

# Two More Moon Tracking Computer Programs



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The first moon tracking computer program included here was rewritten from WA1JXN/WA3GPL and K5JL versions presented in earlier issues of the EME notes. Warren Butler, W2WD, wrote the program for TRS-80 level II BASIC(16K). Cassette copies of the program are available from Warren for the cost of the cassette and postage (approximately \$1.00).

The second program was written in FORTRAN IV by Geoffrey Grayer, G3NAQ. Again the WA1JXN/WA3GPL program served as the starting point for this effort.

COORDINATES OF THE MOON

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10 '
20 PRINT
30 ' DISPLAYS GHA, DECLINATION, AZIMUTH, ELEVATION OF THE MOON
40 ' FROM A SELECTED LATITUDE, LONGITUDE FOR SELECTED DATES
50 ' AND TIMES (GMT). EASTERN STANDARD TIME IS SHOWN BUT CAN BE CHANGED--
60 ' @ LINE 2040, CHANGE 500 TO TIME DIFFERENTIAL DESIRED--
70 ' EG., FOR PACIFIC STANDARD TIME, USE 800 IN PLACE OF 500.
80 ' @ LINES 850 & 860 CHANGE EST TO TIME ZONE DESIRED--
90 ' EG., REPLACE EST WITH PST FOR THE EXAMPLE BEING USED.
100 ' HARDCOPY OUTPUT CAN BE SELECTED IF PRINTER IS AVAILABLE;
110 ' OTHERWISE, DATA WILL BE DISPLAYED ON CRT ONLY.
120 PRINT
130 ' BASED ON PROGRAMS BY LANCE COLLISTER, WAIJXN/WA3GPL AND
140 ' JAY LIEBMANN, K5JL.
150 ' MODIFIED FOR TRS-80 LEVEL II BASIC (16K) BY WARREN BUTLER,W2WD
160 PRINT (4/4/79).
170 ' DATA FOR UP TO 31 DAYS CAN BE REQUESTED---EACH TIME THE
180 ' COMPUTER ASKS FOR AN INPUT BY PRINTING ?, ENTER DATA IN
190 ' THE FORMAT REQUESTED. AFTER THE LAST INPUT, INSERT ZEROS
200 ' IN THE SAME FORMAT.
210 ' ANSWER OTHER QUESTIONS AS APPROPRIATE
220 ' UNIVERSAL WINDOWS ARE SHOWN BY LETTERS FOLLOWING DEC VALUES
230 ' U = EUROPEAN UNIVERSAL WINDOW
240 ' W = W/VE UNIVERSAL WINDOW
250 ' J = J/VK/ZL UNIVERSAL WINDOW
260 CLEAR 500
270 DIM F(31),V(31),Y(31),Q(31),S(31)
280 P5=2.598006535962238*3.1415926535
290 D5=360.000000000000/P5
300 R5=P5/360.000000000000
310 CLS:PRINT:PRINT:PRINT:PRINT"WHAT ARE THE STATION CALL LETTERS";
320 INPUT W$
330 PRINT"WHAT IS YOUR LATITUDE IN DEGREES, MINUTES";
340 INPUT L5,U5
350 PRINT"WHAT IS YOUR LONGITUDE IN DEGREES, MINUTES";
360 INPUT L6,U6
370 L5=(L5+U5/60)*R5
380 L6=(L6+U6/60)*R5
390 PRINT"WHAT IS THE DESIRED PRINTING INCREMENT IN MINUTES";
400 INPUT I
410 INPUT"DO YOU ONLY WANT PRINTOUT WHEN THE MOON IS NEAR THE HORIZON
    0)";B$ (YES;
430 IF B$="YES" THEN 460
440 LET I6=100
450 GOTO 550
460 INPUT"BELOW WHAT ELEVATION IN DEGREES DO YOU WANT PRINTOUT";I6
470 INPUT"DO YOU WANT HARDCOPY PRINTOUT (YES/NO)";WW$
480 PRINT"WHAT ARE THE GMT MONTH, DAY, YEAR DESIRED?"
490 PRINT"USE FORMAT MM,DD,YYYY ---- 4-DIGITS FOR YEAR"
500 FOR N=1 TO 31

