



**TABLES
AND
WORKSHEET
FOR
WILLIAM F. BUCKLEY, JR.'s
CELESTIAL
NAVIGATION
SIMPLIFIED**



**THE DEVELOPMENT
OF CELESTIAL NAVIGATION**

Navigation can be traced to the Polynesians who realized that certain stars at their zenith passed over certain islands. This enabled them to navigate the Pacific latitudinally, aligning themselves with the appropriate star and moving either east or west.

Medieval Norse navigators valued the Pole Star for measuring latitudes since its altitude above the horizon was nearly constant. As time went on they also recognized that latitude could be found by measuring the altitude of the sun at its highest point, at noon. Still later, European mariners used the planets and stars, and devised almanacs to show the various positions of the celestial bodies at different times of the year. This provided a reliable guide for finding latitude.

Longitude, however, could not be accurately determined until the chronometer was developed in the mid eighteenth century, allowing proper timekeeping at sea. Chronometers became standard equipment for ships, and when the sextant replaced the astrolabe, the measurement of altitude became more precise. Yet, even with these improvements, celestial navigation still meant complicated, spherical trigonometric solutions.

Not until the development of the computer, just before World War II, could the thousands of values be pre-calculated and published in Sight Reduction Tables. Knowledge of simple arithmetic now suffices for the celestial navigator; with valid Almanacs and Sight Reduction Tables, the modern sailor can determine his position accurately and quickly and yet still feel a common bond with ancient marine voyagers.

340 (DAY 170) GREENWICH P. M. 1975 JUNE 19 (THURSDAY)

