032753	.032817
			213.530597				-.256273				.396151			6866.354		
38520	1469.205766	1466.388681		.100252	-2.263733	-2.263752		338	2.818166	2.817024		522	-2.1614		.034200	.032403
			213.630849				-.256611				.396673			6864.192		
38534	1683.233227	1680.019530		.090684	-2.520369	-2.520363		328	3.210817	3.213697		507	-1.9552		.033064	.031984
			213.721533				-.256939				.397180			6862.237		
38548	1897.351940	1893.741063			-2.777111	-2.777302			3.613000	3.610877					.032024	.031560

To start the table, we initially used the SAO values of NRM, to find temporary ratios, ΔQNR/ΔNRM and ΔNRP/ΔQNR, that would give a reasonably good fit to the SAO values for QNR and NRP. This made it possible to establish a few of the calculated values, QNR(WPO) and NRP(WPO). The calculated NRP(WPO) values could then be subtracted from the NRM(SAO) values to obtain some starting values for PRM(WPO). With these, we derived the equations shown at the upper left. For convenience, these were based on an initial value of zero for PRM. Based on this start, we now fill in new values in the table according to the following procedure:

Procedure Used in Preparing Table VII

1. From each new issue of Ephemeris VI, we enter the values of JNL and NRM(SAO) in columns 1 and 2.

2. We extrapolate the value of NRP(WPO) forward, using the tabulated 1st and 2nd difference to obtain a tentative value for NRP.

3. The tentative value of NRP is subtracted from NRM(SAO) to obtain a tentative value for PRM(WPO).

4. The tentative value of PRM(WPO) is then used to calculate final values of QNR(WPO) and NRP(WPO) that are entered in columns 7 and 11.

5. The final NRP(WPO) is subtracted from NRM(SAO) to obtain the final value for PRM(WPO). This final value seldom varies from the tentative value by more than a few microturns so that it is not necessary to recalculate QNR(WPO) and NRP(WPO).

6. The first and second differences are then filled in for PRM (columns 4 and 5), QNR (columns 8 and 9) and NRP (columns 12 and 13).

7. The SAO values of QNR(SAO) and NRP(SAO) are entered in columns 6 and 10 for comparision.

Columns 14 and 15 illustrate how we can keep track of the variation in semimajor axis. The first entry in this column was calculated from the mean motion, corresponding to 1/14 of the value entered in column 4 of the same row. Succeeding values are obtained by subtracting the numbers listed as Δ CP in column 14. The ΔCP values are obtained with the equation shown above the table, in which ΔΔPRM represents the 2nd difference in PRM. The constant in this equation, - 21.5601, is 1/14 of the value obtained with equation (13).

Columns 16 and 17 compare the SAO values for eccentricity with those calculated from the King-Hele equations (14) and (15). Equation (14) gives a lifetime, t_L, of 629 days from JNL = 38436, indicating that this satellite should reenter the Earth's atmosphere on or about November 1, 1965. It should be a very spectacular sight because this is the rocket that is filled with sand.

As indicated, the QNR(SAO) values agree with the calculated QNR(WPO) values quite well and, as anticipated, the NRP(SAO) values do not show as good agreement. The calculated values are definitely better for long-term prediction and have given more accurate predictions of position angles.

With the 14 day interval, one must divide first differences by 14 to obtain daily motion and must divide 2nd differences by 2 x $(14)^2$ or 392 to obtain the acceleration coefficients. For example, if we wish to write Rationalized Orbital Elements for the epoch, JNE = 38534, we first interpolate in the table to obtain:

	Base Value	1st Diff.	2nd Diff.
PRM	1680.019530	213.676191	.090684
QNR	-.520363	-.256775	-.000328
NRP	.213694	.396927	.000507

We then divide 1st differences by 14 and 2nd differences by 392 to write:

$$PRM = 1680.019530 + 15.2625851(ENL) + .231E\text{-}3(ENL)^2$$

$$QNR = -.520363 - .0183411(ENL) - .837E\text{-}6(ENL)^2$$

$$NRP = .213694 + .0283519(ENL) + .129E\text{-}5(ENL)^2$$

For comparision, the SAO equations for the same epoch may be written:

$$PRM = 1680.02241 + 15.263657\ (ENL) + .259E\text{-}3(ENL)^2$$

$$QNR = -.520369 - .018324\ (ENL)$$

$$NRP = .210816 + .027669\ (ENL)$$

This comparision helps to illustrate several points:

1. The two sets of elements describe the same initial position because the NRM values for each are nearly equal, .233224 vs .233226.

2. The principal difference in long-term prediction will be due to the difference in mean motion. The value obtained from the Gear Ratio Elements will usually be better because it must fit the past history.

3. While the rates of motion of the orbit pole agree quite well, the rates of motion of the perigee differ substantially. This may be ascribed to possible effects of the pear shape on the SAO analysis.

An incidental benefit of the table of Gear Ratio Elements is that we begin to see the pattern of acceleration. The early period, between 38436 and 38492, is one in which the perigee is in sunlight. From 38506 through 38548 it is in darkness, where the atmospheric drag is reduced. The entire cycle should extend through about 137 days.

The values in the first row of Table VII represent my extrapolation back to the time of launching, JNL = 38423.686866, These values place the orbit directly over Cape Canaveral and allow the real satellite a few minutes to rise from the launching pad to meet its mathematical model.

d. Gear Ratio Elements for Keeping Track of the ECHO Satellites

Radiation pressure causes large, cyclic changes in eccentricity for the ECHO satellites, ranging up to 0.05 for ECHO I and 0.025 for ECHO II. This phenomenon leads to apparent irregularities in the motion of the perigee. For example, as the eccentricity passes through zero, the perigee position must jump from one side of the orbit to the other. These variations also lead to cyclic changes in the rate of motion of the orbit pole because, as indicated by equation (6), this rate is affected by the eccentricity. These effects of radiation pressure are coupled with large, irregular variations in acceleration. Thus, it becomes virtually impossible to describe the overall behavior of the ECHO satellites with a simple set of long-term equations.

One can devise means for accurate prediction for these satellites over short periods of time. However, the most useful application of the Gear Ratio Elements to this type of satellite appears to be that of providing a means for rough prediction that remains valid over long periods of time. With this objective in mind, we can make the Gear Ratio Elements simpler, rather than more complicated.

We start with the basic assumption that the eccentricity is zero and that there is no perigee position. We then need only one gear ratio, that between the orbit pole position, QNR, and the mean polar angle, NRM, of the satellite. With these assumptions, we can write Gear Ratio Elements for the two ECHO satellites as follows:

Gear Ratio Elements for Tracking ECHO Satellites

ECHO I	ECHO II
JNE = 38541.0	JNE = 38548.0
NGR = .131381	NGR = .226400
CP = 7806.94	CP = 7547.40
NRM = 5704.0997 + ΔNRM	NRM = 1697.8462 + ΔNRM
QNR = .272361 - .000733181(ΔNRM)	QNR = .819782 - .000171478(ΔNRM)

For ECHO I, the integral number of turns was taken from an arbitrary starting point. For ECHO II, the count is taken from the time of launching.

Auxiliary prediction equations, using the same epoch as for each set of elements, would be:

For ECHO I: $\Delta \mathrm{NRM} = 12.595787(\mathrm{ENL}) + .174\mathrm{E}{-4}(\mathrm{ENL})^2$

For ECHO II: $\Delta \mathrm{NRM} = 13.238029(\mathrm{ENL}) + .893\mathrm{E}{-4}(\mathrm{ENL})^2$

These will be somewhat less dependable than for other satellites, due to the rather rapid changes in acceleration.

Such Gear Ratio Elements can be kept up to date partly through observation and partly through the use of data from any other source. As an example, the ITCP issued Modified Orbital Elements on June 4, 1964, including the following data for ECHO II:

OBJECT	64 004A	
NAME	ECHO II	
SOURCE	SAO	
EPOCH of perigee (UT)	06 Jun 02 H 30M35	→ JNL = 38552.104410
INCLIN	81A50	
NODE W	000A17	
MPD=1D	-07M17	
PERIGEE	155A79	→ NRP = .182750
change/P	-A16391	
A Period	108M720	
change/P	-M00012	
ECCEN	U02317	
P RADIUS	4580#8	
R A NODE	291A77	

Of this data, we need only the two values indicated for JNL and NRP. (The NRP value is obtained by dividing the argument of perigee, $155^{\circ}79$, by 360 and subtracting $0^{t}25$).

Modified Orbital Elements are always written for an epoch at which PRM is zero so that the above value of NRP is also equal to NRM. Using the ECHO II prediction equation, the full value of NRM can readily be identified as:

$$\text{NRM} = 1752.182750 \quad \text{for} \quad \text{JNL} = 38552.104410$$

and these values can be regarded as equivalent to any observation that the tracker might obtain through his own effort.

As a check on the effectiveness of the Gear Ratio Elements, we can use the above data to compute QNR in:

$$\text{QNR} = .819782 - .000171478(1752.182750 - 1697.846200)$$

from which the result ($0^{t}810464$) should be numerically equal to the value given in the Modified Orbital Elements for the Right Ascension of the Node ($291^{\circ}77$)

Based on past history, the above Gear Ratio Elements for the ECHO satellites should give satisfactory prediction for a year or more and should thus provide a good beginner's exercise in tracking, when coupled with graphical methods of prediction such as those involving the Rationalized Wulff Net.

CONCLUSIONS

Obviously, Gear Ratio Elements are not truly "permanent" in that they must ultimately deteriorate due to lack of arithmetical precision. However, they are correct in principle in that motion of the orbit pole and perigee is more properly a function of motion of the satellite, rather than of time.

It is evident that they provide a more enduring model of satellite behavior, permitting the tracker to continue for a much longer period before adjustments become necessary. Since starting this investigation of their performance, I have continued tracking three satellites, each for about 200 days, and have continued to obtain accurate predictions for each from a single set of Gear Ratio Elements. During the entire period, the process of bringing the elements up to date and making new predictions has been completely automatic. It now appears that the same elements will continue to be satisfactory for at least one year.

Phone: STerling 3-4100

EXHIBIT E

INDEPENDENT TRACKING COORDINATION PROGRAM
824 Connecticut Avenue
Washington 6, D. C.

BULLETIN

7 April 1964

CONTENTS:

Rules for Combining Polar Angles
Rules for the Negative of an Angle
Worksheet for Advancing Epoch of Rationalized Orbital Elements
Drafting Aids to Making Accurate Overlays
Circular Slide Rule for Five Significant Figures
More Significant Figures with Used Desk Calculators
More Significant Figures with Curta Hand Calculator

Rules for Combining Polar Angles

The predictable way in which the 3-letter "names" of polar angles change under addition and subtraction is illustrated in the work sheets.

IN GENERAL: Polar angles may properly be combined if, and only if, they have a common pole (common middle letter-identity) and another identity in common.

If the INITIAL identity of one is the same as the TERMINAL identity of the other, the SUM ANGLE will have the remaining initial and terminal identities; for example:

$$ABC + CBD = ABD$$

If the INITIAL identities are the same, the INITIAL identity of the REMAINDER ANGLE will be the remaining identity of the subtrahend; for example:

$$ABD - ABC = CBD$$

If the TERMINAL identities are the same, the TERMINAL identity of the REMAINDER ANGLE will be the remaining identity of the subtrahend; for example:

$$ABD - CBD = ABC$$

Rule for the Name of the Negative of an Angle

If an angle is defined by the three-letter symbols, ABC, then the angle, CBA is the negative of ABC, for example:

$$-ABC = CBA$$

WORKSHEET FOR ADVANCING EPOCH: Example

Data used in the example given below was taken from the Work Sheet B example discussed in ITCP Bulletin 5 April 1964. Additional copies of Work Sheets are available on request to this office. Please specify which Work Sheets are desired.

WORK SHEET D: For Advancing the Epoch of Rationalized Orbital Elements

No. = - -

JNE = new epoch = $^{d}.$ Transmits: . mc/s

$-($JN$\cancel{E}$ = old epoch = $^{d}.$) . mc/s

= $\cancel{E}$NE = interval = $^{d}.$ $(\cancel{E}NE)^2$ = .

NGR = $^{t}.$ CG = . km CP = . km CG/CP = .

$TNR_{\cancel{0}} = {}^{t}.$	$TNR_{\cancel{1}} = -{}^{t}.$ (ENL)	$TNR_{\cancel{2}} = {}^{t}.$ $(ENL)^2$
$+ TNR_{\cancel{1}}(\cancel{E}NE) = -{}^{t}.$	$+2\ TNR_{\cancel{2}}(\cancel{E}NE) = {}^{t}.$	
$+ TNR_{\cancel{2}}(\cancel{E}NE)^2 = {}^{t}.$		
$= TNR_0 = {}^{t}.$	$TNR_1 = -{}^{t}.$ (ENL)	$TNR_2 = {}^{t}.$ $(ENL)^2$

$NRP_{\cancel{0}} = {}^{t}.$	$NRP_{\cancel{1}} = {}^{t}.$ (ENL)	$NRP_{\cancel{2}} = {}^{t}.$ $(ENL)^2$
$+ NPR_{\cancel{1}}(\cancel{E}NE) = {}^{t}.$	$+2\ NRP_{\cancel{2}}(\cancel{E}NE) = {}^{t}.$	
$+ NRP_{\cancel{2}}(\cancel{E}NE)^2 = {}^{t}.$		
$= NRP_0 = {}^{t}.$	$NRP_1 = {}^{t}.$ (ENL)	$NRP_2 = {}^{t}.$ $(ENL)^2$

$PRM_{\cancel{0}} = {}^{t}.$	$PRM_{\cancel{1}} = {}^{t}.$ (ENL)	$PRM_{\cancel{2}} = {}^{t}.$ $(ENL)^2$
$+ PRM_{\cancel{1}}(\cancel{E}NE)\ {}^{t}.$	$+2\ PRM_{\cancel{2}}(\cancel{E}NE) = {}^{t}.$	
$+ PRM_{\cancel{2}}(\cancel{E}NE)^2 = {}^{t}.$		
$= PRM_0 = {}^{t}.$	$PRM_1 = {}^{t}.$ (ENL)	$PRM_2 = {}^{t}.$ $(ENL)^2$

EXHIBIT E-1

WORK SHEET D: For Advancing the Epoch of Rationalized Orbital Elements

No. = - -

JNE = new epoch = d.

-(JN$\not{E}$ = old epoch = d.)

= $\not{E}$NE = interval = d. ($\not{E}$NE)^2 = .

Transmits: . mc/s

. mc/s

NGR = t. CG = . km CP = . km CG/CP = .

$TNR_{\not{0}}$ = t.

+ $TNR_{\not{1}}$($\not{E}$NE) = t.

+ $TNR_{\not{2}}$($\not{E}$NE)^2 = t.

= TNR_0 = t.

$TNR_{\not{1}}$ = t. (ENL)

+2 $TNR_{\not{2}}$($\not{E}$NE) = t.

TNR_1 = t. (ENL)

$TNR_{\not{2}}$ = t. (ENL)^2

TNR_2 = t. (ENL)^2

$NRP_{\not{0}}$ = t.

+ $NPR_{\not{1}}$($\not{E}$NE) = t.

+ $NRP_{\not{2}}$($\not{E}$NE)^2 = t.

= NRP_0 = t.

$NRP_{\not{1}}$ = t. (ENL)

+2 $NRP_{\not{2}}$($\not{E}$NE) = t.

NRP_1 = t. (ENL)

$NRP_{\not{2}}$ = t. (ENL)^2

NRP_2 = t. (ENL)^2

$PRM_{\not{0}}$ = t.

+ $PRM_{\not{1}}$($\not{E}$NE) t.

+ $PRM_{\not{2}}$($\not{E}$NE)^2 = t.

= PRM_0 = t.

$PRM_{\not{1}}$ = t. (ENL)

+2 $PRM_{\not{2}}$($\not{E}$NE) = t.

PRM_1 = t. (ENL)

$PRM_{\not{2}}$ = t. (ENL)^2

PRM_2 = t. (ENL)^2

Additional copies available from: ITCP, 824 Conn. Ave., Wash., D.C. 20006.

WORK SHEET D: For Advancing the Epoch of Rationalized Orbital Elements

No. = - -

JNE = new epoch = d.

-(JN0 = old epoch = d.)

= 0NE = interval = d.

$(0NE)^2$ = .

Transmits: . mc/s

. mc/s

NGR = t.

CG = . km

CP = . km

CG/CP = .

TNR_0 = t.	TNR_1 = t. (ENL)	TNR_2 = t. $(ENL)^2$
+ $TNR_1(0NE)$ = t.	+2 $TNR_2(0NE)$ = t.	
+ $TNR_2(0NE)^2$ = t.		
= TNR_0 = t.	TNR_1 = t. (ENL)	TNR_2 = t. $(ENL)^2$

NRP_0 = t.	NRP_1 = t. (ENL)	NRP_2 = t. $(ENL)^2$
+ $NPR_1(0NE)$ = t.	+2 $NRP_2(0NE)$ = t.	
+ $NRP_2(0NE)^2$ = t.		
= NRP_0 = t.	NRP_1 = t. (ENL)	NRP_2 = t. $(ENL)^2$

PRM_0 = t.	PRM_1 = t. (ENL)	PRM_2 = t. $(ENL)^2$
+ $PRM_1(0NE)$ t.	+2 $PRM_2(0NE)$ = t.	
+ $PRM_2(0NE)^2$ = t.		
= PRM_0 = t.	PRM_1 = t. (ENL)	PRM_2 = t. $(ENL)^2$

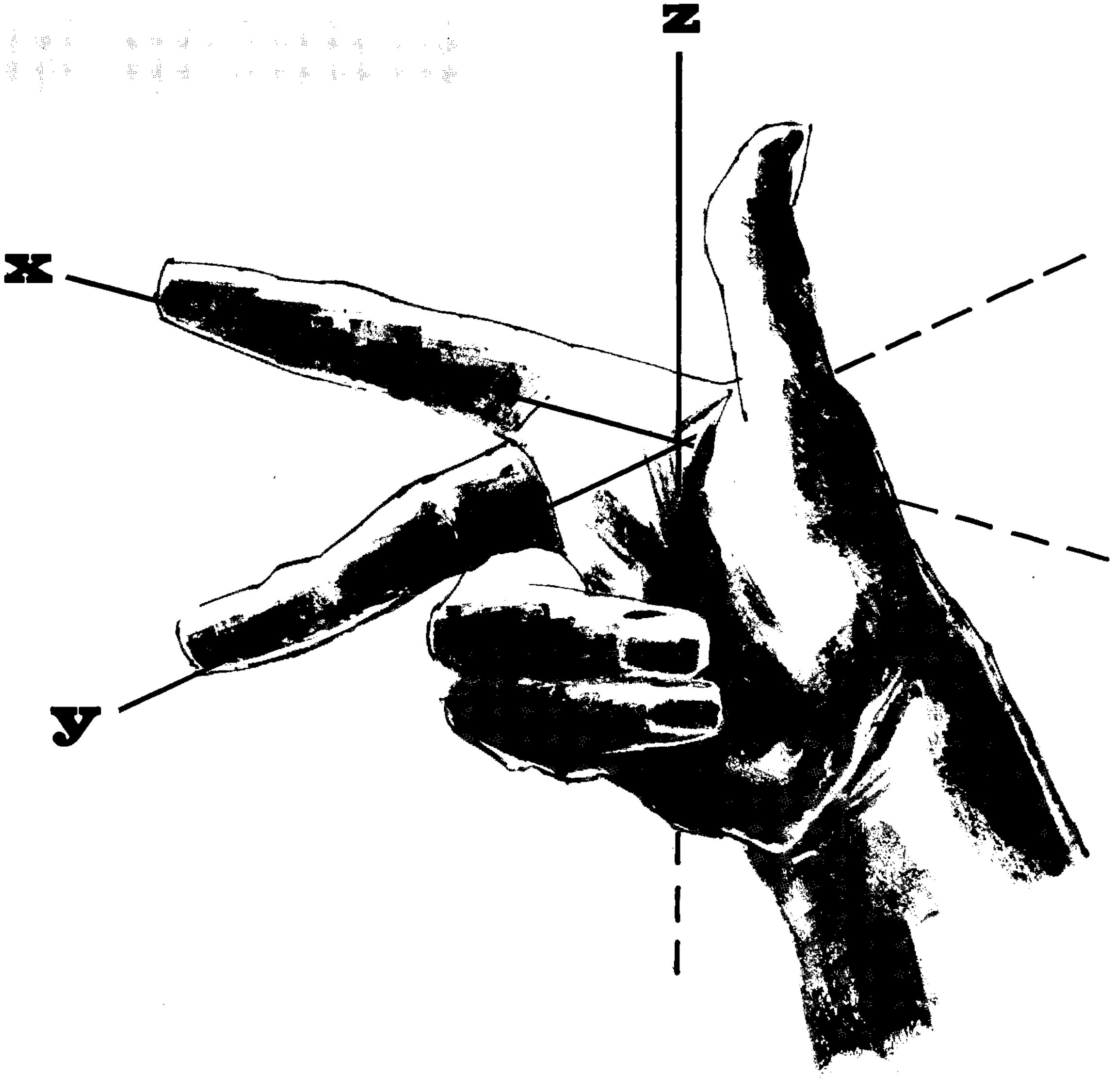
EXHIBIT F

SEVEN PLACE COSINES, SINES AND TANGENTS

[redacted]

FOR EVERY TENTH MICROTURN

[illegible]



Seven Place
Cosines, Sines and Tangents
For Every Tenth Microturn

Norton Goodwin, *Director*

Independent Tracking Coordination Program
Society of Photographic Scientists and Engineers

Photographically composed and printed in the United States of America by
H. G. Roebuck & Son, Inc. 2140 Aisquith Street, Baltimore, Maryland 21218

NOTE ON PHOTOGRAPHIC TYPOGRAPHY

These tables were photographically composed from digital computer tape records. The particular typefaces in which these tables are set are Spartan Book Condensed Large and Spartan Heavy Condensed Large. The selection was made from trial copy composed in a variety of fonts.

Typography was prepared by a commercial printer on a conventional photocomposition unit controlled by perforated paper tapes. The control tapes were produced by a converter unit designed to process magnetic tape records into a form suitable for general-purpose phototypesetting machines.

Acknowledgment is made of the assistance of Robert H. Blechen, Computer Sciences Department, The Rand Corporation, in securing a magnetic tape record of the tabular values, edited in the specified page format, and to Donald Rollert and Carl Rosencrown, Graphic Systems Engineering Department, Mergenthaler Linotype Company for their concern in converting the magnetic tape record to Linofilm tape.

PREFACE

THESE TABLES differ from trigonometric tables now available in that the sine and cosine values of a given argument appear on opposite pages, and in that decimal fractions of the period of these functions are the arguments. They were designed to facilitate routine desk-calculator transformations of the coordinates of artificial earth satellites in particular. They should prove generally advantageous in any area, such as space navigation or electrical engineering, involving cyclical coordinate changes.

The prime source of these tables is a subtabulation performed by Dr. E. C. Bower based on key values obtained from Francois Callet's "Tables Portatives de Logarithmes." Values have been correctly rounded from an accuracy of one unit in the fifteenth decimal place.

The arrangement of values in the one customary in logarithmic tables. Each page lists five hundred arguments at ten microturn intervals. The first two significant figures of the argument identify particular pages, the next two identify particular rows, and the last significant figure identifies a particular column. To facilitate "reading up," a tenth column is provided which gives the same value as the zeroth column in the succeeding row.

Complete values are given only in the zeroth column. In the remaining columns, unless the value is printed in boldface, the missing first two significant figures are those of the first complete value in the same row, or higher. If the value is printed in boldface, the missing first two significant figures are those of the first value in the succeeding row.

Tabular values of cosines and sines of from t00000 to t25000 are given. Since $arctan\ a/b = arccot\ b/a$, tangents are only given for from t00000 to t12500 and cotangents for from t12500 to t25000. All tabulated values are positive. Rules for determining the senses and magnitudes of the various functions in the remaining three quadrants are given in an Appendix.

Washington, March, 1964

Norton Goodwin

COS t00--

	0	1	2	3	4	5	6	7	8	9	10	
00	1.00 00000	00000	00000	00000	00000	00000	**99999**	**99999**	**99999**	**99998**	**99998**	99
01	.99 99998	99998	99997	99997	99996	99996	99995	99994	99994	99993	99992	98
02	99992	99991	99990	99990	99989	99988	99987	99986	99985	99983	99982	97
03	99982	99981	99980	99979	99977	99976	99974	99973	99971	99970	99968	96
04	99968	99967	99965	99964	99962	99960	99958	99956	99955	99953	99951	95
05	99951	99949	99947	99945	99942	99940	99938	99936	99934	99931	99929	94
06	99929	99927	99924	99922	99919	99917	99914	99911	99909	99906	99903	93
07	99903	99900	99898	99895	99892	99889	99886	99883	99880	99877	99874	92
08	99874	99870	99867	99864	99861	99857	99854	99851	99847	99844	99840	91
09	99840	99837	99833	99829	99826	99822	99818	99814	99810	99807	99803	90
10	99803	99799	99795	99791	99787	99782	99778	99774	99770	99765	99761	89
11	99761	99757	99752	99748	99743	99739	99734	99730	99725	99720	99716	88
12	99716	99711	99706	99701	99696	99692	99687	99682	99677	99672	99666	87
13	99666	99661	99656	99651	99646	99640	99635	99630	99624	99619	99613	86
14	99613	99608	99602	99596	99591	99585	99579	99573	99568	99562	99556	85
15	99556	99550	99544	99538	99532	99526	99520	99513	99507	99501	99495	84
16	99495	99488	99482	99476	99469	99463	99456	99449	99443	99436	99430	83
17	99430	99423	99416	99409	99402	99395	99389	99382	99375	99368	99360	82
18	99360	99353	99346	99339	99332	99324	99317	99310	99302	99295	99287	81
19	99287	99280	99272	99265	99257	99249	99242	99234	99226	99218	99210	80
20	99210	99203	99195	99187	99179	99170	99162	99154	99146	99138	99130	79
21	99130	99121	99113	99104	99096	99088	99079	99071	99062	99053	99045	78
22	99045	99036	99027	99018	99010	99001	98992	98983	98974	98965	98956	77
23	98956	98947	98938	98928	98919	98910	98901	98891	98882	98872	98863	76
24	98863	98854	98844	98834	98825	98815	98805	98796	98786	98776	98766	75
25	98766	98756	98747	98737	98727	98716	98706	98696	98686	98676	98666	74
26	98666	98655	98645	98635	98624	98614	98603	98593	98582	98572	98561	73
27	98561	98550	98540	98529	98518	98507	98496	98485	98475	98464	98452	72
28	98452	98441	98430	98419	98408	98397	98385	98374	98363	98351	98340	71
29	98340	98329	98317	98305	98294	98282	98271	98259	98247	98235	98224	70
30	98224	98212	98200	98188	98176	98164	98152	98140	98128	98115	98103	69
31	98103	98091	98079	98066	98054	98041	98029	98016	98004	97991	97979	68
32	97979	97966	97953	97941	97928	97915	97902	97889	97876	97863	97850	67
33	97850	97837	97824	97811	97798	97785	97772	97758	97745	97732	97718	66
34	97718	97705	97691	97678	97664	97651	97637	97623	97610	97596	97582	65
35	97582	97568	97554	97540	97526	97512	97498	97484	97470	97456	97442	64
36	97442	97428	97413	97399	97385	97370	97356	97341	97327	97312	97298	63
37	97298	97283	97269	97254	97239	97224	97209	97195	97180	97165	97150	62
38	97150	97135	97120	97105	97089	97074	97059	97044	97029	97013	96998	61
39	96998	96982	96967	96951	96936	96920	96905	96889	96873	96858	96842	60
40	96842	96826	96810	96794	96778	96762	96746	96730	96714	96698	96682	59
41	96682	96666	96650	96633	96617	96601	96584	96568	96551	96535	96518	58
42	96518	96502	96485	96468	96452	96435	96418	96401	96384	96367	96350	57
43	96350	96333	96316	96299	96282	96265	96248	96231	96213	96196	96179	56
44	96179	96161	96144	96126	96109	96091	96074	96056	96039	96021	96003	55
45	96003	95985	95967	95950	95932	95914	95896	95878	95860	95842	95823	54
46	95823	95805	95787	95769	95751	95732	95714	95695	95677	95658	95640	53
47	95640	95621	95603	95584	95565	95547	95528	95509	95490	95471	95452	52
48	95452	95433	95414	95395	95376	95357	95338	95319	95300	95280	95261	51
49	95261	95242	95222	95203	95183	95164	95144	95125	95105	95085	95066	50
	10	9	8	7	6	5	4	3	2	1	0	

SIN t24--

SIN t00--

	0	1	2	3	4	5	6	7	8	9	10	
00	.00 00000	00628	01257	01885	02513	03142	03770	04398	05027	05655	06283	99
01	06283	06912	07540	08168	08796	09425	10053	10681	11310	11938	12566	98
02	12566	13195	13823	14451	15080	15708	16336	16965	17593	18221	18850	97
03	18850	19478	20106	20734	21363	21991	22619	23248	23876	24504	25133	96
04	25133	25761	26389	27018	27646	28274	28903	29531	30159	30788	31416	95
05	31416	32044	32673	33301	33929	34557	35186	35814	36442	37071	37699	94
06	37699	38327	38956	39584	40212	40841	41469	42097	42726	43354	43982	93
07	43982	44610	45239	45867	46495	47124	47752	48380	49009	49637	50265	92
08	50265	50894	51522	52150	52779	53407	54035	54663	55292	55920	56548	91
09	56548	57177	57805	58433	59062	59690	60318	60947	61575	62203	62831	90
10	62831	63460	64088	64716	65345	65973	66601	67230	67858	68486	69114	89
11	69114	69743	70371	70999	71628	72256	72884	73513	74141	74769	75398	88
12	75398	76026	76654	77282	77911	78539	79167	79796	80424	81052	81681	87
13	81681	82309	82937	83565	84194	84822	85450	86079	86707	87335	87963	86
14	87963	88592	89220	89848	90477	91105	91733	92362	92990	93618	94246	85
15	94246	94875	95503	96131	96760	97388	98016	98644	99273	99901	**00529**	84
16	.01 00529	01158	01786	02414	03042	03671	04299	04927	05556	06184	06812	83
17	06812	07440	08069	08697	09325	09954	10582	11210	11838	12467	13095	82
18	13095	13723	14351	14980	15608	16236	16865	17493	18121	18749	19378	81
19	19378	20006	20634	21263	21891	22519	23147	23776	24404	25032	25660	80
20	25660	26289	26917	27545	28173	28802	29430	30058	30687	31315	31943	79
21	31943	32571	33200	33828	34456	35084	35713	36341	36969	37597	38226	78
22	38226	38854	39482	40110	40739	41367	41995	42623	43252	43880	44508	77
23	44508	45136	45765	46393	47021	47649	48278	48906	49534	50162	50791	76
24	50791	51419	52047	52675	53304	53932	54560	55188	55817	56445	57073	75
25	57073	57701	58330	58958	59586	60214	60843	61471	62099	62727	63356	74
26	63356	63984	64612	65240	65868	66497	67125	67753	68381	69010	69638	73
27	69638	70266	70894	71523	72151	72779	73407	74035	74664	75292	75920	72
28	75920	76548	77177	77805	78433	79061	79689	80318	80946	81574	82202	71
29	82202	82831	83459	84087	84715	85343	85972	86600	87228	87856	88484	70
30	88484	89113	89741	90369	90997	91625	92254	92882	93510	94138	94766	69
31	94766	95395	96023	96651	97279	97907	98536	99164	99792	**00420**	**01048**	68
32	.02 01048	01677	02305	02933	03561	04189	04818	05446	06074	06702	07330	67
33	07330	07958	08587	09215	09843	10471	11099	11728	12356	12984	13612	66
34	13612	14240	14868	15497	16125	16753	17381	18009	18637	19266	19894	65
35	19894	20522	21150	21778	22406	23035	23663	24291	24919	25547	26175	64
36	26175	26804	27432	28060	28688	29316	29944	30572	31201	31829	32457	63
37	32457	33085	33713	34341	34970	35598	36226	36854	37482	38110	38738	62
38	38738	39366	39995	40623	41251	41879	42507	43135	43763	44392	45020	61
39	45020	45648	46276	46904	47532	48160	48788	49417	50045	50673	51301	60
40	51301	51929	52557	53185	53813	54442	55070	55698	56326	56954	57582	59
41	57582	58210	58838	59466	60095	60723	61351	61979	62607	63235	63863	58
42	63863	64491	65119	65747	66376	67004	67632	68260	68888	69516	70144	57
43	70144	70772	71400	72028	72656	73285	73913	74541	75169	75797	76425	56
44	76425	77053	77681	78309	78937	79565	80193	80821	81450	82078	82706	55
45	82706	83334	83962	84590	85218	85846	86474	87102	87730	88358	88986	54
46	88986	89614	90242	90870	91499	92127	92755	93383	94011	94639	95267	53
47	95267	95895	96523	97151	97779	98407	99035	99663	**00291**	**00919**	**01547**	52
48	.03 01547	02175	02803	03431	04059	04687	05315	05943	06571	07199	07827	51
49	07827	08455	09083	09712	10340	10968	11596	12224	12852	13480	14108	50
	10	9	8	7	6	5	4	3	2	1	0	

COS t24--

COS t00--

	0	1	2	3	4	5	6	7	8	9	10	
50	.99 95066	95046	95026	95006	94986	94966	94946	94926	94906	94886	94866	49
51	94866	94846	94826	94806	94785	94765	94745	94724	94704	94683	94663	48
52	94663	94642	94622	94601	94581	94560	94539	94518	94498	94477	94456	47
53	94456	94435	94414	94393	94372	94351	94330	94308	94287	94266	94245	46
54	94245	94223	94202	94180	94159	94138	94116	94094	94073	94051	94029	45
55	94029	94008	93986	93964	93942	93920	93899	93877	93855	93833	93810	44
56	93810	93788	93766	93744	93722	93699	93677	93655	93632	93610	93587	43
57	93587	93565	93542	93520	93497	93474	93452	93429	93406	93383	93360	42
58	93360	93338	93315	93292	93269	93246	93222	93199	93176	93153	93130	41
59	93130	93106	93083	93060	93036	93013	92989	92966	92942	92918	92895	40
60	92895	92871	92847	92824	92800	92776	92752	92728	92704	92680	92656	39
61	92656	92632	92608	92584	92559	92535	92511	92486	92462	92438	92413	38
62	92413	92389	92364	92340	92315	92290	92266	92241	92216	92191	92167	37
63	92167	92142	92117	92092	92067	92042	92017	91992	91966	91941	91916	36
64	91916	91891	91865	91840	91815	91789	91764	91738	91713	91687	91661	35
65	91661	91636	91610	91584	91558	91533	91507	91481	91455	91429	91403	34
66	91403	91377	91351	91325	91298	91272	91246	91220	91193	91167	91140	33
67	91140	91114	91087	91061	91034	91008	90981	90954	90928	90901	90874	32
68	90874	90847	90820	90793	90766	90739	90712	90685	90658	90631	90604	31
69	90604	90576	90549	90522	90494	90467	90440	90412	90385	90357	90329	30
70	90329	90302	90274	90246	90219	90191	90163	90135	90107	90079	90051	29
71	90051	90023	89995	89967	89939	89911	89882	89854	89826	89797	89769	28
72	89769	89741	89712	89684	89655	89626	89598	89569	89540	89512	89483	27
73	89483	89454	89425	89396	89367	89338	89309	89280	89251	89222	89193	26
74	89193	89164	89134	89105	89076	89046	89017	88987	88958	88928	88899	25
75	88899	88869	88839	88810	88780	88750	88720	88691	88661	88631	88601	24
76	88601	88571	88541	88511	88481	88450	88420	88390	88360	88329	88299	23
77	88299	88268	88238	88208	88177	88146	88116	88085	88055	88024	87993	22
78	87993	87962	87931	87901	87870	87839	87808	87777	87746	87714	87683	21
79	87683	87652	87621	87590	87558	87527	87496	87464	87433	87401	87370	20
80	87370	87338	87306	87275	87243	87211	87179	87148	87116	87084	87052	19
81	87052	87020	86988	86956	86924	86892	86859	86827	86795	86763	86730	18
82	86730	86698	86665	86633	86601	86568	86535	86503	86470	86437	86405	17
83	86405	86372	86339	86306	86273	86240	86208	86175	86141	86108	86075	16
84	86075	86042	86009	85976	85942	85909	85876	85842	85809	85775	85742	15
85	85742	85708	85675	85641	85607	85574	85540	85506	85472	85438	85404	14
86	85404	85370	85336	85302	85268	85234	85200	85166	85132	85097	85063	13
87	85063	85029	84994	84960	84925	84891	84856	84822	84787	84753	84718	12
88	84718	84683	84648	84614	84579	84544	84509	84474	84439	84404	84369	11
89	84369	84334	84298	84263	84228	84193	84157	84122	84086	84051	84016	10
90	84016	83980	83944	83909	83873	83837	83802	83766	83730	83694	83658	09
91	83658	83622	83587	83551	83514	83478	83442	83406	83370	83334	83297	08
92	83297	83261	83225	83188	83152	83115	83079	83042	83006	82969	82932	07
93	82932	82896	82859	82822	82785	82748	82712	82675	82638	82601	82564	06
94	82564	82526	82489	82452	82415	82378	82340	82303	82266	82228	82191	05
95	82191	82153	82116	82078	82040	82003	81965	81927	81890	81852	81814	04
96	81814	81776	81738	81700	81662	81624	81586	81548	81510	81471	81433	03
97	81433	81395	81357	81318	81280	81241	81203	81164	81126	81087	81048	02
98	81048	81010	80971	80932	80893	80855	80816	80777	80738	80699	80660	01
99	80660	80621	80582	80542	80503	80464	80425	80385	80346	80307	80267	00
	10	9	8	7	6	5	4	3	2	1	0	

SIN t24--

TAN t00--

'	0	1	2	3	4	5	6	7	8	9	10	
00	.00 00000	00628	01257	01885	02513	03142	03770	04398	05027	05655	06283	99
01	06283	06912	07540	08168	08796	09425	10053	10681	11310	11938	12566	98
02	12566	13195	13823	14451	15080	15708	16336	16965	17593	18221	18850	97
03	18850	19478	20106	20735	21363	21991	22620	23248	23876	24504	25133	96
04	25133	25761	26389	27018	27646	28274	28903	29531	30159	30788	31416	95
05	31416	32044	32673	33301	33929	34558	35186	35814	36443	37071	37699	94
06	37699	38328	38956	39584	40213	40841	41469	42098	42726	43354	43983	93
07	43983	44611	45239	45868	46496	47124	47753	48381	49009	49638	50266	92
08	50266	50894	51523	52151	52779	53408	54036	54664	55293	55921	56549	91
09	56549	57178	57806	58434	59063	59691	60319	60948	61576	62204	62833	90
10	62833	63461	64089	64718	65346	65974	66603	67231	67859	68488	69116	89
11	69116	69744	70373	71001	71630	72258	72886	73515	74143	74771	75400	88
12	75400	76028	76656	77285	77913	78541	79170	79798	80427	81055	81683	87
13	81683	82312	82940	83568	84197	84825	85453	86082	86710	87338	87967	86
14	87967	88595	89224	89852	90480	91109	91737	92365	92994	93622	94251	85
15	94251	94879	95507	96136	96764	97392	98021	98649	99278	99906	**00534**	84
16	.01 00534	01163	01791	02420	03048	03676	04305	04933	05561	06190	06818	83
17	06818	07447	08075	08703	09332	09960	10589	11217	11845	12474	13102	82
18	13102	13731	14359	14987	15616	16244	16873	17501	18129	18758	19386	81
19	19386	20015	20643	21271	21900	22528	23157	23785	24413	25042	25670	80
20	25670	26299	26927	27556	28184	28812	29441	30069	30698	31326	31955	79
21	31955	32583	33211	33840	34468	35097	35725	36354	36982	37610	38239	78
22	38239	38867	39496	40124	40753	41381	42010	42638	43266	43895	44523	77
23	44523	45152	45780	46409	47037	47666	48294	48922	49551	50179	50808	76
24	50808	51436	52065	52693	53322	53950	54579	55207	55836	56464	57093	75
25	57093	57721	58350	58978	59606	60235	60863	61492	62120	62749	63377	74
26	63377	64006	64634	65263	65891	66520	67148	67777	68405	69034	69662	73
27	69662	70291	70919	71548	72176	72805	73433	74062	74690	75319	75947	72
28	75947	76576	77204	77833	78461	79090	79718	80347	80975	81604	82233	71
29	82233	82861	83490	84118	84747	85375	86004	86632	87261	87889	88518	70
30	88518	89146	89775	90404	91032	91661	92289	92918	93546	94175	94803	69
31	94803	95432	96060	96689	97318	97946	98575	99203	99832	**00460**	**01089**	68
32	.02 01089	01718	02346	02975	03603	04232	04860	05489	06118	06746	07375	67
33	07375	08003	08632	09261	09889	10518	11146	11775	12404	13032	13661	66
34	13661	14289	14918	15547	16175	16804	17432	18061	18690	19318	19947	65
35	19947	20576	21204	21833	22461	23090	23719	24347	24976	25605	26233	64
36	26233	26862	27491	28119	28748	29376	30005	30634	31262	31891	32520	63
37	32520	33148	33777	34406	35034	35663	36292	36920	37549	38178	38806	62
38	38806	39435	40064	40692	41321	41950	42579	43207	43836	44465	45093	61
39	45093	45722	46351	46979	47608	48237	48865	49494	50123	50752	51380	60
40	51380	52009	52638	53266	53895	54524	55153	55781	56410	57039	57668	59
41	57668	58296	58925	59554	60183	60811	61440	62069	62698	63326	63955	58
42	63955	64584	65213	65841	66470	67099	67728	68356	68985	69614	70243	57
43	70243	70872	71500	72129	72758	73387	74015	74644	75273	75902	76531	56
44	76531	77159	77788	78417	79046	79675	80303	80932	81561	82190	82819	55
45	82819	83448	84076	84705	85334	85963	86592	87221	87849	88478	89107	54
46	89107	89736	90365	90994	91622	92251	92880	93509	94138	94767	95396	53
47	95396	96024	96653	97282	97911	98540	99169	99798	**00427**	**01055**	**01684**	52
48	.03 01684	02313	02942	03571	04200	04829	05458	06087	06716	07344	07973	51
49	07973	08602	09231	09860	10489	11118	11747	12376	13005	13634	14263	50
	10	9	8	7	6	5	4	3	2	1	0	

COT t24--

	0	1	2	3	4	5	6	7	8	9	10	
00	.68 45471	45929	46387	46845	47303	47761	48219	48677	49134	49592	50050	99
01	50050	50508	50965	51423	51881	52338	52796	53254	53711	54169	54626	98
02	54626	55084	55541	55998	56456	56913	57371	57828	58285	58742	59200	97
03	59200	59657	60114	60571	61028	61485	61942	62399	62856	63313	63770	96
04	63770	64227	64684	65141	65598	66055	66512	66968	67425	67882	68338	95
05	68338	68795	69252	69708	70165	70621	71078	71534	71991	72447	72904	94
06	72904	73360	73817	74273	74729	75185	75642	76098	76554	77010	77466	93
07	77466	77923	78379	78835	79291	79747	80203	80659	81115	81571	82026	92
08	82026	82482	82938	83394	83850	84305	84761	85217	85672	86128	86584	91
09	86584	87039	87495	87950	88406	88861	89317	89772	90227	90683	91138	90
10	91138	91593	92049	92504	92959	93414	93869	94325	94780	95235	95690	89
11	95690	96145	96600	97055	97510	97965	98420	98874	99329	99784	**00239**	88
12	.69 00239	00694	01148	01603	02058	02512	02967	03422	03876	04331	04785	87
13	04785	05240	05694	06149	06603	07057	07512	07966	08420	08875	09329	86
14	09329	09783	10237	10691	11145	11600	12054	12508	12962	13416	13870	85
15	13870	14324	14778	15231	15685	16139	16593	17047	17500	17954	18408	84
16	18408	18861	19315	19769	20222	20676	21129	21583	22036	22490	22943	83
17	22943	23397	23850	24303	24757	25210	25663	26116	26570	27023	27476	82
18	27476	27929	28382	28835	29288	29741	30194	30647	31100	31553	32006	81
19	32006	32459	32912	33364	33817	34270	34723	35175	35628	36080	36533	80
20	36533	36986	37438	37891	38343	38796	39248	39700	40153	40605	41058	79
21	41058	41510	41962	42414	42867	43319	43771	44223	44675	45127	45579	78
22	45579	46031	46483	46935	47387	47839	48291	48743	49195	49646	50098	77
23	50098	50550	51002	51453	51905	52357	52808	53260	53711	54163	54614	76
24	54614	55066	55517	55969	56420	56872	57323	57774	58225	58677	59128	75
25	59128	59579	60030	60481	60933	61384	61835	62286	62737	63188	63639	74
26	63639	64090	64541	64991	65442	65893	66344	66795	67245	67696	68147	73
27	68147	68597	69048	69499	69949	70400	70850	71301	71751	72202	72652	72
28	72652	73102	73553	74003	74453	74904	75354	75804	76254	76704	77154	71
29	77154	77605	78055	78505	78955	79405	79855	80305	80754	81204	81654	70
30	81654	82104	82554	83004	83453	83903	84353	84802	85252	85702	86151	69
31	86151	86601	87050	87500	87949	88399	88848	89297	89747	90196	90645	68
32	90645	91095	91544	91993	92442	92891	93341	93790	94239	94688	95137	67
33	95137	95586	96035	96484	96933	97382	97830	98279	98728	99177	99626	66
34	99626	**00074**	**00523**	**00972**	**01420**	**01869**	**02317**	**02766**	**03215**	**03663**	**04112**	65
35	.70 04112	04560	05008	05457	05905	06353	06802	07250	07698	08146	08595	64
36	08595	09043	09491	09939	10387	10835	11283	11731	12179	12627	13075	63
37	13075	13523	13971	14419	14866	15314	15762	16210	16657	17105	17553	62
38	17553	18000	18448	18895	19343	19791	20238	20685	21133	21580	22028	61
39	22028	22475	22922	23370	23817	24264	24711	25158	25606	26053	26500	60
40	26500	26947	27394	27841	28288	28735	29182	29629	30075	30522	30969	59
41	30969	31416	31863	32309	32756	33203	33649	34096	34542	34989	35436	58
42	35436	35882	36329	36775	37221	37668	38114	38560	39007	39453	39899	57
43	39899	40346	40792	41238	41684	42130	42576	43022	43468	43914	44360	56
44	44360	44806	45252	45698	46144	46590	47036	47481	47927	48373	48819	55
45	48819	49264	49710	50155	50601	51047	51492	51938	52383	52829	53274	54
46	53274	53719	54165	54610	55055	55501	55946	56391	56836	57281	57727	53
47	57727	58172	58617	59062	59507	59952	60397	60842	61287	61732	62176	52
48	62176	62621	63066	63511	63956	64400	64845	65290	65734	66179	66624	51
49	66624	67068	67513	67957	68402	68846	69290	69735	70179	70624	71068	50
	10	9	8	7	6	5	4	3	2	1	0	