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51# INPUT F(N), V(N), Y(N)
52# IF F(N)=# THEN 64#
53# NEXT N
54# GOTO 5#
55# INPUT"DO YOU WANT HARDCOPY (YES/NO)";WW$
56# PRINT
57# PRINT"WHAT ARE THE GMT MONTH, DAY, YEAR, TIME BEGINNING, TIME ENDING?"
58# PRINT"USE THE FORMAT MM,DD,YYYY,TTTT,TTTT
REMINDER --- USE 4 DIGITS FOR YEAR!"
59# FOR N=1TO31
60# INPUT F(N), V(N), Y(N), Q(N), S(N)
61# IF F(N)=# THEN 64#
62# NEXT N
63# GOTO 59#
64# N5=N-1
65# FOR N=1 TO N5
66# IF B$="YES" THEN 68#
67# GOTO 71#
68# E1=24##
69# B=#
70# GOTO 73#
71# E1=S(N)
72# B=Q(N)
73# M=F(N)
74# D=V(N)
75# Y=Y(N)
76# Y1=Y-(INT(Y/1##):1##)
77# PRINT
78# IF WW$="YES" LPRINT
79# PRINT:CLS
80# IF WW$="YES" LPRINT
81# PRINT"POSITION OF THE MOON ON ";M;"/";D;"/";Y1;" GMT FROM"" "W$
82# IF WW$="YES" LPRINT"POSITION OF THE MOON ON ";M;"/";D;"/";Y1;" GMT FROM"" "W
$
83# PRINT
84# IF WW$="YES" LPRINT
85# PRINT"GMT"TAB(11)"GHA"TAB(21)"DEC"TAB(35)"EST"TAB(47)"AZ"TAB(57)"EL"
86# IF WW$="YES" LPRINT"GMT"TAB(11)"GHA"TAB(21)"DEC"TAB(35)"EST"TAB(47)"AZ"TAB(5
7)"EL"
87# PRINT
88# IF WW$="YES" LPRINT
89# I1=2
90# IF M>=3 THEN 98#
91# IF INT((Y-1853)/4)<11 THEN 94#
92# C1=-1
93# GOTO 95#
94# C1=#
95# J1=365*(Y-1853)+D+3*(M+9)+INT((M+1)/2)
96# J2=INT((Y-1853)/4)+1+C1
97# GOTO 1#9#
98# IF INT((Y-1852)/4)<11 THEN 1#1#
99# C1=-1
1## GOTO 1#2#

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2010 Y$="J"
2020 GOTO 2040
2030 Y$=" "
2040 ES=(INT(B+.5))-500
2050 IF ES<=0 THEN ES=ES+2400
2060 ES$=":::##"
2070 PRINT USING BS$;BS;:PRINTTAB(10)Z3TAB(20)Z4;Y$TAB(35)USING ES$;ES;:PRINTTAB(45)
    Z1TAB(55)Z2
2080 IF WW$="YES" LPRINT USING BS$;BS;:LPRINTTAB(10)Z3TAB(20)Z4;Y$TAB(35)USING ES$;
    ES;:LPRINTTAB(45)Z1TAB(55)Z2
2090 I1=T
2100 B=B+I
2110 Z=(B-INT(B/100)::100)-60
2120 IF Z<0 THEN 1110
2130 B=INT(B/100)::100+100+Z
2140 GOTO 1110
2150 NEXT N
2160 N=0
2170 PRINT
2180 PRINT
2190 PRINT"DO YOU WANT MORE INFORMATION (YES/NO)";
2200 INPUT D$
2210 IF D$="YES" THEN 280
2220 END

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POSITION OF THE MOON ON 5 / 19 / 79 GMT FROM W2WD