GMT	☉ SUN		♈ ARIES		♁ VENUS-3.9		♃ JUPITER-1.9		♄ SATURN 0.3		☾ MOON		Lat.	Moon- set	Diff.	
	GHA	Dec.	GHA	Dec.	GHA	Dec.	GHA	Dec.	GHA	Dec.	GHA	Dec.				
12 00	359 42.7	N23 25.2	87 05.5	311 06 N18 43	68 13 N 6 40	336 21 N22 00	234 58 S15 24	N								
10	2 12.6	25.2	89 36.0	313 36	70 43	338 52	237 22	26								
20	4 42.6	25.2	92 06.4	316 06	73 13	341 22	239 47	27	72	22	03	*				
30	7 12.6	25.2	94 36.8	318 36	75 44	343 53	242 11	29	70	22	54	-12				
40	9 42.6	25.2	97 07.2	321 06	78 14	346 23	244 36	30	68	23	26	00				
50	12 12.5	25.2	99 37.6	323 36	80 44	348 53	247 01	32	66	24	08	+05				
13 00	14 42.5	N23 25.2	102 08.0	326 06 N18 42	83 15 N 6 40	351 24 N22 00	249 25 S15 33	62	00	06	08					
10	17 12.5	25.2	104 38.4	328 36	85 45	353 54	251 50	35	60	00	15					
20	19 42.5	25.2	107 08.8	331 06	88 15	356 24	254 15	36	60	00	15					
30	22 12.5	25.2	109 39.2	333 36	90 46	358 55	256 39	37	58	00	23	11				
40	24 42.4	25.2	112 09.7	336 06	93 16	1 25	259 04	39	56	00	31	13				
50	27 12.4	25.2	114 40.1	338 36	95 46	3 55	261 28	40	54	00	37	14				
14 00	29 42.4	N23 25.2	117 10.5	341 06 N18 42	98 17 N 6 40	6 26 N22 00	263 53 S15 42	50	00	48	16					
10	32 12.4	25.2	119 40.9	343 36	100 47	8 56	266 18	43	50	00	48	16				
20	34 42.3	25.2	122 11.3	346 06	103 17	11 26	268 42	45	45	01	00	17				
30	37 12.3	25.2	124 41.7	348 36	105 48	13 57	271 07	46	40	01	09	19				
40	39 42.3	25.2	127 12.1	351 06	108 18	16 27	273 31	48	35	01	17	20				
50	42 12.3	25.2	129 42.5	353 36	110 48	18 57	275 56	49	30	01	24	22				
15 00	44 42.3	N23 25.2	132 12.9	356 07 N18 41	113 19 N 6 40	21 28 N22 00	278 21 S15 51	20	01	37	23					
10	47 12.2	25.2	134 43.4	358 37	115 49	23 58	280 45	52	20	01	48	25				
20	49 42.2	25.2	137 13.8	1 07	118 20	26 29	283 10	53	0	01	58	27				
30	52 12.2	25.2	139 44.2	3 37	120 50	28 59	285 35	55	10	02	08	28				
40	54 42.2	25.2	142 14.6	6 07	123 20	31 29	287 59	56	20	02	19	30				
50	57 12.1	25.2	144 45.0	8 37	125 51	34 00	290 24	58	30	02	32	32				
16 00	59 42.1	N23 25.2	147 15.4	11 07 N18 40	128 21 N 6 40	36 30 N22 00	292 48 S15 59	35	02	39	33					
10	62 12.1	25.2	149 45.8	13 37	130 51	39 00	295 13	16	01	40	48	34				
20	64 42.1	25.2	152 16.2	16 07	133 22	41 31	297 38	02	45	02	58	36				
30	67 12.1	25.2	154 46.6	18 37	135 52	44 01	300 02	03	50	03	09	38				
40	69 42.0	25.2	157 17.0	21 07	138 22	46 31	302 27	05	52	03	15	39				
50	72 12.0	25.2	159 47.5	23 37	140 53	49 02	304 51	06	54	03	21	40				
17 00	74 42.0	N23 25.2	162 17.9	26 07 N18 39	143 23 N 6 40	51 32 N22 00	307 16 S16 08	56	03	28	42					
10	77 12.0	25.2	164 48.3	28 37	145 53	54 02	309 41	09	58	03	36	41				
20	79 41.9	25.2	167 18.7	31 07	148 24	56 33	312 05	11	60	03	44	44				
30	82 11.9	25.2	169 49.1	33 37	150 54	59 03	314 30	12	56	03	28	41				
40	84 41.9	25.2	172 19.5	36 07	153 24	61 34	316 54	13	S							
50	87 11.9	25.2	174 49.9	38 37	155 55	64 04	319 19	15								
18 00	89 41.8	N23 25.2	177 20.3	41 07 N18 38	158 25 N 6 40	66 34 N22 00	321 44 S16 16	Moon's P. in A.								
10	92 11.8	25.2	179 50.7	43 37	160 55	69 05	324 08	17								
20	94 41.8	25.2	182 21.2	46 07	163 26	71 35	326 33	19								
30	97 11.8	25.2	184 51.6	48 37	165 56	74 05	328 57	20								
40	99 41.8	25.2	187 22.0	51 07	168 27	76 36	331 22	22								
50	102 11.7	25.2	189 52.4	53 37	170 57	79 06	333 46	23	0							
19 00	104 41.7	N23 25.2	192 22.8	56 07 N18 37	173 27 N 6 41	81 36 N21 59	336 11 S16 24	10	58	55	33					
10	107 11.7	25.2	194 53.2	58 37	175 58	84 07	338 36	26	14	57	32					
20	109 41.7	25.2	197 23.6	61 07	178 28	86 37	341 00	27	18	56	31					
30	112 11.6	25.2	199 54.0	63 37	180 58	89 07	343 25	29	21	55	30					
40	114 41.6	25.2	202 24.4	66 07	183 29	91 38	345 49	30	23	54	29					
50	117 11.6	25.2	204 54.9	68 37	185 59	94 08	348 14	31	26	53	28					
20 00	119 41.6	N23 25.2	207 25.3	71 07 N18 37	188 29 N 6 41	96 39 N21 59	350 39 S16 33	28	52	61	27					
10	122 11.6	25.2	209 55.7	73 37	191 00	99 09	353 03	34	30	51	63	26				
20	124 41.5	25.2	212 26.1	76 07	193 30	101 39	355 28	35	32	50	64	25				
30	127 11.5	25.2	214 56.5	78 37	196 00	104 10	357 52	37	33	49	65	24				
40	129 41.5	25.2	217 26.9	81 07	198 31	106 40	0 17	38	35	48	67	23				
50	132 11.5	25.2	219 57.3	83 37	201 01	109 10	2 41	39	37	47	68	22				
21 00	134 41.4	N23 25.2	222 27.7	86 07 N18 36	203 31 N 6 41	111 41 N21 59	5 06 S16 41	38	46	69	20					
10	137 11.4	25.2	224 58.1	88 37	206 02	114 11	7 31	42	40	45	70	20				
20	139 41.4	25.2	227 28.5	91 07	208 32	116 41	9 55	43	41	44	71	19				
30	142 11.4	25.2	229 59.0	93 37	211 02	119 12	12 20	45	43	42	72	18				
40	144 41.4	25.2	232 29.4	96 07	213 33	121 42	14 44	46	43	43	72	17				
50	147 11.3	25.2	234 59.8	98 37	216 03	124 12	17 09	47	44	41	74	16				
22 00	149 41.3	N23 25.2	237 30.2	101 07 N18 35	218 34 N 6 41	126 43 N21 59	19 33 S16 49	46	40	47	75	15				
10	152 11.3	25.2	240 00.6	103 37	221 04	129 13	21 58	50	47	40	76	14				
20	154 41.3	25.2	242 31.0	106 07	223 34	131 43	24 23	51	50	38	77	13				
30	157 11.2	25.2	245 01.4	108 37	226 05	134 14	26 47	53	50	37	77	12				
40	159 41.2	25.2	247 31.8	111 07	228 35	136 44	29 12	54	51	36	78	11				
50	162 11.2	25.2	250 02.2	113 37	231 05	139 15	31 36	55	52	35	79	10				
23 00	164 41.2	N23 25.2	252 32.7	116 07 N18 34	233 36 N 6 41	141 45 N21 59	34 01 S16 57	53	53	34	80					
10	167 11.1	25.2	255 03.1	118 37	236 06	144 15	36 25	58	56	33						
20	169 41.1	25.2	257 33.5	121 07	238 36	146 46	38 50	16	59	32						
30	172 11.1	25.2	260 03.9	123 37	241 07	149 16	41 15	17	Sun	SD	15:8					
40	174 41.1	25.2	262 34.3	126 07	243 37	151 46	43 39	02	Moon	SD	16'					
50	177 11.1	25.2	265 04.7	128 37	246 07	154 17	46 04	03								
Rate	14 59.9	0 00.0		15 00.1	50 00.8		15 02.1	NO 00.1		15 02.1	0 00.0		14 27.6	50 08.4		Age 10d