COS t12--

'	0	1	2	3	4	5	6	7	8	9	10	
00	.72 89686	89256	88826	88396	87966	87535	87105	86675	86244	85814	85384	99
01	85384	84953	84523	84092	83662	83231	82801	82370	81940	81509	81078	98
02	81078	80648	80217	79786	79355	78924	78494	78063	77632	77201	76770	97
03	76770	76339	75908	75477	75046	74615	74184	73752	73321	72890	72459	96
04	72459	72027	71596	71165	70733	70302	69871	69439	69008	68576	68145	95
05	68145	67713	67281	66850	66418	65987	65555	65123	64691	64260	63828	94
06	63828	63396	62964	62532	62100	61668	61236	60804	60372	59940	59508	93
07	59508	59076	58644	58211	57779	57347	56915	56482	56050	55618	55185	92
08	55185	54753	54320	53888	53455	53023	52590	52158	51725	51292	50860	91
09	50860	50427	49994	49561	49129	48696	48263	47830	47397	46964	46531	90
10	46531	46098	45665	45232	44799	44366	43933	43500	43067	42633	42200	89
11	42200	41767	41333	40900	40467	40033	39600	39166	38733	38299	37866	88
12	37866	37432	36999	36565	36131	35698	35264	34830	34397	33963	33529	87
13	33529	33095	32661	32227	31793	31359	30925	30491	30057	29623	29189	86
14	29189	28755	28321	27887	27452	27018	26584	26150	25715	25281	24846	85
15	24846	24412	23978	23543	23109	22674	22239	21805	21370	20936	20501	84
16	20501	20066	19631	19197	18762	18327	17892	17457	17022	16587	16153	83
17	16153	15718	15282	14847	14412	13977	13542	13107	12672	12237	11801	82
18	11801	11366	10931	10495	10060	09625	09189	08754	08318	07883	07447	81
19	07447	07012	06576	06140	05705	05269	04833	04398	03962	03526	03090	80
20	03090	02654	02219	01783	01347	00911	00475	00039	**99603**	**99167**	**98730**	79
21	.71 98730	98294	97858	97422	96986	96550	96113	95677	95241	94804	94368	78
22	94368	93931	93495	93059	92622	92185	91749	91312	90876	90439	90002	77
23	90002	89566	89129	88692	88255	87819	87382	86945	86508	86071	85634	76
24	85634	85197	84760	84323	83886	83449	83012	82575	82137	81700	81263	75
25	81263	80826	80388	79951	79514	79076	78639	78201	77764	77327	76889	74
26	76889	76451	76014	75576	75139	74701	74263	73826	73388	72950	72512	73
27	72512	72074	71637	71199	70761	70323	69885	69447	69009	68571	68133	72
28	68133	67694	67256	66818	66380	65942	65503	65065	64627	64188	63750	71
29	63750	63312	62873	62435	61996	61558	61119	60681	60242	59803	59365	70
30	59365	58926	58487	58049	57610	57171	56732	56293	55855	55416	54977	69
31	54977	54538	54099	53660	53221	52782	52342	51903	51464	51025	50586	68
32	50586	50147	49707	49268	48829	48389	47950	47510	47071	46632	46192	67
33	46192	45752	45313	44873	44434	43994	43554	43115	42675	42235	41795	66
34	41795	41356	40916	40476	40036	39596	39156	38716	38276	37836	37396	65
35	37396	36956	36516	36076	35635	35195	34755	34315	33874	33434	32994	64
36	32994	32553	32113	31673	31232	30792	30351	29911	29470	29029	28589	63
37	28589	28148	27707	27267	26826	26385	25944	25504	25063	24622	24181	62
38	24181	23740	23299	22858	22417	21976	21535	21094	20653	20211	19770	61
39	19770	19329	18888	18446	18005	17564	17122	16681	16240	15798	15357	60
40	15357	14915	14474	14032	13591	13149	12707	12266	11824	11382	10940	59
41	10940	10499	10057	09615	09173	08731	08289	07847	07405	06963	06521	58
42	06521	06079	05637	05195	04753	04311	03869	03426	02984	02542	02099	57
43	02099	01657	01215	00772	00330	**99887**	**99445**	**99003**	**98560**	**98117**	**97675**	56
44	.70 97675	97232	96790	96347	95904	95461	95019	94576	94133	93690	93247	55
45	93247	92804	92361	91918	91476	91032	90589	90146	89703	89260	88817	54
46	88817	88374	87931	87487	87044	86601	86157	85714	85271	84827	84384	53
47	84384	83940	83497	83053	82610	82166	81723	81279	80835	80392	79948	52
48	79948	79504	79060	78617	78173	77729	77285	76841	76397	75953	75509	51
49	75509	75065	74621	74177	73733	73289	72845	72401	71956	71512	71068	50
	10	9	8	7	6	5	4	3	2	1	0	

SIN t12--

SIN t11--

	0	1	2	3	4	5	6	7	8	9	10	
50	.66 13119	13590	14061	14532	15004	15475	15946	16417	16888	17359	17830	49
51	17830	18301	18772	19243	19714	20185	20656	21127	21598	22069	22540	48
52	22540	23010	23481	23952	24423	24893	25364	25834	26305	26776	27246	47
53	27246	27717	28187	28658	29128	29598	30069	30539	31010	31480	31950	46
54	31950	32420	32891	33361	33831	34301	34771	35241	35711	36181	36651	45
55	36651	37121	37591	38061	38531	39001	39471	39941	40411	40880	41350	44
56	41350	41820	42290	42759	43229	43698	44168	44638	45107	45577	46046	43
57	46046	46516	46985	47455	47924	48393	48863	49332	49801	50270	50740	42
58	50740	51209	51678	52147	52616	53085	53554	54024	54493	54962	55430	41
59	55430	55899	56368	56837	57306	57775	58244	58712	59181	59650	60119	40
60	60119	60587	61056	61525	61993	62462	62930	63399	63867	64336	64804	39
61	64804	65273	65741	66209	66678	67146	67614	68083	68551	69019	69487	38
62	69487	69955	70423	70892	71360	71828	72296	72764	73232	73700	74167	37
63	74167	74635	75103	75571	76039	76507	76974	77442	77910	78378	78845	36
64	78845	79313	79780	80248	80715	81183	81651	82118	82585	83053	83520	35
65	83520	83988	84455	84922	85389	85857	86324	86791	87258	87725	88193	34
66	88193	88660	89127	89594	90061	90528	90995	91462	91929	92395	92862	33
67	92862	93329	93796	94263	94730	95196	95663	96130	96596	97063	97529	32
68	97529	97996	98463	98929	99396	99862	**00328**	**00795**	**01261**	**01728**	**02194**	31
69	.67 02194	02660	03127	03593	04059	04525	04991	05457	05924	06390	06856	30
70	06856	07322	07788	08254	08720	09186	09652	10117	10583	11049	11515	29
71	11515	11981	12446	12912	13378	13844	14309	14775	15240	15706	16171	28
72	16171	16637	17102	17568	18033	18499	18964	19429	19895	20360	20825	27
73	20825	21291	21756	22221	22686	23151	23616	24081	24547	25012	25477	26
74	25477	25942	26406	26871	27336	27801	28266	28731	29196	29660	30125	25
75	30125	30590	31055	31519	31984	32448	32913	33378	33842	34307	34771	24
76	34771	35235	35700	36164	36629	37093	37557	38022	38486	38950	39414	23
77	39414	39878	40343	40807	41271	41735	42199	42663	43127	43591	44055	22
78	44055	44519	44983	45447	45910	46374	46838	47302	47765	48229	48693	21
79	48693	49156	49620	50084	50547	51011	51474	51938	52401	52865	53328	20
80	53328	53791	54255	54718	55181	55645	56108	56571	57034	57498	57961	19
81	57961	58424	58887	59350	59813	60276	60739	61202	61665	62128	62591	18
82	62591	63053	63516	63979	64442	64905	65367	65830	66293	66755	67218	17
83	67218	67680	68143	68606	69068	69530	69993	70455	70918	71380	71842	16
84	71842	72305	72767	73229	73692	74154	74616	75078	75540	76002	76464	15
85	76464	76926	77388	77850	78312	78774	79236	79698	80160	80622	81084	14
86	81084	81545	82007	82469	82931	83392	83854	84315	84777	85239	85700	13
87	85700	86162	86623	87085	87546	88007	88469	88930	89392	89853	90314	12
88	90314	90775	91237	91698	92159	92620	93081	93542	94003	94464	94925	11
89	94925	95386	95847	96308	96769	97230	97691	98152	98612	99073	99534	10
90	99534	99994	**00455**	**00916**	**01376**	**01837**	**02298**	**02758**	**03219**	**03679**	**04140**	09
91	.68 04140	04600	05060	05521	05981	06442	06902	07362	07822	08283	08743	08
92	08743	09203	09663	10123	10583	11043	11503	11963	12423	12883	13343	07
93	13343	13803	14263	14723	15183	15642	16102	16562	17022	17481	17941	06
94	17941	18401	18860	19320	19779	20239	20698	21158	21617	22077	22536	05
95	22536	22995	23455	23914	24373	24833	25292	25751	26210	26669	27128	04
96	27128	27588	28047	28506	28965	29424	29883	30342	30800	31259	31718	03
97	31718	32177	32636	33095	33553	34012	34471	34929	35388	35847	36305	02
98	36305	36764	37222	37681	38139	38598	39056	39514	39973	40431	40889	01
99	40889	41348	41806	42264	42722	43181	43639	44097	44555	45013	45471	00
	10	9	8	7	6	5	4	3	2	1	0	

COS t13--

COS t11--

'	0	1	2	3	4	5	6	7	8	9	10	
50	.75 01111	00695	00280	**99864**	**99448**	**99033**	**98617**	**98201**	**97786**	**97370**	**96954**	49
51	.74 96954	96538	96122	95707	95291	94875	94459	94043	93627	93211	92794	48
52	92794	92378	91962	91546	91130	90714	90297	89881	89465	89048	88632	47
53	88632	88216	87799	87383	86966	86550	86133	85716	85300	84883	84466	46
54	84466	84050	83633	83216	82799	82383	81966	81549	81132	80715	80298	45
55	80298	79881	79464	79047	78630	78213	77795	77378	76961	76544	76127	44
56	76127	75709	75292	74875	74457	74040	73622	73205	72787	72370	71952	43
57	71952	71535	71117	70699	70282	69864	69446	69028	68611	68193	67775	42
58	67775	67357	66939	66521	66103	65685	65267	64849	64431	64013	63595	41
59	63595	63176	62758	62340	61922	61503	61085	60667	60248	59830	59411	40
60	59411	58993	58574	58156	57737	57319	56900	56481	56063	55644	55225	39
61	55225	54807	54388	53969	53550	53131	52712	52293	51874	51455	51036	38
62	51036	50617	50198	49779	49360	48941	48521	48102	47683	47264	46844	37
63	46844	46425	46005	45586	45167	44747	44328	43908	43488	43069	42649	36
64	42649	42230	41810	41390	40970	40551	40131	39711	39291	38871	38451	35
65	38451	38031	37611	37191	36771	36351	35931	35511	35091	34671	34250	34
66	34250	33830	33410	32990	32569	32149	31729	31308	30888	30467	30047	33
67	30047	29626	29206	28785	28364	27944	27523	27102	26682	26261	25840	32
68	25840	25419	24998	24577	24156	23735	23315	22894	22472	22051	21630	31
69	21630	21209	20788	20367	19946	19524	19103	18682	18260	17839	17418	30
70	17418	16996	16575	16153	15732	15310	14889	14467	14046	13624	13202	29
71	13202	12781	12359	11937	11515	11093	10672	10250	09828	09406	08984	28
72	08984	08562	08140	07718	07296	06873	06451	06029	05607	05185	04762	27
73	04762	04340	03918	03495	03073	02651	02228	01806	01383	00961	00538	26
74	00538	00116	**99693**	**99270**	**98848**	**98425**	**98002**	**97579**	**97157**	**96734**	**96311**	25
75	.73 96311	95888	95465	95042	94619	94196	93773	93350	92927	92504	92081	24
76	92081	91658	91234	90811	90388	89965	89541	89118	88695	88271	87848	23
77	87848	87424	87001	86577	86154	85730	85307	84883	84459	84036	83612	22
78	83612	83188	82764	82340	81917	81493	81069	80645	80221	79797	79373	21
79	79373	78949	78525	78101	77677	77252	76828	76404	75980	75555	75131	20
80	75131	74707	74282	73858	73434	73009	72585	72160	71736	71311	70886	19
81	70886	70462	70037	69613	69188	68763	68338	67913	67489	67064	66639	18
82	66639	66214	65789	65364	64939	64514	64089	63664	63239	62814	62388	17
83	62388	61963	61538	61113	60687	60262	59837	59411	58986	58560	58135	16
84	58135	57709	57284	56858	56433	56007	55581	55156	54730	54304	53879	15
85	53879	53453	53027	52601	52175	51749	51323	50897	50471	50045	49619	14
86	49619	49193	48767	48341	47915	47489	47062	46636	46210	45784	45357	13
87	45357	44931	44504	44078	43652	43225	42799	42372	41945	41519	41092	12
88	41092	40666	40239	39812	39385	38959	38532	38105	37678	37251	36824	11
89	36824	36397	35970	35543	35116	34689	34262	33835	33408	32981	32553	10
90	32553	32126	31699	31272	30844	30417	29990	29562	29135	28707	28280	09
91	28280	27852	27425	26997	26569	26142	25714	25286	24859	24431	24003	08
92	24003	23575	23147	22720	22292	21864	21436	21008	20580	20152	19724	07
93	19724	19296	18867	18439	18011	17583	17155	16726	16298	15870	15441	06
94	15441	15013	14584	14156	13727	13299	12870	12442	12013	11585	11156	05
95	11156	10727	10299	09870	09441	09012	08583	08155	07726	07297	06868	04
96	06868	06439	06010	05581	05152	04723	04293	03864	03435	03006	02577	03
97	02577	02147	01718	01289	00859	00430	00001	**99571**	**99142**	**98712**	**98283**	02
98	72 98283	97853	97424	96994	96564	96135	95705	95275	94846	94416	93986	01
99	93986	93556	93126	92696	92266	91836	91406	90976	90546	90116	89686	00
	10	9	8	7	6	5	4	3	2	1	0	

SIN t13--

SIN t11--

	0	1	2	3	4	5	6	7	8	9	10	
00	.63 74240	74724	75208	75692	76176	76660	77144	77628	78112	78596	79080	99
01	79080	79564	80048	80531	81015	81499	81983	82466	82950	83434	83917	98
02	83917	84401	84885	85368	85852	86335	86819	87302	87786	88269	88752	97
03	88752	89236	89719	90202	90686	91169	91652	92135	92619	93102	93585	96
04	93585	94068	94551	95034	95517	96000	96483	96966	97449	97932	98415	95
05	98415	98898	99380	99863	**00346**	**00829**	**01312**	**01794**	**02277**	**02760**	**03242**	94
06	.64 03242	03725	04207	04690	05172	05655	06137	06620	07102	07585	08067	93
07	08067	08549	09032	09514	09996	10479	10961	11443	11925	12407	12889	92
08	12889	13372	13854	14336	14818	15300	15782	16264	16745	17227	17709	91
09	17709	18191	18673	19155	19636	20118	20600	21082	21563	22045	22527	90
10	22527	23008	23490	23971	24453	24934	25416	25897	26379	26860	27341	89
11	27341	27823	28304	28785	29266	29748	30229	30710	31191	31672	32153	88
12	32153	32635	33116	33597	34078	34559	35040	35521	36001	36482	36963	87
13	36963	37444	37925	38406	38886	39367	39848	40328	40809	41290	41770	86
14	41770	42251	42731	43212	43692	44173	44653	45134	45614	46095	46575	85
15	46575	47055	47535	48016	48496	48976	49456	49937	50417	50897	51377	84
16	51377	51857	52337	52817	53297	53777	54257	54737	55217	55697	56176	83
17	56176	56656	57136	57616	58096	58575	59055	59535	60014	60494	60973	82
18	60973	61453	61932	62412	62891	63371	63850	64330	64809	65288	65768	81
19	65768	66247	66726	67206	67685	68164	68643	69122	69601	70081	70560	80
20	70560	71039	71518	71997	72476	72955	73433	73912	74391	74870	75349	79
21	75349	75828	76306	76785	77264	77743	78221	78700	79178	79657	80136	78
22	80136	80614	81093	81571	82050	82528	83006	83485	83963	84442	84920	77
23	84920	85398	85876	86355	86833	87311	87789	88267	88745	89223	89701	76
24	89701	90179	90657	91135	91613	92091	92569	93047	93525	94003	94480	75
25	94480	94958	95436	95914	96391	96869	97347	97824	98302	98779	99257	74
26	99257	99734	**00212**	**00689**	**01167**	**01644**	**02122**	**02599**	**03076**	**03554**	**04031**	73
27	.65 04031	04508	04985	05463	05940	06417	06894	07371	07848	08325	08802	72
28	08802	09279	09756	10233	10710	11187	11664	12141	12617	13094	13571	71
29	13571	14048	14524	15001	15478	15954	16431	16908	17384	17861	18337	70
30	18337	18814	19290	19767	20243	20719	21196	21672	22148	22625	23101	69
31	23101	23577	24053	24529	25006	25482	25958	26434	26910	27386	27862	68
32	27862	28338	28814	29290	29766	30242	30717	31193	31669	32145	32620	67
33	32620	33096	33572	34047	34523	34999	35474	35950	36425	36901	37376	66
34	37376	37852	38327	38803	39278	39753	40229	40704	41179	41654	42130	65
35	42130	42605	43080	43555	44030	44505	44980	45455	45930	46405	46880	64
36	46880	47355	47830	48305	48780	49255	49730	50204	50679	51154	51629	63
37	51629	52103	52578	53053	53527	54002	54476	54951	55425	55900	56374	62
38	56374	56849	57323	57797	58272	58746	59220	59695	60169	60643	61117	61
39	61117	61591	62065	62540	63014	63488	63962	64436	64910	65384	65858	60
40	65858	66331	66805	67279	67753	68227	68701	69174	69648	70122	70595	59
41	70595	71069	71543	72016	72490	72963	73437	73910	74384	74857	75331	58
42	75331	75804	76277	76751	77224	77697	78170	78644	79117	79590	80063	57
43	80063	80536	81009	81482	81956	82429	82902	83374	83847	84320	84793	56
44	84793	85266	85739	86212	86684	87157	87630	88103	88575	89048	89521	55
45	89521	89993	90466	90938	91411	91883	92356	92828	93301	93773	94245	54
46	94245	94718	95190	95662	96135	96607	97079	97551	98023	98496	98968	53
47	98968	99440	99912	**00384**	**00856**	**01328**	**01800**	**02272**	**02744**	**03215**	**03687**	52
48	.66 03687	04159	04631	05103	05574	06046	06518	06989	07461	07933	08404	51
49	08404	08876	09347	09819	10290	10762	11233	11705	12176	12647	13119	50
	10	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**	

COS t13--

COS t11--

′	0	1	2	3	4	5	6	7	8	9	10	
00	.77 05132	04732	04331	03931	03530	03130	02729	02328	01927	01527	01126	99
01	01126	00725	00324	**99923**	**99522**	**99121**	**98720**	**98319**	**97918**	**97517**	**97116**	98
02	.76 97116	96715	96314	95913	95512	95110	94709	94308	93906	93505	93104	97
03	93104	92702	92301	91899	91498	91096	90695	90293	89891	89490	89088	96
04	89088	88686	88284	87883	87481	87079	86677	86275	85873	85471	85069	95
05	85069	84667	84265	83863	83461	83059	82656	82254	81852	81450	81047	94
06	81047	80645	80243	79840	79438	79035	78633	78230	77828	77425	77023	93
07	77023	76620	76217	75815	75412	75009	74606	74203	73801	73398	72995	92
08	72995	72592	72189	71786	71383	70980	70577	70174	69770	69367	68964	91
09	68964	68561	68157	67754	67351	66947	66544	66141	65737	65334	64930	90
10	64930	64527	64123	63719	63316	62912	62508	62105	61701	61297	60893	89
11	60893	60489	60085	59682	59278	58874	58470	58066	57661	57257	56853	88
12	56853	56449	56045	55641	55236	54832	54428	54023	53619	53215	52810	87
13	52810	52406	52001	51597	51192	50788	50383	49978	49574	49169	48764	86
14	48764	48360	47955	47550	47145	46740	46335	45930	45525	45120	44715	85
15	44715	44310	43905	43500	43095	42690	42284	41879	41474	41069	40663	84
16	40663	40258	39853	39447	39042	38636	38231	37825	37420	37014	36608	83
17	36608	36203	35797	35391	34985	34580	34174	33768	33362	32956	32550	82
18	32550	32144	31738	31332	30926	30520	30114	29708	29302	28895	28489	81
19	28489	28083	27677	27270	26864	26458	26051	25645	25238	24832	24425	80
20	24425	24019	23612	23205	22799	22392	21985	21578	21172	20765	20358	79
21	20358	19951	19544	19137	18730	18323	17916	17509	17102	16695	16288	78
22	16288	15881	15474	15066	14659	14252	13844	13437	13030	12622	12215	77
23	12215	11807	11400	10992	10585	10177	09770	09362	08954	08547	08139	76
24	08139	07731	07323	06915	06507	06100	05692	05284	04876	04468	04060	75
25	04060	03652	03243	02835	02427	02019	01611	01202	00794	00386	**99978**	74
26	.75 99978	99569	99161	98752	98344	97935	97527	97118	96710	96301	95892	73
27	95892	95484	95075	94666	94258	93849	93440	93031	92622	92213	91804	72
28	91804	91395	90986	90577	90168	89759	89350	88941	88532	88122	87713	71
29	87713	87304	86895	86485	86076	85667	85257	84848	84438	84029	83619	70
30	83619	83210	82800	82390	81981	81571	81161	80752	80342	79932	79522	69
31	79522	79112	78702	78292	77882	77472	77062	76652	76242	75832	75422	68
32	75422	75012	74602	74191	73781	73371	72960	72550	72140	71729	71319	67
33	71319	70908	70498	70087	69677	69266	68856	68445	68034	67624	67213	66
34	67213	66802	66391	65980	65570	65159	64748	64337	63926	63515	63104	65
35	63104	62693	62282	61871	61459	61048	60637	60226	59814	59403	58992	64
36	58992	58580	58169	57758	57346	56935	56523	56112	55700	55288	54877	63
37	54877	54465	54053	53642	53230	52818	52406	51994	51583	51171	50759	62
38	50759	50347	49935	49523	49111	48699	48287	47874	47462	47050	46638	61
39	46638	46226	45813	45401	44989	44576	44164	43751	43339	42926	42514	60
40	42514	42101	41689	41276	40863	40451	40038	39625	39212	38800	38387	59
41	38387	37974	37561	37148	36735	36322	35909	35496	35083	34670	34257	58
42	34257	33844	33431	33017	32604	32191	31778	31364	30951	30537	30124	57
43	30124	29711	29297	28884	28470	28057	27643	27229	26816	26402	25988	56
44	25988	25574	25161	24747	24333	23919	23505	23091	22677	22263	21849	55
45	21849	21435	21021	20607	20193	19779	19365	18950	18536	18122	17708	54
46	17708	17293	16879	16464	16050	15636	15221	14807	14392	13977	13563	53
47	13563	13148	12733	12319	11904	11489	11075	10660	10245	09830	09415	52
48	09415	09000	08585	08170	07755	07340	06925	06510	06095	05680	05264	51
49	05264	04849	04434	04019	03603	03188	02773	02357	01942	01526	01111	50
	10	9	8	7	6	5	4	3	2	1	0	

SIN t13--

SIN t10--

	0	1	2	3	4	5	6	7	8	9	10	
50	.61 29071	29567	30063	30560	31056	31553	32049	32545	33042	33538	34034	49
51	34034	34530	35026	35523	36019	36515	37011	37507	38003	38499	38995	48
52	38995	39491	39987	40483	40979	41475	41971	42466	42962	43458	43954	47
53	43954	44449	44945	45441	45936	46432	46928	47423	47919	48414	48910	46
54	48910	49405	49901	50396	50892	51387	51882	52378	52873	53368	53864	45
55	53864	54359	54854	55349	55845	56340	56835	57330	57825	58320	58815	44
56	58815	59310	59805	60300	60795	61290	61785	62280	62774	63269	63764	43
57	63764	64259	64753	65248	65743	66238	66732	67227	67721	68216	68710	42
58	68710	69205	69699	70194	70688	71183	71677	72172	72666	73160	73655	41
59	73655	74149	74643	75137	75631	76126	76620	77114	77608	78102	78596	40
60	78596	79090	79584	80078	80572	81066	81560	82054	82548	83041	83535	39
61	83535	84029	84523	85017	85510	86004	86498	86991	87485	87978	88472	38
62	88472	88966	89459	89953	90446	90939	91433	91926	92420	92913	93406	37
63	93406	93900	94393	94886	95379	95873	96366	96859	97352	97845	98338	36
64	98338	98831	99324	99817	**00310**	**00803**	**01296**	**01789**	**02282**	**02775**	**03268**	35
65	.62 03268	03760	04253	04746	05239	05731	06224	06717	07209	07702	08195	34
66	08195	08687	09180	09672	10165	10657	11150	11642	12134	12627	13119	33
67	13119	13611	14104	14596	15088	15580	16073	16565	17057	17549	18041	32
68	18041	18533	19025	19517	20009	20501	20993	21485	21977	22469	22961	31
69	22961	23452	23944	24436	24928	25420	25911	26403	26895	27386	27878	30
70	27878	28369	28861	29352	29844	30335	30827	31318	31810	32301	32792	29
71	32792	33284	33775	34266	34758	35249	35740	36231	36722	37214	37705	28
72	37705	38196	38687	39178	39669	40160	40651	41142	41633	42124	42614	27
73	42614	43105	43596	44087	44578	45068	45559	46050	46540	47031	47522	26
74	47522	48012	48503	48993	49484	49974	50465	50955	51446	51936	52427	25
75	52427	52917	53407	53898	54388	54878	55368	55858	56349	56839	57329	24
76	57329	57819	58309	58799	59289	59779	60269	60759	61249	61739	62229	23
77	62229	62719	63208	63698	64188	64678	65168	65657	66147	66637	67126	22
78	67126	67616	68105	68595	69084	69574	70063	70553	71042	71532	72021	21
79	72021	72511	73000	73489	73978	74468	74957	75446	75935	76424	76914	20
80	76914	77403	77892	78381	78870	79359	79848	80337	80826	81315	81804	19
81	81804	82292	82781	83270	83759	84248	84736	85225	85714	86202	86691	18
82	86691	87180	87668	88157	88645	89134	89622	90111	90599	91088	91576	17
83	91576	92064	92553	93041	93529	94018	94506	94994	95482	95971	96459	16
84	96459	96947	97435	97923	98411	98899	99387	99875	**00363**	**00851**	**01339**	15
85	.63 01339	01827	02314	02802	03290	03778	04266	04753	05241	05729	06216	14
86	06216	06704	07191	07679	08167	08654	09142	09629	10117	10604	11091	13
87	11091	11579	12066	12553	13041	13528	14015	14502	14990	15477	15964	12
88	15964	16451	16938	17425	17912	18399	18886	19373	19860	20347	20834	11
89	20834	21321	21808	22295	22781	23268	23755	24242	24728	25215	25702	10
90	25702	26188	26675	27161	27648	28134	28621	29107	29594	30080	30567	09
91	30567	31053	31539	32026	32512	32998	33485	33971	34457	34943	35429	08
92	35429	35915	36402	36888	37374	37860	38346	38832	39318	39804	40289	07
93	40289	40775	41261	41747	42233	42719	43204	43690	44176	44661	45147	06
94	45147	45633	46118	46604	47089	47575	48060	48546	49031	49517	50002	05
95	50002	50487	50973	51458	51943	52429	52914	53399	53884	54370	54855	04
96	54855	55340	55825	56310	56795	57280	57765	58250	58735	59220	59705	03
97	59705	60190	60674	61159	61644	62129	62614	63098	63583	64068	64552	02
98	64552	65037	65522	66006	66491	66975	67460	67944	68429	68913	69397	01
99	69397	69882	70366	70850	71335	71819	72303	72787	73272	73756	74240	00
	10	9	8	7	6	5	4	3	2	1	0	

COS t14--

COS t10--

	0	1	2	3	4	5	6	7	8	9	10	
50	.79 01550	01165	00780	00395	00009	**99624**	**99239**	**98854**	**98468**	**98083**	**97698**	49
51	.78 97698	97312	96927	96541	96156	95770	95385	94999	94613	94228	93842	48
52	93842	93456	93070	92685	92299	91913	91527	91141	90755	90369	89983	47
53	89983	89597	89211	88825	88439	88052	87666	87280	86894	86507	86121	46
54	86121	85735	85348	84962	84576	84189	83803	83416	83029	82643	82256	45
55	82256	81869	81483	81096	80709	80322	79936	79549	79162	78775	78388	44
56	78388	78001	77614	77227	76840	76453	76066	75678	75291	74904	74517	43
57	74517	74129	73742	73355	72967	72580	72192	71805	71417	71030	70642	42
58	70642	70255	69867	69479	69092	68704	68316	67928	67541	67153	66765	41
59	66765	66377	65989	65601	65213	64825	64437	64049	63661	63273	62884	40
60	62884	62496	62108	61720	61331	60943	60554	60166	59778	59389	59001	39
61	59001	58612	58224	57835	57446	57058	56669	56280	55891	55503	55114	38
62	55114	54725	54336	53947	53558	53169	52780	52391	52002	51613	51224	37
63	51224	50835	50446	50056	49667	49278	48889	48499	48110	47720	47331	36
64	47331	46942	46552	46163	45773	45383	44994	44604	44214	43825	43435	35
65	43435	43045	42655	42265	41876	41486	41096	40706	40316	39926	39536	34
66	39536	39146	38756	38365	37975	37585	37195	36804	36414	36024	35633	33
67	35633	35243	34853	34462	34072	33681	33291	32900	32509	32119	31728	32
68	31728	31337	30947	30556	30165	29774	29383	28993	28602	28211	27820	31
69	27820	27429	27038	26647	26255	25864	25473	25082	24691	24299	23908	30
70	23908	23517	23125	22734	22343	21951	21560	21168	20777	20385	19993	29
71	19993	19602	19210	18818	18427	18035	17643	17251	16860	16468	16076	28
72	16076	15684	15292	14900	14508	14116	13724	13332	12939	12547	12155	27
73	12155	11763	11370	10978	10586	10193	09801	09409	09016	08624	08231	26
74	08231	07838	07446	07053	06661	06268	05875	05482	05090	04697	04304	25
75	04304	03911	03518	03125	02732	02339	01946	01553	01160	00767	00374	24
76	00374	**99981**	**99588**	**99194**	**98801**	**98408**	**98015**	**97621**	**97228**	**96834**	**96441**	23
77	.77 96441	96047	95654	95260	94867	94473	94080	93686	93292	92898	92505	22
78	92505	92111	91717	91323	90929	90535	90141	89747	89353	88959	88565	21
79	88565	88171	87777	87383	86989	86595	86200	85806	85412	85017	84623	20
80	84623	84229	83834	83440	83045	82651	82256	81862	81467	81072	80678	19
81	80678	80283	79888	79493	79099	78704	78309	77914	77519	77124	76729	18
82	76729	76334	75939	75544	75149	74754	74358	73963	73568	73173	72777	17
83	72777	72382	71987	71591	71196	70801	70405	70010	69614	69218	68823	16
84	68823	68427	68032	67636	67240	66844	66449	66053	65657	65261	64865	15
85	64865	64469	64073	63677	63281	62885	62489	62093	61697	61301	60904	14
86	60904	60508	60112	59716	59319	58923	58526	58130	57734	57337	56941	13
87	56941	56544	56147	55751	55354	54957	54561	54164	53767	53370	52974	12
88	52974	52577	52180	51783	51386	50989	50592	50195	49798	49401	49004	11
89	49004	48606	48209	47812	47415	47017	46620	46223	45825	45428	45031	10
90	45031	44633	44236	43838	43441	43043	42645	42248	41850	41452	41055	09
91	41055	40657	40259	39861	39463	39065	38667	38269	37871	37473	37075	08
92	37075	36677	36279	35881	35483	35085	34686	34288	33890	33492	33093	07
93	33093	32695	32296	31898	31499	31101	30702	30304	29905	29507	29108	06
94	29108	28709	28311	27912	27513	27114	26715	26316	25918	25519	25120	05
95	25120	24721	24322	23923	23523	23124	22725	22326	21927	21528	21128	04
96	21128	20729	20330	19930	19531	19131	18732	18333	17933	17533	17134	03
97	17134	16734	16335	15935	15535	15136	14736	14336	13936	13536	13136	02
98	13136	12737	12337	11937	11537	11137	10737	10336	09936	09536	09136	01
99	09136	08736	08335	07935	07535	07135	06734	06334	05933	05533	05132	00
	10	9	8	7	6	5	4	3	2	1	0	

SIN t14--

SIN t10--

	0	1	2	3	4	5	6	7	8	9	10	′
00	.58 77853	78361	78869	79377	79886	80394	80902	81410	81918	82426	82935	99
01	82935	83443	83951	84459	84967	85475	85983	86491	86999	87506	88014	98
02	88014	88522	89030	89538	90046	90553	91061	91569	92076	92584	93092	97
03	93092	93599	94107	94614	95122	95630	96137	96644	97152	97659	98167	96
04	98167	98674	99181	99689	**00196**	**00703**	**01211**	**01718**	**02225**	**02732**	**03239**	95
05	.59 03239	03747	04254	04761	05268	05775	06282	06789	07296	07803	08310	94
06	08310	08817	09324	09831	10337	10844	11351	11858	12365	12871	13378	93
07	13378	13885	14391	14898	15405	15911	16418	16924	17431	17937	18444	92
08	18444	18950	19457	19963	20469	20976	21482	21988	22495	23001	23507	91
09	23507	24013	24520	25026	25532	26038	26544	27050	27556	28062	28568	90
10	28568	29074	29580	30086	30592	31098	31604	32110	32615	33121	33627	89
11	33627	34133	34638	35144	35650	36155	36661	37167	37672	38178	38683	88
12	38683	39189	39694	40200	40705	41211	41716	42221	42727	43232	43737	87
13	43737	44243	44748	45253	45758	46263	46769	47274	47779	48284	48789	86
14	48789	49294	49799	50304	50809	51314	51819	52324	52829	53334	53838	85
15	53838	54343	54848	55353	55857	56362	56867	57372	57876	58381	58885	84
16	58885	59390	59895	60399	60904	61408	61912	62417	62921	63426	63930	83
17	63930	64434	64939	65443	65947	66451	66956	67460	67964	68468	68972	82
18	68972	69476	69980	70485	70989	71493	71997	72501	73004	73508	74012	81
19	74012	74516	75020	75524	76028	76531	77035	77539	78043	78546	79050	80
20	79050	79553	80057	80561	81064	81568	82071	82575	83078	83582	84085	79
21	84085	84588	85092	85595	86098	86602	87105	87608	88112	88615	89118	78
22	89118	89621	90124	90627	91130	91633	92136	92639	93142	93645	94148	77
23	94148	94651	95154	95657	96160	96663	97166	97668	98171	98674	99177	76
24	99177	99679	**00182**	**00684**	**01187**	**01690**	**02192**	**02695**	**03197**	**03700**	**04202**	75
25	.60 04202	04705	05207	05710	06212	06714	07217	07719	08221	08723	09226	74
26	09226	09728	10230	10732	11234	11736	12239	12741	13243	13745	14247	73
27	14247	14749	15251	15752	16254	16756	17258	17760	18262	18764	19265	72
28	19265	19767	20269	20770	21272	21774	22275	22777	23278	23780	24282	71
29	24282	24783	25285	25786	26287	26789	27290	27792	28293	28794	29295	70
30	29295	29797	30298	30799	31300	31801	32303	32804	33305	33806	34307	69
31	34307	34808	35309	35810	36311	36812	37313	37814	38314	38815	39316	68
32	39316	39817	40318	40818	41319	41820	42320	42821	43322	43822	44323	67
33	44323	44823	45324	45824	46325	46825	47326	47826	48326	48827	49327	66
34	49327	49827	50328	50828	51328	51828	52329	52829	53329	53829	54329	65
35	54329	54829	55329	55829	56329	56829	57329	57829	58329	58829	59329	64
36	59329	59828	60328	60828	61328	61828	62327	62827	63327	63826	64326	63
37	64326	64825	65325	65825	66324	66824	67323	67822	68322	68821	69321	62
38	69321	69820	70319	70819	71318	71817	72316	72816	73315	73814	74313	61
39	74313	74812	75311	75810	76309	76808	77307	77806	78305	78804	79303	60
40	79303	79802	80301	80800	81298	81797	82296	82795	83293	83792	84291	59
41	84291	84789	85288	85786	86285	86783	87282	87780	88279	88777	89276	58
42	89276	89774	90273	90771	91269	91767	92266	92764	93262	93760	94259	57
43	94259	94757	95255	95753	96251	96749	97247	97745	98243	98741	99239	56
44	99239	99737	**00235**	**00733**	**01230**	**01728**	**02226**	**02724**	**03221**	**03719**	**04217**	55
45	.61 04217	04715	05212	05710	06207	06705	07203	07700	08198	08695	09192	54
46	09192	09690	10187	10685	11182	11679	12177	12674	13171	13668	14166	53
47	14166	14663	15160	15657	16154	16651	17148	17645	18142	18639	19136	52
48	19136	19633	20130	20627	21124	21621	22118	22614	23111	23608	24105	51
49	24105	24601	25098	25595	26091	26588	27084	27581	28078	28574	29071	50
	10	9	8	7	6	5	4	3	2	1	0	

COS t14--

COS t10--

	0	1	2	3	4	5	6	7	8	9	10	
00	.80 90170	89801	89431	89062	88692	88323	87953	87584	87214	86845	86475	99
01	86475	86106	85736	85366	84996	84627	84257	83887	83517	83147	82777	98
02	82777	82407	82037	81667	81297	80927	80557	80187	79817	79446	79076	97
03	79076	78706	78335	77965	77595	77224	76854	76483	76113	75742	75372	96
04	75372	75001	74631	74260	73889	73518	73148	72777	72406	72035	71664	95
05	71664	71293	70922	70551	70180	69809	69438	69067	68696	68325	67954	94
06	67954	67582	67211	66840	66468	66097	65726	65354	64983	64611	64240	93
07	64240	63868	63496	63125	62753	62381	62010	61638	61266	60894	60523	92
08	60523	60151	59779	59407	59035	58663	58291	57919	57547	57174	56802	91
09	56802	56430	56058	55686	55313	54941	54569	54196	53824	53451	53079	90
10	53079	52706	52334	51961	51589	51216	50843	50471	50098	49725	49352	89
11	49352	48979	48607	48234	47861	47488	47115	46742	46369	45996	45622	88
12	45622	45249	44876	44503	44130	43756	43383	43010	42636	42263	41889	87
13	41889	41516	41142	40769	40395	40022	39648	39274	38901	38527	38153	86
14	38153	37780	37406	37032	36658	36284	35910	35536	35162	34788	34414	85
15	34414	34040	33666	33292	32917	32543	32169	31795	31420	31046	30672	84
16	30672	30297	29923	29548	29174	28799	28424	28050	27675	27301	26926	83
17	26926	26551	26176	25802	25427	25052	24677	24302	23927	23552	23177	82
18	23177	22802	22427	22052	21677	21301	20926	20551	20176	19800	19425	81
19	19425	19050	18674	18299	17923	17548	17172	16797	16421	16046	15670	80
20	15670	15294	14918	14543	14167	13791	13415	13039	12663	12287	11912	79
21	11912	11536	11159	10783	10407	10031	09655	09279	08903	08526	08150	78
22	08150	07774	07397	07021	06645	06268	05892	05515	05139	04762	04385	77
23	04385	04009	03632	03255	02879	02502	02125	01748	01371	00994	00618	76
24	00618	00241	**99864**	**99487**	**99110**	**98732**	**98355**	**97978**	**97601**	**97224**	**96847**	75
25	.79 96847	96469	96092	95715	95337	94960	94582	94205	93828	93450	93072	74
26	93072	92695	92317	91940	91562	91184	90806	90429	90051	89673	89295	73
27	89295	88917	88539	88161	87783	87405	87027	86649	86271	85893	85515	72
28	85515	85137	84758	84380	84002	83623	83245	82867	82488	82110	81731	71
29	81731	81353	80974	80595	80217	79838	79459	79081	78702	78323	77944	70
30	77944	77566	77187	76808	76429	76050	75671	75292	74913	74534	74155	69
31	74155	73775	73396	73017	72638	72258	71879	71500	71120	70741	70361	68
32	70361	69982	69602	69223	68843	68464	68084	67704	67325	66945	66565	67
33	66565	66185	65806	65426	65046	64666	64286	63906	63526	63146	62766	66
34	62766	62386	62006	61626	61245	60865	60485	60105	59724	59344	58963	65
35	58963	58583	58203	57822	57442	57061	56680	56300	55919	55539	55158	64
36	55158	54777	54396	54016	53635	53254	52873	52492	52111	51730	51349	63
37	51349	50968	50587	50206	49825	49444	49062	48681	48300	47919	47537	62
38	47537	47156	46774	46393	46012	45630	45249	44867	44485	44104	43722	61
39	43722	43340	42959	42577	42195	41813	41432	41050	40668	40286	39904	60
40	39904	39522	39140	38758	38376	37994	37612	37229	36847	36465	36083	59
41	36083	35700	35318	34936	34553	34171	33788	33406	33023	32641	32258	58
42	32258	31876	31493	31110	30728	30345	29962	29579	29196	28814	28431	57
43	28431	28048	27665	27282	26899	26516	26133	25750	25366	24983	24600	56
44	24600	24217	23833	23450	23067	22683	22300	21917	21533	21150	20766	55
45	20766	20383	19999	19615	19232	18848	18464	18081	17697	17313	16929	54
46	16929	16545	16161	15777	15394	15010	14626	14241	13857	13473	13089	53
47	13089	12705	12321	11936	11552	11168	10784	10399	10015	09630	09246	52
48	09246	08861	08477	08092	07708	07323	06938	06554	06169	05784	05400	51
49	05400	05015	04630	04245	03860	03475	03090	02705	02320	01935	01550	50
	10	9	8	7	6	5	4	3	2	1	0	

SIN t14--

SIN t09--

	0	1	2	3	4	5	6	7	8	9	10	′
50	.56 20834	21353	21873	22393	22912	23432	23951	24471	24990	25510	26029	49
51	26029	26549	27068	27588	28107	28626	29146	29665	30184	30704	31223	48
52	31223	31742	32261	32780	33299	33819	34338	34857	35376	35895	36414	47
53	36414	36933	37452	37971	38490	39009	39528	40046	40565	41084	41603	46
54	41603	42122	42640	43159	43678	44196	44715	45234	45752	46271	46790	45
55	46790	47308	47827	48345	48864	49382	49900	50419	50937	51456	51974	44
56	51974	52492	53011	53529	54047	54565	55084	55602	56120	56638	57156	43
57	57156	57674	58192	58710	59228	59746	60264	60782	61300	61818	62336	42
58	62336	62854	63372	63890	64408	64925	65443	65961	66479	66996	67514	41
59	67514	68032	68549	69067	69584	70102	70620	71137	71655	72172	72689	40
60	72689	73207	73724	74242	74759	75276	75794	76311	76828	77346	77863	39
61	77863	78380	78897	79414	79931	80449	80966	81483	82000	82517	83034	38
62	83034	83551	84068	84585	85102	85619	86135	86652	87169	87686	88203	37
63	88203	88719	89236	89753	90270	90786	91303	91819	92336	92853	93369	36
64	93369	93886	94402	94919	95435	95952	96468	96984	97501	98017	98533	35
65	98533	99050	99566	**00082**	**00599**	**01115**	**01631**	**02147**	**02663**	**03179**	**03696**	34
66	.57 03696	04212	04728	05244	05760	06276	06792	07308	07824	08339	08855	33
67	08855	09371	09887	10403	10919	11434	11950	12466	12982	13497	14013	32
68	14013	14529	15044	15560	16075	16591	17106	17622	18137	18653	19168	31
69	19168	19684	20199	20714	21230	21745	22260	22776	23291	23806	24321	30
70	24321	24836	25352	25867	26382	26897	27412	27927	28442	28957	29472	29
71	29472	29987	30502	31017	31532	32047	32561	33076	33591	34106	34621	28
72	34621	35135	35650	36165	36679	37194	37709	38223	38738	39252	39767	27
73	39767	40281	40796	41310	41825	42339	42853	43368	43882	44397	44911	26
74	44911	45425	45939	46454	46968	47482	47996	48510	49024	49538	50053	25
75	50053	50567	51081	51595	52109	52623	53136	53650	54164	54678	55192	24
76	55192	55706	56220	56733	57247	57761	58275	58788	59302	59816	60329	23
77	60329	60843	61356	61870	62383	62897	63410	63924	64437	64951	65464	22
78	65464	65977	66491	67004	67517	68031	68544	69057	69570	70084	70597	21
79	70597	71110	71623	72136	72649	73162	73675	74188	74701	75214	75727	20
80	75727	76240	76753	77266	77779	78291	78804	79317	79830	80342	80855	19
81	80855	81368	81880	82393	82906	83418	83931	84443	84956	85468	85981	18
82	85981	86493	87006	87518	88031	88543	89055	89568	90080	90592	91104	17
83	91104	91617	92129	92641	93153	93665	94177	94689	95202	95714	96226	16
84	96226	96738	97250	97762	98273	98785	99297	99809	**00321**	**00833**	**01345**	15
85	.58 01345	01856	02368	02880	03391	03903	04415	04926	05438	05950	06461	14
86	06461	06973	07484	07996	08507	09019	09530	10041	10553	11064	11576	13
87	11576	12087	12598	13109	13621	14132	14643	15154	15665	16176	16688	12
88	16688	17199	17710	18221	18732	19243	19754	20265	20776	21286	21797	11
89	21797	22308	22819	23330	23841	24351	24862	25373	25883	26394	26905	10
90	26905	27415	27926	28437	28947	29458	29968	30479	30989	31500	32010	09
91	32010	32520	33031	33541	34051	34562	35072	35582	36092	36603	37113	08
92	37113	37623	38133	38643	39153	39663	40173	40683	41193	41703	42213	07
93	42213	42723	43233	43743	44253	44763	45273	45782	46292	46802	47312	06
94	47312	47821	48331	48841	49350	49860	50369	50879	51389	51898	52408	05
95	52408	52917	53426	53936	54445	54955	55464	55973	56483	56992	57501	04
96	57501	58010	58520	59029	59538	60047	60556	61065	61574	62083	62592	03
97	62592	63101	63610	64119	64628	65137	65646	66155	66664	67173	67681	02
98	67681	68190	68699	69208	69716	70225	70734	71242	71751	72260	72768	01
99	72768	73277	73785	74294	74802	75311	75819	76327	76836	77344	77853	00
	10	9	8	7	6	5	4	3	2	1	0	