GMT	GHA	DEC	EDT	AZ	EL
*615	357.4	-10	*215	106	2.2
*630	1	-9.9	*230	108.4	4.9
*645	4.6	-9.9	*245	110.8	7.5
*700	8.2	-9.8	*300	113.4	10.1
*715	11.8	-9.8	*315	115.9	12.6
*730	15.4	-9.8	*330	118.6	15.1
*745	19.1	-9.7	*345	121.3	17.5
*800	22.7	-9.7	*400	124.2	19.8
*815	26.3	-9.6	*415	127.2	22.1
*830	29.9	-9.6	*430	130.3	24.3
*845	33.5	-9.6	*445	133.5	26.4
*900	37.1	-9.5	*500	136.9	28.4
*915	40.8	-9.5	*515	140.4	30.3
*930	44.4	-9.4	*530	144.1	32
*945	48	-9.4	*545	147.9	33.6
1000	51.6	-9.4	*600	151.9	35
1015	55.2	-9.3	*615	156.1	36.2
1030	58.8	-9.3	*630	160.4	37.3
1045	62.5	-9.2	*645	164.8	38.2
1100	66.1	-9.2	*700	169.3	38.8
1115	69.7	-9.1	*715	174	39.3
1130	73.3	-9.1	*730	178.6	39.5
1145	76.9	-9.1	*745	183.3	39.5
1200	80.5	-9	*800	188	39.3
1215	84.2	-9	*815	192.6	38.8
1230	87.8	-8.9	*830	197.1	38.2
1245	91.4	-8.9	*845	201.5	37.3
1300	95	-8.9	*900	205.8	36.2
1315	98.6	-8.8	*915	210	35
1330	102.2	-8.8	*930	214	33.5
1345	105.9	-8.7	*945	217.9	31.9
1400	109.5	-8.7	1000	221.5	30.2
1415	113.1	-8.6	1015	225.1	28.3
1430	116.7	-8.6	1030	228.5	26.4
1445	120.3	-8.6	1045	231.7	24.3
1500	123.9	-8.5	1100	234.8	22.1
1515	127.6	-8.5	1115	237.8	19.8
1530	131.2	-8.4	1130	240.7	17.5
1545	134.8	-8.4	1145	243.5	15.1
1600	138.4	-8.4	1200	246.2	12.6
1615	142	-8.3	1215	248.8	10.1
1630	145.6	-8.3	1230	251.4	7.6
1645	149.3	-8.2	1245	253.9	4.9
1700	152.9	-8.2	1300	256.3	2.3

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1010 C1=0
1020 IF M=9 THEN 1060
1030 IF M=11 THEN 1060
1040 C2=0
1050 GOTO 1070
1060 C2=1
1070 J1=365*(Y-1852)+D+3*(M-3)+INT((M-2)/2)
1080 J2=INT((Y-1852)/4)+C1+C2
1090 J=J1+J2
1100 T1=J-17472.5
1110 D9=(B-INT(B/100))*100+INT(B/100)*60
1120 D6=(E1-INT(E1/100))*100+INT(E1/100)*60
1130 D7=D9-D6
1140 D8=D7-I
1150 IF D7>0 THEN 1170
1160 GOTO 1190
1170 IF D8>=0 THEN 2150
1180 B=E1
1190 T=(B-INT(B/100))*100/144+INT(B/100)/24
1200 T5=T+T
1210 K1=((.751213+.036601102*T5)-INT(.751213+.036601102*T5))*P5
1220 K2=((.822513+.0362916457*T5)-INT(.822513+.0362916457*T5))*P5
1230 K3=((.995766+.0273777852*T5)-INT(.995766+.0273777852*T5))*P5
1240 K4=((.974271+.0338631922*T5)-INT(.974271+.0338631922*T5))*P5
1250 K5=((.0312525+.0367481957*T5)-INT(.0312525+.0367481957*T5))*P5
1260 L8=K1+.658*R5*SIN(2*K4)+6.289*R5*SIN(K2)
1270 L8=L8-1.274*R5*SIN(K2-2*K4)-.186*R5*SIN(K3)
1280 L8=L8+.214*R5*SIN(2*K2)-.114*R5*SIN(2*K5)
1290 L8=L8-.059*R5*SIN(2*K2-2*K4)-.057*R5*SIN(K2+K3-2*K4)
1300 K6=K5+.6593*R5*SIN(2*K4)+6.2303*R5*SIN(K2)-1.272*R5*SIN(K2-2*K4)
1310 L7=5.144*R5*SIN(K6)-.146*R5*SIN(K5-2*K4)
1320 LET D1=COS(L7)*SIN(L8)*.397821+SIN(L7)*.917463
1330 LET D1=ATN(D1/(SQR(1-D1^2)))
1340 G1=50+.5+((D1)/(.792))*D5
1350 G2=80+((D1)/(.808))*D5
1360 G3=141.5-((D1)*(.738))*D5
1370 G4=170.5-((D1)*(.857))*D5
1380 A2=COS(L7)*COS(L8)/COS(D1)
1390 A1=(COS(L7)*SIN(L8)*.917463-SIN(L7)*.397821)/COS(D1)
1400 A=ATN(A1/A2)
1410 GOSUB 1670
1420 R1=A
1430 L1=.065709822*T1
1440 L=L*24*1.02738+6.646055+(L1-INT(L1/24)*24)
1450 L=(L-INT(L/24)*24)
1460 G=(L/24)*P5-R1
1470 IF G<P5 THEN 1500
1480 G=G-P5
1490 GOTO 1530
1500 IF G<0 THEN 1520