INTERPOLATION OF G.H.A. SUN

	0 ^m	1 ^m	2 ^m	3 ^m	4 ^m	5 ^m	6 ^m	7 ^m	8 ^m	9 ^m	
00	0 00.0	0 15.0	0 30.0	0 45.0	1 00.0	1 15.0	1 30.0	1 45.0	2 00.0	2 15.0	00
01	0 00.3	0 15.3	0 30.3	0 45.3	1 00.3	1 15.3	1 30.3	1 45.3	2 00.3	2 15.3	01
02	0 00.5	0 15.5	0 30.5	0 45.5	1 00.5	1 15.5	1 30.5	1 45.5	2 00.5	2 15.5	02
03	0 00.8	0 15.8	0 30.8	0 45.8	1 00.8	1 15.8	1 30.8	1 45.8	2 00.8	2 15.8	03
04	0 01.0	0 16.0	0 31.0	0 46.0	1 01.0	1 16.0	1 31.0	1 46.0	2 01.0	2 16.0	04
05	0 01.3	0 16.3	0 31.3	0 46.3	1 01.3	1 16.3	1 31.3	1 46.3	2 01.3	2 16.3	05
06	0 01.5	0 16.5	0 31.5	0 46.5	1 01.5	1 16.5	1 31.5	1 46.5	2 01.5	2 16.5	06
07	0 01.8	0 16.8	0 31.8	0 46.8	1 01.8	1 16.8	1 31.8	1 46.8	2 01.8	2 16.8	07
08	0 02.0	0 17.0	0 32.0	0 47.0	1 02.0	1 17.0	1 32.0	1 47.0	2 02.0	2 17.0	08
09	0 02.3	0 17.3	0 32.3	0 47.3	1 02.3	1 17.3	1 32.3	1 47.3	2 02.3	2 17.3	09
10	0 02.5	0 17.5	0 32.5	0 47.5	1 02.5	1 17.5	1 32.5	1 47.5	2 02.5	2 17.5	10
11	0 02.8	0 17.8	0 32.8	0 47.8	1 02.8	1 17.8	1 32.8	1 47.8	2 02.8	2 17.8	11
12	0 03.0	0 18.0	0 33.0	0 48.0	1 03.0	1 18.0	1 33.0	1 48.0	2 03.0	2 18.0	12
13	0 03.3	0 18.3	0 33.3	0 48.3	1 03.3	1 18.3	1 33.3	1 48.3	2 03.3	2 18.3	13
14	0 03.5	0 18.5	0 33.5	0 48.5	1 03.5	1 18.5	1 33.5	1 48.5	2 03.5	2 18.5	14
15	0 03.8	0 18.8	0 33.8	0 48.8	1 03.8	1 18.8	1 33.8	1 48.8	2 03.8	2 18.8	15
16	0 04.0	0 19.0	0 34.0	0 49.0	1 04.0	1 19.0	1 34.0	1 49.0	2 04.0	2 19.0	16
17	0 04.3	0 19.3	0 34.3	0 49.3	1 04.3	1 19.3	1 34.3	1 49.3	2 04.3	2 19.3	17
18	0 04.5	0 19.5	0 34.5	0 49.5	1 04.5	1 19.5	1 34.5	1 49.5	2 04.5	2 19.5	18
19	0 04.8	0 19.8	0 34.8	0 49.8	1 04.8	1 19.8	1 34.8	1 49.8	2 04.8	2 19.8	19
20	0 05.0	0 20.0	0 35.0	0 50.0	1 05.0	1 20.0	1 35.0	1 50.0	2 05.0	2 20.0	20
21	0 05.3	0 20.3	0 35.3	0 50.3	1 05.3	1 20.3	1 35.3	1 50.3	2 05.3	2 20.3	21
22	0 05.5	0 20.5	0 35.5	0 50.5	1 05.5	1 20.5	1 35.5	1 50.5	2 05.5	2 20.5	22
23	0 05.8	0 20.8	0 35.8	0 50.8	1 05.8	1 20.8	1 35.8	1 50.8	2 05.8	2 20.8	23
24	0 06.0	0 21.0	0 36.0	0 51.0	1 06.0	1 21.0	1 36.0	1 51.0	2 06.0	2 21.0	24
25	0 06.3	0 21.3	0 36.3	0 51.3	1 06.3	1 21.3	1 36.3	1 51.3	2 06.3	2 21.3	25
26	0 06.5	0 21.5	0 36.5	0 51.5	1 06.5	1 21.5	1 36.5	1 51.5	2 06.5	2 21.5	26
27	0 06.8	0 21.8	0 36.8	0 51.8	1 06.8	1 21.8	1 36.8	1 51.8	2 06.8	2 21.8	27
28	0 07.0	0 22.0	0 37.0	0 52.0	1 07.0	1 22.0	1 37.0	1 52.0	2 07.0	2 22.0	28
29	0 07.3	0 22.3	0 37.3	0 52.3	1 07.3	1 22.3	1 37.3	1 52.3	2 07.3	2 22.3	29