COS t15--

COS t09--

'	0	1	2	3	4	5	6	7	8	9	10	
50	.82 70806	70453	70099	69746	69393	69039	68686	68333	67979	67626	67272	49
51	67272	66919	66565	66212	65858	65505	65151	64797	64443	64090	63736	48
52	63736	63382	63028	62674	62320	61966	61612	61258	60904	60550	60196	47
53	60196	59842	59488	59133	58779	58425	58071	57716	57362	57007	56653	46
54	56653	56298	55944	55589	55235	54880	54526	54171	53816	53461	53107	45
55	53107	52752	52397	52042	51687	51332	50977	50622	50267	49912	49557	44
56	49557	49202	48847	48491	48136	47781	47426	47070	46715	46360	46004	43
57	46004	45649	45293	44938	44582	44226	43871	43515	43159	42804	42448	42
58	42448	42092	41736	41381	41025	40669	40313	39957	39601	39245	38889	41
59	38889	38532	38176	37820	37464	37108	36751	36395	36039	35682	35326	40
60	35326	34970	34613	34257	33900	33543	33187	32830	32474	32117	31760	39
61	31760	31403	31047	30690	30333	29976	29619	29262	28905	28548	28191	38
62	28191	27834	27477	27120	26762	26405	26048	25691	25333	24976	24619	37
63	24619	24261	23904	23546	23189	22831	22474	22116	21758	21401	21043	36
64	21043	20685	20327	19970	19612	19254	18896	18538	18180	17822	17464	35
65	17464	17106	16748	16390	16032	15673	15315	14957	14599	14240	13882	34
66	13882	13524	13165	12807	12448	12090	11731	11373	11014	10655	10297	33
67	10297	09938	09579	09220	08862	08503	08144	07785	07426	07067	06708	32
68	06708	06349	05990	05631	05272	04912	04553	04194	03835	03476	03116	31
69	03116	02757	02397	02038	01679	01319	00960	00600	00240	**99881**	**99521**	30
70	.81 99521	99161	98802	98442	98082	97722	97362	97003	96643	96283	95923	29
71	95923	95563	95203	94843	94483	94122	93762	93402	93042	92682	92321	28
72	92321	91961	91601	91240	90880	90519	90159	89798	89438	89077	88716	27
73	88716	88356	87995	87634	87274	86913	86552	86191	85830	85469	85108	26
74	85108	84747	84386	84025	83664	83303	82942	82581	82220	81858	81497	25
75	81497	81136	80775	80413	80052	79690	79329	78967	78606	78244	77883	24
76	77883	77521	77159	76798	76436	76074	75712	75351	74989	74627	74265	23
77	74265	73903	73541	73179	72817	72455	72093	71731	71368	71006	70644	22
78	70644	70282	69919	69557	69195	68832	68470	68107	67745	67382	67020	21
79	67020	66657	66295	65932	65569	65207	64844	64481	64118	63755	63393	20
80	63393	63030	62667	62304	61941	61578	61215	60851	60488	60125	59762	19
81	59762	59399	59035	58672	58309	57945	57582	57219	56855	56492	56128	18
82	56128	55765	55401	55037	54674	54310	53946	53582	53219	52855	52491	17
83	52491	52127	51763	51399	51035	50671	50307	49943	49579	49215	48851	16
84	48851	48487	48122	47758	47394	47029	46665	46301	45936	45572	45207	15
85	45207	44843	44478	44114	43749	43384	43020	42655	42290	41925	41561	14
86	41561	41196	40831	40466	40101	39736	39371	39006	38641	38276	37911	13
87	37911	37545	37180	36815	36450	36084	35719	35354	34988	34623	34258	12
88	34258	33892	33527	33161	32795	32430	32064	31698	31333	30967	30601	11
89	30601	30235	29870	29504	29138	28772	28406	28040	27674	27308	26942	10
90	26942	26576	26209	25843	25477	25111	24744	24378	24012	23645	23279	09
91	23279	22912	22546	22179	21813	21446	21080	20713	20346	19980	19613	08
92	19613	19246	18879	18513	18146	17779	17412	17045	16678	16311	15944	07
93	15944	15577	15210	14842	14475	14108	13741	13373	13006	12639	12271	06
94	12271	11904	11537	11169	10802	10434	10066	09699	09331	08964	08596	05
95	08596	08228	07860	07493	07125	06757	06389	06021	05653	05285	04917	04
96	04917	04549	04181	03813	03445	03076	02708	02340	01972	01603	01235	03
97	01235	00867	00498	00130	**99761**	**99393**	**99024**	**98656**	**98287**	**97919**	**97550**	02
98	.80 97550	97181	96812	96444	96075	95706	95337	94968	94599	94230	93862	01
99	93862	93492	93123	92754	92385	92016	91647	91278	90909	90539	90170	00
	10	9	8	7	6	5	4	3	2	1	0	

SIN t15--

SIN t09--

	0	1	2	3	4	5	6	7	8	9	10	
00	.53 58268	58798	59329	59859	60390	60920	61451	61981	62511	63042	63572	99
01	63572	64102	64633	65163	65693	66223	66753	67284	67814	68344	68874	98
02	68874	69404	69934	70464	70994	71524	72054	72584	73114	73644	74174	97
03	74174	74703	75233	75763	76293	76823	77352	77882	78412	78942	79471	96
04	79471	80001	80531	81060	81590	82119	82649	83178	83708	84237	84767	95
05	84767	85296	85826	86355	86884	87414	87943	88472	89002	89531	90060	94
06	90060	90589	91119	91648	92177	92706	93235	93764	94293	94822	95351	93
07	95351	95880	96409	96938	97467	97996	98525	99054	99583	**00112**	**00641**	92
08	.54 00641	01169	01698	02227	02756	03284	03813	04342	04870	05399	05928	91
09	05928	06456	06985	07513	08042	08570	09099	09627	10156	10684	11213	90
10	11213	11741	12269	12798	13326	13854	14382	14911	15439	15967	16495	89
11	16495	17023	17552	18080	18608	19136	19664	20192	20720	21248	21776	88
12	21776	22304	22832	23360	23888	24415	24943	25471	25999	26527	27054	87
13	27054	27582	28110	28637	29165	29693	30220	30748	31276	31803	32331	86
14	32331	32858	33386	33913	34441	34968	35495	36023	36550	37078	37605	85
15	37605	38132	38659	39187	39714	40241	40768	41295	41823	42350	42877	84
16	42877	43404	43931	44458	44985	45512	46039	46566	47093	47620	48147	83
17	48147	48674	49200	49727	50254	50781	51308	51834	52361	52888	53414	82
18	53414	53941	54468	54994	55521	56048	56574	57101	57627	58154	58680	81
19	58680	59206	59733	60259	60786	61312	61838	62365	62891	63417	63943	80
20	63943	64470	64996	65522	66048	66574	67100	67627	68153	68679	69205	79
21	69205	69731	70257	70783	71309	71835	72360	72886	73412	73938	74464	78
22	74464	74990	75515	76041	76567	77093	77618	78144	78670	79195	79721	77
23	79721	80246	80772	81297	81823	82348	82874	83399	83925	84450	84976	76
24	84976	85501	86026	86552	87077	87602	88127	88653	89178	89703	90228	75
25	90228	90753	91278	91804	92329	92854	93379	93904	94429	94954	95479	74
26	95479	96004	96528	97053	97578	98103	98628	99153	99677	**00202**	**00727**	73
27	.55 00727	01252	01776	02301	02826	03350	03875	04399	04924	05449	05973	72
28	05973	06498	07022	07546	08071	08595	09120	09644	10168	10693	11217	71
29	11217	11741	12265	12790	13314	13838	14362	14886	15411	15935	16459	70
30	16459	16983	17507	18031	18555	19079	19603	20127	20651	21174	21698	69
31	21698	22222	22746	23270	23794	24317	24841	25365	25888	26412	26936	68
32	26936	27459	27983	28506	29030	29554	30077	30601	31124	31647	32171	67
33	32171	32694	33218	33741	34264	34788	35311	35834	36358	36881	37404	66
34	37404	37927	38450	38973	39497	40020	40543	41066	41589	42112	42635	65
35	42635	43158	43681	44204	44727	45249	45772	46295	46818	47341	47863	64
36	47863	48386	48909	49432	49954	50477	51000	51522	52045	52567	53090	63
37	53090	53612	54135	54657	55180	55702	56225	56747	57270	57792	58314	62
38	58314	58837	59359	59881	60403	60926	61448	61970	62492	63014	63536	61
39	63536	64058	64580	65102	65624	66146	66668	67190	67712	68234	68756	60
40	68756	69278	69800	70322	70844	71365	71887	72409	72930	73452	73974	59
41	73974	74496	75017	75539	76060	76582	77103	77625	78146	78668	79189	58
42	79189	79711	80232	80754	81275	81796	82318	82839	83360	83881	84403	57
43	84403	84924	85445	85966	86487	87008	87530	88051	88572	89093	89614	56
44	89614	90135	90656	91177	91698	92218	92739	93260	93781	94302	94823	55
45	94823	95343	95864	96385	96906	97426	97947	98467	98988	99509	**00029**	54
46	.56 00029	00550	01070	01591	02111	02632	03152	03673	04193	04713	05234	53
47	05234	05754	06274	06795	07315	07835	08355	08876	09396	09916	10436	52
48	10436	10956	11476	11996	12516	13036	13556	14076	14596	15116	15636	51
49	15636	16156	16676	17196	17715	18235	18755	19275	19794	20314	20834	50
	10	9	8	7	6	5	4	3	2	1	0	

COS t15--

COS t09--

'	0	1	2	3	4	5	6	7	8	9	10	
00	.84 43279	42943	42606	42269	41932	41595	41259	40922	40585	40248	39911	99
01	39911	39574	39237	38900	38563	38225	37888	37551	37214	36877	36539	98
02	36539	36202	35864	35527	35190	34852	34515	34177	33839	33502	33164	97
03	33164	32826	32489	32151	31813	31475	31138	30800	30462	30124	29786	96
04	29786	29448	29110	28772	28434	28095	27757	27419	27081	26742	26404	95
05	26404	26066	25727	25389	25051	24712	24374	24035	23696	23358	23019	94
06	23019	22680	22342	22003	21664	21325	20987	20648	20309	19970	19631	93
07	19631	19292	18953	18614	18275	17935	17596	17257	16918	16578	16239	92
08	16239	15900	15560	15221	14882	14542	14203	13863	13523	13184	12844	91
09	12844	12504	12165	11825	11485	11145	10806	10466	10126	09786	09446	90
10	09446	09106	08766	08426	08086	07745	07405	07065	06725	06385	06044	89
11	06044	05704	05363	05023	04683	04342	04002	03661	03321	02980	02639	88
12	02639	02299	01958	01617	01276	00936	00595	00254	**99913**	**99572**	**99231**	87
13	.83 99231	98890	98549	98208	97867	97526	97184	96843	96502	96161	95819	86
14	95819	95478	95137	94795	94454	94112	93771	93429	93088	92746	92405	85
15	92405	92063	91721	91379	91038	90696	90354	90012	89670	89328	88986	84
16	88986	88644	88302	87960	87618	87276	86934	86592	86249	85907	85565	83
17	85565	85222	84880	84538	84195	83853	83510	83168	82825	82483	82140	82
18	82140	81797	81455	81112	80769	80426	80083	79741	79398	79055	78712	81
19	78712	78369	78026	77683	77340	76997	76653	76310	75967	75624	75280	80
20	75280	74937	74594	74250	73907	73563	73220	72876	72533	72189	71846	79
21	71846	71502	71158	70815	70471	70127	69783	69439	69095	68752	68408	78
22	68408	68064	67720	67376	67031	66687	66343	65999	65655	65311	64966	77
23	64966	64622	64278	63933	63589	63244	62900	62555	62211	61866	61522	76
24	61522	61177	60832	60488	60143	59798	59453	59108	58763	58419	58074	75
25	58074	57729	57384	57039	56694	56348	56003	55658	55313	54968	54622	74
26	54622	54277	53932	53586	53241	52895	52550	52205	51859	51513	51168	73
27	51168	50822	50476	50131	49785	49439	49093	48748	48402	48056	47710	72
28	47710	47364	47018	46672	46326	45980	45634	45287	44941	44595	44249	71
29	44249	43902	43556	43210	42863	42517	42171	41824	41477	41131	40784	70
30	40784	40438	40091	39744	39398	39051	38704	38357	38010	37664	37317	69
31	37317	36970	36623	36276	35929	35581	35234	34887	34540	34193	33846	68
32	33846	33498	33151	32804	32456	32109	31761	31414	31066	30719	30371	67
33	30371	30024	29676	29328	28981	28633	28285	27937	27589	27242	26894	66
34	26894	26546	26198	25850	25502	25154	24805	24457	24109	23761	23413	65
35	23413	23064	22716	22368	22019	21671	21323	20974	20626	20277	19929	64
36	19929	19580	19231	18883	18534	18185	17836	17488	17139	16790	16441	63
37	16441	16092	15743	15394	15045	14696	14347	13998	13649	13300	12950	62
38	12950	12601	12252	11902	11553	11204	10854	10505	10155	09806	09456	61
39	09456	09107	08757	08407	08058	07708	07358	07009	06659	06309	05959	60
40	05959	05609	05259	04909	04559	04209	03859	03509	03159	02809	02458	59
41	02458	02108	01758	01408	01057	00707	00356	00006	**99656**	**99305**	**98955**	58
42	.82 98955	98604	98253	97903	97552	97201	96851	96500	96149	95798	95447	57
43	95447	95096	94746	94395	94044	93693	93342	92990	92639	92288	91937	56
44	91937	91586	91234	90883	90532	90181	89829	89478	89126	88775	88423	55
45	88423	88072	87720	87369	87017	86665	86313	85962	85610	85258	84906	54
46	84906	84554	84203	83851	83499	83147	82795	82442	82090	81738	81386	53
47	81386	81034	80682	80329	79977	79625	79272	78920	78568	78215	77863	52
48	77863	77510	77157	76805	76452	76100	75747	75394	75041	74689	74336	51
49	74336	73983	73630	73277	72924	72571	72218	71865	71512	71159	70806	50
	10	9	8	7	6	5	4	3	2	1	0	

SIN t15--

SIN t08--

	0	1	2	3	4	5	6	7	8	9	10	·
50	.50 90414	90955	91496	92037	92577	93118	93659	94199	94740	95281	95821	49
51	95821	96362	96903	97443	97984	98524	99065	99605	**00146**	**00686**	**01227**	48
52	.51 01227	01767	02307	02848	03388	03928	04469	05009	05549	06089	06630	47
53	06630	07170	07710	08250	08790	09331	09871	10411	10951	11491	12031	46
54	12031	12571	13111	13651	14191	14731	15271	15810	16350	16890	17430	45
55	17430	17970	18510	19049	19589	20129	20669	21208	21748	22287	22827	44
56	22827	23367	23906	24446	24985	25525	26064	26604	27143	27683	28222	43
57	28222	28762	29301	29840	30380	30919	31458	31998	32537	33076	33615	42
58	33615	34154	34694	35233	35772	36311	36850	37389	37928	38467	39006	41
59	39006	39545	40084	40623	41162	41701	42240	42779	43318	43857	44395	40
60	44395	44934	45473	46012	46550	47089	47628	48166	48705	49244	49782	39
61	49782	50321	50859	51398	51937	52475	53014	53552	54090	54629	55167	38
62	55167	55706	56244	56782	57321	57859	58397	58936	59474	60012	60550	37
63	60550	61088	61627	62165	62703	63241	63779	64317	64855	65393	65931	36
64	65931	66469	67007	67545	68083	68621	69159	69696	70234	70772	71310	35
65	71310	71848	72385	72923	73461	73999	74536	75074	75612	76149	76687	34
66	76687	77224	77762	78299	78837	79374	79912	80449	80987	81524	82061	33
67	82061	82599	83136	83673	84211	84748	85285	85823	86360	86897	87434	32
68	87434	87971	88508	89046	89583	90120	90657	91194	91731	92268	92805	31
69	92805	93342	93879	94416	94953	95489	96026	96563	97100	97637	98173	30
70	98173	98710	99247	99784	**00320**	**00857**	**01394**	**01930**	**02467**	**03003**	**03540**	29
71	.52 03540	04077	04613	05150	05686	06222	06759	07295	07832	08368	08904	28
72	08904	09441	09977	10513	11050	11586	12122	12658	13195	13731	14267	27
73	14267	14803	15339	15875	16411	16947	17483	18019	18555	19091	19627	26
74	19627	20163	20699	21235	21771	22307	22843	23378	23914	24450	24986	25
75	24986	25521	26057	26593	27128	27664	28200	28735	29271	29806	30342	24
76	30342	30877	31413	31948	32484	33019	33555	34090	34625	35161	35696	23
77	35696	36231	36767	37302	37837	38372	38908	39443	39978	40513	41048	22
78	41048	41583	42118	42653	43189	43724	44259	44794	45328	45863	46398	21
79	46398	46933	47468	48003	48538	49073	49607	50142	50677	51212	51746	20
80	51746	52281	52816	53350	53885	54420	54954	55489	56023	56558	57092	19
81	57092	57627	58161	58696	59230	59764	60299	60833	61367	61902	62436	18
82	62436	62970	63505	64039	64573	65107	65641	66176	66710	67244	67778	17
83	67778	68312	68846	69380	69914	70448	70982	71516	72050	72584	73118	16
84	73118	73651	74185	74719	75253	75787	76320	76854	77388	77921	78455	15
85	78455	78989	79522	80056	80590	81123	81657	82190	82724	83257	83791	14
86	83791	84324	84857	85391	85924	86458	86991	87524	88058	88591	89124	13
87	89124	89657	90191	90724	91257	91790	92323	92856	93389	93922	94455	12
88	94455	94988	95521	96054	96587	97120	97653	98186	98719	99252	99785	11
89	99785	**00317**	**00850**	**01383**	**01916**	**02449**	**02981**	**03514**	**04047**	**04579**	**05112**	10
90	.53 05112	05644	06177	06710	07242	07775	08307	08840	09372	09905	10437	09
91	10437	10969	11502	12034	12566	13099	13631	14163	14695	15228	15760	08
92	15760	16292	16824	17356	17888	18421	18953	19485	20017	20549	21081	07
93	21081	21613	22145	22677	23209	23740	24272	24804	25336	25868	26400	06
94	26400	26931	27463	27995	28526	29058	29590	30121	30653	31185	31716	05
95	31716	32248	32779	33311	33842	34374	34905	35437	35968	36499	37031	04
96	37031	37562	38093	38625	39156	39687	40219	40750	41281	41812	42343	03
97	42343	42874	43405	43937	44468	44999	45530	46061	46592	47123	47654	02
98	47654	48185	48715	49246	49777	50308	50839	51370	51900	52431	52962	01
99	52962	53493	54023	54554	55085	55615	56146	56676	57207	57737	58268	00
	10	9	8	7	6	5	4	3	2	1	0	

COS t16--

COS t08--

	0	1	2	3	4	5	6	7	8	9	10	
50	.86 07420	07100	06781	06461	06141	05821	05501	05181	04860	04540	04220	49
51	04220	03900	03580	03259	02939	02619	02298	01978	01658	01337	01017	48
52	01017	00696	00376	00055	**99734**	**99414**	**99093**	**98772**	**98451**	**98131**	**97810**	47
53	.85 97810	97489	97168	96847	96526	96205	95884	95563	95242	94921	94599	46
54	94599	94278	93957	93636	93314	92993	92672	92350	92029	91707	91386	45
55	91386	91064	90743	90421	90099	89778	89456	89134	88812	88491	88169	44
56	88169	87847	87525	87203	86881	86559	86237	85915	85593	85270	84948	43
57	84948	84626	84304	83981	83659	83337	83014	82692	82369	82047	81724	42
58	81724	81402	81079	80757	80434	80111	79788	79466	79143	78820	78497	41
59	78497	78174	77851	77528	77205	76882	76559	76236	75913	75590	75267	40
60	75267	74943	74620	74297	73973	73650	73327	73003	72680	72356	72033	39
61	72033	71709	71385	71062	70738	70414	70091	69767	69443	69119	68795	38
62	68795	68471	68147	67823	67499	67175	66851	66527	66203	65879	65554	37
63	65554	65230	64906	64581	64257	63933	63608	63284	62959	62635	62310	36
64	62310	61986	61661	61336	61012	60687	60362	60037	59712	59388	59063	35
65	59063	58738	58413	58088	57763	57438	57113	56787	56462	56137	55812	34
66	55812	55486	55161	54836	54510	54185	53860	53534	53209	52883	52557	33
67	52557	52232	51906	51581	51255	50929	50603	50277	49952	49626	49300	32
68	49300	48974	48648	48322	47996	47670	47344	47017	46691	46365	46039	31
69	46039	45712	45386	45060	44733	44407	44080	43754	43427	43101	42774	30
70	42774	42448	42121	41794	41468	41141	40814	40487	40160	39833	39507	29
71	39507	39180	38853	38526	38198	37871	37544	37217	36890	36563	36235	28
72	36235	35908	35581	35253	34926	34599	34271	33944	33616	33288	32961	27
73	32961	32633	32306	31978	31650	31322	30994	30667	30339	30011	29683	26
74	29683	29355	29027	28699	28371	28043	27715	27386	27058	26730	26402	25
75	26402	26073	25745	25417	25088	24760	24431	24103	23774	23446	23117	24
76	23117	22788	22460	22131	21802	21473	21145	20816	20487	20158	19829	23
77	19829	19500	19171	18842	18513	18184	17855	17525	17196	16867	16538	22
78	16538	16208	15879	15550	15220	14891	14561	14232	13902	13573	13243	21
79	13243	12913	12584	12254	11924	11594	11264	10935	10605	10275	09945	20
80	09945	09615	09285	08955	08625	08295	07964	07634	07304	06974	06643	19
81	06643	06313	05983	05652	05322	04991	04661	04330	04000	03669	03339	18
82	03339	03008	02677	02346	02016	01685	01354	01023	00692	00361	00030	17
83	00030	**99699**	**99368**	**99037**	**98706**	**98375**	**98044**	**97713**	**97381**	**97050**	**96719**	16
84	.84 96719	96388	96056	95725	95393	95062	94730	94399	94067	93736	93404	15
85	93404	93072	92741	92409	92077	91745	91413	91082	90750	90418	90086	14
86	90086	89754	89422	89090	88758	88425	88093	87761	87429	87097	86764	13
87	86764	86432	86099	85767	85435	85102	84770	84437	84105	83772	83439	12
88	83439	83107	82774	82441	82108	81776	81443	81110	80777	80444	80111	11
89	80111	79778	79445	79112	78779	78446	78112	77779	77446	77113	76779	10
90	76779	76446	76113	75779	75446	75112	74779	74445	74112	73778	73444	09
91	73444	73111	72777	72443	72109	71776	71442	71108	70774	70440	70106	08
92	70106	69772	69438	69104	68770	68436	68101	67767	67433	67099	66764	07
93	66764	66430	66096	65761	65427	65092	64758	64423	64089	63754	63419	06
94	63419	63085	62750	62415	62080	61746	61411	61076	60741	60406	60071	05
95	60071	59736	59401	59066	58731	58396	58060	57725	57390	57055	56719	04
96	56719	56384	56049	55713	55378	55042	54707	54371	54036	53700	53364	03
97	53364	53029	52693	52357	52021	51686	51350	51014	50678	50342	50006	02
98	50006	49670	49334	48998	48662	48326	47989	47653	47317	46981	46644	01
99	46644	46308	45972	45635	45299	44962	44626	44289	43953	43616	43279	00
	10	9	8	7	6	5	4	3	2	1	0	

SIN t16--

SIN t08--

	0	1	2	3	4	5	6	7	8	9	10	
00	.48 17537	18087	18638	19188	19739	20290	20840	21390	21941	22491	23042	99
01	23042	23592	24143	24693	25243	25794	26344	26894	27444	27995	28545	98
02	28545	29095	29645	30195	30746	31296	31846	32396	32946	33496	34046	97
03	34046	34596	35146	35696	36246	36796	37346	37896	38446	38996	39545	96
04	39545	40095	40645	41195	41745	42294	42844	43394	43944	44493	45043	95
05	45043	45593	46142	46692	47241	47791	48340	48890	49439	49989	50538	94
06	50538	51088	51637	52187	52736	53285	53835	54384	54933	55483	56032	93
07	56032	56581	57130	57680	58229	58778	59327	59876	60425	60975	61524	92
08	61524	62073	62622	63171	63720	64269	64818	65367	65916	66465	67013	91
09	67013	67562	68111	68660	69209	69758	70306	70855	71404	71953	72501	90
10	72501	73050	73599	74147	74696	75244	75793	76342	76890	77439	77987	89
11	77987	78536	79084	79633	80181	80729	81278	81826	82375	82923	83471	88
12	83471	84019	84568	85116	85664	86212	86761	87309	87857	88405	88953	87
13	88953	89501	90049	90597	91145	91694	92242	92789	93337	93885	94433	86
14	94433	94981	95529	96077	96625	97173	97720	98268	98816	99364	99912	85
15	99912	**00459**	**01007**	**01555**	**02102**	**02650**	**03198**	**03745**	**04293**	**04840**	**05388**	84
16	.49 05388	05935	06483	07030	07578	08125	08673	09220	09767	10315	10862	83
17	10862	11409	11957	12504	13051	13599	14146	14693	15240	15787	16334	82
18	16334	16882	17429	17976	18523	19070	19617	20164	20711	21258	21805	81
19	21805	22352	22899	23446	23993	24539	25086	25633	26180	26727	27273	80
20	27273	27820	28367	28914	29460	30007	30554	31100	31647	32193	32740	79
21	32740	33287	33833	34380	34926	35473	36019	36565	37112	37658	38205	78
22	38205	38751	39297	39844	40390	40936	41482	42029	42575	43121	43667	77
23	43667	44213	44760	45306	45852	46398	46944	47490	48036	48582	49128	76
24	49128	49674	50220	50766	51312	51858	52403	52949	53495	54041	54587	75
25	54587	55132	55678	56224	56770	57315	57861	58407	58952	59498	60043	74
26	60043	60589	61135	61680	62226	62771	63317	63862	64408	64953	65498	73
27	65498	66044	66589	67134	67680	68225	68770	69316	69861	70406	70951	72
28	70951	71496	72042	72587	73132	73677	74222	74767	75312	75857	76402	71
29	76402	76947	77492	78037	78582	79127	79672	80217	80761	81306	81851	70
30	81851	82396	82941	83485	84030	84575	85119	85664	86209	86753	87298	69
31	87298	87843	88387	88932	89476	90021	90565	91110	91654	92199	92743	68
32	92743	93287	93832	94376	94921	95465	96009	96553	97098	97642	98186	67
33	98186	98730	99274	99819	**00363**	**00907**	**01451**	**01995**	**02539**	**03083**	**03627**	66
34	.50 03627	04171	04715	05259	05803	06347	06891	07435	07979	08522	09066	65
35	09066	09610	10154	10698	11241	11785	12329	12872	13416	13960	14503	64
36	14503	15047	15591	16134	16678	17221	17765	18308	18852	19395	19939	63
37	19939	20482	21025	21569	22112	22655	23199	23742	24285	24828	25372	62
38	25372	25915	26458	27001	27544	28087	28631	29174	29717	30260	30803	61
39	30803	31346	31889	32432	32975	33518	34061	34603	35146	35689	36232	60
40	36232	36775	37318	37860	38403	38946	39489	40031	40574	41117	41659	59
41	41659	42202	42744	43287	43830	44372	44915	45457	46000	46542	47084	58
42	47084	47627	48169	48712	49254	49796	50339	50881	51423	51965	52508	57
43	52508	53050	53592	54134	54676	55218	55761	56303	56845	57387	57929	56
44	57929	58471	59013	59555	60097	60639	61181	61723	62264	62806	63348	55
45	63348	63890	64432	64973	65515	66057	66599	67140	67682	68224	68765	54
46	68765	69307	69849	70390	70932	71473	72015	72556	73098	73639	74181	53
47	74181	74722	75263	75805	76346	76887	77429	77970	78511	79053	79594	52
48	79594	80135	80676	81217	81758	82300	82841	83382	83923	84464	85005	51
49	85005	85546	86087	86628	87169	87710	88251	88792	89332	89873	90414	50
	10	9	8	7	6	5	4	3	2	1	0	

COS t16--

COS t08--

.	0	1	2	3	4	5	6	7	8	9	10	
00	.87 63067	62764	62461	62159	61856	61553	61250	60947	60644	60341	60038	99
01	60038	59735	59432	59129	58826	58522	58219	57916	57613	57309	57006	98
02	57006	56703	56399	56096	55792	55489	55185	54881	54578	54274	53970	97
03	53970	53667	53363	53059	52755	52451	52147	51843	51539	51235	50931	96
04	50931	50627	50323	50019	49715	49411	49106	48802	48498	48193	47889	95
05	47889	47584	47280	46975	46671	46366	46062	45757	45452	45148	44843	94
06	44843	44538	44233	43928	43624	43319	43014	42709	42404	42099	41793	93
07	41793	41488	41183	40878	40573	40267	39962	39657	39351	39046	38741	92
08	38741	38435	38130	37824	37519	37213	36907	36602	36296	35990	35684	91
09	35684	35378	35073	34767	34461	34155	33849	33543	33237	32931	32625	90
10	32625	32318	32012	31706	31400	31093	30787	30481	30174	29868	29561	89
11	29561	29255	28948	28642	28335	28028	27722	27415	27108	26802	26495	88
12	26495	26188	25881	25574	25267	24960	24653	24346	24039	23732	23425	87
13	23425	23117	22810	22503	22196	21888	21581	21273	20966	20659	20351	86
14	20351	20044	19736	19428	19121	18813	18505	18198	17890	17582	17274	85
15	17274	16966	16658	16350	16042	15734	15426	15118	14810	14502	14194	84
16	14194	13885	13577	13269	12961	12652	12344	12035	11727	11418	11110	83
17	11110	10801	10493	10184	09875	09567	09258	08949	08640	08331	08022	82
18	08022	07714	07405	07096	06787	06478	06168	05859	05550	05241	04932	81
19	04932	04622	04313	04004	03694	03385	03076	02766	02457	02147	01838	80
20	01838	01528	01218	00909	00599	00289	**99979**	**99670**	**99360**	**99050**	**98740**	79
21	.86 98740	98430	98120	97810	97500	97190	96880	96570	96259	95949	95639	78
22	95639	95329	95018	94708	94398	94087	93777	93466	93156	92845	92534	77
23	92534	92224	91913	91602	91292	90981	90670	90359	90048	89737	89426	76
24	89426	89116	88804	88493	88182	87871	87560	87249	86938	86626	86315	75
25	86315	86004	85692	85381	85070	84758	84447	84135	83824	83512	83200	74
26	83200	82889	82577	82265	81954	81642	81330	81018	80706	80394	80082	73
27	80082	79770	79458	79146	78834	78522	78210	77897	77585	77273	76961	72
28	76961	76648	76336	76023	75711	75398	75086	74773	74461	74148	73835	71
29	73835	73523	73210	72897	72585	72272	71959	71646	71333	71020	70707	70
30	70707	70394	70081	69768	69455	69141	68828	68515	68202	67888	67575	69
31	67575	67262	66948	66635	66321	66008	65694	65381	65067	64753	64440	68
32	64440	64126	63812	63499	63185	62871	62557	62243	61929	61615	61301	67
33	61301	60987	60673	60359	60045	59730	59416	59102	58788	58473	58159	66
34	58159	57844	57530	57216	56901	56587	56272	55957	55643	55328	55013	65
35	55013	54699	54384	54069	53754	53439	53124	52809	52494	52179	51864	64
36	51864	51549	51234	50919	50604	50289	49973	49658	49343	49027	48712	63
37	48712	48396	48081	47766	47450	47134	46819	46503	46188	45872	45556	62
38	45556	45240	44924	44609	44293	43977	43661	43345	43029	42713	42397	61
39	42397	42081	41765	41448	41132	40816	40500	40183	39867	39551	39234	60
40	39234	38918	38601	38285	37968	37652	37335	37018	36702	36385	36068	59
41	36068	35751	35434	35118	34801	34484	34167	33850	33533	33216	32899	58
42	32899	32582	32264	31947	31630	31313	30995	30678	30361	30043	29726	57
43	29726	29408	29091	28773	28456	28138	27820	27503	27185	26867	26549	56
44	26549	26232	25914	25596	25278	24960	24642	24324	24006	23688	23370	55
45	23370	23052	22733	22415	22097	21779	21460	21142	20824	20505	20187	54
46	20187	19868	19550	19231	18912	18594	18275	17956	17638	17319	17000	53
47	17000	16681	16362	16044	15725	15406	15087	14768	14449	14129	13810	52
48	13810	13491	13172	12853	12533	12214	11895	11575	11256	10936	10617	51
49	10617	10297	09978	09658	09339	09019	08699	08380	08060	07740	07420	50
	10	9	8	7	6	5	4	3	2	1	0	

SIN t16--

SIN t07--

		0	1	2	3	4	5	6	7	8	9	10	·
50	.45	39905	40465	41025	41584	42144	42704	43264	43823	44383	44943	45502	49
51		45502	46062	46622	47181	47741	48301	48860	49420	49979	50539	51098	48
52		51098	51658	52217	52776	53336	53895	54455	55014	55573	56133	56692	47
53		56692	57251	57811	58370	58929	59488	60047	60607	61166	61725	62284	46
54		62284	62843	63402	63961	64520	65079	65638	66197	66756	67315	67874	45
55		67874	68433	68992	69551	70110	70669	71228	71786	72345	72904	73463	44
56		73463	74022	74580	75139	75698	76256	76815	77374	77932	78491	79049	43
57		79049	79608	80167	80725	81284	81842	82401	82959	83518	84076	84634	42
58		84634	85193	85751	86309	86868	87426	87984	88543	89101	89659	90217	41
59		90217	90776	91334	91892	92450	93008	93566	94124	94683	95241	95799	40
60		95799	96357	96915	97473	98031	98589	99146	99704	**00262**	**00820**	**01378**	39
61	.46	01378	01936	02494	03051	03609	04167	04725	05283	05840	06398	06956	38
62		06956	07513	08071	08629	09186	09744	10301	10859	11416	11974	12531	37
63		12531	13089	13646	14204	14761	15319	15876	16433	16991	17548	18105	36
64		18105	18663	19220	19777	20334	20892	21449	22006	22563	23120	23678	35
65		23678	24235	24792	25349	25906	26463	27020	27577	28134	28691	29248	34
66		29248	29805	30362	30919	31475	32032	32589	33146	33703	34260	34816	33
67		34816	35373	35930	36486	37043	37600	38157	38713	39270	39826	40383	32
68		40383	40940	41496	42053	42609	43166	43722	44279	44835	45391	45948	31
69		45948	46504	47061	47617	48173	48730	49286	49842	50398	50955	51511	30
70		51511	52067	52623	53179	53735	54292	54848	55404	55960	56516	57072	29
71		57072	57628	58184	58740	59296	59852	60408	60964	61520	62075	62631	28
72		62631	63187	63743	64299	64854	65410	65966	66522	67077	67633	68189	27
73		68189	68744	69300	69856	70411	70967	71522	72078	72633	73189	73744	26
74		73744	74300	74855	75411	75966	76521	77077	77632	78188	78743	79298	25
75		79298	79853	80409	80964	81519	82074	82630	83185	83740	84295	84850	24
76		84850	85405	85960	86515	87070	87625	88180	88735	89290	89845	90400	23
77		90400	90955	91510	92065	92620	93175	93729	94284	94839	95394	95948	22
78		95948	96503	97058	97613	98167	98722	99276	99831	**00386**	**00940**	**01495**	21
79	.47	01495	02049	02604	03158	03713	04267	04822	05376	05931	06485	07039	20
80		07039	07594	08148	08702	09257	09811	10365	10919	11474	12028	12582	19
81		12582	13136	13690	14244	14799	15353	15907	16461	17015	17569	18123	18
82		18123	18677	19231	19785	20339	20893	21446	22000	22554	23108	23662	17
83		23662	24216	24769	25323	25877	26431	26984	27538	28092	28645	29199	16
84		29199	29752	30306	30860	31413	31967	32520	33074	33627	34181	34734	15
85		34734	35287	35841	36394	36948	37501	38054	38608	39161	39714	40267	14
86		40267	40821	41374	41927	42480	43033	43586	44140	44693	45246	45799	13
87		45799	46352	46905	47458	48011	48564	49117	49670	50223	50776	51328	12
88		51328	51881	52434	52987	53540	54093	54645	55198	55751	56304	56856	11
89		56856	57409	57962	58514	59067	59619	60172	60724	61277	61830	62382	10
90		62382	62935	63487	64039	64592	65144	65697	66249	66801	67354	67906	09
91		67906	68458	69011	69563	70115	70667	71219	71772	72324	72876	73428	08
92		73428	73980	74532	75084	75636	76188	76740	77292	77844	78396	78948	07
93		78948	79500	80052	80604	81156	81708	82260	82811	83363	83915	84467	06
94		84467	85018	85570	86122	86673	87225	87777	88328	88880	89431	89983	05
95		89983	90535	91086	91638	92189	92741	93292	93843	94395	94946	95498	04
96		95498	96049	96600	97152	97703	98254	98805	99357	99908	**00459**	**01010**	03
97	.48	01010	01561	02113	02664	03215	03766	04317	04868	05419	05970	06521	02
98		06521	07072	07623	08174	08725	09276	09826	10377	10928	11479	12030	01
99		12030	12581	13131	13682	14233	14784	15334	15885	16436	16986	17537	00
		10	9	8	7	6	5	4	3	2	1	0	

COS t17--

COS t07--

·	0	1	2	3	4	5	6	7	8	9	10	
50	.89 10065	09780	09495	09209	08924	08639	08353	08068	07782	07497	07211	49
51	07211	06925	06640	06354	06068	05783	05497	05211	04925	04639	04353	48
52	04353	04067	03781	03495	03209	02923	02637	02351	02064	01778	01492	47
53	01492	01206	00919	00633	00346	00060	**99773**	**99487**	**99200**	**98914**	**98627**	46
54	.88 98627	98340	98054	97767	97480	97193	96907	96620	96333	96046	95759	45
55	95759	95472	95185	94898	94610	94323	94036	93749	93462	93174	92887	44
56	92887	92600	92312	92025	91737	91450	91162	90875	90587	90299	90012	43
57	90012	89724	89436	89148	88860	88573	88285	87997	87709	87421	87133	42
58	87133	86845	86557	86268	85980	85692	85404	85115	84827	84539	84250	41
59	84250	83962	83673	83385	83096	82808	82519	82231	81942	81653	81364	40
60	81364	81076	80787	80498	80209	79920	79631	79342	79053	78764	78475	39
61	78475	78186	77897	77608	77318	77029	76740	76450	76161	75872	75582	38
62	75582	75293	75003	74714	74424	74134	73845	73555	73265	72976	72686	37
63	72686	72396	72106	71816	71526	71236	70946	70656	70366	70076	69786	36
64	69786	69496	69206	68915	68625	68335	68044	67754	67464	67173	66883	35
65	66883	66592	66301	66011	65720	65430	65139	64848	64557	64267	63976	34
66	63976	63685	63394	63103	62812	62521	62230	61939	61648	61356	61065	33
67	61065	60774	60483	60191	59900	59609	59317	59026	58734	58443	58151	32
68	58151	57860	57568	57277	56985	56693	56401	56110	55818	55526	55234	31
69	55234	54942	54650	54358	54066	53774	53482	53190	52898	52605	52313	30
70	52313	52021	51729	51436	51144	50851	50559	50266	49974	49681	49389	29
71	49389	49096	48803	48511	48218	47925	47632	47340	47047	46754	46461	28
72	46461	46168	45875	45582	45289	44996	44702	44409	44116	43823	43530	27
73	43530	43236	42943	42649	42356	42063	41769	41475	41182	40888	40595	26
74	40595	40301	40007	39714	39420	39126	38832	38538	38244	37950	37656	25
75	37656	37362	37068	36774	36480	36186	35892	35597	35303	35009	34714	24
76	34714	34420	34126	33831	33537	33242	32948	32653	32358	32064	31769	23
77	31769	31474	31180	30885	30590	30295	30000	29705	29410	29115	28820	22
78	28820	28525	28230	27935	27640	27345	27049	26754	26459	26163	25868	21
79	25868	25573	25277	24982	24686	24391	24095	23799	23504	23208	22912	20
80	22912	22616	22321	22025	21729	21433	21137	20841	20545	20249	19953	19
81	19953	19657	19361	19065	18768	18472	18176	17879	17583	17287	16990	18
82	16990	16694	16397	16101	15804	15508	15211	14914	14618	14321	14024	17
83	14024	13727	13430	13133	12837	12540	12243	11946	11649	11351	11054	16
84	11054	10757	10460	10163	09865	09568	09271	08973	08676	08379	08081	15
85	08081	07784	07486	07189	06891	06593	06296	05998	05700	05402	05104	14
86	05104	04807	04509	04211	03913	03615	03317	03019	02721	02423	02124	13
87	02124	01826	01528	01230	00931	00633	00335	00036	**99738**	**99439**	**99141**	12
88	.87 99141	98842	98544	98245	97946	97648	97349	97050	96751	96453	96154	11
89	96154	95855	95556	95257	94958	94659	94360	94061	93761	93462	93163	10
90	93163	92864	92565	92265	91966	91667	91367	91068	90768	90469	90169	09
91	90169	89869	89570	89270	88970	88671	88371	88071	87771	87471	87172	08
92	87172	86872	86572	86272	85972	85672	85371	85071	84771	84471	84171	07
93	84171	83870	83570	83270	82969	82669	82368	82068	81767	81467	81166	06
94	81166	80866	80565	80264	79963	79663	79362	79061	78760	78459	78158	05
95	78158	77857	77556	77255	76954	76653	76352	76051	75749	75448	75147	04
96	75147	74846	74544	74243	73941	73640	73338	73037	72735	72434	72132	03
97	72132	71830	71529	71227	70925	70623	70322	70020	69718	69416	69114	02
98	69114	68812	68510	68208	67905	67603	67301	66999	66697	66394	66092	01
99	66092	65790	65487	65185	64882	64580	64277	63975	63672	63369	63067	00
	10	9	8	7	6	5	4	3	2	1	0	

SIN t17--

SIN t07--

	0	1	2	3	4	5	6	7	8	9	10	
00	.42 57793	58361	58930	59498	60067	60635	61204	61772	62341	62909	63477	99
01	63477	64046	64614	65182	65751	66319	66887	67455	68024	68592	69160	98
02	69160	69728	70296	70864	71433	72001	72569	73137	73705	74273	74841	97
03	74841	75409	75977	76545	77113	77681	78249	78817	79385	79952	80520	96
04	80520	81088	81656	82224	82791	83359	83927	84495	85062	85630	86198	95
05	86198	86766	87333	87901	88468	89036	89604	90171	90739	91306	91874	94
06	91874	92441	93009	93576	94144	94711	95278	95846	96413	96981	97548	93
07	97548	98115	98683	99250	99817	**00384**	**00952**	**01519**	**02086**	**02653**	**03221**	92
08	.43 03221	03788	04355	04922	05489	06056	06623	07190	07757	08324	08891	91
09	08891	09458	10025	10592	11159	11726	12293	12860	13427	13994	14560	90
10	14560	15127	15694	16261	16828	17394	17961	18528	19095	19661	20228	89
11	20228	20795	21361	21928	22494	23061	23628	24194	24761	25327	25894	88
12	25894	26460	27027	27593	28159	28726	29292	29859	30425	30991	31558	87
13	31558	32124	32690	33256	33823	34389	34955	35521	36088	36654	37220	86
14	37220	37786	38352	38918	39484	40050	40616	41182	41749	42315	42880	85
15	42880	43446	44012	44578	45144	45710	46276	46842	47408	47974	48539	84
16	48539	49105	49671	50237	50802	51368	51934	52500	53065	53631	54197	83
17	54197	54762	55328	55893	56459	57024	57590	58156	58721	59286	59852	82
18	59852	60417	60983	61548	62114	62679	63244	63810	64375	64940	65506	81
19	65506	66071	66636	67201	67767	68332	68897	69462	70027	70593	71158	80
20	71158	71723	72288	72853	73418	73983	74548	75113	75678	76243	76808	79
21	76808	77373	77938	78503	79068	79632	80197	80762	81327	81892	82456	78
22	82456	83021	83586	84151	84715	85280	85845	86409	86974	87539	88103	77
23	88103	88668	89232	89797	90362	90926	91491	92055	92619	93184	93748	76
24	93748	94313	94877	95442	96006	96570	97135	97699	98263	98827	99392	75
25	99392	99956	**00520**	**01084**	**01649**	**02213**	**02777**	**03341**	**03905**	**04469**	**05033**	74
26	.44 05033	05597	06161	06725	07289	07853	08417	08981	09545	10109	10673	73
27	10673	11237	11801	12365	12929	13492	14056	14620	15184	15748	16311	72
28	16311	16875	17439	18002	18566	19130	19693	20257	20821	21384	21948	71
29	21948	22511	23075	23638	24202	24765	25329	25892	26456	27019	27582	70
30	27582	28146	28709	29272	29836	30399	30962	31526	32089	32652	33215	69
31	33215	33778	34342	34905	35468	36031	36594	37157	37720	38283	38846	68
32	38846	39409	39972	40535	41098	41661	42224	42787	43350	43913	44476	67
33	44476	45039	45601	46164	46727	47290	47853	48415	48978	49541	50103	66
34	50103	50666	51229	51791	52354	52917	53479	54042	54604	55167	55729	65
35	55729	56292	56854	57417	57979	58542	59104	59666	60229	60791	61353	64
36	61353	61916	62478	63040	63602	64165	64727	65289	65851	66414	66976	63
37	66976	67538	68100	68662	69224	69786	70348	70910	71472	72034	72596	62
38	72596	73158	73720	74282	74844	75406	75968	76530	77091	77653	78215	61
39	78215	78777	79339	79900	80462	81024	81586	82147	82709	83271	83832	60
40	83832	84394	84955	85517	86078	86640	87202	87763	88325	88886	89447	59
41	89447	90009	90570	91132	91693	92254	92816	93377	93938	94500	95061	58
42	95061	95622	96183	96745	97306	97867	98428	98989	99550	**00112**	**00673**	57
43	.45 00673	01234	01795	02356	02917	03478	04039	04600	05161	05722	06283	56
44	06283	06844	07404	07965	08526	09087	09648	10209	10769	11330	11891	55
45	11891	12452	13012	13573	14134	14694	15255	15816	16376	16937	17497	54
46	17497	18058	18618	19179	19739	20300	20860	21421	21981	22541	23102	53
47	23102	23662	24223	24783	25343	25904	26464	27024	27584	28144	28705	52
48	28705	29265	29825	30385	30945	31505	32066	32626	33186	33746	34306	51
49	34306	34866	35426	35986	36546	37106	37666	38225	38785	39345	39905	50
	10	9	8	7	6	5	4	3	2	1	0	

COS t17--

COS t07--

'	0	1	2	3	4	5	6	7	8	9	10	
00	.90 48271	48003	47735	47468	47200	46932	46665	46397	46129	45861	45593	99
01	45593	45326	45058	44790	44522	44254	43986	43717	43449	43181	42913	98
02	42913	42645	42376	42108	41840	41571	41303	41034	40766	40497	40229	97
03	40229	39960	39691	39423	39154	38885	38616	38348	38079	37810	37541	96
04	37541	37272	37003	36734	36465	36196	35927	35657	35388	35119	34850	95
05	34850	34580	34311	34042	33772	33503	33233	32964	32694	32424	32155	94
06	32155	31885	31615	31346	31076	30806	30536	30266	29996	29726	29456	93
07	29456	29186	28916	28646	28376	28106	27836	27565	27295	27025	26754	92
08	26754	26484	26213	25943	25673	25402	25131	24861	24590	24319	24049	91
09	24049	23778	23507	23236	22966	22695	22424	22153	21882	21611	21340	90
10	21340	21068	20797	20526	20255	19984	19712	19441	19170	18898	18627	89
11	18627	18355	18084	17812	17541	17269	16998	16726	16454	16182	15911	88
12	15911	15639	15367	15095	14823	14551	14279	14007	13735	13463	13191	87
13	13191	12919	12646	12374	12102	11830	11557	11285	11012	10740	10467	86
14	10467	10195	09922	09650	09377	09104	08832	08559	08286	08013	07741	85
15	07741	07468	07195	06922	06649	06376	06103	05830	05556	05283	05010	84
16	05010	04737	04463	04190	03917	03643	03370	03097	02823	02550	02276	83
17	02276	02002	01729	01455	01181	00908	00634	00360	00086	**99812**	**99538**	82
18	.89 99538	99264	98990	98716	98442	98168	97894	97620	97346	97071	96797	81
19	96797	96523	96249	95974	95700	95425	95151	94876	94602	94327	94053	80
20	94053	93778	93503	93228	92954	92679	92404	92129	91854	91579	91304	79
21	91304	91029	90754	90479	90204	89929	89654	89378	89103	88828	88552	78
22	88552	88277	88002	87726	87451	87175	86900	86624	86348	86073	85797	77
23	85797	85521	85246	84970	84694	84418	84142	83866	83590	83314	83038	76
24	83038	82762	82486	82210	81934	81657	81381	81105	80829	80552	80276	75
25	80276	79999	79723	79446	79170	78893	78617	78340	78063	77787	77510	74
26	77510	77233	76956	76679	76402	76125	75848	75571	75294	75017	74740	73
27	74740	74463	74186	73909	73631	73354	73077	72799	72522	72245	71967	72
28	71967	71690	71412	71135	70857	70579	70302	70024	69746	69468	69191	71
29	69191	68913	68635	68357	68079	67801	67523	67245	66967	66689	66410	70
30	66410	66132	65854	65576	65297	65019	64741	64462	64184	63905	63627	69
31	63627	63348	63070	62791	62512	62233	61955	61676	61397	61118	60839	68
32	60839	60561	60282	60003	59724	59444	59165	58886	58607	58328	58049	67
33	58049	57769	57490	57211	56931	56652	56372	56093	55813	55534	55254	66
34	55254	54975	54695	54415	54136	53856	53576	53296	53016	52736	52456	65
35	52456	52177	51896	51616	51336	51056	50776	50496	50216	49935	49655	64
36	49655	49375	49094	48814	48534	48253	47973	47692	47411	47131	46850	63
37	46850	46569	46289	46008	45727	45446	45166	44885	44604	44323	44042	62
38	44042	43761	43480	43199	42917	42636	42355	42074	41792	41511	41230	61
39	41230	40948	40667	40385	40104	39822	39541	39259	38978	38696	38414	60
40	38414	38132	37851	37569	37287	37005	36723	36441	36159	35877	35595	59
41	35595	35313	35031	34749	34467	34184	33902	33620	33337	33055	32773	58
42	32773	32490	32208	31925	31643	31360	31077	30795	30512	30229	29947	57
43	29947	29664	29381	29098	28815	28532	28249	27966	27683	27400	27117	56
44	27117	26834	26551	26267	25984	25701	25417	25134	24851	24567	24284	55
45	24284	24000	23717	23433	23150	22866	22582	22298	22015	21731	21447	54
46	21447	21163	20879	20595	20311	20027	19743	19459	19175	18891	18607	53
47	18607	18323	18038	17754	17470	17186	16901	16617	16332	16048	15763	52
48	15763	15479	15194	14909	14625	14340	14055	13771	13486	13201	12916	51
49	12916	12631	12346	12061	11776	11491	11206	10921	10636	10350	10065	50
	10	9	8	7	6	5	4	3	2	1	0	

SIN t17--

SIN t06--

	0	1	2	3	4	5	6	7	8	9	10	
50	.39 71479	72056	72632	73209	73785	74362	74938	75515	76092	76668	77245	49
51	77245	77821	78397	78974	79550	80127	80703	81280	81856	82432	83009	48
52	83009	83585	84161	84738	85314	85890	86466	87043	87619	88195	88771	47
53	88771	89347	89923	90500	91076	91652	92228	92804	93380	93956	94532	46
54	94532	95108	95684	96260	96836	97412	97988	98564	99140	99716	**00291**	45
55	.40 00291	00867	01443	02019	02595	03170	03746	04322	04898	05473	06049	44
56	06049	06625	07201	07776	08352	08927	09503	10079	10654	11230	11805	43
57	11805	12381	12956	13532	14107	14683	15258	15834	16409	16985	17560	42
58	17560	18135	18711	19286	19861	20437	21012	21587	22162	22738	23313	41
59	23313	23888	24463	25039	25614	26189	26764	27339	27914	28489	29064	40
60	29064	29639	30214	30789	31364	31939	32514	33089	33664	34239	34814	39
61	34814	35389	35964	36539	37114	37689	38263	38838	39413	39988	40562	38
62	40562	41137	41712	42287	42861	43436	44011	44585	45160	45734	46309	37
63	46309	46884	47458	48033	48607	49182	49756	50331	50905	51480	52054	36
64	52054	52629	53203	53777	54352	54926	55500	56075	56649	57223	57798	35
65	57798	58372	58946	59520	60095	60669	61243	61817	62391	62965	63539	34
66	63539	64114	64688	65262	65836	66410	66984	67558	68132	68706	69280	33
67	69280	69854	70428	71001	71575	72149	72723	73297	73871	74445	75018	32
68	75018	75592	76166	76740	77313	77887	78461	79034	79608	80182	80755	31
69	80755	81329	81903	82476	83050	83623	84197	84770	85344	85917	86491	30
70	86491	87064	87638	88211	88784	89358	89931	90505	91078	91651	92225	29
71	92225	92798	93371	93944	94518	95091	95664	96237	96810	97384	97957	28
72	97957	98530	99103	99676	**00249**	**00822**	**01395**	**01968**	**02541**	**03114**	**03687**	27
73	.41 03687	04260	04833	05406	05979	06552	07125	07698	08271	08843	09416	26
74	09416	09989	10562	11135	11707	12280	12853	13426	13998	14571	15144	25
75	15144	15716	16289	16861	17434	18007	18579	19152	19724	20297	20869	24
76	20869	21442	22014	22587	23159	23732	24304	24876	25449	26021	26593	23
77	26593	27166	27738	28310	28883	29455	30027	30599	31171	31744	32316	22
78	32316	32888	33460	34032	34604	35176	35748	36321	36893	37465	38037	21
79	38037	38609	39181	39753	40324	40896	41468	42040	42612	43184	43756	20
80	43756	44328	44899	45471	46043	46615	47187	47758	48330	48902	49473	19
81	49473	50045	50617	51188	51760	52332	52903	53475	54046	54618	55189	18
82	55189	55761	56332	56904	57475	58047	58618	59189	59761	60332	60904	17
83	60904	61475	62046	62617	63189	63760	64331	64903	65474	66045	66616	16
84	66616	67187	67758	68330	68901	69472	70043	70614	71185	71756	72327	15
85	72327	72898	73469	74040	74611	75182	75753	76324	76895	77466	78036	14
86	78036	78607	79178	79749	80320	80891	81461	82032	82603	83173	83744	13
87	83744	84315	84885	85456	86027	86597	87168	87739	88309	88880	89450	12
88	89450	90021	90591	91162	91732	92303	92873	93443	94014	94584	95155	11
89	95155	95725	96295	96866	97436	98006	98576	99147	99717	**00287**	**00857**	10
90	.42 00857	01427	01998	02568	03138	03708	04278	04848	05418	05988	06558	09
91	06558	07128	07698	08268	08838	09408	09978	10548	11118	11688	12258	08
92	12258	12828	13397	13967	14537	15107	15677	16246	16816	17386	17955	07
93	17955	18525	19095	19664	20234	20804	21373	21943	22512	23082	23652	06
94	23652	24221	24791	25360	25930	26499	27068	27638	28207	28777	29346	05
95	29346	29915	30485	31054	31623	32193	32762	33331	33900	34470	35039	04
96	35039	35608	36177	36746	37315	37884	38454	39023	39592	40161	40730	03
97	40730	41299	41868	42437	43006	43575	44144	44713	45281	45850	46419	02
98	46419	46988	47557	48126	48694	49263	49832	50401	50969	51538	52107	01
99	52107	52676	53244	53813	54381	54950	55519	56087	56656	57224	57793	00
	10	9	8	7	6	5	4	3	2	1	0	

COS t18--

COS t06--

	0	1	2	3	4	5	6	7	8	9	10	
50	.91 77546	77297	77047	76797	76548	76298	76048	75799	75549	75299	75049	49
51	75049	74799	74549	74299	74049	73799	73549	73299	73049	72799	72548	48
52	72548	72298	72048	71797	71547	71297	71046	70796	70545	70294	70044	47
53	70044	69793	69543	69292	69041	68790	68540	68289	68038	67787	67536	46
54	67536	67285	67034	66783	66532	66280	66029	65778	65527	65276	65024	45
55	65024	64773	64521	64270	64019	63767	63515	63264	63012	62761	62509	44
56	62509	62257	62005	61754	61502	61250	60998	60746	60494	60242	59990	43
57	59990	59738	59486	59234	58982	58729	58477	58225	57972	57720	57468	42
58	57468	57215	56963	56710	56458	56205	55952	55700	55447	55194	54941	41
59	54941	54689	54436	54183	53930	53677	53424	53171	52918	52665	52412	40
60	52412	52159	51905	51652	51399	51146	50892	50639	50385	50132	49878	39
61	49878	49625	49371	49118	48864	48610	48357	48103	47849	47595	47341	38
62	47341	47088	46834	46580	46326	46072	45818	45563	45309	45055	44801	37
63	44801	44547	44292	44038	43784	43529	43275	43020	42766	42511	42257	36
64	42257	42002	41747	41493	41238	40983	40728	40474	40219	39964	39709	35
65	39709	39454	39199	38944	38689	38434	38178	37923	37668	37413	37158	34
66	37158	36902	36647	36391	36136	35880	35625	35369	35114	34858	34603	33
67	34603	34347	34091	33835	33579	33324	33068	32812	32556	32300	32044	32
68	32044	31788	31532	31276	31019	30763	30507	30251	29994	29738	29482	31
69	29482	29225	28969	28712	28456	28199	27943	27686	27429	27173	26916	30
70	26916	26659	26402	26145	25889	25632	25375	25118	24861	24604	24346	29
71	24346	24089	23832	23575	23318	23060	22803	22546	22288	22031	21773	28
72	21773	21516	21258	21001	20743	20486	20228	19970	19712	19455	19197	27
73	19197	18939	18681	18423	18165	17907	17649	17391	17133	16875	16617	26
74	16617	16358	16100	15842	15583	15325	15067	14808	14550	14291	14033	25
75	14033	13774	13516	13257	12998	12740	12481	12222	11963	11704	11445	24
76	11445	11186	10927	10668	10409	10150	09891	09632	09373	09114	08854	23
77	08854	08595	08336	08076	07817	07557	07298	07038	06779	06519	06260	22
78	06260	06000	05740	05481	05221	04961	04701	04441	04181	03921	03662	21
79	03662	03401	03141	02881	02621	02361	02101	01841	01580	01320	01060	20
80	01060	00799	00539	00278	00018	**99757**	**99497**	**99236**	**98976**	**98715**	**98454**	19
81	.90 98454	98194	97933	97672	97411	97150	96889	96628	96367	96106	95845	18
82	95845	95584	95323	95062	94801	94539	94278	94017	93756	93494	93233	17
83	93233	92971	92710	92448	92187	91925	91663	91402	91140	90878	90617	16
84	90617	90355	90093	89831	89569	89307	89045	88783	88521	88259	87997	15
85	87997	87735	87472	87210	86948	86686	86423	86161	85898	85636	85373	14
86	85373	85111	84848	84586	84323	84060	83798	83535	83272	83009	82747	13
87	82747	82484	82221	81958	81695	81432	81169	80906	80642	80379	80116	12
88	80116	79853	79589	79326	79063	78799	78536	78273	78009	77746	77482	11
89	77482	77218	76955	76691	76427	76164	75900	75636	75372	75108	74844	10
90	74844	74580	74316	74052	73788	73524	73260	72996	72732	72467	72203	09
91	72203	71939	71674	71410	71145	70881	70616	70352	70087	69823	69558	08
92	69558	69293	69029	68764	68499	68234	67970	67705	67440	67175	66910	07
93	66910	66645	66380	66114	65849	65584	65319	65054	64788	64523	64258	06
94	64258	63992	63727	63461	63196	62930	62665	62399	62134	61868	61602	05
95	61602	61336	61071	60805	60539	60273	60007	59741	59475	59209	58943	04
96	58943	58677	58411	58144	57878	57612	57346	57079	56813	56547	56280	03
97	56280	56014	55747	55481	55214	54947	54681	54414	54147	53881	53614	02
98	53614	53347	53080	52813	52546	52279	52012	51745	51478	51211	50944	01
99	50944	50677	50410	50142	49875	49608	49340	49073	48806	48538	48271	00
	10	9	8	7	6	5	4	3	2	1	0	

SIN t18--

SIN t06--

	0	1	2	3	4	5	6	7	8	9	10	
00	.36 81246	81830	82414	82998	83582	84166	84750	85335	85919	86503	87087	99
01	87087	87671	88255	88839	89423	90007	90591	91175	91759	92343	92927	98
02	92927	93510	94094	94678	95262	95846	96430	97014	97597	98181	98765	97
03	98765	99349	99932	**00516**	**01100**	**01683**	**02267**	**02851**	**03434**	**04018**	**04602**	96
04	.37 04602	05185	05769	06352	06936	07520	08103	08687	09270	09854	10437	95
05	10437	11021	11604	12187	12771	13354	13938	14521	15104	15688	16271	94
06	16271	16854	17438	18021	18604	19187	19771	20354	20937	21520	22103	93
07	22103	22687	23270	23853	24436	25019	25602	26185	26768	27351	27934	92
08	27934	28518	29101	29683	30266	30849	31432	32015	32598	33181	33764	91
09	33764	34347	34930	35513	36095	36678	37261	37844	38427	39009	39592	90
10	39592	40175	40757	41340	41923	42506	43088	43671	44253	44836	45419	89
11	45419	46001	46584	47166	47749	48331	48914	49496	50079	50661	51244	88
12	51244	51826	52409	52991	53573	54156	54738	55320	55903	56485	57067	87
13	57067	57650	58232	58814	59396	59979	60561	61143	61725	62307	62889	86
14	62889	63472	64054	64636	65218	65800	66382	66964	67546	68128	68710	85
15	68710	69292	69874	70456	71038	71620	72202	72784	73366	73947	74529	84
16	74529	75111	75693	76275	76857	77438	78020	78602	79184	79765	80347	83
17	80347	80929	81510	82092	82674	83255	83837	84418	85000	85582	86163	82
18	86163	86745	87326	87908	88489	89071	89652	90234	90815	91396	91978	81
19	91978	92559	93141	93722	94303	94885	95466	96047	96628	97210	97791	80
20	97791	98372	98953	99535	**00116**	**00697**	**01278**	**01859**	**02440**	**03022**	**03603**	79
21	.38 03603	04184	04765	05346	05927	06508	07089	07670	08251	08832	09413	78
22	09413	09994	10575	11156	11736	12317	12898	13479	14060	14641	15221	77
23	15221	15802	16383	16964	17545	18125	18706	19287	19867	20448	21029	76
24	21029	21609	22190	22771	23351	23932	24512	25093	25673	26254	26834	75
25	26834	27415	27995	28576	29156	29737	30317	30897	31478	32058	32638	74
26	32638	33219	33799	34379	34960	35540	36120	36700	37281	37861	38441	73
27	38441	39021	39601	40182	40762	41342	41922	42502	43082	43662	44242	72
28	44242	44822	45402	45982	46562	47142	47722	48302	48882	49462	50042	71
29	50042	50622	51202	51781	52361	52941	53521	54101	54680	55260	55840	70
30	55840	56420	56999	57579	58159	58738	59318	59898	60477	61057	61636	69
31	61636	62216	62796	63375	63955	64534	65114	65693	66273	66852	67432	68
32	67432	68011	68590	69170	69749	70328	70908	71487	72066	72646	73225	67
33	73225	73804	74384	74963	75542	76121	76700	77280	77859	78438	79017	66
34	79017	79596	80175	80754	81333	81912	82491	83070	83649	84228	84807	65
35	84807	85386	85965	86544	87123	87702	88281	88860	89439	90018	90596	64
36	90596	91175	91754	92333	92912	93490	94069	94648	95226	95805	96384	63
37	96384	96962	97541	98120	98698	99277	99855	**00434**	**01013**	**01591**	**02170**	62
38	.39 02170	02748	03327	03905	04484	05062	05640	06219	06797	07376	07954	61
39	07954	08532	09111	09689	10267	10845	11424	12002	12580	13158	13737	60
40	13737	14315	14893	15471	16049	16627	17206	17784	18362	18940	19518	59
41	19518	20096	20674	21252	21830	22408	22986	23564	24142	24720	25298	58
42	25298	25875	26453	27031	27609	28187	28765	29342	29920	30498	31076	57
43	31076	31653	32231	32809	33386	33964	34542	35119	35697	36275	36852	56
44	36852	37430	38007	38585	39162	39740	40317	40895	41472	42050	42627	55
45	42627	43205	43782	44359	44937	45514	46092	46669	47246	47823	48401	54
46	48401	48978	49555	50132	50710	51287	51864	52441	53018	53595	54173	53
47	54173	54750	55327	55904	56481	57058	57635	58212	58789	59366	59943	52
48	59943	60520	61097	61674	62251	62828	63404	63981	64558	65135	65712	51
49	65712	66288	66865	67442	68019	68595	69172	69749	70326	70902	71479	50
	10	9	8	7	6	5	4	3	2	1	0	

COS t18--

COS t06--

	0	1	2	3	4	5	6	7	8	9	10	
00	.92 97765	97534	97302	97071	96839	96608	96376	96145	95913	95682	95450	99
01	95450	95218	94987	94755	94523	94291	94059	93827	93596	93364	93132	98
02	93132	92899	92667	92435	92203	91971	91739	91506	91274	91042	90809	97
03	90809	90577	90344	90112	89879	89647	89414	89182	88949	88716	88484	96
04	88484	88251	88018	87785	87552	87319	87086	86853	86620	86387	86154	95
05	86154	85921	85688	85454	85221	84988	84755	84521	84288	84054	83821	94
06	83821	83587	83354	83120	82887	82653	82419	82185	81952	81718	81484	93
07	81484	81250	81016	80782	80548	80314	80080	79846	79612	79378	79144	92
08	79144	78909	78675	78441	78206	77972	77737	77503	77268	77034	76799	91
09	76799	76565	76330	76095	75861	75626	75391	75156	74921	74686	74452	90
10	74452	74217	73982	73746	73511	73276	73041	72806	72571	72335	72100	89
11	72100	71865	71629	71394	71158	70923	70687	70452	70216	69981	69745	88
12	69745	69509	69273	69038	68802	68566	68330	68094	67858	67622	67386	87
13	67386	67150	66914	66678	66442	66205	65969	65733	65496	65260	65024	86
14	65024	64787	64551	64314	64078	63841	63604	63368	63131	62894	62658	85
15	62658	62421	62184	61947	61710	61473	61236	60999	60762	60525	60288	84
16	60288	60051	59813	59576	59339	59101	58864	58627	58389	58152	57914	83
17	57914	57677	57439	57202	56964	56726	56488	56251	56013	55775	55537	82
18	55537	55299	55061	54823	54585	54347	54109	53871	53633	53395	53156	81
19	53156	52918	52680	52442	52203	51965	51726	51488	51249	51011	50772	80
20	50772	50533	50295	50056	49817	49579	49340	49101	48862	48623	48384	79
21	48384	48145	47906	47667	47428	47189	46949	46710	46471	46232	45992	78
22	45992	45753	45514	45274	45035	44795	44556	44316	44076	43837	43597	77
23	43597	43357	43117	42878	42638	42398	42158	41918	41678	41438	41198	76
24	41198	40958	40718	40478	40237	39997	39757	39517	39276	39036	38795	75
25	38795	38555	38314	38074	37833	37593	37352	37111	36871	36630	36389	74
26	36389	36148	35907	35666	35425	35185	34944	34702	34461	34220	33979	73
27	33979	33738	33497	33255	33014	32773	32531	32290	32049	31807	31566	72
28	31566	31324	31082	30841	30599	30357	30116	29874	29632	29390	29148	71
29	29148	28906	28664	28422	28180	27938	27696	27454	27212	26970	26727	70
30	26727	26485	26243	26000	25758	25516	25273	25031	24788	24545	24303	69
31	24303	24060	23818	23575	23332	23089	22846	22604	22361	22118	21875	68
32	21875	21632	21389	21146	20902	20659	20416	20173	19930	19686	19443	67
33	19443	19200	18956	18713	18469	18226	17982	17738	17495	17251	17007	66
34	17007	16764	16520	16276	16032	15788	15544	15301	15057	14812	14568	65
35	14568	14324	14080	13836	13592	13348	13103	12859	12615	12370	12126	64
36	12126	11881	11637	11392	11148	10903	10658	10414	10169	09924	09679	63
37	09679	09435	09190	08945	08700	08455	08210	07965	07720	07475	07229	62
38	07229	06984	06739	06494	06248	06003	05758	05512	05267	05021	04776	61
39	04776	04530	04285	04039	03793	03548	03302	03056	02810	02564	02318	60
40	02318	02073	01827	01581	01335	01088	00842	00596	00350	00104	**99858**	59
41	.91 99858	99611	99365	99119	98872	98626	98379	98133	97886	97640	97393	58
42	97393	97146	96900	96653	96406	96159	95913	95666	95419	95172	94925	57
43	94925	94678	94431	94184	93937	93689	93442	93195	92948	92700	92453	56
44	92453	92206	91958	91711	91463	91216	90968	90721	90473	90225	89978	55
45	89978	89730	89482	89234	88987	88739	88491	88243	87995	87747	87499	54
46	87499	87251	87002	86754	86506	86258	86010	85761	85513	85264	85016	53
47	85016	84768	84519	84271	84022	83773	83525	83276	83027	82779	82530	52
48	82530	82281	82032	81783	81534	81285	81036	80787	80538	80289	80040	51
49	80040	79791	79541	79292	79043	78793	78544	78295	78045	77796	77546	50
	10	9	8	7	6	5	4	3	2	1	0	

SIN t18--

SIN t05--

	0	1	2	3	4	5	6	7	8	9	10	
50	.33 87379	87970	88562	89153	89744	90335	90926	91517	92108	92699	93290	49
51	93290	93881	94472	95063	95654	96245	96836	97427	98018	98609	99200	48
52	99200	99791	**00382**	**00973**	**01563**	**02154**	**02745**	**03336**	**03927**	**04518**	**05108**	47
53	.34 05108	05699	06290	06881	07471	08062	08653	09243	09834	10425	11015	46
54	11015	11606	12197	12787	13378	13968	14559	15150	15740	16331	16921	45
55	16921	17512	18102	18693	19283	19873	20464	21054	21645	22235	22825	44
56	22825	23416	24006	24596	25187	25777	26367	26958	27548	28138	28728	43
57	28728	29319	29909	30499	31089	31679	32270	32860	33450	34040	34630	42
58	34630	35220	35810	36400	36990	37580	38170	38760	39350	39940	40530	41
59	40530	41120	41710	42300	42890	43480	44070	44660	45250	45839	46429	40
60	46429	47019	47609	48199	48788	49378	49968	50558	51147	51737	52327	39
61	52327	52916	53506	54096	54685	55275	55865	56454	57044	57633	58223	38
62	58223	58813	59402	59992	60581	61171	61760	62350	62939	63528	64118	37
63	64118	64707	65297	65886	66475	67065	67654	68243	68833	69422	70011	36
64	70011	70601	71190	71779	72368	72957	73547	74136	74725	75314	75903	35
65	75903	76493	77082	77671	78260	78849	79438	80027	80616	81205	81794	34
66	81794	82383	82972	83561	84150	84739	85328	85917	86506	87095	87683	33
67	87683	88272	88861	89450	90039	90628	91216	91805	92394	92983	93571	32
68	93571	94160	94749	95338	95926	96515	97104	97692	98281	98869	99458	31
69	99458	**00047**	**00635**	**01224**	**01812**	**02401**	**02989**	**03578**	**04166**	**04755**	**05343**	30
70	.35 05343	05932	06520	07108	07697	08285	08874	09462	10050	10639	11227	29
71	11227	11815	12404	12992	13580	14168	14757	15345	15933	16521	17109	28
72	17109	17698	18286	18874	19462	20050	20638	21226	21814	22402	22991	27
73	22991	23579	24167	24755	25343	25931	26518	27106	27694	28282	28870	26
74	28870	29458	30046	30634	31222	31809	32397	32985	33573	34161	34748	25
75	34748	35336	35924	36512	37099	37687	38275	38862	39450	40038	40625	24
76	40625	41213	41801	42388	42976	43563	44151	44738	45326	45913	46501	23
77	46501	47088	47676	48263	48851	49438	50025	50613	51200	51788	52375	22
78	52375	52962	53549	54137	54724	55311	55899	56486	57073	57660	58248	21
79	58248	58835	59422	60009	60596	61183	61770	62358	62945	63532	64119	20
80	64119	64706	65293	65880	66467	67054	67641	68228	68815	69402	69989	19
81	69989	70576	71162	71749	72336	72923	73510	74097	74684	75270	75857	18
82	75857	76444	77031	77617	78204	78791	79377	79964	80551	81137	81724	17
83	81724	82311	82897	83484	84071	84657	85244	85830	86417	87003	87590	16
84	87590	88176	88763	89349	89936	90522	91108	91695	92281	92868	93454	15
85	93454	94040	94627	95213	95799	96386	96972	97558	98144	98731	99317	14
86	99317	99903	**00489**	**01075**	**01661**	**02248**	**02834**	**03420**	**04006**	**04592**	**05178**	13
87	.36 05178	05764	06350	06936	07522	08108	08694	09280	09866	10452	11038	12
88	11038	11624	12210	12796	13382	13967	14553	15139	15725	16311	16897	11
89	16897	17482	18068	18654	19240	19825	20411	20997	21582	22168	22754	10
90	22754	23339	23925	24511	25096	25682	26267	26853	27438	28024	28609	09
91	28609	29195	29780	30366	30951	31537	32122	32707	33293	33878	34464	08
92	34464	35049	35634	36220	36805	37390	37975	38561	39146	39731	40316	07
93	40316	40902	41487	42072	42657	43242	43827	44412	44998	45583	46168	06
94	46168	46753	47338	47923	48508	49093	49678	50263	50848	51433	52018	05
95	52018	52603	53187	53772	54357	54942	55527	56112	56697	57281	57866	04
96	57866	58451	59036	59620	60205	60790	61374	61959	62544	63128	63713	03
97	63713	64298	64882	65467	66052	66636	67221	67805	68390	68974	69559	02
98	69559	70143	70728	71312	71897	72481	73065	73650	74234	74818	75403	01
99	75403	75987	76571	77156	77740	78324	78909	79493	80077	80661	81246	00
	10	9	8	7	6	5	4	3	2	1	0	

COS t19--

COS t05--

	0	1	2	3	4	5	6	7	8	9	10	
50	.94 08808	08595	08382	08169	07956	07743	07530	07317	07104	06891	06677	49
51	06677	06464	06251	06038	05824	05611	05398	05184	04971	04757	04544	48
52	04544	04330	04116	03903	03689	03475	03261	03048	02834	02620	02406	47
53	02406	02192	01978	01764	01550	01336	01122	00907	00693	00479	00265	46
54	00265	00050	**99836**	**99621**	**99407**	**99193**	**98978**	**98763**	**98549**	**98334**	**98120**	45
55	.93 98120	97905	97690	97475	97260	97046	96831	96616	96401	96186	95971	44
56	95971	95756	95541	95325	95110	94895	94680	94464	94249	94034	93818	43
57	93818	93603	93387	93172	92956	92741	92525	92309	92094	91878	91662	42
58	91662	91446	91230	91014	90799	90583	90367	90151	89934	89718	89502	41
59	89502	89286	89070	88853	88637	88421	88204	87988	87772	87555	87339	40
60	87339	87122	86905	86689	86472	86255	86039	85822	85605	85388	85171	39
61	85171	84954	84737	84520	84303	84086	83869	83652	83435	83218	83000	38
62	83000	82783	82566	82348	82131	81913	81696	81478	81261	81043	80826	37
63	80826	80608	80390	80172	79955	79737	79519	79301	79083	78865	78647	36
64	78647	78429	78211	77993	77775	77557	77338	77120	76902	76683	76465	35
65	76465	76247	76028	75810	75591	75373	75154	74935	74717	74498	74279	34
66	74279	74060	73842	73623	73404	73185	72966	72747	72528	72309	72090	33
67	72090	71870	71651	71432	71213	70993	70774	70555	70335	70116	69896	32
68	69896	69677	69457	69238	69018	68798	68579	68359	68139	67919	67699	31
69	67699	67480	67260	67040	66820	66600	66380	66159	65939	65719	65499	30
70	65499	65279	65058	64838	64618	64397	64177	63956	63736	63515	63295	29
71	63295	63074	62853	62633	62412	62191	61970	61749	61528	61307	61087	28
72	61087	60866	60644	60423	60202	59981	59760	59539	59317	59096	58875	27
73	58875	58653	58432	58211	57989	57768	57546	57324	57103	56881	56659	26
74	56659	56438	56216	55994	55772	55550	55328	55106	54884	54662	54440	25
75	54440	54218	53996	53774	53552	53329	53107	52885	52662	52440	52218	24
76	52218	51995	51773	51550	51327	51105	50882	50659	50437	50214	49991	23
77	49991	49768	49545	49322	49099	48876	48653	48430	48207	47984	47761	22
78	47761	47538	47314	47091	46868	46644	46421	46198	45974	45751	45527	21
79	45527	45303	45080	44856	44632	44409	44185	43961	43737	43513	43289	20
80	43289	43065	42841	42617	42393	42169	41945	41721	41497	41272	41048	19
81	41048	40824	40599	40375	40151	39926	39702	39477	39253	39028	38803	18
82	38803	38579	38354	38129	37904	37679	37455	37230	37005	36780	36555	17
83	36555	36330	36104	35879	35654	35429	35204	34978	34753	34528	34302	16
84	34302	34077	33851	33626	33400	33175	32949	32724	32498	32272	32046	15
85	32046	31821	31595	31369	31143	30917	30691	30465	30239	30013	29787	14
86	29787	29560	29334	29108	28882	28655	28429	28203	27976	27750	27523	13
87	27523	27297	27070	26844	26617	26390	26164	25937	25710	25483	25256	12
88	25256	25029	24802	24575	24348	24121	23894	23667	23440	23213	22986	11
89	22986	22758	22531	22304	22076	21849	21621	21394	21166	20939	20711	10
90	20711	20483	20256	20028	19800	19573	19345	19117	18889	18661	18433	09
91	18433	18205	17977	17749	17521	17293	17064	16836	16608	16380	16151	08
92	16151	15923	15694	15466	15238	15009	14780	14552	14323	14095	13866	07
93	13866	13637	13408	13179	12951	12722	12493	12264	12035	11806	11577	06
94	11577	11348	11118	10889	10660	10431	10201	09972	09743	09513	09284	05
95	09284	09054	08825	08595	08366	08136	07906	07677	07447	07217	06987	04
96	06987	06758	06528	06298	06068	05838	05608	05378	05148	04918	04687	03
97	04687	04457	04227	03997	03766	03536	03305	03075	02845	02614	02384	02
98	02384	02153	01922	01692	01461	01230	00999	00769	00538	00307	00076	01
99	00076	**99845**	**99614**	**99383**	**99152**	**98921**	**98690**	**98459**	**98227**	**97996**	**97765**	00
	10	9	8	7	6	5	4	3	2	1	0	

SIN t19--

SIN t05--

	0	1	2	3	4	5	6	7	8	9	10	
00	.30 90170	90768	91365	91963	92560	93158	93755	94353	94950	95548	96145	99
01	96145	96742	97340	97937	98535	99132	99729	**00327**	**00924**	**01522**	**02119**	98
02	.31 02119	02716	03313	03911	04508	05105	05703	06300	06897	07494	08091	97
03	08091	08689	09286	09883	10480	11077	11674	12272	12869	13466	14063	96
04	14063	14660	15257	15854	16451	17048	17645	18242	18839	19436	20033	95
05	20033	20630	21227	21824	22421	23018	23614	24211	24808	25405	26002	94
06	26002	26599	27196	27792	28389	28986	29583	30179	30776	31373	31970	93
07	31970	32566	33163	33760	34356	34953	35550	36146	36743	37339	37936	92
08	37936	38533	39129	39726	40322	40919	41515	42112	42708	43305	43901	91
09	43901	44498	45094	45691	46287	46883	47480	48076	48673	49269	49865	90
10	49865	50462	51058	51654	52250	52847	53443	54039	54635	55232	55828	89
11	55828	56424	57020	57616	58213	58809	59405	60001	60597	61193	61789	88
12	61789	62385	62982	63578	64174	64770	65366	65962	66558	67154	67750	87
13	67750	68346	68942	69537	70133	70729	71325	71921	72517	73113	73709	86
14	73709	74304	74900	75496	76092	76688	77283	77879	78475	79071	79666	85
15	79666	80262	80858	81453	82049	82645	83240	83836	84432	85027	85623	84
16	85623	86218	86814	87410	88005	88601	89196	89792	90387	90983	91578	83
17	91578	92173	92769	93364	93960	94555	95151	95746	96341	96937	97532	82
18	97532	98127	98723	99318	99913	**00508**	**01104**	**01699**	**02294**	**02889**	**03485**	81
19	.32 03485	04080	04675	05270	05865	06461	07056	07651	08246	08841	09436	80
20	09436	10031	10626	11221	11816	12411	13006	13601	14196	14791	15386	79
21	15386	15981	16576	17171	17766	18361	18956	19551	20145	20740	21335	78
22	21335	21930	22525	23120	23714	24309	24904	25499	26093	26688	27283	77
23	27283	27877	28472	29067	29661	30256	30851	31445	32040	32635	33229	76
24	33229	33824	34418	35013	35607	36202	36796	37391	37985	38580	39174	75
25	39174	39769	40363	40957	41552	42146	42741	43335	43929	44524	45118	74
26	45118	45712	46307	46901	47495	48089	48684	49278	49872	50466	51060	73
27	51060	51655	52249	52843	53437	54031	54625	55219	55814	56408	57002	72
28	57002	57596	58190	58784	59378	59972	60566	61160	61754	62348	62942	71
29	62942	63536	64129	64723	65317	65911	66505	67099	67693	68286	68880	70
30	68880	69474	70068	70662	71255	71849	72443	73037	73630	74224	74818	69
31	74818	75411	76005	76599	77192	77786	78379	78973	79567	80160	80754	68
32	80754	81347	81941	82534	83128	83721	84315	84908	85502	86095	86688	67
33	86688	87282	87875	88469	89062	89655	90249	90842	91435	92029	92622	66
34	92622	93215	93809	94402	94995	95588	96181	96775	97368	97961	98554	65
35	98554	99147	99740	**00334**	**00927**	**01520**	**02113**	**02706**	**03299**	**03892**	**04485**	64
36	.33 04485	05078	05671	06264	06857	07450	08043	08636	09229	09822	10415	63
37	10415	11007	11600	12193	12786	13379	13972	14565	15157	15750	16343	62
38	16343	16936	17528	18121	18714	19306	19899	20492	21085	21677	22270	61
39	22270	22862	23455	24048	24640	25233	25825	26418	27010	27603	28195	60
40	28195	28788	29380	29973	30565	31158	31750	32343	32935	33527	34120	59
41	34120	34712	35304	35897	36489	37081	37674	38266	38858	39451	40043	58
42	40043	40635	41227	41819	42412	43004	43596	44188	44780	45372	45964	57
43	45964	46557	47149	47741	48333	48925	49517	50109	50701	51293	51885	56
44	51885	52477	53069	53661	54253	54845	55436	56028	56620	57212	57804	55
45	57804	58396	58988	59579	60171	60763	61355	61946	62538	63130	63722	54
46	63722	64313	64905	65497	66088	66680	67272	67863	68455	69046	69638	53
47	69638	70230	70821	71413	72004	72596	73187	73779	74370	74962	75553	52
48	75553	76145	76736	77327	77919	78510	79101	79693	80284	80875	81467	51
49	81467	82058	82649	83241	83832	84423	85014	85606	86197	86788	87379	50
	10	9	8	7	6	5	4	3	2	1	0	

COS t19--

COS t05--

•	0	1	2	3	4	5	6	7	8	9	10	
00	.95 10565	10371	10177	09983	09788	09594	09400	09205	09011	08816	08622	99
01	08622	08427	08233	08038	07843	07649	07454	07259	07064	06869	06674	98
02	06674	06480	06285	06090	05894	05699	05504	05309	05114	04919	04723	97
03	04723	04528	04333	04137	03942	03747	03551	03356	03160	02964	02769	96
04	02769	02573	02377	02182	01986	01790	01594	01398	01202	01006	00810	95
05	00810	00614	00418	00222	00026	**99830**	**99633**	**99437**	**99241**	**99044**	**98848**	94
06	.94 98848	98652	98455	98259	98062	97865	97669	97472	97275	97079	96882	93
07	96882	96685	96488	96291	96094	95898	95701	95504	95306	95109	94912	92
08	94912	94715	94518	94321	94123	93926	93729	93531	93334	93136	92939	91
09	92939	92741	92544	92346	92148	91951	91753	91555	91357	91159	90961	90
10	90961	90764	90566	90368	90170	89971	89773	89575	89377	89179	88980	89
11	88980	88782	88584	88385	88187	87989	87790	87592	87393	87194	86996	88
12	86996	86797	86598	86400	86201	86002	85803	85604	85405	85206	85007	87
13	85007	84808	84609	84410	84211	84012	83812	83613	83414	83214	83015	86
14	83015	82816	82616	82417	82217	82017	81818	81618	81419	81219	81019	85
15	81019	80819	80619	80420	80220	80020	79820	79620	79420	79219	79019	84
16	79019	78819	78619	78419	78218	78018	77818	77617	77417	77216	77016	83
17	77016	76815	76615	76414	76213	76013	75812	75611	75410	75210	75009	82
18	75009	74808	74607	74406	74205	74004	73803	73601	73400	73199	72998	81
19	72998	72796	72595	72394	72192	71991	71789	71588	71386	71185	70983	80
20	70983	70781	70580	70378	70176	69974	69772	69571	69369	69167	68965	79
21	68965	68763	68561	68358	68156	67954	67752	67550	67347	67145	66942	78
22	66942	66740	66538	66335	66133	65930	65727	65525	65322	65119	64917	77
23	64917	64714	64511	64308	64105	63902	63699	63496	63293	63090	62887	76
24	62887	62684	62481	62277	62074	61871	61667	61464	61261	61057	60854	75
25	60854	60650	60446	60243	60039	59836	59632	59428	59224	59020	58816	74
26	58816	58613	58409	58205	58001	57797	57592	57388	57184	56980	56776	73
27	56776	56571	56367	56163	55958	55754	55549	55345	55140	54936	54731	72
28	54731	54526	54322	54117	53912	53707	53503	53298	53093	52888	52683	71
29	52683	52478	52273	52068	51862	51657	51452	51247	51041	50836	50631	70
30	50631	50425	50220	50014	49809	49603	49398	49192	48986	48781	48575	69
31	48575	48369	48163	47958	47752	47546	47340	47134	46928	46722	46515	68
32	46515	46309	46103	45897	45691	45484	45278	45072	44865	44659	44452	67
33	44452	44246	44039	43833	43626	43419	43213	43006	42799	42592	42385	66
34	42385	42178	41971	41765	41557	41350	41143	40936	40729	40522	40315	65
35	40315	40107	39900	39693	39485	39278	39070	38863	38655	38448	38240	64
36	38240	38033	37825	37617	37409	37202	36994	36786	36578	36370	36162	63
37	36162	35954	35746	35538	35330	35122	34913	34705	34497	34289	34080	62
38	34080	33872	33663	33455	33246	33038	32829	32621	32412	32203	31995	61
39	31995	31786	31577	31368	31159	30950	30742	30533	30324	30114	29905	60
40	29905	29696	29487	29278	29069	28859	28650	28441	28231	28022	27812	59
41	27812	27603	27393	27184	26974	26764	26555	26345	26135	25925	25716	58
42	25716	25506	25296	25086	24876	24666	24456	24246	24036	23825	23615	57
43	23615	23405	23195	22984	22774	22563	22353	22143	21932	21722	21511	56
44	21511	21300	21090	20879	20668	20457	20247	20036	19825	19614	19403	55
45	19403	19192	18981	18770	18559	18348	18136	17925	17714	17503	17291	54
46	17291	17080	16869	16657	16446	16234	16023	15811	15599	15388	15176	53
47	15176	14964	14753	14541	14329	14117	13905	13693	13481	13269	13057	52
48	13057	12845	12633	12421	12208	11996	11784	11571	11359	11147	10934	51
49	10934	10722	10509	10297	10084	09871	09659	09446	09233	09021	08808	50
	10	9	8	7	6	5	4	3	2	1	0	

SIN t19--

SIN t04--

	0	1	2	3	4	5	6	7	8	9	10	
50	.27 89911	90514	91118	91721	92324	92928	93531	94134	94738	95341	95944	49
51	95944	96547	97151	97754	98357	98960	99564	**00167**	**00770**	**01373**	**01976**	48
52	.28 01976	02579	03183	03786	04389	04992	05595	06198	06801	07404	08007	47
53	08007	08610	09213	09816	10419	11022	11625	12228	12831	13434	14037	46
54	14037	14640	15243	15846	16449	17052	17654	18257	18860	19463	20066	45
55	20066	20669	21271	21874	22477	23080	23682	24285	24888	25491	26093	44
56	26093	26696	27299	27901	28504	29107	29709	30312	30915	31517	32120	43
57	32120	32722	33325	33928	34530	35133	35735	36338	36940	37543	38145	42
58	38145	38748	39350	39953	40555	41158	41760	42362	42965	43567	44169	41
59	44169	44772	45374	45977	46579	47181	47784	48386	48988	49590	50193	40
60	50193	50795	51397	51999	52602	53204	53806	54408	55010	55612	56215	39
61	56215	56817	57419	58021	58623	59225	59827	60429	61031	61633	62236	38
62	62236	62838	63440	64042	64644	65246	65847	66449	67051	67653	68255	37
63	68255	68857	69459	70061	70663	71265	71867	72468	73070	73672	74274	36
64	74274	74876	75477	76079	76681	77283	77885	78486	79088	79690	80291	35
65	80291	80893	81495	82096	82698	83300	83901	84503	85105	85706	86308	34
66	86308	86909	87511	88112	88714	89315	89917	90518	91120	91721	92323	33
67	92323	92924	93526	94127	94729	95330	95931	96533	97134	97736	98337	32
68	98337	98938	99540	**00141**	**00742**	**01344**	**01945**	**02546**	**03147**	**03749**	**04350**	31
69	.29 04350	04951	05552	06154	06755	07356	07957	08558	09159	09761	10362	30
70	10362	10963	11564	12165	12766	13367	13968	14569	15170	15771	16372	29
71	16372	16973	17574	18175	18776	19377	19978	20579	21180	21781	22382	28
72	22382	22983	23584	24184	24785	25386	25987	26588	27189	27789	28390	27
73	28390	28991	29592	30192	30793	31394	31995	32595	33196	33797	34397	26
74	34397	34998	35599	36199	36800	37400	38001	38602	39202	39803	40403	25
75	40403	41004	41604	42205	42805	43406	44006	44607	45207	45808	46408	24
76	46408	47009	47609	48209	48810	49410	50010	50611	51211	51811	52412	23
77	52412	53012	53612	54213	54813	55413	56013	56614	57214	57814	58414	22
78	58414	59014	59615	60215	60815	61415	62015	62615	63215	63816	64416	21
79	64416	65016	65616	66216	66816	67416	68016	68616	69216	69816	70416	20
80	70416	71016	71616	72216	72816	73415	74015	74615	75215	75815	76415	19
81	76415	77015	77614	78214	78814	79414	80014	80613	81213	81813	82413	18
82	82413	83012	83612	84212	84811	85411	86011	86610	87210	87810	88409	17
83	88409	89009	89608	90208	90808	91407	92007	92606	93206	93805	94405	16
84	94405	95004	95604	96203	96803	97402	98001	98601	99200	99800	**00399**	15
85	.30 00399	00998	01598	02197	02796	03396	03995	04594	05194	05793	06392	14
86	06392	06991	07591	08190	08789	09388	09987	10587	11186	11785	12384	13
87	12384	12983	13582	14181	14781	15380	15979	16578	17177	17776	18375	12
88	18375	18974	19573	20172	20771	21370	21969	22568	23167	23765	24364	11
89	24364	24963	25562	26161	26760	27359	27958	28556	29155	29754	30353	10
90	30353	30951	31550	32149	32748	33346	33945	34544	35143	35741	36340	09
91	36340	36938	37537	38136	38734	39333	39932	40530	41129	41727	42326	08
92	42326	42924	43523	44121	44720	45318	45917	46515	47114	47712	48311	07
93	48311	48909	49507	50106	50704	51302	51901	52499	53097	53696	54294	06
94	54294	54892	55491	56089	56687	57285	57884	58482	59080	59678	60276	05
95	60276	60875	61473	62071	62669	63267	63865	64463	65061	65659	66258	04
96	66258	66856	67454	68052	68650	69248	69846	70444	71042	71640	72237	03
97	72237	72835	73433	74031	74629	75227	75825	76423	77021	77618	78216	02
98	78216	78814	79412	80010	80607	81205	81803	82401	82998	83596	84194	01
99	84194	84791	85389	85987	86584	87182	87780	88377	88975	89572	90170	00
	10	9	8	7	6	5	4	3	2	1	0	