30	0 07.5	0 22.5	0 37.5	0 52.5	1 07.5	1 22.5	1 37.5	1 52.5	2 07.5	2 22.5	30
31	0 07.8	0 22.8	0 37.8	0 52.8	1 07.8	1 22.8	1 37.8	1 52.8	2 07.8	2 22.8	31
32	0 08.0	0 23.0	0 38.0	0 53.0	1 08.0	1 23.0	1 38.0	1 53.0	2 08.0	2 23.0	32
33	0 08.3	0 23.3	0 38.3	0 53.3	1 08.3	1 23.3	1 38.3	1 53.3	2 08.3	2 23.3	33
34	0 08.5	0 23.5	0 38.5	0 53.5	1 08.5	1 23.5	1 38.5	1 53.5	2 08.5	2 23.5	34
35	0 08.8	0 23.8	0 38.8	0 53.8	1 08.8	1 23.8	1 38.8	1 53.8	2 08.8	2 23.8	35
36	0 09.0	0 24.0	0 39.0	0 54.0	1 09.0	1 24.0	1 39.0	1 54.0	2 09.0	2 24.0	36
37	0 09.3	0 24.3	0 39.3	0 54.3	1 09.3	1 24.3	1 39.3	1 54.3	2 09.3	2 24.3	37
38	0 09.5	0 24.5	0 39.5	0 54.5	1 09.5	1 24.5	1 39.5	1 54.5	2 09.5	2 24.5	38
39	0 09.8	0 24.8	0 39.8	0 54.8	1 09.8	1 24.8	1 39.8	1 54.8	2 09.8	2 24.8	39
40	0 10.0	0 25.0	0 40.0	0 55.0	1 10.0	1 25.0	1 40.0	1 55.0	2 10.0	2 25.0	40
41	0 10.3	0 25.3	0 40.3	0 55.3	1 10.3	1 25.3	1 40.3	1 55.3	2 10.3	2 25.3	41
42	0 10.5	0 25.5	0 40.5	0 55.5	1 10.5	1 25.5	1 40.5	1 55.5	2 10.5	2 25.5	42
43	0 10.8	0 25.8	0 40.8	0 55.8	1 10.8	1 25.8	1 40.8	1 55.8	2 10.8	2 25.8	43
44	0 11.0	0 26.0	0 41.0	0 56.0	1 11.0	1 26.0	1 41.0	1 56.0	2 11.0	2 26.0	44
45	0 11.3	0 26.3	0 41.3	0 56.3	1 11.3	1 26.3	1 41.3	1 56.3	2 11.3	2 26.3	45
46	0 11.5	0 26.5	0 41.5	0 56.5	1 11.5	1 26.5	1 41.5	1 56.5	2 11.5	2 26.5	46
47	0 11.8	0 26.8	0 41.8	0 56.8	1 11.8	1 26.8	1 41.8	1 56.8	2 11.8	2 26.8	47
48	0 12.0	0 27.0	0 42.0	0 57.0	1 12.0	1 27.0	1 42.0	1 57.0	2 12.0	2 27.0	48
49	0 12.3	0 27.3	0 42.3	0 57.3	1 12.3	1 27.3	1 42.3	1 57.3	2 12.3	2 27.3	49
50	0 12.5	0 27.5	0 42.5	0 57.5	1 12.5	1 27.5	1 42.5	1 57.5	2 12.5	2 27.5	50
51	0 12.8	0 27.8	0 42.8	0 57.8	1 12.8	1 27.8	1 42.8	1 57.8	2 12.8	2 27.8	51
52	0 13.0	0 28.0	0 43.0	0 58.0	1 13.0	1 28.0	1 43.0	1 58.0	2 13.0	2 28.0	52
53	0 13.3	0 28.3	0 43.3	0 58.3	1 13.3	1 28.3	1 43.3	1 58.3	2 13.3	2 28.3	53
54	0 13.5	0 28.5	0 43.5	0 58.5	1 13.5	1 28.5	1 43.5	1 58.5	2 13.5	2 28.5	54
55	0 13.8	0 28.8	0 43.8	0 58.8	1 13.8	1 28.8	1 43.8	1 58.8	2 13.8	2 28.8	55
56	0 14.0	0 29.0	0 44.0	0 59.0	1 14.0	1 29.0	1 44.0	1 59.0	2 14.0	2 29.0	56
57	0 14.3	0 29.3	0 44.3	0 59.3	1 14.3	1 29.3	1 44.3	1 59.3	2 14.3	2 29.3	57
58	0 14.5	0 29.5	0 44.5	0 59.5	1 14.5	1 29.5	1 44.5	1 59.5	2 14.5	2 29.5	58
59	0 14.8	0 29.8	0 44.8	0 59.8	1 14.8	1 29.8	1 44.8	1 59.8	2 14.8	2 29.8	59
60	0 15.0	0 30.0	0 45.0	1 00.0	1 15.0	1 30.0	1 45.0	2 00.0	2 15.0	2 30.0	60