COS t20--

COS t04--

	0	1	2	3	4	5	6	7	8	9	10	
50	.96 02937	02762	02586	02411	02235	02060	01884	01709	01533	01358	01182	49
51	01182	01006	00831	00655	00479	00303	00127	**99951**	**99775**	**99599**	**99423**	48
52	.95 99423	99247	99071	98895	98719	98543	98366	98190	98014	97837	97661	47
53	97661	97484	97308	97131	96955	96778	96602	96425	96248	96072	95895	46
54	95895	95718	95541	95364	95187	95010	94833	94656	94479	94302	94125	45
55	94125	93948	93770	93593	93416	93238	93061	92883	92706	92528	92351	44
56	92351	92173	91996	91818	91640	91463	91285	91107	90929	90751	90573	43
57	90573	90395	90217	90039	89861	89683	89505	89327	89149	88970	88792	42
58	88792	88614	88435	88257	88078	87900	87721	87543	87364	87186	87007	41
59	87007	86828	86649	86471	86292	86113	85934	85755	85576	85397	85218	40
60	85218	85039	84860	84680	84501	84322	84143	83963	83784	83605	83425	39
61	83425	83246	83066	82887	82707	82527	82348	82168	81988	81808	81629	38
62	81629	81449	81269	81089	80909	80729	80549	80369	80189	80009	79828	37
63	79828	79648	79468	79288	79107	78927	78746	78566	78385	78205	78024	36
64	78024	77844	77663	77482	77302	77121	76940	76759	76578	76397	76216	35
65	76216	76035	75854	75673	75492	75311	75130	74949	74767	74586	74405	34
66	74405	74223	74042	73861	73679	73498	73316	73134	72953	72771	72589	33
67	72589	72408	72226	72044	71862	71680	71498	71316	71134	70952	70770	32
68	70770	70588	70406	70224	70041	69859	69677	69495	69312	69130	68947	31
69	68947	68765	68582	68400	68217	68034	67852	67669	67486	67303	67121	30
70	67121	66938	66755	66572	66389	66206	66023	65840	65656	65473	65290	29
71	65290	65107	64923	64740	64557	64373	64190	64006	63823	63639	63456	28
72	63456	63272	63088	62905	62721	62537	62353	62169	61986	61802	61618	27
73	61618	61434	61250	61065	60881	60697	60513	60329	60144	59960	59776	26
74	59776	59591	59407	59222	59038	58853	58669	58484	58300	58115	57930	25
75	57930	57745	57561	57376	57191	57006	56821	56636	56451	56266	56081	24
76	56081	55896	55710	55525	55340	55155	54969	54784	54599	54413	54228	23
77	54228	54042	53856	53671	53485	53300	53114	52928	52742	52557	52371	22
78	52371	52185	51999	51813	51627	51441	51255	51069	50882	50696	50510	21
79	50510	50324	50137	49951	49765	49578	49392	49205	49019	48832	48645	20
80	48645	48459	48272	48085	47899	47712	47525	47338	47151	46964	46777	19
81	46777	46590	46403	46216	46029	45842	45654	45467	45280	45093	44905	18
82	44905	44718	44530	44343	44155	43968	43780	43593	43405	43217	43029	17
83	43029	42842	42654	42466	42278	42090	41902	41714	41526	41338	41150	16
84	41150	40962	40773	40585	40397	40209	40020	39832	39643	39455	39267	15
85	39267	39078	38889	38701	38512	38323	38135	37946	37757	37568	37379	14
86	37379	37191	37002	36813	36624	36434	36245	36056	35867	35678	35489	13
87	35489	35299	35110	34921	34731	34542	34352	34163	33973	33784	33594	12
88	33594	33404	33215	33025	32835	32645	32455	32265	32076	31886	31696	11
89	31696	31506	31315	31125	30935	30745	30555	30364	30174	29984	29793	10
90	29793	29603	29413	29222	29032	28841	28650	28460	28269	28078	27888	09
91	27888	27697	27506	27315	27124	26933	26742	26551	26360	26169	25978	08
92	25978	25787	25595	25404	25213	25022	24830	24639	24447	24256	24064	07
93	24064	23873	23681	23490	23298	23106	22915	22723	22531	22339	22147	06
94	22147	21955	21763	21571	21379	21187	20995	20803	20611	20419	20226	05
95	20226	20034	19842	19649	19457	19264	19072	18879	18687	18494	18302	04
96	18302	18109	17916	17723	17531	17338	17145	16952	16759	16566	16373	03
97	16373	16180	15987	15794	15601	15407	15214	15021	14828	14634	14441	02
98	14441	14247	14054	13860	13667	13473	13280	13086	12892	12699	12505	01
99	12505	12311	12117	11923	11729	11535	11342	11147	10953	10759	10565	00
	10	9	8	7	6	5	4	3	2	1	0	

SIN t20--

SIN t04--

	0	1	2	3	4	5	6	7	8	9	10	
00	.24 86899	87507	88116	88725	89333	89942	90550	91159	91767	92376	92984	99
01	92984	93593	94201	94810	95418	96026	96635	97243	97852	98460	99068	98
02	99068	99677	**00285**	**00894**	**01502**	**02110**	**02719**	**03327**	**03935**	**04544**	**05152**	97
03	.25 05152	05760	06368	06977	07585	08193	08801	09410	10018	10626	11234	96
04	11234	11842	12450	13059	13667	14275	14883	15491	16099	16707	17315	95
05	17315	17924	18532	19140	19748	20356	20964	21572	22180	22788	23396	94
06	23396	24004	24612	25220	25828	26436	27044	27651	28259	28867	29475	93
07	29475	30083	30691	31299	31907	32514	33122	33730	34338	34946	35554	92
08	35554	36161	36769	37377	37985	38592	39200	39808	40416	41023	41631	91
09	41631	42239	42846	43454	44062	44669	45277	45884	46492	47100	47707	90
10	47707	48315	48922	49530	50138	50745	51353	51960	52568	53175	53783	89
11	53783	54390	54998	55605	56212	56820	57427	58035	58642	59250	59857	88
12	59857	60464	61072	61679	62286	62894	63501	64108	64716	65323	65930	87
13	65930	66538	67145	67752	68359	68967	69574	70181	70788	71395	72003	86
14	72003	72610	73217	73824	74431	75038	75645	76253	76860	77467	78074	85
15	78074	78681	79288	79895	80502	81109	81716	82323	82930	83537	84144	84
16	84144	84751	85358	85965	86572	87179	87786	88393	89000	89607	90213	83
17	90213	90820	91427	92034	92641	93248	93854	94461	95068	95675	96282	82
18	96282	96888	97495	98102	98709	99315	99922	**00529**	**01136**	**01742**	**02349**	81
19	.26 02349	02956	03562	04169	04775	05382	05989	06595	07202	07808	08415	80
20	08415	09022	09628	10235	10841	11448	12054	12661	13267	13874	14480	79
21	14480	15087	15693	16300	16906	17512	18119	18725	19332	19938	20544	78
22	20544	21151	21757	22363	22970	23576	24182	24789	25395	26001	26607	77
23	26607	27214	27820	28426	29032	29639	30245	30851	31457	32063	32669	76
24	32669	33276	33882	34488	35094	35700	36306	36912	37518	38124	38730	75
25	38730	39337	39943	40549	41155	41761	42367	42973	43579	44185	44790	74
26	44790	45396	46002	46608	47214	47820	48426	49032	49638	50244	50849	73
27	50849	51455	52061	52667	53273	53878	54484	55090	55696	56302	56907	72
28	56907	57513	58119	58724	59330	59936	60542	61147	61753	62358	62964	71
29	62964	63570	64175	64781	65387	65992	66598	67203	67809	68414	69020	70
30	69020	69625	70231	70836	71442	72047	72653	73258	73864	74469	75075	69
31	75075	75680	76285	76891	77496	78102	78707	79312	79918	80523	81128	68
32	81128	81734	82339	82944	83549	84155	84760	85365	85970	86576	87181	67
33	87181	87786	88391	88996	89602	90207	90812	91417	92022	92627	93232	66
34	93232	93838	94443	95048	95653	96258	96863	97468	98073	98678	99283	65
35	99283	99888	**00493**	**01098**	**01703**	**02308**	**02913**	**03518**	**04123**	**04727**	**05332**	64
36	.27 05332	05937	06542	07147	07752	08357	08962	09566	10171	10776	11381	63
37	11381	11985	12590	13195	13800	14404	15009	15614	16219	16823	17428	62
38	17428	18033	18637	19242	19847	20451	21056	21660	22265	22870	23474	61
39	23474	24079	24683	25288	25892	26497	27101	27706	28310	28915	29519	60
40	29519	30124	30728	31333	31937	32542	33146	33750	34355	34959	35563	59
41	35563	36168	36772	37376	37981	38585	39189	39794	40398	41002	41606	58
42	41606	42211	42815	43419	44023	44627	45232	45836	46440	47044	47648	57
43	47648	48252	48857	49461	50065	50669	51273	51877	52481	53085	53689	56
44	53689	54293	54897	55501	56105	56709	57313	57917	58521	59125	59729	55
45	59729	60333	60937	61541	62144	62748	63352	63956	64560	65164	65767	54
46	65767	66371	66975	67579	68183	68786	69390	69994	70598	71201	71805	53
47	71805	72409	73012	73616	74220	74823	75427	76031	76634	77238	77841	52
48	77841	78445	79049	79652	80256	80859	81463	82066	82670	83273	83877	51
49	83877	84480	85084	85687	86291	86894	87497	88101	88704	89308	89911	50
	10	9	8	7	6	5	4	3	2	1	0	

COS t20--

COS t04--

	0	1	2	3	4	5	6	7	8	9	10	
00	.96 85832	85675	85519	85363	85206	85050	84893	84737	84580	84424	84267	99
01	84267	84110	83954	83797	83640	83483	83327	83170	83013	82856	82699	98
02	82699	82542	82385	82228	82070	81913	81756	81599	81441	81284	81127	97
03	81127	80969	80812	80654	80497	80339	80182	80024	79866	79709	79551	96
04	79551	79393	79235	79077	78919	78761	78603	78445	78287	78129	77971	95
05	77971	77813	77655	77496	77338	77180	77021	76863	76704	76546	76387	94
06	76387	76229	76070	75912	75753	75594	75435	75277	75118	74959	74800	93
07	74800	74641	74482	74323	74164	74005	73846	73687	73527	73368	73209	92
08	73209	73049	72890	72731	72571	72412	72252	72093	71933	71773	71614	91
09	71614	71454	71294	71134	70975	70815	70655	70495	70335	70175	70015	90
10	70015	69855	69695	69534	69374	69214	69054	68893	68733	68573	68412	89
11	68412	68252	68091	67931	67770	67609	67449	67288	67127	66967	66806	88
12	66806	66645	66484	66323	66162	66001	65840	65679	65518	65357	65195	87
13	65195	65034	64873	64712	64550	64389	64227	64066	63904	63743	63581	86
14	63581	63420	63258	63096	62935	62773	62611	62449	62287	62125	61963	85
15	61963	61801	61639	61477	61315	61153	60991	60828	60666	60504	60342	84
16	60342	60179	60017	59854	59692	59529	59367	59204	59041	58879	58716	83
17	58716	58553	58390	58228	58065	57902	57739	57576	57413	57250	57087	82
18	57087	56923	56760	56597	56434	56270	56107	55944	55780	55617	55453	81
19	55453	55290	55126	54963	54799	54635	54472	54308	54144	53980	53816	80
20	53816	53652	53489	53325	53161	52996	52832	52668	52504	52340	52176	79
21	52176	52011	51847	51683	51518	51354	51189	51025	50860	50696	50531	78
22	50531	50366	50202	50037	49872	49707	49542	49377	49212	49048	48882	77
23	48882	48717	48552	48387	48222	48057	47892	47726	47561	47396	47230	76
24	47230	47065	46899	46734	46568	46403	46237	46071	45906	45740	45574	75
25	45574	45408	45243	45077	44911	44745	44579	44413	44247	44080	43914	74
26	43914	43748	43582	43416	43249	43083	42917	42750	42584	42417	42251	73
27	42251	42084	41917	41751	41584	41417	41251	41084	40917	40750	40583	72
28	40583	40416	40249	40082	39915	39748	39581	39414	39246	39079	38912	71
29	38912	38745	38577	38410	38242	38075	37907	37740	37572	37404	37237	70
30	37237	37069	36901	36734	36566	36398	36230	36062	35894	35726	35558	69
31	35558	35390	35222	35053	34885	34717	34549	34380	34212	34044	33875	68
32	33875	33707	33538	33370	33201	33032	32864	32695	32526	32358	32189	67
33	32189	32020	31851	31682	31513	31344	31175	31006	30837	30668	30498	66
34	30498	30329	30160	29991	29821	29652	29482	29313	29143	28974	28804	65
35	28804	28635	28465	28295	28126	27956	27786	27616	27446	27276	27106	64
36	27106	26936	26766	26596	26426	26256	26086	25916	25745	25575	25405	63
37	25405	25234	25064	24893	24723	24552	24382	24211	24041	23870	23699	62
38	23699	23528	23358	23187	23016	22845	22674	22503	22332	22161	21990	61
39	21990	21819	21648	21476	21305	21134	20962	20791	20620	20448	20277	60
40	20277	20105	19934	19762	19590	19419	19247	19075	18903	18732	18560	59
41	18560	18388	18216	18044	17872	17700	17528	17356	17184	17011	16839	58
42	16839	16667	16495	16322	16150	15977	15805	15632	15460	15287	15115	57
43	15115	14942	14769	14597	14424	14251	14078	13905	13732	13559	13386	56
44	13386	13213	13040	12867	12694	12521	12348	12174	12001	11828	11654	55
45	11654	11481	11307	11134	10960	10787	10613	10439	10266	10092	09918	54
46	09918	09745	09571	09397	09223	09049	08875	08701	08527	08353	08179	53
47	08179	08004	07830	07656	07482	07307	07133	06959	06784	06610	06435	52
48	06435	06261	06086	05911	05737	05562	05387	05212	05038	04863	04688	51
49	04688	04513	04338	04163	03988	03813	03638	03463	03287	03112	02937	50
	10	9	8	7	6	5	4	3	2	1	0	

SIN t20--

SIN t03--

	0	1	2	3	4	5	6	7	8	9	10	
50	.21 81432	82046	82659	83272	83885	84498	85111	85725	86338	86951	87564	49
51	87564	88177	88790	89403	90016	90629	91242	91855	92468	93081	93694	48
52	93694	94307	94920	95533	96146	96759	97372	97985	98598	99211	99824	47
53	99824	**00437**	**01050**	**01663**	**02276**	**02889**	**03502**	**04114**	**04727**	**05340**	**05953**	46
54	.22 05953	06566	07179	07791	08404	09017	09630	10243	10855	11468	12081	45
55	12081	12694	13306	13919	14532	15145	15757	16370	16983	17595	18208	44
56	18208	18821	19433	20046	20659	21271	21884	22496	23109	23722	24334	43
57	24334	24947	25559	26172	26784	27397	28010	28622	29235	29847	30460	42
58	30460	31072	31685	32297	32909	33522	34134	34747	35359	35972	36584	41
59	36584	37196	37809	38421	39034	39646	40258	40871	41483	42095	42708	40
60	42708	43320	43932	44545	45157	45769	46381	46994	47606	48218	48830	39
61	48830	49443	50055	50667	51279	51891	52503	53116	53728	54340	54952	38
62	54952	55564	56176	56788	57401	58013	58625	59237	59849	60461	61073	37
63	61073	61685	62297	62909	63521	64133	64745	65357	65969	66581	67193	36
64	67193	67805	68417	69029	69641	70253	70865	71477	72088	72700	73312	35
65	73312	73924	74536	75148	75760	76371	76983	77595	78207	78819	79430	34
66	79430	80042	80654	81266	81877	82489	83101	83713	84324	84936	85548	33
67	85548	86159	86771	87383	87994	88606	89218	89829	90441	91053	91664	32
68	91664	92276	92887	93499	94110	94722	95334	95945	96557	97168	97780	31
69	97780	98391	99003	99614	**00226**	**00837**	**01449**	**02060**	**02671**	**03283**	**03894**	30
70	.23 03894	04506	05117	05728	06340	06951	07563	08174	08785	09397	10008	29
71	10008	10619	11231	11842	12453	13064	13676	14287	14898	15510	16121	28
72	16121	16732	17343	17954	18566	19177	19788	20399	21010	21621	22233	27
73	22233	22844	23455	24066	24677	25288	25899	26510	27121	27733	28344	26
74	28344	28955	29566	30177	30788	31399	32010	32621	33232	33843	34454	25
75	34454	35065	35676	36286	36897	37508	38119	38730	39341	39952	40563	24
76	40563	41174	41784	42395	43006	43617	44228	44839	45449	46060	46671	23
77	46671	47282	47892	48503	49114	49725	50335	50946	51557	52168	52778	22
78	52778	53389	54000	54610	55221	55832	56442	57053	57663	58274	58885	21
79	58885	59495	60106	60716	61327	61937	62548	63158	63769	64379	64990	20
80	64990	65600	66211	66821	67432	68042	68653	69263	69874	70484	71094	19
81	71094	71705	72315	72926	73536	74146	74757	75367	75977	76588	77198	18
82	77198	77808	78419	79029	79639	80249	80860	81470	82080	82690	83301	17
83	83301	83911	84521	85131	85741	86352	86962	87572	88182	88792	89402	16
84	89402	90012	90622	91233	91843	92453	93063	93673	94283	94893	95503	15
85	95503	96113	96723	97333	97943	98553	99163	99773	**00383**	**00993**	**01603**	14
86	.24 01603	04213	02823	03432	04042	04652	05262	05872	06482	07092	07702	13
87	07702	08311	08921	09531	10141	10751	11360	11970	12580	13190	13799	12
88	13799	14409	15019	15629	16238	16848	17458	18067	18677	19287	19896	11
89	19896	20506	21116	21725	22335	22944	23554	24164	24773	25383	25992	10
90	25992	26602	27211	27821	28430	29040	29649	30259	30868	31478	32087	09
91	32087	32697	33306	33916	34525	35134	35744	36353	36963	37572	38181	08
92	38181	38791	39400	40009	40619	41228	41837	42447	43056	43665	44274	07
93	44274	44884	45493	46102	46711	47321	47930	48539	49148	49757	50367	06
94	50367	50976	51585	52194	52803	53412	54021	54630	55240	55849	56458	05
95	56458	57067	57676	58285	58894	59503	60112	60721	61330	61939	62548	04
96	62548	63157	63766	64375	64984	65593	66202	66810	67419	68028	68637	03
97	68637	69246	69855	70464	71073	71681	72290	72899	73508	74117	74725	02
98	74725	75334	75943	76552	77160	77769	78378	78987	79595	80204	80813	01
99	80813	81421	82030	82639	83247	83856	84464	85073	85682	86290	86899	00
	10	9	8	7	6	5	4	3	2	1	0	

COS t21--

	0	1	2	3	4	5	6	7	8	9	10	
50	.97 59168	59031	58893	58756	58619	58482	58345	58207	58070	57932	57795	49
51	57795	57658	57520	57383	57245	57107	56970	56832	56694	56556	56419	48
52	56419	56281	56143	56005	55867	55729	55591	55453	55315	55177	55038	47
53	55038	54900	54762	54624	54485	54347	54208	54070	53931	53793	53654	46
54	53654	53516	53377	53238	53100	52961	52822	52683	52544	52405	52266	45
55	52266	52127	51988	51849	51710	51571	51432	51292	51153	51014	50874	44
56	50874	50735	50596	50456	50317	50177	50038	49898	49758	49619	49479	43
57	49479	49339	49199	49059	48919	48780	48640	48500	48360	48219	48079	42
58	48079	47939	47799	47659	47518	47378	47238	47097	46957	46816	46676	41
59	46676	46535	46395	46254	46114	45973	45832	45691	45550	45410	45269	40
60	45269	45128	44987	44846	44705	44564	44423	44281	44140	43999	43858	39
61	43858	43716	43575	43434	43292	43151	43009	42868	42726	42584	42443	38
62	42443	42301	42159	42018	41876	41734	41592	41450	41308	41166	41024	37
63	41024	40882	40740	40598	40455	40313	40171	40029	39886	39744	39601	36
64	39601	39459	39316	39174	39031	38889	38746	38603	38461	38318	38175	35
65	38175	38032	37889	37746	37603	37460	37317	37174	37031	36888	36745	34
66	36745	36601	36458	36315	36171	36028	35885	35741	35598	35454	35311	33
67	35311	35167	35023	34880	34736	34592	34448	34304	34160	34017	33873	32
68	33873	33729	33585	33440	33296	33152	33008	32864	32719	32575	32431	31
69	32431	32286	32142	31997	31853	31708	31564	31419	31275	31130	30985	30
70	30985	30840	30696	30551	30406	30261	30116	29971	29826	29681	29536	29
71	29536	29390	29245	29100	28955	28809	28664	28519	28373	28228	28082	28
72	28082	27937	27791	27646	27500	27354	27208	27063	26917	26771	26625	27
73	26625	26479	26333	26187	26041	25895	25749	25603	25457	25310	25164	26
74	25164	25018	24871	24725	24579	24432	24286	24139	23992	23846	23699	25
75	23699	23553	23406	23259	23112	22965	22818	22672	22525	22378	22231	24
76	22231	2208	21936	21789	21642	21495	21347	21200	21053	20905	20758	23
77	20758	20611	20463	20315	20168	20020	19873	19725	19577	19429	19282	22
78	19282	19134	18986	18838	18690	18542	18394	18246	18098	17950	17801	21
79	17801	17653	17505	17357	17208	17060	16911	16763	16614	16466	16317	20
80	16317	16169	16020	15871	15723	15574	15425	15276	15127	14978	14829	19
81	14829	14680	14531	14382	14233	14084	13935	13786	13636	13487	13338	18
82	13338	13188	13039	12889	12740	12590	12441	12291	12142	11992	11842	17
83	11842	11692	11543	11393	11243	11093	10943	10793	10643	10493	10343	16
84	10343	10193	10042	09892	09742	09592	09441	09291	09141	08990	08840	15
85	08840	08689	08538	08388	08237	08087	07936	07785	07634	07483	07333	14
86	07333	07182	07031	06880	06729	06578	06426	06275	06124	05973	05822	13
87	05822	05670	05519	05368	05216	05065	04913	04762	04610	04459	04307	12
88	04307	04155	04003	03852	03700	03548	03396	03244	03092	02940	02788	11
89	02788	02636	02484	02332	02180	02028	01875	01723	01571	01418	01266	10
90	01266	01114	00961	00809	00656	00503	00351	00198	00045	**99893**	**99740**	09
91	.96 99740	99587	99434	99281	99128	98975	98822	98669	98516	98363	98210	08
92	98210	98056	97903	97750	97597	97443	97290	97136	96983	96829	96676	07
93	96676	96522	96369	96215	96061	95907	95754	95600	95446	95292	95138	06
94	95138	94984	94830	94676	94522	94368	94214	94059	93905	93751	93597	05
95	93597	93442	93288	93133	92979	92824	92670	92515	92361	92206	92051	04
96	92051	91897	91742	91587	91432	91277	91122	90967	90812	90657	90502	03
97	90502	90347	90192	90037	89881	89726	89571	89415	89260	89105	88949	02
98	88949	88794	88638	88482	88327	88171	88015	87860	87704	87548	87392	01
99	87392	87236	87080	86924	86768	86612	86456	86300	86144	85988	85832	00
	10	9	8	7	6	5	4	3	2	1	0	

SIN t03--

	0	1	2	3	4	5	6	7	8	9	10	
00	.18 73813	74430	75048	75665	76282	76899	77516	78133	78750	79368	79985	99
01	79985	80602	81219	81836	82453	83070	83687	84304	84921	85538	86155	98
02	86155	86772	87390	88007	88624	89241	89858	90475	91092	91709	92325	97
03	92325	92942	93559	94176	94793	95410	96027	96644	97261	97878	98495	96
04	98495	99112	99729	**00345**	**00962**	**01579**	**02196**	**02813**	**03430**	**04046**	**04663**	95
05	.19 04663	05280	05897	06514	07131	07747	08364	08981	09598	10214	10831	94
06	10831	11448	12065	12681	13298	13915	14531	15148	15765	16381	16998	93
07	16998	17615	18231	18848	19465	20081	20698	21315	21931	22548	23164	92
08	23164	23781	24398	25014	25631	26247	26864	27480	28097	28713	29330	91
09	29330	29946	30563	31179	31796	32412	33029	33645	34262	34878	35495	90
10	35495	36111	36728	37344	37960	38577	39193	39810	40426	41042	41659	89
11	41659	42275	42891	43508	44124	44740	45357	45973	46589	47206	47822	88
12	47822	48438	49054	49671	50287	50903	51519	52136	52752	53368	53984	87
13	53984	54601	55217	55833	56449	57065	57681	58298	58914	59530	60146	86
14	60146	60762	61378	61994	62610	63227	63843	64459	65075	65691	66307	85
15	66307	66923	67539	68155	68771	69387	70003	70619	71235	71851	72467	84
16	72467	73083	73699	74315	74931	75547	76163	76779	77395	78011	78626	83
17	78626	79242	79858	80474	81090	81706	82322	82938	83553	84169	84785	82
18	84785	85401	86017	86632	87248	87864	88480	89096	89711	90327	90943	81
19	90943	91559	92174	92790	93406	94021	94637	95253	95868	96484	97100	80
20	97100	97715	98331	98947	99562	**00178**	**00794**	**01409**	**02025**	**02640**	**03256**	79
21	.20 03256	03872	04487	05103	05718	06334	06949	07565	08180	08796	09411	78
22	09411	10027	10642	11258	11873	12489	13104	13720	14335	14951	15566	77
23	15566	16181	16797	17412	18028	18643	19258	19874	20489	21105	21720	76
24	21720	22335	22951	23566	24181	24797	25412	26027	26642	27258	27873	75
25	27873	28488	29103	29719	30334	30949	31564	32180	32795	33410	34025	74
26	34025	34640	35256	35871	36486	37101	37716	38331	38946	39562	40177	73
27	40177	40792	41407	42022	42637	43252	43867	44482	45097	45712	46327	72
28	46327	46942	47557	48172	48787	49402	50017	50632	51247	51862	52477	71
29	52477	53092	53707	54322	54937	55552	56167	56781	57396	58011	58626	70
30	58626	59241	59856	60471	61085	61700	62315	62930	63545	64160	64774	69
31	64774	65389	66004	66619	67233	67848	68463	69078	69692	70307	70922	68
32	70922	71536	72151	72766	73380	73995	74610	75224	75839	76454	77068	67
33	77068	77683	78297	78912	79527	80141	80756	81370	81985	82599	83214	66
34	83214	83829	84443	85058	85672	86287	86901	87516	88130	88744	89359	65
35	89359	89973	90588	91202	91817	92431	93045	93660	94274	94889	95503	64
36	95503	96117	96732	97346	97960	98575	99189	99803	**00418**	**01032**	**01646**	63
37	.21 01646	02261	02875	03489	04103	04718	05332	05946	06560	07175	07789	62
38	07789	08403	09017	09631	10245	10860	11474	12088	12702	13316	13930	61
39	13930	14544	15159	15773	16387	17001	17615	18229	18843	19457	20071	60
40	20071	20685	21299	21913	22527	23141	23755	24369	24983	25597	26211	59
41	26211	26825	27439	28053	28667	29281	29895	30508	31122	31736	32350	58
42	32350	32964	33578	34192	34806	35419	36033	36647	37261	37875	38488	57
43	38488	39102	39716	40330	40943	41557	42171	42785	43398	44012	44626	56
44	44626	45239	45853	46467	47081	47694	48308	48921	49535	50149	50762	55
45	50762	51376	51990	52603	53217	53830	54444	55057	55671	56285	56898	54
46	56898	57512	58125	58739	59352	59966	60579	61193	61806	62420	63033	53
47	63033	63646	64260	64873	65487	66100	66713	67327	67940	68554	69167	52
48	69167	69780	70394	71007	71620	72234	72847	73460	74074	74687	75300	51
49	75300	75913	76527	77140	77753	78366	78980	79593	80206	80819	81432	50
	10	9	8	7	6	5	4	3	2	1	0	

COS t21--

COS t03--

	0	1	2	3	4	5	6	7	8	9	10	
00	.98 22873	22755	22637	22519	22401	22283	22165	22047	21929	21811	21693	99
01	21693	21575	21457	21339	21220	21102	20984	20865	20747	20629	20510	98
02	20510	20392	20273	20154	20036	19917	19798	19680	19561	19442	19323	97
03	19323	19204	19085	18966	18847	18728	18609	18490	18371	18251	18132	96
04	18132	18013	17893	17774	17655	17535	17416	17296	17177	17057	16937	95
05	16937	16818	16698	16578	16458	16338	16219	16099	15979	15859	15739	94
06	15739	15619	15498	15378	15258	15138	15018	14897	14777	14656	14536	93
07	14536	14416	14295	14175	14054	13933	13813	13692	13571	13450	13330	92
08	13330	13209	13088	12967	12846	12725	12604	12483	12362	12241	12119	91
09	12119	11998	11877	11756	11634	11513	11391	11270	11148	11027	10905	90
10	10905	10784	10662	10540	10418	10297	10175	10053	09931	09809	09687	89
11	09687	09565	09443	09321	09199	09077	08954	08832	08710	08588	08465	88
12	08465	08343	08220	08098	07975	07853	07730	07608	07485	07362	07239	87
13	07239	07117	06994	06871	06748	06625	06502	06379	06256	06133	06010	86
14	06010	05887	05763	05640	05517	05393	05270	05147	05023	04900	04776	85
15	04776	04653	04529	04405	04282	04158	04034	03910	03787	03663	03539	84
16	03539	03415	03291	03167	03043	02919	02795	02670	02546	02422	02298	83
17	02298	02173	02049	01924	01800	01675	01551	01426	01302	01177	01052	82
18	01052	00928	00803	00678	00553	00428	00303	00179	00054	**99928**	**99803**	81
19	.97 99803	99678	99553	99428	99303	99177	99052	98927	98801	98676	98551	80
20	98551	98425	98299	98174	98048	97923	97797	97671	97545	97420	97294	79
21	97294	97168	97042	96916	96790	96664	96538	96412	96286	96159	96033	78
22	96033	95907	95781	95654	95528	95401	95275	95148	95022	94895	94769	77
23	94769	94642	94515	94389	94262	94135	94008	93881	93754	93627	93500	76
24	93500	93373	93246	93119	92992	92865	92737	92610	92483	92356	92228	75
25	92228	92101	91973	91846	91718	91591	91463	91335	91208	91080	90952	74
26	90952	90824	90696	90568	90441	90313	90185	90056	89928	89800	89672	73
27	89672	89544	89416	89287	89159	89031	88902	88774	88645	88517	88388	72
28	88388	88260	88131	88002	87874	87745	87616	87487	87358	87230	87101	71
29	87101	86972	86843	86714	86584	86455	86326	86197	86068	85938	85809	70
30	85809	85680	85550	85421	85291	85162	85032	84903	84773	84643	84514	69
31	84514	84384	84254	84124	83994	83864	83735	83605	83475	83344	83214	68
32	83214	83084	82954	82824	82694	82563	82433	82303	82172	82042	81911	67
33	81911	81781	81650	81520	81389	81258	81128	80997	80866	80735	80604	66
34	80604	80473	80342	80211	80080	79949	79818	79687	79556	79425	79293	65
35	79293	79162	79031	78899	78768	78637	78505	78374	78242	78110	77979	64
36	77979	77847	77715	77584	77452	77320	77188	77056	76924	76792	76660	63
37	76660	76528	76396	76264	76132	75999	75867	75735	75602	75470	75338	62
38	75338	75205	75073	74940	74808	74675	74542	74410	74277	74144	74011	61
39	74011	73879	73746	73613	73480	73347	73214	73081	72948	72814	72681	60
40	72681	72548	72415	72281	72148	72015	71881	71748	71614	71481	71347	59
41	71347	71214	71080	70946	70813	70679	70545	70411	70277	70143	70009	58
42	70009	69875	69741	69607	69473	69339	69205	69071	68936	68802	68668	57
43	68668	68533	68399	68264	68130	67995	67861	67726	67591	67457	67322	56
44	67322	67187	67052	66918	66783	66648	66513	66378	66243	66108	65973	55
45	65973	65837	65702	65567	65432	65296	65161	65026	64890	64755	64619	54
46	64619	64484	64348	64213	64077	63941	63806	63670	63534	63398	63262	53
47	63262	63126	62990	62854	62718	62582	62446	62310	62174	62037	61901	52
48	61901	61765	61629	61492	61356	61219	61083	60946	60810	60673	60536	51
49	60536	60400	60263	60126	59989	59852	59716	59579	59442	59305	59168	50
	10	9	8	7	6	5	4	3	2	1	0	

SIN t21--

SIN t02--

	0	1	2	3	4	5	6	7	8	9	10	
50	.15 64345	64965	65586	66206	66827	67447	68068	68689	69309	69930	70550	49
51	70550	71171	71791	72412	73032	73653	74273	74894	75514	76135	76755	48
52	76755	77376	77996	78616	79237	79857	80478	81098	81719	82339	82959	47
53	82959	83580	84200	84821	85441	86061	86682	87302	87922	88543	89163	46
54	89163	89783	90404	91024	91644	92265	92885	93505	94125	94746	95366	45
55	95366	95986	96607	97227	97847	98467	99088	99708	**00328**	**00948**	**01568**	44
56	.16 01568	02189	02809	03429	04049	04669	05290	05910	06530	07150	07770	43
57	07770	08390	09010	09631	10251	10871	11491	12111	12731	13351	13971	42
58	13971	14591	15211	15832	16452	17072	17692	18312	18932	19552	20172	41
59	20172	20792	21412	22032	22652	23272	23892	24512	25132	25752	26372	40
60	26372	26992	27612	28231	28851	29471	30091	30711	31331	31951	32571	39
61	32571	33191	33811	34430	35050	35670	36290	36910	37530	38150	38769	38
62	38769	39389	40009	40629	41249	41868	42488	43108	43728	44348	44967	37
63	44967	45587	46207	46827	47446	48066	48686	49305	49925	50545	51165	36
64	51165	51784	52404	53024	53643	54263	54883	55502	56122	56742	57361	35
65	57361	57981	58600	59220	59840	60459	61079	61698	62318	62938	63557	34
66	63557	64177	64796	65416	66035	66655	67274	67894	68513	69133	69752	33
67	69752	70372	70991	71611	72230	72850	73469	74089	74708	75328	75947	32
68	75947	76567	77186	77805	78425	79044	79664	80283	80902	81522	82141	31
69	82141	82760	83380	83999	84619	85238	85857	86477	87096	87715	88334	30
70	88334	88954	89573	90192	90812	91431	92050	92669	93289	93908	94527	29
71	94527	95146	95766	96385	97004	97623	98242	98862	99481	**00100**	**00719**	28
72	.17 00719	01338	01957	02577	03196	03815	04434	05053	05672	06291	06910	27
73	06910	07529	08149	08768	09387	10006	10625	11244	11863	12482	13101	26
74	13101	13720	14339	14958	15577	16196	16815	17434	18053	18672	19291	25
75	19291	19910	20529	21148	21767	22386	23005	23624	24242	24861	25480	24
76	25480	26099	26718	27337	27956	28575	29194	29812	30431	31050	31669	23
77	31669	32288	32907	33525	34144	34763	35382	36001	36619	37238	37857	22
78	37857	38476	39094	39713	40332	40951	41569	42188	42807	43425	44044	21
79	44044	44663	45281	45900	46519	47137	47756	48375	48993	49612	50231	20
80	50231	50849	51468	52086	52705	53324	53942	54561	55179	55798	56416	19
81	56416	57035	57654	58272	58891	59509	60128	60746	61365	61983	62602	18
82	62602	63220	63839	64457	65075	65694	66312	66931	67549	68168	68786	17
83	68786	69404	70023	70641	71260	71878	72496	73115	73733	74351	74970	16
84	74970	75588	76207	76825	77443	78061	78680	79298	79916	80535	81153	15
85	81153	81771	82389	83008	83626	84244	84862	85481	86099	86717	87335	14
86	87335	87953	88572	89190	89808	90426	91044	91662	92281	92899	93517	13
87	93517	94135	94753	95371	95989	96607	97226	97844	98462	99080	99698	12
88	99698	**00316**	**00934**	**01552**	**02170**	**02788**	**03406**	**04024**	**04642**	**05260**	**05878**	11
89	.18 05878	06496	07114	07732	08350	08968	09586	10204	10822	11440	12058	10
90	12058	12676	13293	13911	14529	15147	15765	16383	17001	17619	18236	09
91	18236	18854	19472	20090	20708	21326	21943	22561	23179	23797	24415	08
92	24415	25032	25650	26268	26886	27503	28121	28739	29356	29974	30592	07
93	30592	31210	31827	32445	33063	33680	34298	34916	35533	36151	36769	06
94	36769	37386	38004	38621	39239	39857	40474	41092	41709	42327	42944	05
95	42944	43562	44180	44797	45415	46032	46650	47267	47885	48502	49120	04
96	49120	49737	50355	50972	51590	52207	52824	53442	54059	54677	55294	03
97	55294	55912	56529	57146	57764	58381	58998	59616	60233	60851	61468	02
98	61468	62085	62703	63320	63937	64554	65172	65789	66406	67024	67641	01
99	67641	68258	68875	69493	70110	70727	71344	71962	72579	73196	73813	00
	10	9	8	7	6	5	4	3	2	1	0	

COS t22--

COS t02--

	0	1	2	3	4	5	6	7	8	9	10	
50	.98 76883	76785	76687	76588	76490	76391	76293	76194	76096	75997	75899	49
51	75899	75800	75701	75602	75504	75405	75306	75207	75108	75009	74910	48
52	74910	74811	74712	74612	74513	74414	74315	74215	74116	74017	73917	47
53	73917	73818	73718	73619	73519	73419	73320	73220	73120	73020	72921	46
54	72921	72821	72721	72621	72521	72421	72321	72221	72121	72020	71920	45
55	71920	71820	71720	71619	71519	71418	71318	71218	71117	71016	70916	44
56	70916	70815	70714	70614	70513	70412	70311	70210	70110	70009	69908	43
57	69908	69807	69705	69604	69503	69402	69301	69199	69098	68997	68895	42
58	68895	68794	68693	68591	68489	68388	68286	68185	68083	67981	67879	41
59	67879	67778	67676	67574	67472	67370	67268	67166	67064	66962	66859	40
60	66859	66757	66655	66553	66450	66348	66246	66143	66041	65938	65836	39
61	65836	65733	65630	65528	65425	65322	65219	65117	65014	64911	64808	38
62	64808	64705	64602	64499	64396	64293	64189	64086	63983	63880	63776	37
63	63776	63673	63569	63466	63363	63259	63155	63052	62948	62844	62741	36
64	62741	62637	62533	62429	62325	62222	62118	62014	61910	61805	61701	35
65	61701	61597	61493	61389	61285	61180	61076	60971	60867	60763	60658	34
66	60658	60554	60449	60344	60240	60135	60030	59925	59821	59716	59611	33
67	59611	59506	59401	59296	59191	59086	58981	58876	58770	58665	58560	32
68	58560	58454	58349	58244	58138	58033	57927	57822	57716	57610	57505	31
69	57505	57399	57293	57188	57082	56976	56870	56764	56658	56552	56446	30
70	56446	56340	56234	56128	56021	55915	55809	55702	55596	55490	55383	29
71	55383	55277	55170	55064	54957	54850	54744	54637	54530	54423	54317	28
72	54317	54210	54103	53996	53889	53782	53675	53568	53460	53353	53246	27
73	53246	53139	53031	52924	52817	52709	52602	52494	52387	52279	52172	26
74	52172	52064	51956	51848	51741	51633	51525	51417	51309	51201	51093	25
75	51093	50985	50877	50769	50661	50553	50444	50336	50228	50119	50011	24
76	50011	49903	49794	49686	49577	49468	49360	49251	49142	49034	48925	23
77	48925	48816	48707	48598	48489	48380	48271	48162	48053	47944	47835	22
78	47835	47726	47617	47507	47398	47289	47179	47070	46960	46851	46741	21
79	46741	46632	46522	46412	46302	46193	46083	45973	45863	45753	45643	20
80	45643	45533	45423	45313	45203	45093	44983	44873	44762	44652	44542	19
81	44542	44431	44321	44210	44100	43989	43879	43768	43658	43547	43436	18
82	43436	43325	43215	43104	42993	42882	42771	42660	42549	42438	42327	17
83	42327	42216	42104	41993	41882	41771	41659	41548	41436	41325	41213	16
84	41213	41102	40990	40879	40767	40655	40544	40432	40320	40208	40096	15
85	40096	39984	39872	39760	39648	39536	39424	39312	39200	39087	38975	14
86	38975	38863	38751	38638	38526	38413	38301	38188	38076	37963	37850	13
87	37850	37738	37625	37512	37399	37286	37173	37060	36947	36834	36721	12
88	36721	36608	36495	36382	36269	36156	36042	35929	35816	35702	35589	11
89	35589	35475	35362	35248	35134	35021	34907	34793	34680	34566	34452	10
90	34452	34338	34224	34110	33996	33882	33768	33654	33540	33426	33312	09
91	33312	33197	33083	32969	32854	32740	32625	32511	32396	32282	32167	08
92	32167	32053	31938	31823	31708	31594	31479	31364	31249	31134	31019	07
93	31019	30904	30789	30674	30559	30443	30328	30213	30098	29982	29867	06
94	29867	29751	29636	29520	29405	29289	29174	29058	28942	28827	28711	05
95	28711	28595	28479	28363	28247	28131	28015	27899	27783	27667	27551	04
96	27551	27435	27318	27202	27086	26969	26853	26737	26620	26504	26387	03
97	26387	26271	26154	26037	25921	25804	25687	25570	25453	25336	25219	02
98	25219	25102	24985	24868	24751	24634	24517	24400	24283	24165	24048	01
99	24048	23931	23813	23696	23578	23461	23343	23226	23108	22990	22873	00
	10	9	8	7	6	5	4	3	2	1	0	

SIN t22--

SIN t02--

	0	1	2	3	4	5	6	7	8	9	10	
00	.12 53332	53956	54579	55202	55826	56449	57072	57696	58319	58942	59566	99
01	59566	60189	60812	61436	62059	62682	63306	63929	64552	65175	65799	98
02	65799	66422	67045	67668	68292	68915	69538	70161	70785	71408	72031	97
03	72031	72654	73277	73901	74524	75147	75770	76393	77017	77640	78263	96
04	78263	78886	79509	80132	80756	81379	82002	82625	83248	83871	84494	95
05	84494	85117	85741	86364	86987	87610	88233	88856	89479	90102	90725	94
06	90725	91348	91971	92594	93217	93840	94463	95086	95710	96333	96956	93
07	96956	97579	98202	98825	99448	**00071**	**00694**	**01317**	**01939**	**02562**	**03185**	92
08	.13 03185	03808	04431	05054	05677	06300	06923	07546	08169	08792	09415	91
09	09415	10038	10661	11283	11906	12529	13152	13775	14398	15021	15644	90
10	15644	16266	16889	17512	18135	18758	19381	20003	20626	21249	21872	89
11	21872	22495	23117	23740	24363	24986	25609	26231	26854	27477	28100	88
12	28100	28722	29345	29968	30591	31213	31836	32459	33082	33704	34327	87
13	34327	34950	35572	36195	36818	37440	38063	38686	39308	39931	40554	86
14	40554	41176	41799	42422	43044	43667	44289	44912	45535	46157	46780	85
15	46780	47402	48025	48648	49270	49893	50515	51138	51760	52383	53006	84
16	53006	53628	54251	54873	55496	56118	56741	57363	57986	58608	59231	83
17	59231	59853	60476	61098	61721	62343	62966	63588	64210	64833	65455	82
18	65455	66078	66700	67323	67945	68567	69190	69812	70435	71057	71679	81
19	71679	72302	72924	73546	74169	74791	75414	76036	76658	77281	77903	80
20	77903	78525	79148	79770	80392	81014	81637	82259	82881	83504	84126	79
21	84126	84748	85370	85993	86615	87237	87859	88482	89104	89726	90348	78
22	90348	90971	91593	92215	92837	93459	94082	94704	95326	95948	96570	77
23	96570	97192	97815	98437	99059	99681	**00303**	**00925**	**01547**	**02169**	**02792**	76
24	.14 02792	03414	04036	04658	05280	05902	06524	07146	07768	08390	09012	75
25	09012	09634	10256	10878	11500	12123	12745	13367	13989	14611	15233	74
26	15233	15855	16477	17099	17720	18342	18964	19586	20208	20830	21452	73
27	21452	22074	22696	23318	23940	24562	25184	25806	26428	27049	27671	72
28	27671	28293	28915	29537	30159	30781	31403	32024	32646	33268	33890	71
29	33890	34512	35133	35755	36377	36999	37621	38242	38864	39486	40108	70
30	40108	40730	41351	41973	42595	43217	43838	44460	45082	45704	46325	69
31	46325	46947	47569	48190	48812	49434	50055	50677	51299	51920	52542	68
32	52542	53164	53785	54407	55029	55650	56272	56894	57515	58137	58758	67
33	58758	59380	60002	60623	61245	61866	62488	63109	63731	64352	64974	66
34	64974	65596	66217	66839	67460	68082	68703	69325	69946	70568	71189	65
35	71189	71811	72432	73054	73675	74296	74918	75539	76161	76782	77404	64
36	77404	78025	78646	79268	79889	80511	81132	81753	82375	82996	83618	63
37	83618	84239	84860	85482	86103	86724	87346	87967	88588	89210	89831	62
38	89831	90452	91074	91695	92316	92937	93559	94180	94801	95422	96044	61
39	96044	96665	97286	97907	98529	99150	99771	**00392**	**01014**	**01635**	**02256**	60
40	.15 02256	02877	03498	04119	04741	05362	05983	06604	07225	07846	08467	59
41	08467	09089	09710	10331	10952	11573	12194	12815	13436	14057	14678	58
42	14678	15300	15921	16542	17163	17784	18405	19026	19647	20268	20889	57
43	20889	21510	22131	22752	23373	23994	24615	25236	25857	26478	27099	56
44	27099	27720	28341	28961	29582	30203	30824	31445	32066	32687	33308	55
45	33308	33929	34550	35170	35791	36412	37033	37654	38275	38896	39516	54
46	39516	40137	40758	41379	42000	42620	43241	43862	44483	45104	45724	53
47	45724	46345	46966	47587	48207	48828	49449	50070	50690	51311	51932	52
48	51932	52552	53173	53794	54415	55035	55656	56277	56897	57518	58139	51
49	58139	58759	59380	60000	60621	61242	61862	62483	63103	63724	64345	50
	10	9	8	7	6	5	4	3	2	1	0	

COS t22--

COS t02--

	0	1	2	3	4	5	6	7	8	9	10	
00	.99 21147	21068	20989	20911	20832	20753	20674	20595	20516	20437	20358	99
01	20358	20278	20199	20120	20041	19961	19882	19803	19723	19644	19564	98
02	19564	19485	19405	19325	19246	19166	19086	19007	18927	18847	18767	97
03	18767	18687	18607	18527	18447	18367	18287	18206	18126	18046	17966	96
04	17966	17885	17805	17725	17644	17564	17483	17403	17322	17241	17161	95
05	17161	17080	16999	16918	16837	16757	16676	16595	16514	16433	16352	94
06	16352	16270	16189	16108	16027	15946	15864	15783	15702	15620	15539	93
07	15539	15457	15376	15294	15212	15131	15049	14967	14885	14804	14722	92
08	14722	14640	14558	14476	14394	14312	14230	14148	14065	13983	13901	91
09	13901	13819	13736	13654	13572	13489	13407	13324	13242	13159	13076	90
10	13076	12994	12911	12828	12745	12662	12580	12497	12414	12331	12248	89
11	12248	12165	12082	11998	11915	11832	11749	11665	11582	11499	11415	88
12	11415	11332	11248	11165	11081	10997	10914	10830	10746	10663	10579	87
13	10579	10495	10411	10327	10243	10159	10075	09991	09907	09823	09738	86
14	09738	09654	09570	09486	09401	09317	09232	09148	09063	08979	08894	85
15	08894	08810	08725	08640	08555	08471	08386	08301	08216	08131	08046	84
16	08046	07961	07876	07791	07706	07620	07535	07450	07365	07279	07194	83
17	07194	07109	07023	06938	06852	06766	06681	06595	06509	06424	06338	82
18	06338	06252	06166	06080	05994	05909	05822	05736	05650	05564	05478	81
19	05478	05392	05306	05219	05133	05047	04960	04874	04787	04701	04614	80
20	04614	04528	04441	04354	04268	04181	04094	04007	03920	03833	03747	79
21	03747	03660	03573	03485	03398	03311	03224	03137	03050	02962	02875	78
22	02875	02788	02700	02613	02525	02438	02350	02262	02175	02087	01999	77
23	01999	01912	01824	01736	01648	01560	01472	01384	01296	01208	01120	76
24	01120	01032	00944	00855	00767	00679	00590	00502	00414	00325	00237	75
25	00237	00148	00059	**99971**	**99882**	**99793**	**99705**	**99616**	**99527**	**99438**	**99349**	74
26	.98 99349	99260	99171	99082	98993	98904	98815	98726	98637	98547	98458	73
27	98458	98369	98279	98190	98101	98011	97922	97832	97742	97653	97563	72
28	97563	97473	97384	97294	97204	97114	97024	96934	96844	96754	96664	71
29	96664	96574	96484	96394	96303	96213	96123	96032	95942	95852	95761	70
30	95761	95671	95580	95490	95399	95308	95218	95127	95036	94945	94854	69
31	94854	94763	94673	94582	94491	94400	94308	94217	94126	94035	93944	68
32	93944	93852	93761	93670	93578	93487	93395	93304	93212	93121	93029	67
33	93029	92937	92846	92754	92662	92570	92478	92387	92295	92203	92111	66
34	92111	92018	91926	91834	91742	91650	91558	91465	91373	91281	91188	65
35	91188	91096	91003	90911	90818	90725	90633	90540	90447	90355	90262	64
36	90262	90169	90076	89983	89890	89797	89704	89611	89518	89425	89332	63
37	89332	89238	89145	89052	88958	88865	88772	88678	88585	88491	88397	62
38	88397	88304	88210	88116	88023	87929	87835	87741	87647	87553	87459	61
39	87459	87365	87271	87177	87083	86989	86895	86800	86706	86612	86517	60
40	86517	86423	86329	86234	86140	86045	85950	85856	85761	85666	85572	59
41	85572	85477	85382	85287	85192	85097	85002	84907	84812	84717	84622	58
42	84622	84527	84431	84336	84241	84146	84050	83955	83859	83764	83668	57
43	83668	83573	83477	83381	83286	83190	83094	82998	82902	82807	82711	56
44	82711	82615	82519	82423	82327	82230	82134	82038	81942	81846	81749	55
45	81749	81653	81556	81460	81364	81267	81170	81074	80977	80881	80784	54
46	80784	80687	80590	80493	80397	80300	80203	80106	80009	79912	79815	53
47	79815	79717	79620	79523	79426	79328	79231	79134	79036	78939	78841	52
48	78841	78744	78646	78549	78451	78353	78256	78158	78060	77962	77864	51
49	77864	77766	77668	77570	77472	77374	77276	77178	77080	76982	76883	50
	10	9	8	7	6	5	4	3	2	1	0	

SIN t22--

SIN t01--

	0	1	2	3	4	5	6	7	8	9	10	
50	.09 41083	41709	42334	42960	43585	44211	44836	45462	46087	46713	47338	49
51	47338	47964	48589	49215	49840	50466	51091	51717	52342	52968	53593	48
52	53593	54218	54844	55469	56095	56720	57346	57971	58597	59222	59847	47
53	59847	60473	61098	61724	62349	62974	63600	64225	64851	65476	66101	46
54	66101	66727	67352	67977	68603	69228	69854	70479	71104	71730	72355	45
55	72355	72980	73606	74231	74856	75482	76107	76732	77358	77983	78608	44
56	78608	79233	79859	80484	81109	81735	82360	82985	83610	84236	84861	43
57	84861	85486	86112	86737	87362	87987	88613	89238	89863	90488	91113	42
58	91113	91739	92364	92989	93614	94240	94865	95490	96115	96740	97365	41
59	97365	97991	98616	99241	99866	**00491**	**01117**	**01742**	**02367**	**02992**	**03617**	40
60	.10 03617	04242	04867	05493	06118	06743	07368	07993	08618	09243	09868	39
61	09868	10494	11119	11744	12369	12994	13619	14244	14869	15494	16119	38
62	16119	16744	17369	17994	18620	19245	19870	20495	21120	21745	22370	37
63	22370	22995	23620	24245	24870	25495	26120	26745	27370	27995	28620	36
64	28620	29245	29870	30495	31120	31745	32370	32995	33620	34245	34869	35
65	34869	35494	36119	36744	37369	37994	38619	39244	39869	40494	41119	34
66	41119	41744	42368	42993	43618	44243	44868	45493	46118	46743	47368	33
67	47368	47992	48617	49242	49867	50492	51117	51741	52366	52991	53616	32
68	53616	54241	54866	55490	56115	56740	57365	57990	58614	59239	59864	31
69	59864	60489	61114	61738	62363	62988	63613	64237	64862	65487	66112	30
70	66112	66736	67361	67986	68610	69235	69860	70485	71109	71734	72359	29
71	72359	72983	73608	74233	74857	75482	76107	76731	77356	77981	78605	28
72	78605	79230	79855	80479	81104	81729	82353	82978	83603	84227	84852	27
73	84852	85476	86101	86726	87350	87975	88599	89224	89849	90473	91098	26
74	91098	91722	92347	92971	93596	94220	94845	95470	96094	96719	97343	25
75	97343	97968	98592	99217	99841	**00466**	**01090**	**01715**	**02339**	**02964**	**03588**	24
76	.11 03588	04213	04837	05462	06086	06710	07335	07959	08584	09208	09833	23
77	09833	10457	11082	11706	12330	12955	13579	14204	14828	15452	16077	22
78	16077	16701	17326	17950	18574	19199	19823	20448	21072	21696	22321	21
79	22321	22945	23569	24194	24818	25442	26067	26691	27315	27940	28564	20
80	28564	29188	29812	30437	31061	31685	32310	32934	33558	34182	34807	19
81	34807	35431	36055	36679	37304	37928	38552	39176	39801	40425	41049	18
82	41049	41673	42297	42922	43546	44170	44794	45418	46043	46667	47291	17
83	47291	47915	48539	49163	49788	50412	51036	51660	52284	52908	53532	16
84	53532	54157	54781	55405	56029	56653	57277	57901	58525	59149	59773	15
85	59773	60398	61022	61646	62270	62894	63518	64142	64766	65390	66014	14
86	66014	66638	67262	67886	68510	69134	69758	70382	71006	71630	72254	13
87	72254	72878	73502	74126	74750	75374	75998	76622	77246	77870	78494	12
88	78494	79118	79742	80366	80989	81613	82237	82861	83485	84109	84733	11
89	84733	85357	85981	86605	87228	87852	88476	89100	89724	90348	90972	10
90	90972	91595	92219	92843	93467	94091	94715	95338	95962	96586	97210	09
91	97210	97834	98457	99081	99705	**00329**	**00953**	**01576**	**02200**	**02824**	**03448**	08
92	.12 03448	04071	04695	05319	05943	06566	07190	07814	08437	09061	09685	07
93	09685	10309	10932	11556	12180	12803	13427	14051	14674	15298	15922	06
94	15922	16545	17169	17793	18416	19040	19664	20287	20911	21534	22158	05
95	22158	22782	23405	24029	24652	25276	25900	26523	27147	27770	28394	04
96	28394	29017	29641	30264	30888	31512	32135	32759	33382	34006	34629	03
97	34629	35253	35876	36500	37123	37747	38370	38994	39617	40241	40864	02
98	40864	41488	42111	42734	43358	43981	44605	45228	45852	46475	47098	01
99	47098	47722	48345	48969	49592	50215	50839	51462	52086	52709	53332	00
	10	9	8	7	6	5	4	3	2	1	0	

COS t23--

COS t01--

	0	1	2	3	4	5	6	7	8	9	10	
50	.99 55620	55560	55501	55442	55383	55324	55264	55205	55145	55086	55026	49
51	55026	54967	54907	54848	54788	54728	54669	54609	54549	54489	54429	48
52	54429	54369	54309	54249	54189	54129	54069	54009	53949	53888	53828	47
53	53828	53768	53707	53647	53587	53526	53465	53405	53344	53284	53223	46
54	53223	53162	53102	53041	52980	52919	52858	52797	52736	52675	52614	45
55	52614	52553	52492	52431	52369	52308	52247	52185	52124	52063	52001	44
56	52001	51940	51878	51816	51755	51693	51631	51570	51508	51446	51384	43
57	51384	51322	51260	51198	51136	51074	51012	50950	50888	50826	50763	42
58	50763	50701	50639	50576	50514	50452	50389	50327	50264	50201	50139	41
59	50139	50076	50013	49951	49888	49825	49762	49699	49636	49573	49510	40
60	49510	49447	49384	49321	49258	49194	49131	49068	49004	48941	48878	39
61	48878	48814	48751	48687	48623	48560	48496	48432	48369	48305	48241	38
62	48241	48177	48113	48049	47985	47921	47857	47793	47729	47665	47601	37
63	47601	47536	47472	47408	47343	47279	47215	47150	47086	47021	46956	36
64	46956	46892	46827	46762	46698	46633	46568	46503	46438	46373	46308	35
65	46308	46243	46178	46113	46048	45983	45917	45852	45787	45721	45656	34
66	45656	45590	45525	45460	45394	45328	45263	45197	45131	45066	45000	33
67	45000	44934	44868	44802	44736	44670	44604	44538	44472	44406	44340	32
68	44340	44274	44207	44141	44075	44008	43942	43875	43809	43742	43676	31
69	43676	43609	43543	43476	43409	43342	43276	43209	43142	43075	43008	30
70	43008	42941	42874	42807	42740	42672	42605	42538	42471	42403	42336	29
71	42336	42269	42201	42134	42066	41999	41931	41863	41796	41728	41660	28
72	41660	41593	41525	41457	41389	41321	41253	41185	41117	41049	40981	27
73	40981	40912	40844	40776	40708	40639	40571	40503	40434	40366	40297	26
74	40297	40228	40160	40091	40023	39954	39885	39816	39747	39678	39610	25
75	39610	39541	39472	39403	39333	39264	39195	39126	39057	38987	38918	24
76	38918	38849	38779	38710	38640	38571	38501	38432	38362	38292	38223	23
77	38223	38153	38083	38013	37943	37874	37804	37734	37664	37594	37523	22
78	37523	37453	37383	37313	37243	37172	37102	37032	36961	36891	36820	21
79	36820	36750	36679	36609	36538	36467	36396	36326	36255	36184	36113	20
80	36113	36042	35971	35900	35829	35758	35687	35616	35545	35473	35402	19
81	35402	35331	35259	35188	35117	35045	34974	34902	34830	34759	34687	18
82	34687	34615	34544	34472	34400	34328	34256	34184	34112	34040	33968	17
83	33968	33896	33824	33752	33680	33607	33535	33463	33390	33318	33245	16
84	33245	33173	33100	33028	32955	32882	32810	32737	32664	32591	32519	15
85	32519	32446	32373	32300	32227	32154	32081	32008	31934	31861	31788	14
86	31788	31715	31641	31568	31495	31421	31348	31274	31201	31127	31053	13
87	31053	30980	30906	30832	30758	30685	30611	30537	30463	30389	30315	12
88	30315	30241	30167	30093	30018	29944	29870	29796	29721	29647	29572	11
89	29572	29498	29423	29349	29274	29200	29125	29050	28976	28901	28826	10
90	28826	28751	28676	28601	28526	28451	28376	28301	28226	28151	28076	09
91	28076	28001	27925	27850	27775	27699	27624	27548	27473	27397	27322	08
92	27322	27246	27170	27095	27019	26943	26867	26791	26715	26639	26563	07
93	26563	26487	26411	26335	26259	26183	26107	26030	25954	25878	25801	06
94	25801	25725	25649	25572	25496	25419	25342	25266	25189	25112	25036	05
95	25036	24959	24882	24805	24728	24651	24574	24497	24420	24343	24266	04
96	24266	24188	24111	24034	23957	23879	23802	23724	23647	23569	23492	03
97	23492	23414	23337	23259	23181	23104	23026	22948	22870	22792	22714	02
98	22714	22636	22558	22480	22402	22324	22246	22167	22089	22011	21933	01
99	21933	21854	21776	21697	21619	21540	21462	21383	21304	21226	21147	00
	10	9	8	7	6	5	4	3	2	1	0	

SIN t23--

SIN t01--

	0	1	2	3	4	5	6	7	8	9	10	
00	.06 27905	28532	29159	29786	30413	31041	31668	32295	32922	33549	34176	99
01	34176	34803	35430	36057	36684	37311	37938	38565	39192	39819	40446	98
02	40446	41073	41700	42327	42954	43581	44208	44835	45462	46089	46716	97
03	46716	47343	47970	48597	49224	49851	50478	51105	51732	52359	52986	96
04	52986	53613	54240	54867	55494	56121	56748	57375	58002	58629	59256	95
05	59256	59883	60510	61137	61764	62391	63018	63645	64272	64898	65525	94
06	65525	66152	66779	67406	68033	68660	69287	69914	70541	71168	71794	93
07	71794	72421	73048	73675	74302	74929	75556	76183	76810	77436	78063	92
08	78063	78690	79317	79944	80571	81198	81825	82451	83078	83705	84332	91
09	84332	84959	85586	86212	86839	87466	88093	88720	89347	89973	90600	90
10	90600	91227	91854	92481	93108	93734	94361	94988	95615	96242	96868	89
11	96868	97495	98122	98749	99375	**00002**	**00629**	**01256**	**01883**	**02509**	**03136**	88
12	.07 03136	03763	04390	05016	05643	06270	06897	07523	08150	08777	09404	87
13	09404	10030	10657	11284	11910	12537	13164	13791	14417	15044	15671	86
14	15671	16297	16924	17551	18178	18804	19431	20058	20684	21311	21938	85
15	21938	22564	23191	23818	24444	25071	25698	26324	26951	27578	28204	84
16	28204	28831	29458	30084	30711	31338	31964	32591	33217	33844	34471	83
17	34471	35097	35724	36351	36977	37604	38230	38857	39484	40110	40737	82
18	40737	41363	41990	42617	43243	43870	44496	45123	45749	46376	47003	81
19	47003	47629	48256	48882	49509	50135	50762	51388	52015	52642	53268	80
20	53268	53895	54521	55148	55774	56401	57027	57654	58280	58907	59533	79
21	59533	60160	60786	61413	62039	62666	63292	63919	64545	65172	65798	78
22	65798	66425	67051	67678	68304	68930	69557	70183	70810	71436	72063	77
23	72063	72689	73316	73942	74568	75195	75821	76448	77074	77701	78327	76
24	78327	78953	79580	80206	80833	81459	82085	82712	83338	83965	84591	75
25	84591	85217	85844	86470	87096	87723	88349	88976	89602	90228	90855	74
26	90855	91481	92107	92734	93360	93986	94613	95239	95865	96492	97118	73
27	97118	97744	98371	98997	99623	**00250**	**00876**	**01502**	**02128**	**02755**	**03381**	72
28	.08 03381	04007	04634	05260	05886	06512	07139	07765	08391	09017	09644	71
29	09644	10270	10896	11522	12149	12775	13401	14027	14654	15280	15906	70
30	15906	16532	17159	17785	18411	19037	19663	20290	20916	21542	22168	69
31	22168	22794	23421	24047	24673	25299	25925	26551	27178	27804	28430	68
32	28430	29056	29682	30308	30935	31561	32187	32813	33439	34065	34691	67
33	34691	35317	35944	36570	37196	37822	38448	39074	39700	40326	40952	66
34	40952	41579	42205	42831	43457	44083	44709	45335	45961	46587	47213	65
35	47213	47839	48465	49091	49717	50343	50970	51596	52222	52848	53474	64
36	53474	54100	54726	55352	55978	56604	57230	57856	58482	59108	59734	63
37	59734	60360	60986	61612	62238	62864	63490	64116	64742	65368	65993	62
38	65993	66619	67245	67871	68497	69123	69749	70375	71001	71627	72253	61
39	72253	72879	73505	74131	74757	75382	76008	76634	77260	77886	78512	60
40	78512	79138	79764	80390	81015	81641	82267	82893	83519	84145	84771	59
41	84771	85397	86022	86648	87274	87900	88526	89152	89777	90403	91029	58
42	91029	91655	92281	92906	93532	94158	94784	95410	96035	96661	97287	57
43	97287	97913	98539	99164	99790	**00416**	**01042**	**01667**	**02293**	**02919**	**03545**	56
44	.09 03545	04170	04796	05422	06048	06673	07299	07925	08551	09176	09802	55
45	09802	10428	11053	11679	12305	12931	13556	14182	14808	15433	16059	54
46	16059	16685	17310	17936	18562	19187	19813	20439	21064	21690	22316	53
47	22316	22941	23567	24192	24818	25444	26069	26695	27321	27946	28572	52
48	28572	29197	29823	30449	31074	31700	32325	32951	33577	34202	34828	51
49	34828	35453	36079	36704	37330	37955	38581	39207	39832	40458	41083	50
	10	9	8	7	6	5	4	3	2	1	0	

COS t23--

COS t01--

	0	1	2	3	4	5	6	7	8	9	10	
00	.99 80267	80228	80188	80149	80109	80070	80030	79990	79950	79911	79871	99
01	79871	79831	79791	79751	79711	79671	79631	79591	79551	79511	79470	98
02	79470	79430	79390	79349	79309	79269	79228	79188	79147	79107	79066	97
03	79066	79025	78985	78944	78903	78862	78821	78781	78740	78699	78658	96
04	78658	78617	78576	78534	78493	78452	78411	78370	78328	78287	78245	95
05	78245	78204	78162	78121	78079	78038	77996	77954	77913	77871	77829	94
06	77829	77787	77746	77704	77662	77620	77578	77536	77493	77451	77409	93
07	77409	77367	77325	77282	77240	77198	77155	77113	77070	77028	76985	92
08	76985	76942	76900	76857	76814	76772	76729	76686	76643	76600	76557	91
09	76557	76514	76471	76428	76385	76342	76298	76255	76212	76168	76125	90
10	76125	76082	76038	75995	75951	75908	75864	75820	75777	75733	75689	89
11	75689	75645	75602	75558	75514	75470	75426	75382	75338	75294	75249	88
12	75249	75205	75161	75117	75072	75028	74984	74939	74895	74850	74806	87
13	74806	74761	74716	74672	74627	74582	74537	74493	74448	74403	74358	86
14	74358	74313	74268	74223	74178	74133	74087	74042	73997	73952	73906	85
15	73906	73861	73815	73770	73724	73679	73633	73588	73542	73496	73451	84
16	73451	73405	73359	73313	73267	73221	73175	73129	73083	73037	72991	83
17	72991	72945	72899	72853	72806	72760	72714	72667	72621	72574	72528	82
18	72528	72481	72435	72388	72341	72295	72248	72201	72154	72107	72060	81
19	72060	72013	71966	71919	71872	71825	71778	71731	71684	71636	71589	80
20	71589	71542	71494	71447	71399	71352	71304	71257	71209	71161	71114	79
21	71114	71066	71018	70970	70923	70875	70827	70779	70731	70683	70635	78
22	70635	70586	70538	70490	70442	70393	70345	70297	70248	70200	70151	77
23	70151	70103	70054	70006	69957	69908	69860	69811	69762	69713	69664	76
24	69664	69615	69566	69517	69468	69419	69370	69321	69272	69223	69173	75
25	69173	69124	69075	69025	68976	68926	68877	68827	68778	68728	68678	74
26	68678	68629	68579	68529	68479	68429	68380	68330	68280	68230	68180	73
27	68180	68129	68079	68029	67979	67929	67878	67828	67778	67727	67677	72
28	67677	67626	67576	67525	67474	67424	67373	67322	67272	67221	67170	71
29	67170	67119	67068	67017	66966	66915	66864	66813	66762	66711	66659	70
30	66659	66608	66557	66505	66454	66402	66351	66299	66248	66196	66145	69
31	66145	66093	66041	65990	65938	65886	65834	65782	65730	65678	65626	68
32	65626	65574	65522	65470	65418	65365	65313	65261	65208	65156	65104	67
33	65104	65051	64999	64946	64894	64841	64788	64736	64683	64630	64577	66
34	64577	64524	64471	64419	64366	64313	64259	64206	64153	64100	64047	65
35	64047	63994	63940	63887	63834	63780	63727	63673	63620	63566	63513	64
36	63513	63459	63405	63352	63298	63244	63190	63136	63082	63028	62974	63
37	62974	62920	62866	62812	62758	62704	62650	62595	62541	62487	62432	62
38	62432	62378	62323	62269	62214	62160	62105	62050	61996	61941	61886	61
39	61886	61831	61776	61722	61667	61612	61557	61502	61446	61391	61336	60
40	61336	61281	61226	61170	61115	61060	61004	60949	60893	60838	60782	59
41	60782	60727	60671	60615	60559	60504	60448	60392	60336	60280	60224	58
42	60224	60168	60112	60056	60000	59944	59888	59831	59775	59719	59662	57
43	59662	59606	59550	59493	59437	59380	59323	59267	59210	59153	59097	56
44	59097	59040	58983	58926	58869	58812	58755	58698	58641	58584	58527	55
45	58527	58470	58413	58355	58298	58241	58183	58126	58068	58011	57953	54
46	57953	57896	57838	57781	57723	57665	57607	57550	57492	57434	57376	53
47	57376	57318	57260	57202	57144	57086	57027	56969	56911	56853	56794	52
48	56794	56736	56678	56619	56561	56502	56444	56385	56326	56268	56209	51
49	56209	56150	56091	56033	55974	55915	55856	55797	55738	55679	55620	50
	10	9	8	7	6	5	4	3	2	1	0	

SIN t23--

SIN t00--

	0	1	2	3	4	5	6	7	8	9	10	
50	.03 14108	14736	15364	15992	16620	17248	17876	18504	19132	19760	20388	49
51	20388	21016	21644	22272	22900	23528	24156	24784	25412	26040	26668	48
52	26668	27295	27923	28551	29179	29807	30435	31063	31691	32319	32947	47
53	32947	33575	34203	34831	35459	36087	36715	37343	37971	38599	39227	46
54	39227	39855	40483	41111	41739	42367	42995	43623	44251	44878	45506	45
55	45506	46134	46762	47390	48018	48646	49274	49902	50530	51158	51786	44
56	51786	52414	53042	53670	54297	54925	55553	56181	56809	57437	58065	43
57	58065	58693	59321	59949	60577	61205	61832	62460	63088	63716	64344	42
58	64344	64972	65600	66228	66856	67484	68111	68739	69367	69995	70623	41
59	70623	71251	71879	72507	73135	73762	74390	75018	75646	76274	76902	40
60	76902	77530	78158	78785	79413	80041	80669	81297	81925	82553	83180	39
61	83180	83808	84436	85064	85692	86320	86948	87575	88203	88831	89459	38
62	89459	90087	90715	91342	91970	92598	93226	93854	94482	95109	95737	37
63	95737	96365	96993	97621	98249	98876	99504	**00132**	**00760**	**01388**	**02015**	36
64	.04 02015	02643	03271	03899	04527	05155	05782	06410	07038	07666	08294	35
65	08294	08921	09549	10177	10805	11432	12060	12688	13316	13944	14571	34
66	14571	15199	15827	16455	17082	17710	18338	18966	19594	20221	20849	33
67	20849	21477	22105	22732	23360	23988	24616	25243	25871	26499	27127	32
68	27127	27754	28382	29010	29638	30265	30893	31521	32149	32776	33404	31
69	33404	34032	34659	35287	35915	36543	37170	37798	38426	39053	39681	30
70	39681	40309	40937	41564	42192	42820	43447	44075	44703	45331	45958	29
71	45958	46586	47214	47841	48469	49097	49724	50352	50980	51607	52235	28
72	52235	52863	53490	54118	54746	55373	56001	56629	57256	57884	58512	27
73	58512	59139	59767	60395	61022	61650	62278	62905	63533	64161	64788	26
74	64788	65416	66043	66671	67299	67926	68554	69182	69809	70437	71065	25
75	71065	71692	72320	72947	73575	74203	74830	75458	76085	76713	77341	24
76	77341	77968	78596	79223	79851	80479	81106	81734	82361	82989	83617	23
77	83617	84244	84872	85499	86127	86754	87382	88010	88637	89265	89892	22
78	89892	90520	91147	91775	92403	93030	93658	94285	94913	95540	96168	21
79	96168	96795	97423	98050	98678	99306	99933	**00561**	**01188**	**01816**	**02443**	20
80	.05 02443	03071	03698	04326	04953	05581	06208	06836	07463	08091	08718	19
81	08718	09346	09973	10601	11228	11856	12483	13111	13738	14366	14993	18
82	14993	15621	16248	16876	17503	18131	18758	19386	20013	20641	21268	17
83	21268	21895	22523	23150	23778	24405	25033	25660	26288	26915	27543	16
84	27543	28170	28797	29425	30052	30680	31307	31935	32562	33189	33817	15
85	33817	34444	35072	35699	36327	36954	37581	38209	38836	39464	40091	14
86	40091	40718	41346	41973	42601	43228	43855	44483	45110	45738	46365	13
87	46365	46992	47620	48247	48874	49502	50129	50757	51384	52011	52639	12
88	52639	53266	53893	54521	55148	55775	56403	57030	57657	58285	58912	11
89	58912	59539	60167	60794	61421	62049	62676	63303	63931	64558	65185	10
90	65185	65813	66440	67067	67695	68322	68949	69576	70204	70831	71458	09
91	71458	72086	72713	73340	73968	74595	75222	75849	76477	77104	77731	08
92	77731	78358	78986	79613	80240	80867	81495	82122	82749	83377	84004	07
93	84004	84631	85258	85885	86513	87140	87767	88394	89022	89649	90276	06
94	90276	90903	91531	92158	92785	93412	94039	94667	95294	95921	96548	05
95	96548	97175	97803	98430	99057	99684	**00311**	**00939**	**01566**	**02193**	**02820**	04
96	.06 02820	03447	04074	04702	05329	05956	06583	07210	07837	08465	09092	03
97	09092	09719	10346	10973	11600	12227	12855	13482	14109	14736	15363	02
98	15363	15990	16617	17245	17872	18499	19126	19753	20380	21007	21634	01
99	21634	22261	22888	23516	24143	24770	25397	26024	26651	27278	27905	00
	10	9	8	7	6	5	4	3	2	1	0	

COS t24--

TAN t00--

•	0	1	2	3	4	5	6	7	8	9	10	
50	.03 14263	14892	15521	16149	16778	17407	18036	18665	19294	19923	20552	49
51	20552	21181	21810	22439	23068	23697	24326	24955	25584	26213	26842	48
52	26842	27471	28100	28729	29358	29987	30616	31245	31874	32503	33132	47
53	33132	33761	34390	35019	35648	36277	36906	37535	38164	38793	39422	46
54	39422	40051	40680	41309	41938	42568	43197	43826	44455	45084	45713	45
55	45713	46342	46971	47600	48229	48858	49487	50116	50745	51375	52004	44
56	52004	52633	53262	53891	54520	55149	55778	56407	57037	57666	58295	43
57	58295	58924	59553	60182	60811	61440	62070	62699	63328	63957	64586	42
58	64586	65215	65844	66474	67103	67732	68361	68990	69619	70249	70878	41
59	70878	71507	72136	72765	73395	74024	74653	75282	75911	76541	77170	40
60	77170	77799	78428	79057	79687	80316	80945	81574	82204	82833	83462	39
61	83462	84091	84721	85350	85979	86608	87238	87867	88496	89125	89755	38
62	89755	90384	91013	91642	92272	92901	93530	94160	94789	95418	96048	37
63	96048	96677	97306	97935	98565	99194	99823	**00453**	**01082**	**01711**	**02341**	36
64	.04 02341	02970	03599	04229	04858	05487	06117	06746	07376	08005	08634	35
65	08634	09264	09893	10522	11152	11781	12411	13040	13669	14299	14928	34
66	14928	15558	16187	16816	17446	18075	18705	19334	19963	20593	21222	33
67	21222	21852	22481	23111	23740	24369	24999	25628	26258	26887	27517	32
68	27517	28146	28776	29405	30035	30664	31294	31923	32553	33182	33812	31
69	33812	34441	35071	35700	36330	36959	37589	38218	38848	39477	40107	30
70	40107	40736	41366	41995	42625	43255	43884	44514	45143	45773	46402	29
71	46402	47032	47661	48291	48921	49550	50180	50809	51439	52069	52698	28
72	52698	53328	53957	54587	55217	55846	56476	57106	57735	58365	58994	27
73	58994	59624	60254	60883	61513	62143	62772	63402	64032	64661	65291	26
74	65291	65921	66550	67180	67810	68439	69069	69699	70329	70958	71588	25
75	71588	72218	72847	73477	74107	74737	75366	75996	76626	77256	77885	24
76	77885	78515	79145	79775	80404	81034	81664	82294	82924	83553	84183	23
77	84183	84813	85443	86072	86702	87332	87962	88592	89222	89851	90481	22
78	90481	91111	91741	92371	93001	93630	94260	94890	95520	96150	96780	21
79	96780	97410	98039	98669	99299	99929	**00559**	**01189**	**01819**	**02449**	**03079**	20
80	.05 03079	03709	04338	04968	05598	06228	06858	07488	08118	08748	09378	19
81	09378	10008	10638	11268	11898	12528	13158	13788	14418	15048	15678	18
82	15678	16308	16938	17568	18198	18828	19458	20088	20718	21348	21978	17
83	21978	22608	23238	23868	24498	25128	25758	26388	27018	27648	28278	16
84	28278	28908	29538	30168	30799	31429	32059	32689	33319	33949	34579	15
85	34579	35209	35839	36469	37100	37730	38360	38990	39620	40250	40880	14
86	40880	41511	42141	42771	43401	44031	44661	45292	45922	46552	47182	13
87	47182	47812	48443	49073	49703	50333	50964	51594	52224	52854	53484	12
88	53484	54115	54745	55375	56005	56636	57266	57896	58527	59157	59787	11
89	59787	60417	61048	61678	62308	62939	63569	64199	64830	65460	66090	10
90	66090	66721	67351	67981	68612	69242	69872	70503	71133	71763	72394	09
91	72394	73024	73655	74285	74915	75546	76176	76807	77437	78067	78698	08
92	78698	79328	79959	80589	81219	81850	82480	83111	83741	84372	85002	07
93	85002	85633	86263	86894	87524	88155	88785	89416	90046	90677	91307	06
94	91307	91938	92568	93199	93829	94460	95090	95721	96351	96982	97613	05
95	97613	98243	98874	99504	**00135**	**00765**	**01396**	**02027**	**02657**	**03288**	**03918**	04
96	.06 03918	04549	05180	05810	06441	07071	07702	08333	08963	09594	10225	03
97	10225	10855	11486	12117	12747	13378	14009	14639	15270	15901	16532	02
98	16532	17162	17793	18424	19054	19685	20316	20947	21577	22208	22839	01
99	22839	23470	24100	24731	25362	25993	26623	27254	27885	28516	29147	00
	10	9	8	7	6	5	4	3	2	1	0	

COT t24--

TAN t01--

		0	1	2	3	4	5	6	7	8	9	10	
00	.06	29147	29777	30408	31039	31670	32301	32932	33562	34193	34824	35455	99
01		35455	36086	36717	37348	37978	38609	39240	39871	40502	41133	41764	98
02		41764	42395	43026	43657	44287	44918	45549	46180	46811	47442	48073	97
03		48073	48704	49335	49966	50597	51228	51859	52490	53121	53752	54383	96
04		54383	55014	55645	56276	56907	57538	58169	58800	59431	60062	60693	95
05		60693	61324	61955	62586	63218	63849	64480	65111	65742	66373	67004	94
06		67004	67635	68266	68898	69529	70160	70791	71422	72053	72684	73316	93
07		73316	73947	74578	75209	75840	76471	77103	77734	78365	78996	79628	92
08		79628	80259	80890	81521	82152	82784	83415	84046	84677	85309	85940	91
09		85940	86571	87203	87834	88465	89096	89728	90359	90990	91622	92253	90
10		92253	92884	93516	94147	94778	95410	96041	96672	97304	97935	98567	89
11		98567	99198	99829	**00461**	**01092**	**01724**	**02355**	**02986**	**03618**	**04249**	**04881**	88
12	.07	04881	05512	06144	06775	07407	08038	08669	09301	09932	10564	11195	87
13		11195	11827	12458	13090	13721	14353	14984	15616	16248	16879	17511	86
14		17511	18142	18774	19405	20037	20668	21300	21932	22563	23195	23826	85
15		23826	24458	25090	25721	26353	26985	27616	28248	28880	29511	30143	84
16		30143	30775	31406	32038	32670	33301	33933	34565	35196	35828	36460	83
17		36460	37092	37723	38355	38987	39619	40250	40882	41514	42146	42777	82
18		42777	43409	44041	44673	45305	45936	46568	47200	47832	48464	49096	81
19		49096	49727	50359	50991	51623	52255	52887	53519	54150	54782	55414	80
20		55414	56046	56678	57310	57942	58574	59206	59838	60470	61102	61734	79
21		61734	62366	62998	63630	64262	64894	65525	66158	66790	67422	68054	78
22		68054	68686	69318	69950	70582	71214	71846	72478	73110	73742	74374	77
23		74374	75006	75638	76270	76903	77535	78167	78799	79431	80063	80695	76
24		80695	81327	81960	82592	83224	83856	84488	85120	85753	86385	87017	75
25		87017	87649	88282	88914	89546	90178	90810	91443	92075	92707	93339	74
26		93339	93972	94604	95236	95869	96501	97133	97766	98398	99030	99663	73
27		99663	**00295**	**00927**	**01560**	**02192**	**02824**	**03457**	**04089**	**04721**	**05354**	**05986**	72
28	.08	05986	06619	07251	07883	08516	09148	09781	10413	11046	11678	12311	71
29		12311	12943	13575	14208	14840	15473	16105	16738	17370	18003	18636	70
30		18636	19268	19901	20533	21166	21798	22431	23063	23696	24329	24961	69
31		24961	25594	26226	26859	27492	28124	28757	29389	30022	30655	31287	68
32		31287	31920	32553	33185	33818	34451	35083	35716	36349	36982	37614	67
33		37614	38247	38880	39513	40145	40778	41411	42044	42676	43309	43942	66
34		43942	44575	45208	45840	46473	47106	47739	48372	49005	49637	50270	65
35		50270	50903	51536	52169	52802	53435	54067	54700	55333	55966	56599	64
36		56599	57232	57865	58498	59131	59764	60397	61030	61663	62296	62929	63
37		62929	63562	64195	64828	65461	66094	66727	67360	67993	68626	69259	62
38		69259	69892	70525	71158	71791	72425	73058	73691	74324	74957	75590	61
39		75590	76223	76856	77490	78123	78756	79389	80022	80655	81289	81922	60
40		81922	82555	83188	83821	84455	85088	85721	86354	86988	87621	88254	59
41		88254	88888	89521	90154	90787	91421	92054	92687	93321	93954	94587	58
42		94587	95221	95854	96487	97121	97754	98388	99021	99654	**00288**	**00921**	57
43	.09	00921	01555	02188	02821	03455	04088	04722	05355	05989	06622	07256	56
44		07256	07889	08523	09156	09790	10423	11057	11690	12324	12957	13591	55
45		13591	14225	14858	15492	16125	16759	17392	18026	18660	19293	19927	54
46		19927	20561	21194	21828	22462	23095	23729	24363	24996	25630	26264	53
47		26264	26897	27531	28165	28799	29432	30066	30700	31334	31967	32601	52
48		32601	33235	33869	34503	35136	35770	36404	37038	37672	38306	38939	51
49		38939	39573	40207	40841	41475	42109	42743	43377	44010	44644	45278	50
		10	9	8	7	6	5	4	3	2	1	0	

COT t23--

TAN t01--

•	0	1	2	3	4	5	6	7	8	9	10	
50	.09 45278	45912	46546	47180	47814	48448	49082	49716	50350	50984	51618	49
51	51618	52252	52886	53520	54154	54788	55422	56056	56690	57324	57958	48
52	57958	58593	59227	59861	60495	61129	61763	62397	63031	63666	64300	47
53	64300	64934	65568	66202	66836	67471	68105	68739	69373	70007	70642	46
54	70642	71276	71910	72544	73179	73813	74447	75082	75716	76350	76984	45
55	76984	77619	78253	78887	79522	80156	80791	81425	82059	82694	83328	44
56	83328	83962	84597	85231	85866	86500	87135	87769	88403	89038	89672	43
57	89672	90307	90941	91576	92210	92845	93479	94114	94748	95383	96017	42
58	96017	96652	97287	97921	98556	99190	99825	**00460**	**01094**	**01729**	**02363**	41
59	.10 02363	02998	03633	04267	04902	05537	06171	06806	07441	08075	08710	40
60	08710	09345	09980	10614	11249	11884	12519	13153	13788	14423	15058	39
61	15058	15692	16327	16962	17597	18232	18867	19501	20136	20771	21406	38
62	21406	22041	22676	23311	23946	24580	25215	25850	26485	27120	27755	37
63	27755	28390	29025	29660	30295	30930	31565	32200	32835	33470	34105	36
64	34105	34740	35375	36010	36645	37280	37915	38551	39186	39821	40456	35
65	40456	41091	41726	42361	42996	43632	44267	44902	45537	46172	46807	34
66	46807	47443	48078	48713	49348	49984	50619	51254	51889	52525	53160	33
67	53160	53795	54431	55066	55701	56336	56972	57607	58243	58878	59513	32
68	59513	60149	60784	61419	62055	62690	63326	63961	64596	65232	65867	31
69	65867	66503	67138	67774	68409	69045	69680	70316	70951	71587	72222	30
70	72222	72858	73493	74129	74765	75400	76036	76671	77307	77943	78578	29
71	78578	79214	79849	80485	81121	81756	82392	83028	83664	84299	84935	28
72	84935	85571	86206	86842	87478	88114	88749	89385	90021	90657	91293	27
73	91293	91928	92564	93200	93836	94472	95107	95743	96379	97015	97651	26
74	97651	98287	98923	99559	**00195**	**00831**	**01466**	**02102**	**02738**	**03374**	**04010**	25
75	.11 04010	04646	05282	05918	06554	07190	07826	08462	09098	09734	10370	24
76	10370	11007	11643	12279	12915	13551	14187	14823	15459	16095	16732	23
77	16732	17368	18004	18640	19276	19912	20549	21185	21821	22457	23094	22
78	23094	23730	24366	25002	25639	26275	26911	27548	28184	28820	29456	21
79	29456	30093	30729	31366	32002	32638	33275	33911	34547	35184	35820	20
80	35820	36457	37093	37730	38366	39002	39639	40275	40912	41548	42185	19
81	42185	42821	43458	44095	44731	45368	46004	46641	47277	47914	48551	18
82	48551	49187	49824	50460	51097	51734	52370	53007	53644	54280	54917	17
83	54917	55554	56191	56827	57464	58101	58737	59374	60011	60648	61285	16
84	61285	61921	62558	63195	63832	64469	65105	65742	66379	67016	67653	15
85	67653	68290	68927	69564	70201	70837	71474	72111	72748	73385	74022	14
86	74022	74659	75296	75933	76570	77207	77844	78481	79118	79755	80393	13
87	80393	81030	81667	82304	82941	83578	84215	84852	85489	86127	86764	12
88	86764	87401	88038	88675	89312	89950	90587	91224	91861	92499	93136	11
89	93136	93773	94410	95048	95685	96322	96960	97597	98234	98872	99509	10
90	99509	**00146**	**00784**	**01421**	**02058**	**02696**	**03333**	**03971**	**04608**	**05246**	**05883**	09
91	.12 05883	06521	07158	07795	08433	09070	09708	10345	10983	11621	12258	08
92	12258	12896	13533	14171	14808	15446	16084	16721	17359	17996	18634	07
93	18634	19272	19909	20547	21185	21822	22460	23098	23736	24373	25011	06
94	25011	25649	26287	26924	27562	28200	28838	29476	30113	30751	31389	05
95	31389	32027	32665	33303	33941	34578	35216	35854	36492	37130	37768	04
96	37768	38406	39044	39682	40320	40958	41596	42234	42872	43510	44148	03
97	44148	44786	45424	46062	46700	47338	47976	48614	49253	49891	50529	02
98	50529	51167	51805	52443	53082	53720	54358	54996	55634	56273	56911	01
99	56911	57549	58187	58826	59464	60102	60740	61379	62017	62655	63294	00
	10	9	8	7	6	5	4	3	2	1	0	

COT t23--

TAN t02--

	0	1	2	3	4	5	6	7	8	9	10	·
00	.12 63294	63932	64570	65209	65847	66486	67124	67762	68401	69039	69678	99
01	69678	70316	70955	71593	72232	72870	73509	74147	74786	75424	76063	98
02	76063	76701	77340	77978	78617	79256	79894	80533	81171	81810	82449	97
03	82449	83087	83726	84365	85003	85642	86281	86920	87558	88197	88836	96
04	88836	89475	90113	90752	91391	92030	92669	93307	93946	94585	95224	95
05	95224	95863	96502	97140	97779	98418	99057	99696	**00335**	**00974**	**01613**	94
06	.13 01613	02252	02891	03530	04169	04808	05447	06086	06725	07364	08003	93
07	08003	08642	09281	09920	10559	11199	11838	12477	13116	13755	14394	92
08	14394	15034	15673	16312	16951	17590	18230	18869	19508	20147	20787	91
09	20787	21426	22065	22704	23344	23983	24622	25262	25901	26541	27180	90
10	27180	27819	28459	29098	29738	30377	31016	31656	32295	32935	33574	89
11	33574	34214	34853	35493	36132	36772	37411	38051	38691	39330	39970	88
12	39970	40609	41249	41889	42528	43168	43808	44447	45087	45727	46366	87
13	46366	47006	47646	48285	48925	49565	50205	50845	51484	52124	52764	86
14	52764	53404	54044	54683	55323	55963	56603	57243	57883	58523	59163	85
15	59163	59803	60443	61082	61722	62362	63002	63642	64282	64922	65562	84
16	65562	66203	66843	67483	68123	68763	69403	70043	70683	71323	71963	83
17	71963	72604	73244	73884	74524	75164	75804	76445	77085	77725	78365	82
18	78365	79006	79646	80286	80926	81567	82207	82847	83488	84128	84768	81
19	84768	85409	86049	86690	87330	87970	88611	89251	89892	90532	91173	80
20	91173	91813	92454	93094	93735	94375	95016	95656	96297	96937	97578	79
21	97578	98219	98859	99500	**00141**	**00781**	**01422**	**02062**	**02703**	**03344**	**03985**	78
22	.14 03985	04625	05266	05907	06547	07188	07829	08470	09111	09751	10392	77
23	10392	11033	11674	12315	12955	13596	14237	14878	15519	16160	16801	76
24	16801	17442	18083	18724	19365	20006	20647	21288	21929	22570	23211	75
25	23211	23852	24493	25134	25775	26416	27057	27698	28339	28981	29622	74
26	29622	30263	30904	31545	32187	32828	33469	34110	34751	35393	36034	73
27	36034	36675	37317	37958	38599	39240	39882	40523	41165	41806	42447	72
28	42447	43089	43730	44372	45013	45654	46296	46937	47579	48220	48862	71
29	48862	49503	50145	50786	51428	52069	52711	53353	53994	54636	55277	70
30	55277	55919	56561	57202	57844	58486	59127	59769	60411	61053	61694	69
31	61694	62336	62978	63620	64261	64903	65545	66187	66829	67470	68112	68
32	68112	68754	69396	70038	70680	71322	71964	72606	73248	73890	74532	67
33	74532	75174	75816	76458	77100	77742	78384	79026	79668	80310	80952	66
34	80952	81594	82236	82878	83520	84163	84805	85447	86089	86731	87374	65
35	87374	88016	88658	89300	89942	90585	91227	91869	92512	93154	93796	64
36	93796	94439	95081	95723	96366	97008	97651	98293	98935	99578	**00220**	63
37	.15 00220	00863	01505	02148	02790	03433	04075	04718	05360	06003	06645	62
38	06645	07288	07931	08573	09216	09859	10501	11144	11787	12429	13072	61
39	13072	13715	14357	15000	15643	16286	16928	17571	18214	18857	19500	60
40	19500	20142	20785	21428	22071	22714	23357	24000	24643	25285	25928	59
41	25928	26571	27214	27857	28500	29143	29786	30429	31072	31715	32359	58
42	32359	33002	33645	34288	34931	35574	36217	36860	37504	38147	38790	57
43	38790	39433	40076	40720	41363	42006	42649	43293	43936	44579	45222	56
44	45222	45866	46509	47152	47796	48439	49083	49726	50369	51013	51656	55
45	51656	52300	52943	53587	54230	54874	55517	56161	56804	57448	58091	54
46	58091	58735	59379	60022	60666	61309	61953	62597	63240	63884	64528	53
47	64528	65171	65815	66459	67103	67746	68390	69034	69678	70322	70965	52
48	70965	71609	72253	72897	73541	74185	74829	75472	76116	76760	77404	51
49	77404	78048	78692	79336	79980	80624	81268	81912	82556	83200	83844	50
	10	9	8	7	6	5	4	3	2	1	0	

COT t22--

'	0	1	2	3	4	5	6	7	8	9	10	
50	.15 83844	84488	85133	85777	86421	87065	87709	88353	88997	89642	90286	49
51	90286	90930	91574	92219	92863	93507	94151	94796	95440	96084	96729	48
52	96729	97373	98017	98662	99306	99950	**00595**	**01239**	**01884**	**02528**	**03173**	47
53	.16 03173	03817	04462	05106	05751	06395	07040	07684	08329	08973	09618	46
54	09618	10263	10907	11552	12196	12841	13486	14130	14775	15420	16065	45
55	16065	16709	17354	17999	18644	19288	19933	20578	21223	21868	22512	44
56	22512	23157	23802	24447	25092	25737	26382	27027	27672	28317	28962	43
57	28962	29607	30252	30897	31542	32187	32832	33477	34122	34767	35412	42
58	35412	36057	36703	37348	37993	38638	39283	39929	40574	41219	41864	41
59	41864	42509	43155	43800	44445	45091	45736	46381	47027	47672	48317	40
60	48317	48963	49608	50254	50899	51545	52190	52835	53481	54126	54772	39
61	54772	55418	56063	56709	57354	58000	58645	59291	59937	60582	61228	38
62	61228	61874	62519	63165	63811	64456	65102	65748	66394	67039	67685	37
63	67685	68331	68977	69623	70268	70914	71560	72206	72852	73498	74144	36
64	74144	74790	75436	76082	76728	77374	78020	78666	79312	79958	80604	35
65	80604	81250	81896	82542	83188	83834	84480	85127	85773	86419	87065	34
66	87065	87711	88358	89004	89650	90296	90943	91589	92235	92881	93528	33
67	93528	94174	94820	95467	96113	96760	97406	98052	98699	99345	99992	32
68	99992	**00638**	**01285**	**01931**	**02578**	**03224**	**03871**	**04518**	**05164**	**05811**	**06457**	31
69	.17 06457	07104	07751	08397	09044	09691	10337	10984	11631	12277	12924	30
70	12924	13571	14218	14864	15511	16158	16805	17452	18099	18746	19392	29
71	19392	20039	20686	21333	21980	22627	23274	23921	24568	25215	25862	28
72	25862	26509	27156	27803	28450	29097	29744	30392	31039	31686	32333	27
73	32333	32980	33627	34275	34922	35569	36216	36864	37511	38158	38806	26
74	38806	39453	40100	40748	41395	42042	42690	43337	43985	44632	45279	25
75	45279	45927	46574	47222	47869	48517	49164	49812	50460	51107	51755	24
76	51755	52402	53050	53698	54345	54993	55641	56288	56936	57584	58231	23
77	58231	58879	59527	60175	60822	61470	62118	62766	63414	64062	64710	22
78	64710	65357	66005	66653	67301	67949	68597	69245	69893	70541	71189	21
79	71189	71837	72485	73133	73781	74429	75078	75726	76374	77022	77670	20
80	77670	78318	78966	79615	80263	80911	81559	82208	82856	83504	84153	19
81	84153	84801	85449	86098	86746	87394	88043	88691	89340	89988	90636	18
82	90636	91285	91933	92582	93230	93879	94528	95176	95825	96473	97122	17
83	97122	97770	98419	99068	99716	**00365**	**01014**	**01663**	**02311**	**02960**	**03609**	16
84	.18 03609	04257	04906	05555	06204	06853	07502	08150	08799	09448	10097	15
85	10097	10746	11395	12044	12693	13342	13991	14640	15289	15938	16587	14
86	16587	17236	17885	18534	19183	19832	20481	21131	21780	22429	23078	13
87	23078	23727	24377	25026	25675	26324	26974	27623	28272	28922	29571	12
88	29571	30220	30870	31519	32168	32818	33467	34117	34766	35416	36065	11
89	36065	36715	37364	38014	38663	39313	39962	40612	41262	41911	42561	10
90	42561	43211	43860	44510	45160	45809	46459	47109	47759	48408	49058	09
91	49058	49708	50358	51008	51657	52307	52957	53607	54257	54907	55557	08
92	55557	56207	56857	57507	58157	58807	59457	60107	60757	61407	62057	07
93	62057	62707	63357	64008	64658	65308	65958	66608	67258	67909	68559	06
94	68559	69209	69859	70510	71160	71810	72461	73111	73761	74412	75062	05
95	75062	75713	76363	77014	77664	78315	78965	79616	80266	80917	81567	04
96	81567	82218	82868	83519	84170	84820	85471	86121	86772	87423	88074	03
97	88074	88724	89375	90026	90677	91327	91978	92629	93280	93931	94581	02
98	94581	95232	95883	96534	97185	97836	98487	99138	99789	**00440**	**01091**	01
99	.19 01091	01742	02393	03044	03695	04346	04997	05649	06300	06951	07602	00
	10	9	8	7	6	5	4	3	2	1	0	