TABLE 6.—Refraction

To be subtracted from sextant altitude

R ₀	Height above sea level in thousands of feet											
	0	5	10	15	20	25	30	35	40	45	50	55
	Sextant Altitude											
0	90	90	90	90	90	90	90	90	90	90	90	90
1	63	59	55	51	46	41	36	31	26	20	17	13
2	33	29	26	22	19	16	14	11	9	7	6	4
3	21	19	16	14	12	10	8	7	5	4	2 40	1 40
4	16	14	12	10	8	7	6	5	3 10	2 20	1 30	0 40
5	12	11	9	8	7	5	4 00	3 10	2 10	1 30	0 39	+0 05
6	10	9	7	5 50	4 50	3 50	3 10	2 20	1 30	0 49	+0 11	-0 19
7	8 10	6 50	5 50	4 50	4 00	3 00	2 20	1 50	1 10	0 24	-0 11	-0 36
8	6 50	5 50	5 00	4 00	3 10	2 30	1 50	1 20	0 38	+0 04	-0 28	-0 54
9	6 00	5 10	4 10	3 20	2 40	2 00	1 30	1 00	0 19	-0 13	-0 42	-1 08
10	5 20	4 30	3 40	2 50	2 10	1 40	1 10	0 35	+0 03	-0 27	-0 53	-1 18
12	4 30	3 40	2 50	2 20	1 40	1 10	0 37	+0 11	-0 16	-0 43	-1 08	-1 31
14	3 30	2 50	2 10	1 40	1 10	0 34	+0 09	-0 14	-0 37	-1 00	-1 23	-1 44