TAN t03--

	0	1	2	3	4	5	6	7	8	9	10	
00	.19 07602	08253	08904	09556	10207	10858	11509	12161	12812	13463	14115	99
01	14115	14766	15417	16069	16720	17372	18023	18674	19326	19977	20629	98
02	20629	21280	21932	22583	23235	23886	24538	25190	25841	26493	27145	97
03	27145	27796	28448	29100	29751	30403	31055	31707	32358	33010	33662	96
04	33662	34314	34966	35617	36269	36921	37573	38225	38877	39529	40181	95
05	40181	40833	41485	42137	42789	43441	44093	44745	45397	46049	46701	94
06	46701	47353	48006	48658	49310	49962	50614	51267	51919	52571	53223	93
07	53223	53876	54528	55180	55833	56485	57137	57790	58442	59095	59747	92
08	59747	60400	61052	61704	62357	63010	63662	64315	64967	65620	66272	91
09	66272	66925	67578	68230	68883	69536	70188	70841	71494	72147	72799	90
10	72799	73452	74105	74758	75411	76063	76716	77369	78022	78675	79328	89
11	79328	79981	80634	81287	81940	82593	83246	83899	84552	85205	85858	88
12	85858	86511	87164	87817	88471	89124	89777	90430	91083	91737	92390	87
13	92390	93043	93696	94350	95003	95656	96310	96963	97616	98270	98923	86
14	98923	99577	**00230**	**00884**	**01537**	**02191**	**02844**	**03498**	**04151**	**04805**	**05458**	85
15	.20 05458	06112	06765	07419	08073	08726	09380	10034	10687	11341	11995	84
16	11995	12649	13303	13956	14610	15264	15918	16572	17226	17879	18533	83
17	18533	19187	19841	20495	21149	21803	22457	23111	23765	24419	25073	82
18	25073	25727	26382	27036	27690	28344	28998	29652	30307	30961	31615	81
19	31615	32269	32924	33578	34232	34887	35541	36195	36850	37504	38158	80
20	38158	38813	39467	40122	40776	41431	42085	42740	43394	44049	44703	79
21	44703	45358	46013	46667	47322	47977	48631	49286	49941	50595	51250	78
22	51250	51905	52560	53214	53869	54524	55179	55834	56489	57144	57799	77
23	57799	58453	59108	59763	60418	61073	61728	62383	63038	63694	64349	76
24	64349	65004	65659	66314	66969	67624	68280	68935	69590	70245	70900	75
25	70900	71556	72211	72866	73522	74177	74832	75488	76143	76799	77454	74
26	77454	78109	78765	79420	80076	80731	81387	82042	82698	83354	84009	73
27	84009	84665	85320	85976	86632	87287	87943	88599	89255	89910	90566	72
28	90566	91222	91878	92534	93189	93845	94501	95157	95813	96469	97125	71
29	97125	97781	98437	99093	99749	**00405**	**01061**	**01717**	**02373**	**03029**	**03685**	70
30	.21 03685	04341	04997	05654	06310	06966	07622	08278	08935	09591	10247	69
31	10247	10904	11560	12216	12873	13529	14185	14842	15498	16155	16811	68
32	16811	17468	18124	18781	19437	20094	20750	21407	22063	22720	23377	67
33	23377	24033	24690	25347	26003	26660	27317	27974	28630	29287	29944	66
34	29944	30601	31258	31915	32571	33228	33885	34542	35199	35856	36513	65
35	36513	37170	37827	38484	39141	39798	40455	41113	41770	42427	43084	64
36	43084	43741	44398	45056	45713	46370	47027	47685	48342	48999	49657	63
37	49657	50314	50971	51629	52286	52944	53601	54259	54916	55574	56231	62
38	56231	56889	57546	58204	58861	59519	60177	60834	61492	62150	62807	61
39	62807	63465	64123	64781	65438	66096	66754	67412	68070	68727	69385	60
40	69385	70043	70701	71359	72017	72675	73333	73991	74649	75307	75965	59
41	75965	76623	77281	77939	78597	79256	79914	80572	81230	81888	82547	58
42	82547	83205	83863	84521	85180	85838	86496	87155	87813	88472	89130	57
43	89130	89788	90447	91105	91764	92422	93081	93740	94398	95057	95715	56
44	95715	96374	97033	97691	98350	99009	99667	**00326**	**00985**	**01643**	**02302**	55
45	.22 02302	02961	03620	04279	04938	05596	06255	06914	07573	08232	08891	54
46	08891	09550	10209	10868	11527	12186	12845	13504	14164	14823	15482	53
47	15482	16141	16800	17459	18119	18778	19437	20096	20756	21415	22074	52
48	22074	22734	23393	24052	24712	25371	26031	26690	27350	28009	28669	51
49	28669	29328	29988	30647	31307	31967	32626	33286	33945	34605	35265	50
	10	9	8	7	6	5	4	3	2	1	0	

COT t21--

TAN t03--

	0	1	2	3	4	5	6	7	8	9	10	
50	.22 35265	35925	36584	37244	37904	38564	39223	39883	40543	41203	41863	49
51	41863	42523	43183	43843	44503	45163	45823	46483	47143	47803	48463	48
52	48463	49123	49783	50443	51103	51763	52424	53084	53744	54404	55065	47
53	55065	55725	56385	57045	57706	58366	59027	59687	60347	61008	61668	46
54	61668	62329	62989	63650	64310	64971	65631	66292	66952	67613	68274	45
55	68274	68934	69595	70256	70916	71577	72238	72899	73559	74220	74881	44
56	74881	75542	76203	76864	77525	78186	78846	79507	80168	80829	81490	43
57	81490	82151	82812	83474	84135	84796	85457	86118	86779	87440	88102	42
58	88102	88763	89424	90085	90747	91408	92069	92731	93392	94053	94715	41
59	94715	95376	96038	96699	97360	98022	98683	99345	**00007**	**00668**	**01330**	40
60	.23 01330	01991	02653	03315	03976	04638	05300	05961	06623	07285	07947	39
61	07947	08608	09270	09932	10594	11256	11918	12580	13241	13903	14565	38
62	14565	15227	15889	16551	17213	17876	18538	19200	19862	20524	21186	37
63	21186	21848	22511	23173	23835	24497	25160	25822	26484	27146	27809	36
64	27809	28471	29134	29796	30458	31121	31783	32446	33108	33771	34433	35
65	34433	35096	35759	36421	37084	37747	38409	39072	39735	40397	41060	34
66	41060	41723	42386	43048	43711	44374	45037	45700	46363	47026	47689	33
67	47689	48352	49014	49677	50341	51004	51667	52330	52993	53656	54319	32
68	54319	54982	55645	56309	56972	57635	58298	58962	59625	60288	60951	31
69	60951	61615	62278	62942	63605	64268	64932	65595	66259	66922	67586	30
70	67586	68249	68913	69577	70240	70904	71567	72231	72895	73559	74222	29
71	74222	74886	75550	76214	76877	77541	78205	78869	79533	80197	80861	28
72	80861	81525	82188	82852	83516	84181	84845	85509	86173	86837	87501	27
73	87501	88165	88829	89493	90158	90822	91486	92150	92815	93479	94143	26
74	94143	94808	95472	96136	96801	97465	98130	98794	99459	**00123**	**00788**	25
75	.24 00788	01452	02117	02781	03446	04111	04775	05440	06105	06769	07434	24
76	07434	08099	08763	09428	10093	10758	11423	12088	12752	13417	14082	23
77	14082	14747	15412	16077	16742	17407	18072	18737	19402	20068	20733	22
78	20733	21398	22063	22728	23393	24059	24724	25389	26054	26720	27385	21
79	27385	28050	28716	29381	30047	30712	31377	32043	32708	33374	34039	20
80	34039	34705	35371	36036	36702	37367	38033	38699	39364	40030	40696	19
81	40696	41362	42027	42693	43359	44025	44691	45357	46023	46688	47354	18
82	47354	48020	48686	49352	50018	50684	51350	52017	52683	53349	54015	17
83	54015	54681	55347	56014	56680	57346	58012	58679	59345	60011	60678	16
84	60678	61344	62010	62677	63343	64010	64676	65343	66009	66676	67342	15
85	67342	68009	68675	69342	70009	70675	71342	72009	72675	73342	74009	14
86	74009	74676	75343	76009	76676	77343	78010	78677	79344	80011	80678	13
87	80678	81345	82012	82679	83346	84013	84680	85347	86014	86681	87349	12
88	87349	88016	88683	89350	90018	90685	91352	92019	92687	93354	94022	11
89	94022	94689	95356	96024	96691	97359	98026	98694	99361	**00029**	**00697**	10
90	.25 00697	01364	02032	02700	03367	04035	04703	05370	06038	06706	07374	09
91	07374	08042	08709	09377	10045	10713	11381	12049	12717	13385	14053	08
92	14053	14721	15389	16057	16725	17393	18062	18730	19398	20066	20734	07
93	20734	21403	22071	22739	23408	24076	24744	25413	26081	26749	27418	06
94	27418	28086	28755	29423	30092	30760	31429	32098	32766	33435	34103	05
95	34103	34772	35441	36110	36778	37447	38116	38785	39454	40122	40791	04
96	40791	41460	42129	42798	43467	44136	44805	45474	46143	46812	47481	03
97	47481	48150	48819	49488	50158	50827	51496	52165	52835	53504	54173	02
98	54173	54842	55512	56181	56851	57520	58189	58859	59528	60198	60867	01
99	60867	61537	62206	62876	63546	64215	64885	65554	66224	66894	67564	00
	10	9	8	7	6	5	4	3	2	1	0	

COT t21--

TAN t04--

		0	1	2	3	4	5	6	7	8	9	10	
00	.25	67564	68233	68903	69573	70243	70913	71582	72252	72922	73592	74262	99
01		74262	74932	75602	76272	76942	77612	78282	78952	79622	80293	80963	98
02		80963	81633	82303	82973	83644	84314	84984	85654	86325	86995	87666	97
03		87666	88336	89006	89677	90347	91018	91688	92359	93029	93700	94371	96
04		94371	95041	95712	96382	97053	97724	98395	99065	99736	**00407**	**01078**	95
05	.26	01078	01749	02419	03090	03761	04432	05103	05774	06445	07116	07787	94
06		07787	08458	09129	09800	10471	11143	11814	12485	13156	13827	14499	93
07		14499	15170	15841	16513	17184	17855	18527	19198	19870	20541	21212	92
08		21212	21884	22555	23227	23899	24570	25242	25913	26585	27257	27928	91
09		27928	28600	29272	29944	30615	31287	31959	32631	33303	33975	34647	90
10		34647	35319	35991	36663	37335	38007	38679	39351	40023	40695	41367	89
11		41367	42039	42711	43384	44056	44728	45400	46073	46745	47417	48090	88
12		48090	48762	49435	50107	50779	51452	52124	52797	53470	54142	54815	87
13		54815	55487	56160	56833	57505	58178	58851	59523	60196	60869	61542	86
14		61542	62215	62888	63560	64233	64906	65579	66252	66925	67598	68271	85
15		68271	68944	69617	70290	70964	71637	72310	72983	73656	74330	75003	84
16		75003	75676	76349	77023	77696	78370	79043	79716	80390	81063	81737	83
17		81737	82410	83084	83757	84431	85105	85778	86452	87126	87799	88473	82
18		88473	89147	89821	90494	91168	91842	92516	93190	93864	94538	95211	81
19		95211	95885	96559	97233	97907	98582	99256	99930	**00604**	**01278**	**01952**	80
20	.27	01952	02626	03301	03975	04649	05323	05998	06672	07346	08021	08695	79
21		08695	09370	10044	10719	11393	12068	12742	13417	14091	14766	15441	78
22		15441	16115	16790	17465	18139	18814	19489	20164	20839	21513	22188	77
23		22188	22863	23538	24213	24888	25563	26238	26913	27588	28263	28938	76
24		28938	29613	30288	30964	31639	32314	32989	33665	34340	35015	35690	75
25		35690	36366	37041	37717	38392	39067	39743	40418	41094	41769	42445	74
26		42445	43121	43796	44472	45147	45823	46499	47175	47850	48526	49202	73
27		49202	49878	50554	51229	51905	52581	53257	53933	54609	55285	55961	72
28		55961	56637	57313	57989	58666	59342	60018	60694	61370	62046	62723	71
29		62723	63399	64075	64752	65428	66104	66781	67457	68134	68810	69487	70
30		69487	70163	70840	71516	72193	72870	73546	74223	74900	75576	76253	69
31		76253	76930	77607	78283	78960	79637	80314	80991	81668	82345	83022	68
32		83022	83699	84376	85053	85730	86407	87084	87761	88438	89115	89793	67
33		89793	90470	91147	91824	92502	93179	93856	94534	95211	95889	96566	66
34		96566	97243	97921	98599	99276	99954	**00631**	**01309**	**01986**	**02664**	**03342**	65
35	.28	03342	04020	04697	05375	06053	06731	07408	08086	08764	09442	10120	64
36		10120	10798	11476	12154	12832	13510	14188	14866	15544	16222	16901	63
37		16901	17579	18257	18935	19613	20292	20970	21648	22327	23005	23683	62
38		23683	24362	25040	25719	26397	27076	27754	28433	29112	29790	30469	61
39		30469	31147	31826	32505	33184	33862	34541	35220	35899	36578	37257	60
40		37257	37936	38614	39293	39972	40651	41330	42009	42689	43368	44047	59
41		44047	44726	45405	46084	46764	47443	48122	48801	49481	50160	50839	58
42		50839	51519	52198	52878	53557	54237	54916	55596	56275	56955	57634	57
43		57634	58314	58994	59673	60353	61033	61713	62392	63072	63752	64432	56
44		64432	65112	65792	66472	67152	67832	68512	69192	69872	70552	71232	55
45		71232	71912	72592	73272	73953	74633	75313	75993	76674	77354	78034	54
46		78034	78715	79395	80076	80756	81436	82117	82797	83478	84159	84839	53
47		84839	85520	86200	86881	87562	88243	88923	89604	90285	90966	91646	52
48		91646	92327	93008	93689	94370	95051	95732	96413	97094	97775	98456	51
49		98456	99137	99819	**00500**	**01181**	**01862**	**02543**	**03225**	**03906**	**04587**	**05269**	50
		10	9	8	7	6	5	4	3	2	1	0	

COT t20--

TAN t04--

•	0	1	2	3	4	5	6	7	8	9	10	
50	.29 05269	05950	06631	07313	07994	08676	09357	10039	10720	11402	12083	49
51	12083	12765	13447	14128	14810	15492	16173	16855	17537	18219	18901	48
52	18901	19582	20264	20946	21628	22310	22992	23674	24356	25038	25720	47
53	25720	26402	27085	27767	28449	29131	29813	30496	31178	31860	32543	46
54	32543	33225	33907	34590	35272	35955	36637	37320	38002	38685	39367	45
55	39367	40050	40733	41415	42098	42781	43463	44146	44829	45512	46195	44
56	46195	46878	47560	48243	48926	49609	50292	50975	51658	52341	53025	43
57	53025	53708	54391	55074	55757	56440	57124	57807	58490	59174	59857	42
58	59857	60540	61224	61907	62591	63274	63958	64641	65325	66008	66692	41
59	66692	67375	68059	68743	69427	70110	70794	71478	72162	72845	73529	40
60	73529	74213	74897	75581	76265	76949	77633	78317	79001	79685	80369	39
61	80369	81053	81738	82422	83106	83790	84475	85159	85843	86528	87212	38
62	87212	87896	88581	89265	89950	90634	91319	92003	92688	93372	94057	37
63	94057	94742	95426	96111	96796	97481	98165	98850	99535	**00220**	**00905**	36
64	.30 00905	01590	02275	02960	03645	04330	05015	05700	06385	07070	07755	35
65	07755	08440	09125	09811	10496	11181	11866	12552	13237	13923	14608	34
66	14608	15293	15979	16664	17350	18035	18721	19407	20092	20778	21463	33
67	21463	22149	22835	23521	24206	24892	25578	26264	26950	27636	28322	32
68	28322	29008	29693	30379	31066	31752	32438	33124	33810	34496	35182	31
69	35182	35868	36555	37241	37927	38614	39300	39986	40673	41359	42046	30
70	42046	42732	43419	44105	44792	45478	46165	46851	47538	48225	48912	29
71	48912	49598	50285	50972	51659	52345	53032	53719	54406	55093	55780	28
72	55780	56467	57154	57841	58528	59215	59903	60590	61277	61964	62651	27
73	62651	63339	64026	64713	65401	66088	66775	67463	68150	68838	69525	26
74	69525	70213	70900	71588	72275	72963	73651	74338	75026	75714	76402	25
75	76402	77089	77777	78465	79153	79841	80529	81217	81905	82593	83281	24
76	83281	83969	84657	85345	86033	86721	87410	88098	88786	89474	90163	23
77	90163	90851	91539	92228	92916	93605	94293	94982	95670	96359	97047	22
78	97047	97736	98424	99113	99802	**00490**	**01179**	**01868**	**02557**	**03246**	**03934**	21
79	.31 03934	04623	05312	06001	06690	07379	08068	08757	09446	10135	10824	20
80	10824	11513	12203	12892	13581	14270	14960	15649	16338	17027	17717	19
81	17717	18406	19096	19785	20475	21164	21854	22543	23233	23922	24612	18
82	24612	25302	25992	26681	27371	28061	28751	29440	30130	30820	31510	17
83	31510	32200	32890	33580	34270	34960	35650	36340	37030	37721	38411	16
84	38411	39101	39791	40482	41172	41862	42553	43243	43933	44624	45314	15
85	45314	46005	46695	47386	48076	48767	49458	50148	50839	51530	52220	14
86	52220	52911	53602	54293	54984	55674	56365	57056	57747	58438	59129	13
87	59129	59820	60511	61202	61894	62585	63276	63967	64658	65350	66041	12
88	66041	66732	67424	68115	68806	69498	70189	70881	71572	72264	72955	11
89	72955	73647	74338	75030	75722	76413	77105	77797	78489	79181	79872	10
90	79872	80564	81256	81948	82640	83332	84024	84716	85408	86100	86792	09
91	86792	87484	88177	88869	89561	90253	90946	91638	92330	93023	93715	08
92	93715	94407	95100	95792	96485	97177	97870	98562	99255	99948	**00640**	07
93	.32 00640	01333	02026	02719	03411	04104	04797	05490	06183	06876	07569	06
94	07569	08262	08955	09648	10341	11034	11727	12420	13113	13806	14500	05
95	14500	15193	15886	16580	17273	17966	18660	19353	20047	20740	21434	04
96	21434	22127	22821	23514	24208	24901	25595	26289	26983	27676	28370	03
97	28370	29064	29758	30452	31146	31840	32533	33227	33921	34616	35310	02
98	35310	36004	36698	37392	38086	38780	39475	40169	40863	41558	42252	01
99	42252	42946	43641	44335	45030	45724	46419	47113	47808	48502	49197	00
	10	9	8	7	6	5	4	3	2	1	0	

COT t20--

	0	1	2	3	4	5	6	7	8	9	10	•
00	.32 49197	49892	50586	51281	51976	52671	53365	54060	54755	55450	56145	99
01	56145	56840	57535	58230	58925	59620	60315	61010	61705	62400	63096	98
02	63096	63791	64486	65181	65877	66572	67268	67963	68658	69354	70049	97
03	70049	70745	71440	72136	72832	73527	74223	74919	75614	76310	77006	96
04	77006	77702	78397	79093	79789	80485	81181	81877	82573	83269	83965	95
05	83965	84661	85357	86054	86750	87446	88142	88838	89535	90231	90927	94
06	90927	91624	92320	93017	93713	94410	95106	95803	96499	97196	97892	93
07	97892	98589	99286	99983	**00679**	**01376**	**02073**	**02770**	**03467**	**04164**	**04860**	92
08	.33 04860	05557	06254	06951	07649	08346	09043	09740	10437	11134	11831	91
09	11831	12529	13226	13923	14621	15318	16015	16713	17410	18108	18805	90
10	18805	19503	20200	20898	21596	22293	22991	23689	24386	25084	25782	89
11	25782	26480	27178	27875	28573	29271	29969	30667	31365	32063	32761	88
12	32761	33460	34158	34856	35554	36252	36951	37649	38347	39046	39744	87
13	39744	40442	41141	41839	42538	43236	43935	44634	45332	46031	46730	86
14	46730	47428	48127	48826	49525	50223	50922	51621	52320	53019	53718	85
15	53718	54417	55116	55815	56514	57213	57912	58612	59311	60010	60709	84
16	60709	61409	62108	62807	63507	64206	64906	65605	66304	67004	67704	83
17	67704	68403	69103	69802	70502	71202	71902	72601	73301	74001	74701	82
18	74701	75401	76101	76801	77501	78201	78901	79601	80301	81001	81701	81
19	81701	82401	83101	83802	84502	85202	85903	86603	87303	88004	88704	80
20	88704	89405	90105	90806	91506	92207	92908	93608	94309	95010	95710	79
21	95710	96411	97112	97813	98514	99215	99916	**00617**	**01318**	**02019**	**02720**	78
22	.34 02720	03421	04122	04823	05524	06225	06927	07628	08329	09031	09732	77
23	09732	10433	11135	11836	12538	13239	13941	14642	15344	16045	16747	76
24	16747	17449	18150	18852	19554	20256	20958	21659	22361	23063	23765	75
25	23765	24467	25169	25871	26573	27275	27978	28680	29382	30084	30786	74
26	30786	31489	32191	32893	33596	34298	35001	35703	36406	37108	37811	73
27	37811	38513	39216	39919	40621	41324	42027	42730	43432	44135	44838	72
28	44838	45541	46244	46947	47650	48353	49056	49759	50462	51165	51868	71
29	51868	52572	53275	53978	54681	55385	56088	56791	57495	58198	58902	70
30	58902	59605	60309	61012	61716	62420	63123	63827	64531	65234	65938	69
31	65938	66642	67346	68050	68754	69458	70161	70865	71570	72274	72978	68
32	72978	73682	74386	75090	75794	76499	77203	77907	78611	79316	80020	67
33	80020	80725	81429	82134	82838	83543	84247	84952	85657	86361	87066	66
34	87066	87771	88475	89180	89885	90590	91295	92000	92705	93410	94115	65
35	94115	94820	95525	96230	96935	97640	98345	99051	99756	**00461**	**01166**	64
36	.35 01166	01872	02577	03283	03988	04694	05399	06105	06810	07516	08221	63
37	08221	08927	09633	10338	11044	11750	12456	13162	13868	14574	15279	62
38	15279	15985	16691	17397	18104	18810	19516	20222	20928	21634	22341	61
39	22341	23047	23753	24460	25166	25872	26579	27285	27992	28698	29405	60
40	29405	30112	30818	31525	32232	32938	33645	34352	35059	35765	36472	59
41	36472	37179	37886	38593	39300	40007	40714	41421	42129	42836	43543	58
42	43543	44250	44957	45665	46372	47079	47787	48494	49202	49909	50617	57
43	50617	51324	52032	52739	53447	54155	54862	55570	56278	56986	57694	56
44	57694	58401	59109	59817	60525	61233	61941	62649	63357	64065	64774	55
45	64774	65482	66190	66898	67606	68315	69023	69731	70440	71148	71857	54
46	71857	72565	73274	73982	74691	75400	76108	76817	77526	78234	78943	53
47	78943	79652	80361	81070	81779	82488	83197	83906	84615	85324	86033	52
48	86033	86742	87451	88160	88869	89579	90288	90997	91707	92416	93126	51
49	93126	93835	94544	95254	95964	96673	97383	98092	98802	99512	**00222**	50
–	10	9	8	7	6	5	4	3	2	1	0	

TAN t05--

·	0	1	2	3	4	5	6	7	8	9	10	
50	.36 00222	00931	01641	02351	03061	03771	04481	05191	05901	06611	07321	49
51	07321	08031	08741	09451	10161	10872	11582	12292	13002	13713	14423	48
52	14423	15134	15844	16554	17265	17976	18686	19397	20107	20818	21529	47
53	21529	22240	22950	23661	24372	25083	25794	26505	27216	27927	28638	46
54	28638	29349	30060	30771	31482	32193	32905	33616	34327	35038	35750	45
55	35750	36461	37173	37884	38596	39307	40019	40730	41442	42153	42865	44
56	42865	43577	44289	45000	45712	46424	47136	47848	48560	49272	49984	43
57	49984	50696	51408	52120	52832	53544	54256	54969	55681	56393	57106	42
58	57106	57818	58530	59243	59955	60668	61380	62093	62806	63518	64231	41
59	64231	64944	65656	66369	67082	67795	68507	69220	69933	70646	71359	40
60	71359	72072	72785	73498	74212	74925	75638	76351	77064	77778	78491	39
61	78491	79204	79918	80631	81345	82058	82772	83485	84199	84912	85626	38
62	85626	86340	87053	87767	88481	89195	89909	90623	91336	92050	92764	37
63	92764	93478	94192	94907	95621	96335	97049	97763	98477	99192	99906	36
64	99906	**00620**	**01335**	**02049**	**02764**	**03478**	**04193**	**04907**	**05622**	**06336**	**07051**	35
65	.37 07051	07766	08480	09195	09910	10625	11340	12054	12769	13484	14199	34
66	14199	14914	15629	16344	17060	17775	18490	19205	19920	20636	21351	33
67	21351	22066	22782	23497	24213	24928	25644	26359	27075	27790	28506	32
68	28506	29222	29937	30653	31369	32085	32800	33516	34232	34948	35664	31
69	35664	36380	37096	37812	38529	39245	39961	40677	41393	42110	42826	30
70	42826	43542	44259	44975	45692	46408	47125	47841	48558	49274	49991	29
71	49991	50708	51424	52141	52858	53575	54292	55009	55725	56442	57159	28
72	57159	57876	58594	59311	60028	60745	61462	62179	62897	63614	64331	27
73	64331	65049	65766	66483	67201	67918	68636	69354	70071	70789	71506	26
74	71506	72224	72942	73660	74378	75095	75813	76531	77249	77967	78685	25
75	78685	79403	80121	80839	81558	82276	82994	83712	84430	85149	85867	24
76	85867	86586	87304	88022	88741	89459	90178	90897	91615	92334	93053	23
77	93053	93771	94490	95209	95928	96647	97366	98084	98803	99522	**00241**	22
78	.38 00241	00961	01680	02399	03118	03837	04556	05276	05995	06714	07434	21
79	07434	08153	08873	09592	10312	11031	11751	12470	13190	13910	14630	20
80	14630	15349	16069	16789	17509	18229	18949	19669	20389	21109	21829	19
81	21829	22549	23269	23989	24709	25430	26150	26870	27591	28311	29031	18
82	29031	29752	30472	31193	31913	32634	33355	34075	34796	35517	36238	17
83	36238	36958	37679	38400	39121	39842	40563	41284	42005	42726	43447	16
84	43447	44168	44889	45611	46332	47053	47775	48496	49217	49939	50660	15
85	50660	51382	52103	52825	53546	54268	54990	55711	56433	57155	57877	14
86	57877	58599	59321	60042	60764	61486	62208	62930	63653	64375	65097	13
87	65097	65819	66541	67264	67986	68708	69431	70153	70875	71598	72320	12
88	72320	73043	73766	74488	75211	75934	76656	77379	78102	78825	79548	11
89	79548	80270	80993	81716	82439	83162	83886	84609	85332	86055	86778	10
90	86778	87501	88225	88948	89671	90395	91118	91842	92565	93289	94012	09
91	94012	94736	95460	96183	96907	97631	98355	99078	99802	**00526**	**01250**	08
92	.39 01250	01974	02698	03422	04146	04870	05594	06319	07043	07767	08491	07
93	08491	09216	09940	10664	11389	12113	12838	13562	14287	15011	15736	06
94	15736	16461	17185	17910	18635	19360	20085	20810	21534	22259	22984	05
95	22984	23709	24435	25160	25885	26610	27335	28060	28786	29511	30236	04
96	30236	30962	31687	32413	33138	33864	34589	35315	36041	36766	37492	03
97	37492	38218	38943	39669	40395	41121	41847	42573	43299	44025	44751	02
98	44751	45477	46203	46929	47656	48382	49108	49835	50561	51287	52014	01
99	52014	52740	53467	54193	54920	55646	56373	57100	57827	58553	59280	00
	10	9	8	7	6	5	4	3	2	1	0	

COT t19--

TAN t06--

	0	1	2	3	4	5	6	7	8	9	10	
00	.39 59280	60007	60734	61461	62188	62915	63642	64369	65096	65823	66550	99
01	66550	67277	68004	68732	69459	70186	70914	71641	72369	73096	73824	98
02	73824	74551	75279	76006	76734	77462	78189	78917	79645	80373	81101	97
03	81101	81829	82557	83285	84013	84741	85469	86197	86925	87653	88382	96
04	88382	89110	89838	90567	91295	92023	92752	93480	94209	94938	95666	95
05	95666	96395	97123	97852	98581	99310	**00039**	**00767**	**01496**	**02225**	**02954**	94
06	.40 02954	03683	04412	05141	05871	06600	07329	08058	08787	09517	10246	93
07	10246	10975	11705	12434	13164	13893	14623	15353	16082	16812	17542	92
08	17542	18271	19001	19731	20461	21191	21921	22651	23381	24111	24841	91
09	24841	25571	26301	27031	27761	28492	29222	29952	30683	31413	32144	90
10	32144	32874	33605	34335	35066	35796	36527	37258	37989	38719	39450	89
11	39450	40181	40912	41643	42374	43105	43836	44567	45298	46029	46760	88
12	46760	47492	48223	48954	49686	50417	51148	51880	52611	53343	54074	87
13	54074	54806	55538	56269	57001	57733	58465	59196	59928	60660	61392	86
14	61392	62124	62856	63588	64320	65052	65785	66517	67249	67981	68714	85
15	68714	69446	70178	70911	71643	72376	73108	73841	74574	75306	76039	84
16	76039	76772	77504	78237	78970	79703	80436	81169	81902	82635	83368	83
17	83368	84101	84834	85567	86300	87034	87767	88500	89234	89967	90701	82
18	90701	91434	92168	92901	93635	94368	95102	95836	96569	97303	98037	81
19	98037	98771	99505	**00239**	**00973**	**01707**	**02441**	**03175**	**03909**	**04643**	**05377**	80
20	.41 05377	06112	06846	07580	08314	09049	09783	10518	11252	11987	12721	79
21	12721	13456	14191	14925	15660	16395	17130	17864	18599	19334	20069	78
22	20069	20804	21539	22274	23009	23745	24480	25215	25950	26686	27421	77
23	27421	28156	28892	29627	30363	31098	31834	32569	33305	34041	34776	76
24	34776	35512	36248	36984	37720	38455	39191	39927	40663	41400	42136	75
25	42136	42872	43608	44344	45080	45817	46553	47289	48026	48762	49499	74
26	49499	50235	50972	51708	52445	53182	53918	54655	55392	56129	56866	73
27	56866	57603	58340	59077	59814	60551	61288	62025	62762	63499	64237	72
28	64237	64974	65711	66449	67186	67923	68661	69398	70136	70874	71611	71
29	71611	72349	73087	73824	74562	75300	76038	76776	77514	78252	78990	70
30	78990	79728	80466	81204	81942	82680	83419	84157	84895	85634	86372	69
31	86372	87111	87849	88588	89326	90065	90803	91542	92281	93020	93758	68
32	93758	94497	95236	95975	96714	97453	98192	98931	99670	**00409**	**01149**	67
33	.42 01149	01888	02627	03366	04106	04845	05585	06324	07064	07803	08543	66
34	08543	09282	10022	10762	11501	12241	12981	13721	14461	15201	15941	65
35	15941	16681	17421	18161	18901	19641	20381	21122	21862	22602	23343	64
36	23343	24083	24824	25564	26305	27045	27786	28526	29267	30008	30749	63
37	30749	31489	32230	32971	33712	34453	35194	35935	36676	37417	38158	62
38	38158	38900	39641	40382	41123	41865	42606	43348	44089	44831	45572	61
39	45572	46314	47055	47797	48539	49280	50022	50764	51506	52248	52990	60
40	52990	53732	54474	55216	55958	56700	57442	58185	58927	59669	60411	59
41	60411	61154	61896	62639	63381	64124	64866	65609	66352	67094	67837	58
42	67837	68580	69323	70066	70808	71551	72294	73037	73780	74524	75267	57
43	75267	76010	76753	77496	78240	78983	79726	80470	81213	81957	82700	56
44	82700	83444	84188	84931	85675	86419	87162	87906	88650	89394	90138	55
45	90138	90882	91626	92370	93114	93858	94602	95347	96091	96835	97580	54
46	97580	98324	99068	99813	**00557**	**01302**	**02047**	**02791**	**03536**	**04281**	**05025**	53
47	.43 05025	05770	06515	07260	08005	08750	09495	10240	10985	11730	12475	52
48	12475	13220	13965	14711	15456	16201	16947	17692	18438	19183	19929	51
49	19929	20674	21420	22166	22911	23657	24403	25149	25895	26640	27386	50
	10	9	8	7	6	5	4	3	2	1	0	

COT t18--

TAN t06--

·	0	1	2	3	4	5	6	7	8	9	10	
50	.43 27386	28132	28878	29625	30371	31117	31863	32609	33356	34102	34848	49
51	34848	35595	36341	37088	37834	38581	39327	40074	40821	41567	42314	48
52	42314	43061	43808	44555	45302	46049	46796	47543	48290	49037	49784	47
53	49784	50531	51279	52026	52773	53521	54268	55015	55763	56511	57258	46
54	57258	58006	58753	59501	60249	60997	61745	62492	63240	63988	64736	45
55	64736	65484	66232	66981	67729	68477	69225	69973	70722	71470	72219	44
56	72219	72967	73715	74464	75213	75961	76710	77459	78207	78956	79705	43
57	79705	80454	81203	81952	82701	83450	84199	84948	85697	86446	87195	42
58	87195	87945	88694	89443	90193	90942	91692	92441	93191	93940	94690	41
59	94690	95440	96189	96939	97689	98439	99189	99939	**00689**	**01439**	**02189**	40
60	.44 02189	02939	03689	04439	05189	05940	06690	07440	08191	08941	09692	39
61	09692	10442	11193	11943	12694	13445	14195	14946	15697	16448	17199	38
62	17199	17950	18701	19452	20203	20954	21705	22456	23207	23959	24710	37
63	24710	25461	26213	26964	27716	28467	29219	29970	30722	31474	32225	36
64	32225	32977	33729	34481	35233	35985	36737	37489	38241	38993	39745	35
65	39745	40497	41249	42002	42754	43506	44259	45011	45764	46516	47269	34
66	47269	48021	48774	49527	50279	51032	51785	52538	53291	54044	54797	33
67	54797	55550	56303	57056	57809	58562	59315	60069	60822	61575	62329	32
68	62329	63082	63836	64589	65343	66097	66850	67604	68358	69111	69865	31
69	69865	70619	71373	72127	72881	73635	74389	75143	75897	76652	77406	30
70	77406	78160	78915	79669	80423	81178	81932	82687	83442	84196	84951	29
71	84951	85706	86460	87215	87970	88725	89480	90235	90990	91745	92500	28
72	92500	93255	94010	94766	95521	96276	97032	97787	98542	99298	**00053**	27
73	.45 00053	00809	01565	02320	03076	03832	04588	05343	06099	06855	07611	26
74	07611	08367	09123	09879	10635	11392	12148	12904	13660	14417	15173	25
75	15173	15930	16686	17443	18199	18956	19712	20469	21226	21983	22739	24
76	22739	23496	24253	25010	25767	26524	27281	28038	28796	29553	30310	23
77	30310	31067	31825	32582	33339	34097	34854	35612	36370	37127	37885	22
78	37885	38643	39400	40158	40916	41674	42432	43190	43948	44706	45464	21
79	45464	46222	46980	47739	48497	49255	50014	50772	51531	52289	53048	20
80	53048	53806	54565	55324	56082	56841	57600	58359	59118	59876	60635	19
81	60635	61395	62154	62913	63672	64431	65190	65950	66709	67468	68228	18
82	68228	68987	69747	70506	71266	72025	72785	73545	74305	75064	75824	17
83	75824	76584	77344	78104	78864	79624	80384	81145	81905	82665	83425	16
84	83425	84186	84946	85706	86467	87227	87988	88749	89509	90270	91031	15
85	91031	91791	92552	93313	94074	94835	95596	96357	97118	97879	98640	14
86	98640	99402	**00163**	**00924**	**01685**	**02447**	**03208**	**03970**	**04731**	**05493**	**06254**	13
87	.46 06254	07016	07778	08540	09301	10063	10825	11587	12349	13111	13873	12
88	13873	14635	15397	16159	16922	17684	18446	19209	19971	20733	21496	11
89	21496	22258	23021	23784	24546	25309	26072	26835	27597	28360	29123	10
90	29123	29886	30649	31412	32175	32939	33702	34465	35228	35992	36755	09
91	36755	37519	38282	39046	39809	40573	41336	42100	42864	43628	44391	08
92	44391	45155	45919	46683	47447	48211	48975	49739	50504	51268	52032	07
93	52032	52796	53561	54325	55090	55854	56619	57383	58148	58913	59677	06
94	59677	60442	61207	61972	62737	63502	64267	65032	65797	66562	67327	05
95	67327	68092	68857	69623	70388	71153	71919	72684	73450	74215	74981	04
96	74981	75747	76512	77278	78044	78810	79576	80342	81108	81874	82640	03
97	82640	83406	84172	84938	85704	86471	87237	88004	88770	89536	90303	02
98	90303	91069	91836	92603	93369	94136	94903	95670	96437	97204	97971	01
99	97971	98738	99505	**00272**	**01039**	**01806**	**02573**	**03341**	**04108**	**04875**	**05643**	00
	10	9	8	7	6	5	4	3	2	1	0	

COT t18--

TAN t07--

	0	1	2	3	4	5	6	7	8	9	10	
00	.47 05643	06410	07178	07945	08713	09481	10248	11016	11784	12552	13320	99
01	13320	14087	14855	15623	16392	17160	17928	18696	19464	20233	21001	98
02	21001	21769	22538	23306	24075	24843	25612	26380	27149	27918	28687	97
03	28687	29456	30224	30993	31762	32531	33300	34070	34839	35608	36377	96
04	36377	37146	37916	38685	39455	40224	40994	41763	42533	43302	44072	95
05	44072	44842	45612	46382	47151	47921	48691	49461	50231	51002	51772	94
06	51772	52542	53312	54082	54853	55623	56394	57164	57935	58705	59476	93
07	59476	60247	61017	61788	62559	63330	64101	64872	65643	66414	67185	92
08	67185	67956	68727	69498	70270	71041	71812	72584	73355	74127	74898	91
09	74898	75670	76441	77213	77985	78757	79528	80300	81072	81844	82616	90
10	82616	83388	84160	84932	85705	86477	87249	88022	88794	89566	90339	89
11	90339	91111	91884	92657	93429	94202	94975	95747	96520	97293	98066	88
12	98066	98839	99612	**00385**	**01158**	**01932**	**02705**	**03478**	**04251**	**05025**	**05798**	87
13	.48 05798	06572	07345	08119	08892	09666	10440	11213	11987	12761	13535	86
14	13535	14309	15083	15857	16631	17405	18179	18953	19728	20502	21276	85
15	21276	22051	22825	23600	24374	25149	25923	26698	27473	28247	29022	84
16	29022	29797	30572	31347	32122	32897	33672	34447	35222	35998	36773	83
17	36773	37548	38324	39099	39875	40650	41426	42201	42977	43753	44528	82
18	44528	45304	46080	46856	47632	48408	49184	49960	50736	51512	52289	81
19	52289	53065	53841	54618	55394	56170	56947	57724	58500	59277	60054	80
20	60054	60830	61607	62384	63161	63938	64715	65492	66269	67046	67823	79
21	67823	68600	69378	70155	70932	71710	72487	73265	74042	74820	75598	78
22	75598	76375	77153	77931	78709	79487	80265	81043	81821	82599	83377	77
23	83377	84155	84933	85711	86490	87268	88047	88825	89604	90382	91161	76
24	91161	91939	92718	93497	94276	95054	95833	96612	97391	98170	98949	75
25	98949	99729	**00508**	**01287**	**02066**	**02846**	**03625**	**04404**	**05184**	**05963**	**06743**	74
26	.49 06743	07523	08302	09082	09862	10642	11421	12201	12981	13761	14541	73
27	14541	15321	16102	16882	17662	18442	19223	20003	20783	21564	22344	72
28	22344	23125	23906	24686	25467	26248	27029	27810	28590	29371	30152	71
29	30152	30934	31715	32496	33277	34058	34840	35621	36402	37184	37965	70
30	37965	38747	39528	40310	41092	41874	42655	43437	44219	45001	45783	69
31	45783	46565	47347	48129	48911	49694	50476	51258	52041	52823	53605	68
32	53605	54388	55171	55953	56736	57519	58301	59084	59867	60650	61433	67
33	61433	62216	62999	63782	64565	65348	66132	66915	67698	68482	69265	66
34	69265	70049	70832	71616	72399	73183	73967	74751	75535	76318	77102	65
35	77102	77886	78670	79454	80239	81023	81807	82591	83376	84160	84944	64
36	84944	85729	86513	87298	88083	88867	89652	90437	91222	92007	92791	63
37	92791	93576	94361	95146	95932	96717	97502	98287	99073	99858	**00643**	62
38	.50 00643	01429	02214	03000	03785	04571	05357	06143	06928	07714	08500	61
39	08500	09286	10072	10858	11644	12430	13217	14003	14789	15576	16362	60
40	16362	17148	17935	18722	19508	20295	21081	21868	22655	23442	24229	59
41	24229	25016	25803	26590	27377	28164	28951	29738	30526	31313	32100	58
42	32100	32888	33675	34463	35251	36038	36826	37614	38401	39189	39977	57
43	39977	40765	41553	42341	43129	43917	44706	45494	46282	47071	47859	56
44	47859	48647	49436	50224	51013	51802	52590	53379	54168	54957	55746	55
45	55746	56535	57324	58113	58902	59691	60480	61269	62059	62848	63637	54
46	63637	64427	65216	66006	66795	67585	68375	69164	69954	70744	71534	53
47	71534	72324	73114	73904	74694	75484	76274	77065	77855	78645	79436	52
48	79436	80226	81017	81807	82598	83389	84179	84970	85761	86552	87343	51
49	87343	88134	88925	89716	90507	91298	92089	92880	93672	94463	95254	50
	10	9	8	7	6	5	4	3	2	1	0	

COT t17--

TAN t07--

•	0	1	2	3	4	5	6	7	8	9	10	
50	.50 95254	96046	96837	97629	98421	99212	**00004**	**00796**	**01588**	**02380**	**03171**	49
51	.51 03171	03963	04755	05548	06340	07132	07924	08716	09509	10301	11093	48
52	11093	11886	12678	13471	14264	15056	15849	16642	17435	18228	19021	47
53	19021	19814	20607	21400	22193	22986	23779	24573	25366	26159	26953	46
54	26953	27746	28540	29333	30127	30921	31715	32508	33302	34096	34890	45
55	34890	35684	36478	37272	38066	38861	39655	40449	41244	42038	42833	44
56	42833	43627	44422	45216	46011	46806	47600	48395	49190	49985	50780	43
57	50780	51575	52370	53165	53961	54756	55551	56346	57142	57937	58733	42
58	58733	59528	60324	61120	61915	62711	63507	64303	65099	65895	66691	41
59	66691	67487	68283	69079	69875	70672	71468	72264	73061	73857	74654	40
60	74654	75450	76247	77044	77840	78637	79434	80231	81028	81825	82622	39
61	82622	83419	84216	85013	85811	86608	87405	88203	89000	89798	90595	38
62	90595	91393	92191	92988	93786	94584	95382	96180	96978	97776	98574	37
63	98574	99372	**00170**	**00969**	**01767**	**02565**	**03364**	**04162**	**04961**	**05759**	**06558**	36
64	.52 06558	07357	08155	08954	09753	10552	11351	12150	12949	13748	14547	35
65	14547	15346	16145	16945	17744	18543	19343	20142	20942	21742	22541	34
66	22541	23341	24141	24941	25740	26540	27340	28140	28940	29741	30541	33
67	30541	31341	32141	32942	33742	34543	35343	36144	36944	37745	38546	32
68	38546	39346	40147	40948	41749	42550	43351	44152	44953	45754	46556	31
69	46556	47357	48158	48960	49761	50563	51364	52166	52968	53769	54571	30
70	54571	55373	56175	56977	57779	58581	59383	60185	60987	61789	62592	29
71	62592	63394	64196	64999	65801	66604	67407	68209	69012	69815	70618	28
72	70618	71421	72223	73026	73829	74633	75436	76239	77042	77846	78649	27
73	78649	79452	80256	81059	81863	82667	83470	84274	85078	85882	86686	26
74	86686	87489	88293	89098	89902	90706	91510	92314	93119	93923	94727	25
75	94727	95532	96336	97141	97946	98750	99555	**00360**	**01165**	**01970**	**02775**	24
76	.53 02775	03580	04385	05190	05995	06800	07606	08411	09216	10022	10827	23
77	10827	11633	12439	13244	14050	14856	15662	16467	17273	18079	18885	22
78	18885	19692	20498	21304	22110	22916	23723	24529	25336	26142	26949	21
79	26949	27756	28562	29369	30176	30983	31790	32596	33404	34211	35018	20
80	35018	35825	36632	37439	38247	39054	39862	40669	41477	42284	43092	19
81	43092	43900	44707	45515	46323	47131	47939	48747	49555	50363	51172	18
82	51172	51980	52788	53597	54405	55213	56022	56831	57639	58448	59257	17
83	59257	60066	60874	61683	62492	63301	64110	64920	65729	66538	67347	16
84	67347	68157	68966	69775	70585	71395	72204	73014	73824	74633	75443	15
85	75443	76253	77063	77873	78683	79493	80303	81114	81924	82734	83545	14
86	83545	84355	85166	85976	86787	87598	88408	89219	90030	90841	91652	13
87	91652	92463	93274	94085	94896	95707	96518	97330	98141	98953	99764	12
88	99764	**00576**	**01387**	**02199**	**03011**	**03822**	**04634**	**05446**	**06258**	**07070**	**07882**	11
89	.54 07882	08694	09506	10319	11131	11943	12756	13568	14380	15193	16006	10
90	16006	16818	17631	18444	19257	20069	20882	21695	22508	23321	24135	09
91	24135	24948	25761	26574	27388	28201	29015	29828	30642	31455	32269	08
92	32269	33083	33897	34711	35525	36338	37153	37967	38781	39595	40409	07
93	40409	41224	42038	42852	43667	44481	45296	46111	46925	47740	48555	06
94	48555	49370	50185	51000	51815	52630	53445	54260	55075	55891	56706	05
95	56706	57522	58337	59153	59968	60784	61600	62415	63231	64047	64863	04
96	64863	65679	66495	67311	68127	68944	69760	70576	71393	72209	73025	03
97	73025	73842	74659	75475	76292	77109	77926	78742	79559	80376	81194	02
98	81194	82011	82828	83645	84462	85280	86097	86914	87732	88550	89367	01
99	89367	90185	91003	91820	92638	93456	94274	95092	95910	96728	97547	00
	10	9	8	7	6	5	4	3	2	1	0	