Reprinted from the Air Almanac, published by the U.S. Naval Observatory; Nautical Almanac Office.

CORRECTIONS TO BE APPLIED TO MARINE SEXTANT ALTITUDES

MARINE SEXTANT ERROR	CORRECTIONS	CORRECTION FOR DIP OF THE HORIZON										
		To be subtracted from sextant altitude										
		Ht. Dip		Ht. Dip		Ht. Dip		Ht. Dip		Ht. Dip		
Sextant Number	In addition to sextant error and dip, corrections are to be applied for: Refraction Semi-diameter (for the Sun and Moon) Parallax (for the Moon) Dome refraction (if applicable)	Ft.	Dip	Ft.	Dip	Ft.	Dip	Ft.	Dip	Ft.	Dip	
Index Error		0	1	114	11	437	21	968	31	1 707	41	2 655
		2	2	137	12	481	22	1 033	32	1 792	42	2 792
		6	3	162	13	527	23	1 099	33	1 880	43	2 937
		12	4	189	14	575	24	1 168	34	1 970	44	3 084
		21	5	218	15	625	25	1 239	35	2 061	45	3 231
		31	6	250	16	677	26	1 311	36	2 155	46	3 381
		43	7	283	17	731	27	1 386	37	2 251	47	3 531
		58	8	318	18	787	28	1 463	38	2 349	48	3 681
		75	9	356	19	845	29	1 543	39	2 449	49	3 831
		93	10	395	20	906	30	1 624	40	2 551	50	3 981
	114		437		968		1 707		2 655			

Reprinted from the Air Almanac, published by the U.S. Naval Observatory; Nautical Almanac Office.

N. Lat. LHA greater than 180° 2m=2
 LHA less than 180° 2m=360-2

DECLINATION (15°-29°) SAME NAME AS LATITUDE

LHA	15°		16°		17°		18°		19°		20°		21°		22°		23°		24°		25°		26°		27°		28°		29°		LHA																																																																				
	Hc	d	Hc	d	Hc	d	Hc	d	Hc	d	Hc	d	Hc	d	Hc	d	Hc	d	Hc	d	Hc	d	Hc	d	Hc	d	Hc	d	Hc	d																																																																					
0	67 00	+60	180	68 00	+60	180	69 00	+60	180	70 00	+60	180	71 00	+60	180	72 00	+60	180	73 00	+60	180	74 00	+60	180	75 00	+60	180	76 00	+60	180	77 00	+60	180	78 00	+60	180	79 00	+60	180	80 00	+60	180	81 00	+60	180	82 00	+60	180	83 00	+60	180	84 00	+60	180	85 00	+60	180	86 00	+60	180	87 00	+60	180	88 00	+60	180	89 00	+60	180	90 00	+60	360																											
1	66 59	+60	178	67 59	+60	177	68 59	+60	177	69 59	+60	177	70 59	+60	177	71 59	+60	177	72 59	+60	177	73 59	+60	177	74 59	+60	177	75 59	+60	177	76 59	+60	177	77 59	+60	177	78 59	+60	177	79 59	+60	177	80 59	+60	177	81 59	+60	177	82 59	+60	177	83 59	+60	177	84 59	+60	177	85 59	+60	177	86 59	+60	177	87 59	+60	177	88 59	+60	177	89 59	+60	177	90 59	+60	359																								
2	66 56	+60	175	67 56	+60	175	68 56	+60	175	69 56	+60	175	70 56	+60	175	71 56	+60	175	72 56	+60	175	73 56	+60	175	74 56	+60	175	75 56	+60	175	76 56	+60	175	77 56	+60	175	78 56	+60	175	79 56	+60	175	80 56	+60	175	81 56	+60	175	82 56	+60	175	83 56	+60	175	84 56	+60	175	85 56	+60	175	86 56	+60	175	87 56	+60	175	88 56	+60	175	89 56	+60	175	90 56	+60	358																								
3	66 51	+60	173	67 51	+60	172	68 50	+60	172	69 50	+60	172	70 49	+60	171	71 49	+60	171	72 48	+60	171	73 48	+60	171	74 47	+60	171	75 47	+60	171	76 46	+60	171	77 46	+60	171	78 45	+60	171	79 45	+60	171	80 45	+60	171	81 45	+60	171	82 45	+60	171	83 45	+60	171	84 45	+60	171	85 45	+60	171	86 45	+60	171	87 45	+60	171	88 45	+60	171	89 45	+60	171	90 45	+60	357																								
4	66 44	+60	170	67 43	+60	170	68 43	+60	169	69 43	+60	169	70 43	+60	169	71 43	+60	169	72 43	+60	169	73 43	+60	169	74 43	+60	169	75 43	+60	169	76 43	+60	169	77 43	+60	169	78 43	+60	169	79 43	+60	169	80 43	+60	169	81 43	+60	169	82 43	+60	169	83 43	+60	169	84 43	+60	169	85 43	+60	169	86 43	+60	169	87 43	+60	169	88 43	+60	169	89 43	+60	169	90 43	+60	356																								
5	66 35	+59	168	67 34	+59	167	68 33	+59	167	69 32	+58	166	70 30	+59	166	71 29	+59	165	72 28	+58	164	73 26	+58	164	74 24	+58	163	75 22	+58	162	76 20	+57	161	77 17	+57	159	78 14	+56	158	79 10	+55	156	80 05	+54	154	80 00	+53	153	80 00	+52	152	80 00	+51	151	80 00	+50	150	80 00	+49	149	80 00	+48	148	80 00	+47	147	80 00	+46	146	80 00	+45	145	80 00	+44	144	80 00	+43	143	80 00	+42	142	80 00	+41	141	80 00	+40	355												
6	66 24	+58	165	67 22	+58	165	68 21	+58	164	69 19	+58	164	70 18	+58	163	71 16	+58	162	72 14	+57	161	73 11	+57	160	74 09	+57	159	75 06	+56	158	76 02	+56	157	76 58	+56	156	77 54	+55	155	78 50	+55	154	79 45	+54	153	80 40	+54	152	81 35	+54	151	82 30	+53	150	83 25	+53	149	84 20	+53	148	85 15	+52	147	86 10	+52	146	87 05	+52	145	88 00	+51	144	89 00	+51	143	90 00	+51	354																					
7	66 11	+58	163	67 09	+58	162	68 07	+58	162	69 05	+58	161	70 03	+57	160	71 00	+57	159	72 00	+57	158	73 00	+57	157	74 00	+56	156	75 00	+56	155	76 00	+55	154	77 00	+55	153	78 00	+54	152	79 00	+54	151	80 00	+53	150	81 00	+53	149	82 00	+52	148	83 00	+52	147	84 00	+51	146	85 00	+51	145	86 00	+51	144	87 00	+50	143	88 00	+50	142	89 00	+50	141	90 00	+50	353																								