COT t17--

TAN t08--

	0	1	2	3	4	5	6	7	8	9	10	
00	.54 97547	98365	99183	**00001**	**00820**	**01638**	**02457**	**03275**	**04094**	**04913**	**05732**	99
01	.55 05732	06550	07369	08188	09007	09826	10645	11464	12284	13103	13922	98
02	13922	14742	15561	16380	17200	18020	18839	19659	20479	21299	22118	97
03	22118	22938	23758	24578	25399	26219	27039	27859	28680	29500	30320	96
04	30320	31141	31962	32782	33603	34424	35244	36065	36886	37707	38528	95
05	38528	39349	40170	40992	41813	42634	43456	44277	45098	45920	46742	94
06	46742	47563	48385	49207	50029	50850	51672	52494	53317	54139	54961	93
07	54961	55783	56605	57428	58250	59073	59895	60718	61540	62363	63186	92
08	63186	64008	64831	65654	66477	67300	68123	68947	69770	70593	71416	91
09	71416	72240	73063	73887	74710	75534	76357	77181	78005	78829	79653	90
10	79653	80477	81301	82125	82949	83773	84597	85422	86246	87070	87895	89
11	87895	88719	89544	90369	91193	92018	92843	93668	94493	95318	96143	88
12	96143	96968	97793	98618	99444	**00269**	**01094**	**01920**	**02745**	**03571**	**04397**	87
13	.56 04397	05222	06048	06874	07700	08526	09352	10178	11004	11830	12656	86
14	12656	13483	14309	15135	15962	16788	17615	18441	19268	20095	20922	85
15	20922	21749	22576	23402	24230	25057	25884	26711	27538	28366	29193	84
16	29193	30020	30848	31676	32503	33331	34159	34986	35814	36642	37470	83
17	37470	38298	39126	39954	40783	41611	42439	43268	44096	44925	45753	82
18	45753	46582	47410	48239	49068	49897	50726	51555	52384	53213	54042	81
19	54042	54871	55700	56530	57359	58189	59018	59848	60677	61507	62337	80
20	62337	63167	63996	64826	65656	66486	67316	68147	68977	69807	70637	79
21	70637	71468	72298	73129	73959	74790	75621	76451	77282	78113	78944	78
22	78944	79775	80606	81437	82268	83099	83931	84762	85593	86425	87256	77
23	87256	88088	88920	89751	90583	91415	92247	93079	93911	94743	95575	76
24	95575	96407	97239	98072	98904	99736	**00569**	**01401**	**02234**	**03067**	**03899**	75
25	.57 03899	04732	05565	06398	07231	08064	08897	09730	10563	11396	12230	74
26	12230	13063	13896	14730	15563	16397	17231	18064	18898	19732	20566	73
27	20566	21400	22234	23068	23902	24736	25571	26405	27239	28074	28908	72
28	28908	29743	30578	31412	32247	33082	33917	34752	35587	36422	37257	71
29	37257	38092	38927	39762	40598	41433	42269	43104	43940	44775	45611	70
30	45611	46447	47283	48119	48955	49791	50627	51463	52299	53135	53972	69
31	53972	54808	55644	56481	57317	58154	58991	59827	60664	61501	62338	68
32	62338	63175	64012	64849	65686	66523	67361	68198	69036	69873	70711	67
33	70711	71548	72386	73223	74061	74899	75737	76575	77413	78251	79089	66
34	79089	79927	80766	81604	82442	83281	84119	84958	85796	86635	87474	65
35	87474	88313	89151	89990	90829	91668	92508	93347	94186	95025	95865	64
36	95865	96704	97543	98383	99223	**00062**	**00902**	**01742**	**02582**	**03421**	**04261**	63
37	.58 04261	05101	05942	06782	07622	08462	09303	10143	10983	11824	12664	62
38	12664	13505	14346	15187	16027	16868	17709	18550	19391	20232	21074	61
39	21074	21915	22756	23598	24439	25281	26122	26964	27805	28647	29489	60
40	29489	30331	31173	32015	32857	33699	34541	35383	36226	37068	37910	59
41	37910	38753	39595	40438	41281	42123	42966	43809	44652	45495	46338	58
42	46338	47181	48024	48868	49711	50554	51398	52241	53085	53928	54772	57
43	54772	55616	56459	57303	58147	58991	59835	60679	61524	62368	63212	56
44	63212	64056	64901	65745	66590	67434	68279	69124	69969	70813	71658	55
45	71658	72503	73348	74193	75039	75884	76729	77574	78420	79265	80111	54
46	80111	80956	81802	82648	83494	84339	85185	86031	86877	87723	88570	53
47	88570	89416	90262	91108	91955	92801	93648	94494	95341	96188	97035	52
48	97035	97881	98728	99575	**00422**	**01269**	**02117**	**02964**	**03811**	**04659**	**05506**	51
49	.59 05506	06353	07201	08049	08896	09744	10592	11440	12287	13135	13984	50
	10	9	8	7	6	5	4	3	2	1	0	

COT t16--

TAN t08--

•	0	1	2	3	4	5	6	7	8	9	10	
50	.59 13984	14832	15680	16528	17376	18225	19073	19922	20770	21619	22467	49
51	22467	23316	24165	25014	25863	26712	27561	28410	29259	30108	30958	48
52	30958	31807	32656	33506	34355	35205	36055	36905	37754	38604	39454	47
53	39454	40304	41154	42004	42855	43705	44555	45406	46256	47106	47957	46
54	47957	48808	49658	50509	51360	52211	53062	53913	54764	55615	56466	45
55	56466	57318	58169	59020	59872	60723	61575	62427	63278	64130	64982	44
56	64982	65834	66686	67538	68390	69242	70094	70947	71799	72651	73504	43
57	73504	74356	75209	76062	76915	77767	78620	79473	80326	81179	82032	42
58	82032	82886	83739	84592	85445	86299	87152	88006	88860	89713	90567	41
59	90567	91421	92275	93129	93983	94837	95691	96545	97400	98254	99108	40
60	99108	99963	**00817**	**01672**	**02527**	**03381**	**04236**	**05091**	**05946**	**06801**	**07656**	39
61	.60 07656	08511	09366	10222	11077	11932	12788	13643	14499	15354	16210	38
62	16210	17066	17922	18778	19634	20490	21346	22202	23058	23914	24771	37
63	24771	25627	26484	27340	28197	29054	29910	30767	31624	32481	33338	36
64	33338	34195	35052	35909	36767	37624	38481	39339	40196	41054	41911	35
65	41911	42769	43627	44485	45343	46201	47059	47917	48775	49633	50492	34
66	50492	51350	52208	53067	53925	54784	55643	56502	57360	58219	59078	33
67	59078	59937	60796	61655	62515	63374	64233	65093	65952	66812	67671	32
68	67671	68531	69391	70251	71110	71970	72830	73690	74551	75411	76271	31
69	76271	77131	77992	78852	79713	80573	81434	82295	83156	84016	84877	30
70	84877	85738	86599	87461	88322	89183	90044	90906	91767	92629	93490	29
71	93490	94352	95214	96075	96937	97799	98661	99523	**00385**	**01247**	**02110**	28
72	.61 02110	02972	03834	04697	05559	06422	07285	08147	09010	09873	10736	27
73	10736	11599	12462	13325	14188	15051	15915	16778	17641	18505	19369	26
74	19369	20232	21096	21960	22823	23687	24551	25415	26279	27144	28008	25
75	28008	28872	29737	30601	31465	32330	33195	34059	34924	35789	36654	24
76	36654	37519	38384	39249	40114	40979	41845	42710	43575	44441	45307	23
77	45307	46172	47038	47904	48770	49635	50501	51367	52234	53100	53966	22
78	53966	54832	55699	56565	57432	58298	59165	60031	60898	61765	62632	21
79	62632	63499	64366	65233	66100	66968	67835	68702	69570	70437	71305	20
80	71305	72172	73040	73908	74776	75644	76512	77380	78248	79116	79984	19
81	79984	80853	81721	82589	83458	84327	85195	86064	86933	87802	88671	18
82	88671	89540	90409	91278	92147	93016	93886	94755	95624	96494	97364	17
83	97364	98233	99103	99973	**00843**	**01713**	**02583**	**03453**	**04323**	**05193**	**06063**	16
84	.62 06063	06934	07804	08675	09545	10416	11286	12157	13028	13899	14770	15
85	14770	15641	16512	17383	18254	19126	19997	20869	21740	22612	23483	14
86	23483	24355	25227	26099	26970	27842	28715	29587	30459	31331	32203	13
87	32203	33076	33948	34821	35693	36566	37439	38312	39184	40057	40930	12
88	40930	41804	42677	43550	44423	45296	46170	47043	47917	48791	49664	11
89	49664	50538	51412	52286	53160	54034	54908	55782	56656	57531	58405	10
90	58405	59279	60154	61029	61903	62778	63653	64528	65403	66278	67153	09
91	67153	68028	68903	69778	70654	71529	72404	73280	74156	75031	75907	08
92	75907	76783	77659	78535	79411	80287	81163	82039	82916	83792	84669	07
93	84669	85545	86422	87298	88175	89052	89929	90806	91683	92560	93437	06
94	93437	94314	95191	96069	96946	97824	98701	99579	**00456**	**01334**	**02212**	05
95	.63 02212	03090	03968	04846	05724	06602	07481	08359	09237	10116	10994	04
96	10994	11873	12752	13630	14509	15388	16267	17146	18025	18904	19783	03
97	19783	20663	21542	22422	23301	24181	25060	25940	26820	27700	28580	02
98	28580	29460	30340	31220	32100	32980	33861	34741	35622	36502	37383	01
99	37383	38264	39144	40025	40906	41787	42668	43549	44430	45312	46193	00
	10	9	8	7	6	5	4	3	2	1	0	

COT t16--

TAN t09--

	0	1	2	3	4	5	6	7	8	9	10	
00	.63 46193	47074	47956	48837	49719	50601	51482	52364	53246	54128	55010	99
01	55010	55892	56774	57657	58539	59421	60304	61186	62069	62952	63834	98
02	63834	64717	65600	66483	67366	68249	69132	70016	70899	71782	72666	97
03	72666	73549	74433	75317	76200	77084	77968	78852	79736	80620	81504	96
04	81504	82388	83273	84157	85041	85926	86811	87695	88580	89465	90350	95
05	90350	91235	92120	93005	93890	94775	95660	96546	97431	98317	99202	94
06	99202	**00088**	**00974**	**01859**	**02745**	**03631**	**04517**	**05403**	**06289**	**07176**	**08062**	93
07	.64 08062	08948	09835	10721	11608	12494	13381	14268	15155	16042	16929	92
08	16929	17816	18703	19590	20477	21365	22252	23140	24027	24915	25803	91
09	25803	26690	27578	28466	29354	30242	31131	32019	32907	33795	34684	90
10	34684	35572	36461	37350	38238	39127	40016	40905	41794	42683	43572	89
11	43572	44461	45351	46240	47130	48019	48909	49798	50688	51578	52468	88
12	52468	53358	54248	55138	56028	56918	57809	58699	59589	60480	61370	87
13	61370	62261	63152	64043	64934	65825	66716	67607	68498	69389	70280	86
14	70280	71172	72063	72955	73847	74738	75630	76522	77414	78306	79198	85
15	79198	80090	80982	81874	82767	83659	84552	85444	86337	87229	88122	84
16	88122	89015	89908	90801	91694	92587	93480	94374	95267	96160	97054	83
17	97054	97948	98841	99735	**00629**	**01523**	**02417**	**03311**	**04205**	**05099**	**05993**	82
18	.65 05993	06887	07782	08676	09571	10465	11360	12255	13150	14044	14939	81
19	14939	15835	16730	17625	18520	19415	20311	21206	22102	22997	23893	80
20	23893	24789	25685	26581	27477	28373	29269	30165	31061	31958	32854	79
21	32854	33751	34647	35544	36441	37338	38234	39131	40028	40925	41823	78
22	41823	42720	43617	44515	45412	46310	47207	48105	49003	49901	50798	77
23	50798	51696	52594	53493	54391	55289	56187	57086	57984	58883	59782	76
24	59782	60680	61579	62478	63377	64276	65175	66074	66974	67873	68772	75
25	68772	69672	70571	71471	72371	73270	74170	75070	75970	76870	77770	74
26	77770	78670	79571	80471	81372	82272	83173	84073	84974	85875	86776	73
27	86776	87677	88578	89479	90380	91281	92183	93084	93985	94887	95789	72
28	95789	96690	97592	98494	99396	**00298**	**01200**	**02102**	**03004**	**03907**	**04809**	71
29	.66 04809	05711	06614	07517	08419	09322	10225	11128	12031	12934	13837	70
30	13837	14740	15643	16547	17450	18354	19257	20161	21065	21968	22872	69
31	22872	23776	24680	25584	26489	27393	28297	29202	30106	31011	31915	68
32	31915	32820	33725	34630	35534	36439	37345	38250	39155	40060	40966	67
33	40966	41871	42777	43682	44588	45494	46400	47305	48211	49117	50024	66
34	50024	50930	51836	52743	53649	54555	55462	56369	57275	58182	59089	65
35	59089	59996	60903	61810	62718	63625	64532	65440	66347	67255	68162	64
36	68162	69070	69978	70886	71794	72702	73610	74518	75426	76335	77243	63
37	77243	78152	79060	79969	80878	81786	82695	83604	84513	85422	86332	62
38	86332	87241	88150	89060	89969	90879	91788	92698	93608	94518	95428	61
39	95428	96338	97248	98158	99068	99978	**00889**	**01799**	**02710**	**03621**	**04531**	60
40	.67 04531	05442	06353	07264	08175	09086	09997	10908	11820	12731	13643	59
41	13643	14554	15466	16378	17289	18201	19113	20025	20937	21849	22762	58
42	22762	23674	24586	25499	26411	27324	28237	29150	30062	30975	31888	57
43	31888	32802	33715	34628	35541	36455	37368	38282	39195	40109	41023	56
44	41023	41937	42851	43765	44679	45593	46507	47422	48336	49251	50165	55
45	50165	51080	51995	52909	53824	54739	55654	56569	57485	58400	59315	54
46	59315	60231	61146	62062	62977	63893	64809	65725	66641	67557	68473	53
47	68473	69389	70305	71222	72138	73055	73971	74888	75805	76722	77638	52
48	77638	78555	79472	80390	81307	82224	83142	84059	84976	85894	86812	51
49	86812	87730	88647	89565	90483	91401	92320	93238	94156	95075	95993	50
	10	9	8	7	6	5	4	3	2	1	0	

COT t15--

TAN t09--

·	0	1	2	3	4	5	6	7	8	9	10	
50	.67 95993	96912	97830	98749	99668	**00587**	**01505**	**02424**	**03344**	**04263**	**05182**	49
51	.68 05182	06101	07021	07940	08860	09779	10699	11619	12539	13459	14379	48
52	14379	15299	16219	17140	18060	18980	19901	20821	21742	22663	23584	47
53	23584	24505	25426	26347	27268	28189	29110	30032	30953	31875	32796	46
54	32796	33718	34640	35562	36484	37406	38328	39250	40172	41095	42017	45
55	42017	42939	43862	44785	45707	46630	47553	48476	49399	50322	51245	44
56	51245	52169	53092	54016	54939	55863	56786	57710	58634	59558	60482	43
57	60482	61406	62330	63254	64179	65103	66028	66952	67877	68802	69726	42
58	69726	70651	71576	72501	73426	74352	75277	76202	77128	78053	78979	41
59	78979	79904	80830	81756	82682	83608	84534	85460	86386	87313	88239	40
60	88239	89166	90092	91019	91946	92872	93799	94726	95653	96580	97508	39
61	97508	98435	99362	**00290**	**01217**	**02145**	**03073**	**04000**	**04928**	**05856**	**06784**	38
62	.69 06784	07712	08640	09569	10497	11425	12354	13282	14211	15140	16069	37
63	16069	16997	17926	18856	19785	20714	21643	22573	23502	24432	25361	36
64	25361	26291	27221	28151	29080	30011	30941	31871	32801	33731	34662	35
65	34662	35592	36523	37454	38384	39315	40246	41177	42108	43039	43971	34
66	43971	44902	45833	46765	47696	48628	49560	50492	51424	52356	53288	33
67	53288	54220	55152	56084	57017	57949	58882	59814	60747	61680	62613	32
68	62613	63546	64479	65412	66345	67278	68212	69145	70079	71012	71946	31
69	71946	72880	73814	74747	75681	76616	77550	78484	79418	80353	81287	30
70	81287	82222	83157	84091	85026	85961	86896	87831	88766	89702	90637	29
71	90637	91572	92508	93443	94379	95315	96251	97187	98123	99059	99995	28
72	99995	**00931**	**01867**	**02804**	**03740**	**04677**	**05613**	**06550**	**07487**	**08424**	**09361**	27
73	.70 09361	10298	11235	12172	13110	14047	14984	15922	16860	17797	18735	26
74	18735	19673	20611	21549	22487	23425	24364	25302	26241	27179	28118	25
75	28118	29056	29995	30934	31873	32812	33751	34690	35630	36569	37509	24
76	37509	38448	39388	40327	41267	42207	43147	44087	45027	45967	46908	23
77	46908	47848	48789	49729	50670	51610	52551	53492	54433	55374	56315	22
78	56315	57256	58198	59139	60081	61022	61964	62906	63847	64789	65731	21
79	65731	66673	67615	68558	69500	70442	71385	72327	73270	74213	75155	20
80	75155	76098	77041	77984	78927	79871	80814	81757	82701	83644	84588	19
81	84588	85532	86476	87419	88363	89307	90252	91196	92140	93085	94029	18
82	94029	94974	95918	96863	97808	98753	99698	**00643**	**01588**	**02533**	**03478**	17
83	.71 03478	04424	05369	06315	07261	08206	09152	10098	11044	11990	12936	16
84	12936	13883	14829	15775	16722	17668	18615	19562	20509	21456	22403	15
85	22403	23350	24297	25244	26192	27139	28086	29034	29982	30930	31877	14
86	31877	32825	33773	34721	35670	36618	37566	38515	39463	40412	41361	13
87	41361	42309	43258	44207	45156	46106	47055	48004	48953	49903	50853	12
88	50853	51802	52752	53702	54652	55602	56552	57502	58452	59402	60353	11
89	60353	61303	62254	63205	64155	65106	66057	67008	67959	68910	69862	10
90	69862	70813	71765	72716	73668	74619	75571	76523	77475	78427	79379	09
91	79379	80331	81284	82236	83189	84141	85094	86047	86999	87952	88905	08
92	88905	89858	90812	91765	92718	93672	94625	95579	96532	97486	98440	07
93	98440	99394	**00348**	**01302**	**02256**	**03210**	**04165**	**05119**	**06074**	**07029**	**07983**	06
94	.72 07983	08938	09893	10848	11803	12758	13713	14669	15624	16580	17535	05
95	17535	18491	19447	20402	21358	22314	23270	24227	25183	26139	27096	04
96	27096	28052	29009	29966	30922	31879	32836	33793	34751	35708	36665	03
97	36665	37622	38580	39538	40495	41453	42411	43369	44327	45285	46243	02
98	46243	47201	48160	49118	50077	51035	51994	52953	53912	54871	55830	01
99	55830	56789	57748	58708	59667	60626	61586	62546	63505	64465	65425	00
	10	9	8	7	6	5	4	3	2	1	0	

COT t15--

TAN t10--

	0	1	2	3	4	5	6	7	8	9	10	•
00	.72 65425	66385	67345	68306	69266	70226	71187	72147	73108	74069	75030	99
01	75030	75990	76951	77913	78874	79835	80796	81758	82719	83681	84643	98
02	84643	85604	86566	87528	88490	89452	90415	91377	92339	93302	94264	97
03	94264	95227	96190	97153	98116	99079	**00042**	**01005**	**01968**	**02932**	**03895**	96
04	.73 03895	04859	05822	06786	07750	08714	09678	10642	11606	12570	13535	95
05	13535	14499	15463	16428	17393	18358	19322	20287	21252	22218	23183	94
06	23183	24148	25114	26079	27045	28010	28976	29942	30908	31874	32840	93
07	32840	33806	34773	35739	36705	37672	38639	39605	40572	41539	42506	92
08	42506	43473	44441	45408	46375	47343	48310	49278	50246	51213	52181	91
09	52181	53149	54117	55086	56054	57022	57991	58959	59928	60897	61865	90
10	61865	62834	63803	64772	65741	66711	67680	68649	69619	70589	71558	89
11	71558	72528	73498	74468	75438	76408	77378	78349	79319	80290	81260	88
12	81260	82231	83202	84173	85144	86115	87086	88057	89028	90000	90971	87
13	90971	91943	92914	93886	94858	95830	96802	97774	98746	99719	**00691**	86
14	.74 00691	01664	02636	03609	04582	05555	06528	07501	08474	09447	10420	85
15	10420	11394	12367	13341	14314	15288	16262	17236	18210	19184	20158	84
16	20158	21133	22107	23082	24056	25031	26006	26980	27955	28930	29905	83
17	29905	30881	31856	32831	33807	34782	35758	36734	37710	38686	39662	82
18	39662	40638	41614	42590	43567	44543	45520	46497	47473	48450	49427	81
19	49427	50404	51381	52359	53336	54313	55291	56268	57246	58224	59202	80
20	59202	60180	61158	62136	63114	64092	65071	66049	67028	68007	68985	79
21	68985	69964	70943	71922	72901	73881	74860	75840	76819	77799	78778	78
22	78778	79758	80738	81718	82698	83678	84658	85639	86619	87600	88580	77
23	88580	89561	90542	91523	92504	93485	94466	95447	96429	97410	98392	76
24	98392	99373	**00355**	**01337**	**02319**	**03301**	**04283**	**05265**	**06248**	**07230**	**08212**	75
25	.75 08212	09195	10178	11160	12143	13126	14109	15092	16076	17059	18042	74
26	18042	19026	20009	20993	21977	22961	23945	24929	25913	26897	27881	73
27	27881	28866	29850	30835	31820	32804	33789	34774	35759	36745	37730	72
28	37730	38715	39701	40686	41672	42658	43643	44629	45615	46601	47588	71
29	47588	48574	49560	50547	51533	52520	53507	54494	55481	56468	57455	70
30	57455	58442	59429	60417	61404	62392	63380	64367	65355	66343	67331	69
31	67331	68319	69308	70296	71285	72273	73262	74250	75239	76228	77217	68
32	77217	78206	79196	80185	81174	82164	83153	84143	85133	86123	87113	67
33	87113	88103	89093	90083	91073	92064	93054	94045	95036	96026	97017	66
34	97017	98008	98999	99991	**00982**	**01973**	**02965**	**03956**	**04948**	**05940**	**06932**	65
35	.76 06932	07924	08916	09908	10900	11892	12885	13877	14870	15863	16855	64
36	16855	17848	18841	19834	20827	21821	22814	23808	24801	25795	26789	63
37	26789	27782	28776	29770	30765	31759	32753	33747	34742	35737	36731	62
38	36731	37726	38721	39716	40711	41706	42702	43697	44692	45688	46684	61
39	46684	47679	48675	49671	50667	51663	52660	53656	54652	55649	56645	60
40	56645	57642	58639	59636	60633	61630	62627	63624	64622	65619	66617	59
41	66617	67615	68612	69610	70608	71606	72604	73603	74601	75599	76598	58
42	76598	77597	78595	79594	80593	81592	82591	83590	84590	85589	86589	57
43	86589	87588	88588	89588	90588	91588	92588	93588	94588	95589	96589	56
44	96589	97590	98590	99591	**00592**	**01593**	**02594**	**03595**	**04596**	**05598**	**06599**	55
45	.77 06599	07601	08602	09604	10606	11608	12610	13612	14614	15616	16619	54
46	16619	17621	18624	19627	20629	21632	22635	23638	24642	25645	26648	53
47	26648	27652	28655	29659	30663	31667	32671	33675	34679	35683	36687	52
48	36687	37692	38696	39701	40706	41711	42716	43721	44726	45731	46736	51
49	46736	47742	48747	49753	50759	51765	52770	53776	54783	55789	56795	50
	10	9	8	7	6	5	4	3	2	1	0	

COT t14--

TAN t10--

•		0	1	2	3	4	5	6	7	8	9	10	
50	.77	56795	57802	58808	59815	60821	61828	62835	63842	64849	65856	66864	49
51		66864	67871	68879	69886	70894	71902	72910	73917	74926	75934	76942	48
52		76942	77950	78959	79967	80976	81985	82994	84003	85012	86021	87030	47
53		87030	88040	89049	90059	91068	92078	93088	94098	95108	96118	97128	46
54		97128	98139	99149	**00160**	**01170**	**02181**	**03192**	**04203**	**05214**	**06225**	**07236**	45
55	.78	07236	08248	09259	10271	11282	12294	13306	14318	15330	16342	17354	44
56		17354	18367	19379	20392	21404	22417	23430	24443	25456	26469	27482	43
57		27482	28496	29509	30523	31536	32550	33564	34578	35592	36606	37620	42
58		37620	38634	39649	40663	41678	42693	43708	44723	45738	46753	47768	41
59		47768	48783	49799	50814	51830	52846	53861	54877	55893	56910	57926	40
60		57926	58942	59959	60975	61992	63008	64025	65042	66059	67076	68094	39
61		68094	69111	70128	71146	72164	73181	74199	75217	76235	77253	78272	38
62		78272	79290	80308	81327	82346	83364	84383	85402	86421	87440	88460	37
63		88460	89479	90498	91518	92538	93557	94577	95597	96617	97637	98658	36
64		98658	99678	**00699**	**01719**	**02740**	**03761**	**04781**	**05802**	**06824**	**07845**	**08866**	35
65	.79	08866	09887	10909	11930	12952	13974	14996	16018	17040	18062	19084	34
66		19084	20107	21129	22152	23175	24197	25220	26243	27266	28290	29313	33
67		29313	30336	31360	32384	33407	34431	35455	36479	37503	38527	39552	32
68		39552	40576	41601	42625	43650	44675	45700	46725	47750	48775	49801	31
69		49801	50826	51852	52877	53903	54929	55955	56981	58007	59034	60060	30
70		60060	61087	62113	63140	64167	65193	66220	67248	68275	69302	70330	29
71		70330	71357	72385	73412	74440	75468	76496	77524	78553	79581	80609	28
72		80609	81638	82667	83695	84724	85753	86782	87811	88841	89870	90899	27
73		90899	91929	92959	93988	95018	96048	97078	98109	99139	**00169**	**01200**	26
74	.80	01200	02231	03261	04292	05323	06354	07385	08416	09448	10479	11511	25
75		11511	12542	13574	14606	15638	16670	17702	18734	19767	20799	21832	24
76		21832	22865	23897	24930	25963	26996	28030	29063	30096	31130	32164	23
77		32164	33197	34231	35265	36299	37333	38367	39402	40436	41471	42506	22
78		42506	43540	44575	45610	46645	47681	48716	49751	50787	51822	52858	21
79		52858	53894	54930	55966	57002	58038	59075	60111	61148	62184	63221	20
80		63221	64258	65295	66332	67369	68406	69444	70481	71519	72557	73595	19
81		73595	74632	75670	76709	77747	78785	79824	80862	81901	82940	83979	18
82		83979	85018	86057	87096	88135	89175	90214	91254	92293	93333	94373	17
83		94373	95413	96453	97494	98534	99574	**00615**	**01656**	**02696**	**03737**	**04778**	16
84	.81	04778	05819	06861	07902	08943	09985	11026	12068	13110	14152	15194	15
85		15194	16236	17278	18321	19363	20406	21449	22491	23534	24577	25620	14
86		25620	26664	27707	28750	29794	30838	31881	32925	33969	35013	36057	13
87		36057	37102	38146	39191	40235	41280	42325	43370	44415	45460	46505	12
88		46505	47551	48596	49642	50687	51733	52779	53825	54871	55917	56964	11
89		56964	58010	59057	60103	61150	62197	63244	64291	65338	66385	67433	10
90		67433	68480	69528	70576	71623	72671	73719	74767	75816	76864	77913	09
91		77913	78961	80010	81059	82108	83157	84206	85255	86304	87354	88403	08
92		88403	89453	90503	91553	92603	93653	94703	95753	96804	97854	98905	07
93		98905	99955	**01006**	**02057**	**03108**	**04159**	**05211**	**06262**	**07314**	**08365**	**09417**	06
94	.82	09417	10469	11521	12573	13625	14677	15730	16782	17835	18887	19940	05
95		19940	20993	22046	23099	24152	25206	26259	27313	28366	29420	30474	04
96		30474	31528	32582	33636	34691	35745	36800	37854	38909	39964	41019	03
97		41019	42074	43129	44185	45240	46296	47351	48407	49463	50519	51575	02
98		51575	52631	53687	54744	55800	56857	57914	58971	60027	61085	62142	01
99		62142	63199	64256	65314	66371	67429	68487	69545	70603	71661	72719	00
		10	9	8	7	6	5	4	3	2	1	0	

COT t14--

TAN t11--

	0	1	2	3	4	5	6	7	8	9	10	
00	.82 72719	73778	74836	75895	76954	78012	79071	80130	81190	82249	83308	99
01	83308	84368	85427	86487	87547	88607	89667	90727	91787	92848	93908	98
02	93908	94969	96029	97090	98151	99212	**00273**	**01334**	**02396**	**03457**	**04519**	97
03	.83 04519	05581	06642	07704	08766	09828	10891	11953	13016	14078	15141	96
04	15141	16204	17267	18330	19393	20456	21519	22583	23646	24710	25774	95
05	25774	26838	27902	28966	30030	31095	32159	33224	34288	35353	36418	94
06	36418	37483	38548	39613	40679	41744	42810	43876	44941	46007	47073	93
07	47073	48139	49206	50272	51339	52405	53472	54539	55606	56673	57740	92
08	57740	58807	59874	60942	62010	63077	64145	65213	66281	67349	68418	91
09	68418	69486	70554	71623	72692	73761	74830	75899	76968	78037	79106	90
10	79106	80176	81246	82315	83385	84455	85525	86595	87666	88736	89807	89
11	89807	90877	91948	93019	94090	95161	96232	97304	98375	99447	**00518**	88
12	.84 00518	01590	02662	03734	04806	05878	06951	08023	09096	10168	11241	87
13	11241	12314	13387	14460	15533	16607	17680	18754	19827	20901	21975	86
14	21975	23049	24123	25198	26272	27346	28421	29496	30571	31646	32721	85
15	32721	33796	34871	35947	37022	38098	39173	40249	41325	42401	43478	84
16	43478	44554	45630	46707	47784	48860	49937	51014	52091	53169	54246	83
17	54246	55323	56401	57479	58556	59634	60712	61791	62869	63947	65026	82
18	65026	66104	67183	68262	69341	70420	71499	72578	73658	74737	75817	81
19	75817	76897	77977	79057	80137	81217	82297	83378	84458	85539	86620	80
20	86620	87701	88782	89863	90944	92025	93107	94188	95270	96352	97434	79
21	97434	98516	99598	**00680**	**01763**	**02845**	**03928**	**05011**	**06094**	**07177**	**08260**	78
22	.85 08260	09343	10426	11510	12593	13677	14761	15845	16929	18013	19097	77
23	19097	20182	21266	22351	23435	24520	25605	26690	27775	28861	29946	76
24	29946	31032	32117	33203	34289	35375	36461	37547	38634	39720	40807	75
25	40807	41894	42980	44067	45154	46242	47329	48416	49504	50591	51679	74
26	51679	52767	53855	54943	56031	57120	58208	59297	60385	61474	62563	73
27	62563	63652	64741	65831	66920	68010	69099	70189	71279	72369	73459	72
28	73459	74549	75639	76730	77820	78911	80002	81093	82184	83275	84366	71
29	84366	85458	86549	87641	88733	89825	90916	92009	93101	94193	95286	70
30	95286	96378	97471	98564	99657	**00750**	**01843**	**02936**	**04029**	**05123**	**06217**	69
31	.86 06217	07310	08404	09498	10592	11687	12781	13875	14970	16065	17160	68
32	17160	18254	19350	20445	21540	22635	23731	24827	25922	27018	28114	67
33	28114	29210	30307	31403	32499	33596	34693	35790	36887	37984	39081	66
34	39081	40178	41276	42373	43471	44569	45667	46765	47863	48961	50059	65
35	50059	51158	52257	53355	54454	55553	56652	57751	58851	59950	61050	64
36	61050	62150	63249	64349	65449	66550	67650	68750	69851	70951	72052	63
37	72052	73153	74254	75355	76457	77558	78659	79761	80863	81965	83067	62
38	83067	84169	85271	86373	87476	88578	89681	90784	91887	92990	94093	61
39	94093	95196	96300	97403	98507	99611	**00715**	**01819**	**02923**	**04027**	**05132**	60
40	.87 05132	06236	07341	08446	09550	10655	11761	12866	13971	15077	16182	59
41	16182	17288	18394	19500	20606	21712	22818	23925	25031	26138	27245	58
42	27245	28352	29459	30566	31673	32781	33888	34996	36104	37212	38320	57
43	38320	39428	40536	41645	42753	43862	44970	46079	47188	48298	49407	56
44	49407	50516	51626	52735	53845	54955	56065	57175	58285	59395	60506	55
45	60506	61617	62727	63838	64949	66060	67171	68283	69394	70506	71617	54
46	71617	72729	73841	74953	76065	77178	78290	79403	80515	81628	82741	53
47	82741	83854	84967	86081	87194	88308	89421	90535	91649	92763	93877	52
48	93877	94991	96106	97220	98335	99450	**00565**	**01680**	**02795**	**03910**	**05025**	51
49	.88 05025	06141	07256	08372	09488	10604	11720	12836	13953	15069	16186	50
	10	9	8	7	6	5	4	3	2	1	0	

COT t13--

TAN t11--

•	0	1	2	3	4	5	6	7	8	9	10	
50	.88 16186	17303	18420	19537	20654	21771	22888	24006	25123	26241	27359	49
51	27359	28477	29595	30713	31832	32950	34069	35187	36306	37425	38544	48
52	38544	39664	40783	41902	43022	44142	45262	46381	47502	48622	49742	47
53	49742	50863	51983	53104	54225	55346	56467	57588	58709	59831	60952	46
54	60952	62074	63196	64318	65440	66562	67685	68807	69930	71052	72175	45
55	72175	73298	74421	75544	76668	77791	78915	80039	81162	82286	83410	44
56	83410	84535	85659	86784	87908	89033	90158	91283	92408	93533	94658	43
57	94658	95784	96909	98035	99161	**00287**	**01413**	**02539**	**03666**	**04792**	**05919**	42
58	.89 05919	07045	08172	09299	10426	11554	12681	13809	14936	16064	17192	41
59	17192	18320	19448	20576	21705	22833	23962	25090	26219	27348	28477	40
60	28477	29607	30736	31866	32995	34125	35255	36385	37515	38645	39776	39
61	39776	40906	42037	43168	44299	45430	46561	47692	48824	49955	51087	38
62	51087	52219	53351	54483	55615	56747	57880	59012	60145	61278	62411	37
63	62411	63544	64677	65810	66944	68077	69211	70345	71479	72613	73747	36
64	73747	74881	76016	77151	78285	79420	80555	81690	82826	83961	85096	35
65	85096	86232	87368	88504	89640	90776	91912	93049	94185	95322	96459	34
66	96459	97595	98733	99870	**01007**	**02144**	**03282**	**04420**	**05558**	**06695**	**07834**	33
67	.90 07834	08972	10110	11249	12387	13526	14665	15804	16943	18082	19221	32
68	19221	20361	21501	22640	23780	24920	26060	27201	28341	29482	30622	31
69	30622	31763	32904	34045	35186	36327	37469	38610	39752	40894	42036	30
70	42036	43178	44320	45463	46605	47748	48890	50033	51176	52319	53463	29
71	53463	54606	55750	56893	58037	59181	60325	61469	62613	63758	64902	28
72	64902	66047	67192	68337	69482	70627	71772	72918	74064	75209	76355	27
73	76355	77501	78647	79793	80940	82086	83233	84380	85527	86674	87821	26
74	87821	88968	90116	91263	92411	93559	94707	95855	97003	98151	99300	25
75	99300	**00448**	**01597**	**02746**	**03895**	**05044**	**06194**	**07343**	**08492**	**09642**	**10792**	24
76	.91 10792	11942	13092	14242	15392	16543	17693	18844	19995	21146	22297	23
77	22297	23448	24600	25751	26903	28055	29207	30359	31511	32663	33816	22
78	33816	34968	36121	37274	38427	39580	40733	41886	43040	44193	45347	21
79	45347	46501	47655	48809	49964	51118	52273	53427	54582	55737	56892	20
80	56892	58047	59203	60358	61514	62670	63825	64982	66138	67294	68450	19
81	68450	69607	70764	71920	73077	74234	75392	76549	77707	78864	80022	18
82	80022	81180	82338	83496	84654	85813	86971	88130	89289	90448	91607	17
83	91607	92766	93925	95085	96244	97404	98564	99724	**00884**	**02045**	**03205**	16
84	.92 03205	04366	05526	06687	07848	09009	10170	11332	12493	13655	14817	15
85	14817	15979	17141	18303	19465	20628	21790	22953	24116	25279	26442	14
86	26442	27605	28769	29932	31096	32260	33423	34588	35752	36916	38081	13
87	38081	39245	40410	41575	42740	43905	45070	46236	47401	48567	49733	12
88	49733	50899	52065	53231	54397	55564	56730	57897	59064	60231	61398	11
89	61398	62566	63733	64901	66068	67236	68404	69572	70741	71909	73078	10
90	73078	74246	75415	76584	77753	78922	80092	81261	82431	83601	84771	09
91	84771	85941	87111	88281	89452	90622	91793	92964	94135	95306	96477	08
92	96477	97649	98820	99992	**01164**	**02336**	**03508**	**04680**	**05852**	**07025**	**08197**	07
93	.93 08197	09370	10543	11716	12889	14063	15236	16410	17583	18757	19931	06
94	19931	21106	22280	23454	24629	25803	26978	28153	29328	30504	31679	05
95	31679	32855	34030	35206	36382	37558	38734	39911	41087	42264	43441	04
96	43441	44617	45795	46972	48149	49326	50504	51682	52860	54038	55216	03
97	55216	56394	57573	58751	59930	61109	62288	63467	64646	65825	67005	02
98	67005	68185	69365	70544	71725	72905	74085	75266	76446	77627	78808	01
99	78808	79989	81170	82352	83533	84715	85897	87079	88261	89443	90625	00
	10	9	8	7	6	5	4	3	2	1	0	

COT t13--

TAN t12--

	0	1	2	3	4	5	6	7	8	9	10	'
00	.93 90625	91808	92990	94173	95356	96539	97722	98905	**00089**	**01272**	**02456**	99
01	.94 02456	03640	04824	06008	07192	08377	09561	10746	11931	13116	14301	98
02	14301	15486	16672	17857	19043	20229	21415	22601	23787	24973	26160	97
03	26160	27346	28533	29720	30907	32095	33282	34469	35657	36845	38033	96
04	38033	39221	40409	41597	42786	43975	45163	46352	47541	48731	49920	95
05	49920	51109	52299	53489	54679	55869	57059	58249	59440	60630	61821	94
06	61821	63012	64203	65394	66586	67777	68969	70160	71352	72544	73736	93
07	73736	74929	76121	77314	78507	79699	80892	82086	83279	84472	85666	92
08	85666	86860	88054	89248	90442	91636	92831	94025	95220	96415	97610	91
09	97610	98805	**00000**	**01196**	**02391**	**03587**	**04783**	**05979**	**07175**	**08371**	**09568**	90
10	.95 09568	10764	11961	13158	14355	15552	16750	17947	19145	20342	21540	89
11	21540	22738	23936	25135	26333	27532	28730	29929	31128	32328	33527	88
12	33527	34726	35926	37126	38326	39526	40726	41926	43127	44327	45528	87
13	45528	46729	47930	49131	50332	51534	52735	53937	55139	56341	57543	86
14	57543	58746	59948	61151	62354	63556	64760	65963	67166	68370	69573	85
15	69573	70777	71981	73185	74389	75594	76798	78003	79208	80412	81618	84
16	81618	82823	84028	85234	86439	87645	88851	90057	91264	92470	93676	83
17	93676	94883	96090	97297	98504	99711	**00919**	**02126**	**03334**	**04542**	**05750**	82
18	.96 05750	06958	08166	09375	10583	11792	13001	14210	15419	16628	17838	81
19	17838	19047	20257	21467	22677	23887	25098	26308	27519	28730	29941	80
20	29941	31152	32363	33574	34786	35997	37209	38421	39633	40845	42058	79
21	42058	43270	44483	45696	46909	48122	49335	50549	51762	52976	54190	78
22	54190	55404	56618	57832	59047	60261	61476	62691	63906	65121	66336	77
23	66336	67552	68768	69983	71199	72415	73632	74848	76064	77281	78498	76
24	78498	79715	80932	82149	83367	84584	85802	87020	88238	89456	90674	75
25	90674	91893	93111	94330	95549	96768	97987	99206	**00426**	**01645**	**02865**	74
26	.97 02865	04085	05305	06525	07746	08966	10187	11408	12629	13850	15071	73
27	15071	16293	17514	18736	19958	21180	22402	23624	24847	26069	27292	72
28	27292	28515	29738	30961	32185	33408	34632	35856	37080	38304	39528	71
29	39528	40752	41977	43202	44426	45651	46877	48102	49327	50553	51779	70
30	51779	53005	54231	55457	56683	57910	59136	60363	61590	62817	64045	69
31	64045	65272	66500	67727	68955	70183	71411	72640	73868	75097	76325	68
32	76325	77554	78783	80013	81242	82472	83701	84931	86161	87391	88621	67
33	88621	89852	91082	92313	93544	94775	96006	97238	98469	99701	**00933**	66
34	.98 00933	02165	03397	04629	05861	07094	08327	09559	10792	12026	13259	65
35	13259	14492	15726	16960	18194	19428	20662	21896	23131	24366	25600	64
36	25600	26835	28071	29306	30541	31777	33013	34249	35485	36721	37957	63
37	37957	39194	40430	41667	42904	44141	45379	46616	47854	49091	50329	62
38	50329	51567	52805	54044	55282	56521	57760	58999	60238	61477	62717	61
39	62717	63956	65196	66436	67676	68916	70156	71397	72638	73878	75119	60
40	75119	76360	77602	78843	80085	81326	82568	83810	85053	86295	87537	59
41	87537	88780	90023	91266	92509	93752	94996	96239	97483	98727	99971	58
42	99971	**01215**	**02460**	**03704**	**04949**	**06194**	**07439**	**08684**	**09929**	**11174**	**12420**	57
43	.99 12420	13666	14912	16158	17404	18650	19897	21144	22390	23637	24885	56
44	24885	26132	27379	28627	29875	31123	32371	33619	34867	36116	37365	55
45	37365	38614	39863	41112	42361	43611	44860	46110	47360	48610	49860	54
46	49860	51111	52361	53612	54863	56114	57365	58617	59868	61120	62372	53
47	62372	63624	64876	66128	67381	68633	69886	71139	72392	73645	74899	52
48	74899	76152	77406	78660	79914	81168	82423	83677	84932	86187	87442	51
49	87442	88697	89952	91207	92463	93719	94975	96231	97487	98743	**00000**	50
	10	9	8	7	6	5	4	3	2	1	0	

COT t12--

APPENDIX

COSINES AND SINES map directions in right-handed rectangular coordinates. It is impossible to be right-handed or left-handed in two dimensions. The Z axis around which directions are mapped on the back cover is normal to the plane of the paper at the intersection of the X and Y axes. By definition, positive rotation carries points on the positive X axis around toward the positive Y axis. In right-handed coordinates, the positive direction along the Z axis is the direction in which the thumb of the right hand would point if the fingers of the right hand were curled around the Z axis in the sense of positive rotation. The positive Z axis must therefore project upward from the back cover toward the viewer.

WHOLE TURNS added to or subtracted from rotation around the Z axis have no effect on directions in the X-Y plane. The direction determined by any finite rotation around Z may be defined by an angle ϕ in the range ± ½ turn from the positive X axis.

THE FIGURE on the back cover maps all possible directions around the Z axis as the collection of points at unit distance from Z in the plane of the paper. These points are defined both in terms of the angle, ϕ, and in terms of the corresponding x, y right-handed rectangular coordinates. By definition:

$$\cos\phi = x \qquad \sin\phi = y$$
$$\cot\phi = x/y \qquad \tan\phi = y/x$$

THESE TABLES map cosines, sines, cotangents, and tangents in the range of positive values of ϕ up to ¼ turn. The following rules for determining the sense and magnitude of cosine and sine for any value of ϕ may be verified from the figure on the back cover:

cos ϕ *is negative if, and only if,* $|\phi| > t25$; (1)

sin ϕ *is negative if, and only if,* ϕ is negative; (2)

$|cos|\phi = |sin|\phi \pm t25$; *and* $|sin|\phi = |cos|\phi \pm t25$; *and,* (3)

$|cot|\phi = |tan|\phi \pm t25$, *and* $|tan|\phi = |cot|\phi$ [illegible] $t25$ (4)

NOTE: When a symbol is represented between vertical brackets, thus: $|\mathbf{A}|$, only the magnitude of the object, **A**, is specified.

$|\mathbf{A}|$ *is always taken as positive, and* $|\mathbf{A}| = \sqrt{\mathbf{A}^2}$