8	65 56	+58	161	66 54	+58	160	67 51	+58	159	68 49	+57	159	69 46	+57	158	70 43	+57	157	71 39	+56	156	72 35	+56	155	73 31	+56	154	74 26	+55	153	75 22	+55	152	76 18	+54	151	77 14	+54	150	78 09	+54	149	79 05	+53	148	80 00	+53	147	81 00	+52	146	82 00	+52	145	83 00	+51	144	84 00	+51	143	85 00	+51	142	86 00	+50	141	87 00	+50	140	88 00	+50	139	89 00	+50	138	90 00	+50	352																					
9	65 40	+57	159	66 37	+57	158	67 34	+57	157	68 31	+57	156	69 27	+57	155	70 23	+56	154	71 18	+56	153	72 14	+55	152	73 08	+55	151	74 02	+55	150	75 00	+54	149	75 55	+54	148	76 50	+53	147	77 45	+53	146	78 40	+52	145	79 35	+52	144	80 30	+52	143	81 25	+51	142	82 20	+51	141	83 15	+51	140	84 10	+50	139	85 05	+50	138	86 00	+50	137	87 00	+49	136	88 00	+49	135	89 00	+49	134	90 00	+49	351																		
10	65 22	+56	156	66 18	+56	156	67 14	+56	155	68 10	+56	154	69 06	+55	153	70 01	+55	152	70 56	+55	151	71 50	+54	150	72 44	+54	149	73 37	+54	148	74 29	+53	147	75 20	+53	146	76 10	+53	145	77 00	+52	144	77 50	+52	143	78 40	+52	142	79 30	+51	141	80 20	+51	140	81 10	+51	139	82 00	+50	138	83 00	+50	137	84 00	+50	136	85 00	+49	135	86 00	+49	134	87 00	+49	133	88 00	+49	132	89 00	+49	131	90 00	+49	350															
11	65 02	+56	154	65 58	+56	153	66 53	+56	152	67 49	+56	151	68 45	+55	150	69 40	+55	149	70 35	+54	148	71 29	+54	147	72 22	+54	146	73 15	+53	145	74 07	+53	144	75 00	+52	143	75 50	+52	142	76 40	+52	141	77 30	+51	140	78 20	+51	139	79 10	+51	138	80 00	+51	137	81 00	+50	136	82 00	+50	135	83 00	+50	134	84 00	+50	133	85 00	+49	132	86 00	+49	131	87 00	+49	130	88 00	+49	129	89 00	+49	128	90 00	+49	349															
12	64 40	+56	152	65 36	+56	151	66 31	+56	150	67 25	+56	149	68 19	+55	148	69 13	+55	147	70 05	+55	146	70 58	+54	145	71 49	+54	144	72 40	+53	143	73 29	+53	142	74 18	+53	141	75 05	+52	140	75 50	+52	139	76 35	+52	138	77 20	+51	137	78 05	+51	136	78 50	+51	135	79 35	+51	134	80 20	+50	133	81 05	+50	132	82 00	+50	131	83 00	+50	130	84 00	+49	129	85 00	+49	128	86 00	+49	127	87 00	+49	126	88 00	+49	125	89 00	+49	124	90 00	+49	348									
13	64 17	+55	150	65 12	+56	149	66 06	+56	148	67 00	+56	147	67 53	+55	146	68 46	+55	145	69 38	+55	144	70 29	+54	143	71 19	+54	142	72 09	+53	141	72 98	+53	140	73 87	+52	139	74 75	+52	138	75 63	+52	137	76 50	+51	136	77 37	+51	135	78 25	+51	134	79 13	+51	133	80 01	+50	132	80 50	+50	131	81 38	+50	130	82 26	+50	129	83 15	+50	128	84 03	+50	127	84 52	+50	126	85 41	+50	125	86 30	+49	124	87 19	+49	123	88 08	+49	122	88 57	+49	121	89 46	+49	120	90 35	+49	347			
14	63 53	+54	148	64 47	+55	147	65 40	+55	146	66 33	+55	145	67 26	+54	144	68 17	+54	143	69 08	+54	142	69 98	+53	141	70 49	+53	140	71 39	+53	139	72 29	+52	138	73 18	+52	137	74 07	+52	136	74 96	+51	135	75 85	+51	134	76 74	+51	133	77 63	+50	132	78 52	+50	131	79 41	+50	130	80 30	+50	129	81 20	+50	128	82 09	+50	127	82 58	+49	126	83 48	+49	125	84 37	+49	124	85 27	+49	123	86 17	+49	122	87 07	+49	121	87 57	+49	120	88 47	+49	119	89 37	+49	118	90 27	+49	346			
15	63 27	+53	146	64 20	+53	145	65 13	+53	144	66 05	+53	143	66 57	+53	142	67 48	+52	141	68 39	+52	140	69 30	+52	139	70 21	+51	138	71 12	+51	137	72 03	+51	136	72 53	+50	135	73 44	+50	134	74 35	+50	133	75 26	+50	132	76 17	+49	131	77 08	+49	130	77 59	+49	129	78 50	+49	128	79 41	+49	127	80 32	+49	126	81 23	+49	125	82 14	+49	124	83 05	+49	123	83 56	+49	122	84 47	+49	121	85 38	+49	120	86 29	+49	119	87 20	+49	118	88 11	+49	117	89 02	+49	116	89 53	+49	115	90 44	+49	345
16	63 00	+53	144	63 53	+53	143	64 45	+53	142	65 36																																																																																									