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151# GOTO 153#
152# G=G+P5
153# H=L6-G
154# E3=COS(L5)**COS(H)**COS(D1)+SIN(D1)**SIN(L5)
155# E2=SQR(1-(E3**E3))
156# E=ATN((E3/E2)-(1/(61.33**E2)))
157# F=ATN(E3/E2)
158# IF E<# THEN 21#
159# IF E>I6**R5 THEN 21#
160# A2=SIN(D1)/(COS(L5)**COS(F))
161# A2=A2-(SIN(L5)/COS(L5))**(SIN(F)/COS(F))
162# A1=SIN(L5)**SIN(D1)+COS(L5)**COS(D1)**COS(H)
163# A1=(SIN(H)**COS(D1))/SQR(1-A1**2)
164# A=ATN(A1/A2)
165# GOSUB 167#
166# GOTO 182#
167# IF A=# THEN 169#
168# GOTO 173#
169# IF A2<# THEN 171#
170# GOTO 181#
171# A=P5/2
172# GOTO 181#
173# IF A># THEN 179#
174# IF A2<# THEN 177#
175# A=P5+A
176# GOTO 181#
177# A=P5+(A-P5/2)
178# GOTO 181#
179# IF A2=># THEN 181#
180# A=A+P5/2
181# RETURN
182# IF (T-I1)>(2**I)/144# THEN 184#
183# GOTO 185#
184# PRINT
185# BS=INT(B+.5):BS$=":::##"
186# Z1=INT(A**D5**1#+.5)/1#
187# Z2=INT(E**D5**1#+.5)/1#
188# Z3=INT(G**D5**1#+.5)/1#
189# Z4=INT(D1**D5**1#+.5)/1#
190# IF Z4<# THEN 2#3#
191# IF Z3<G1 THEN 2#3#
192# IF Z3>G2 THEN 194#
193# GOTO 197#
194# IF Z3<G3 THEN 199#
195# IF Z3>G4 THEN 2#3#
196# GOTO 2#1#
197# Y$="U"
198# GOTO 2#4#
199# Y$="W"
200# GOTO 2#4#

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C THIS PROGRAM IS DESIGNED TO CALCULATE THE AZIMUTH AND ELEVATION OF THE MOON
C THIS IS A FORTRAN VERSION OF PROGRAM 3 OF THE EIMAC EME NOTE AS-49-6
C ORIGINALLY WRITTEN BY LANCE COLLISTER WA3GPL, CONVERTED BY GEOFF GRAYER G3NAQ.
C THE INPUT FORMAT IS AS FOLLOWS...
C FIRST DATA CARD:
C OPTIONAL IDENTIFICATION (A10), LAT. OF STATION DEGS.(I10), LAT. OF STATION
C MINS. (I10), LONG. OF STATION DEGS. (I10), LONG. OF STATION MINS. (I10).
C SECOND AND SUBSEQUENT DATA CARDS:
C YEAR (I10), MONTH (I10), DAY (I10), START HRS-MINS.(I10), STOP HRS-MINS.(I10)
C TIME INCREMENT MINS.(I10) = DEFAULT 10 MINS., MAXIMUM ELEVATION DEGS. (I10) =
C MAY BE USED TO SELECT PRINTOUT ONLY WHEN THE MOON IS NEAR THE HORIZON =
C DEFAULT 90 DEGS.
C ALL TIMES ARE IN GMT USING THE 0000 TO 2400 HOUR SYSTEM.
C A BLANK CARD DENOTES THE END OF THE DATA SET AND TERMINATES THE PROGRAM.
C PRINTOUT IS SUSPENDED WHENEVER THE ELEVATION OF THE MOON IS NEGATIVE.
C FOR FURTHER INFORMATION, REFER TO THE EIMAC NOTE.
C
C GEOFFREY H. GRAYER G3NAQ
C BRIGHTWALTON, BERKSHIRE
C APRIL, 1978
C
C CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC

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INTEGER D,Y,C1,C2,B,L,E1,D6,D7,D8,D9,GMT
REAL PI,P5,D5,H5,K1,K2,K3,K4,K5,L8,K6,L7,D1,A1,A2,A,L1,L,E3,E2
REAL L5,L6,I1
REAL*4 JU
DIMENSION IDENT(10),GMT(4)
FNA(X)=AINT(X*D5*10.+0.5)/10.
FNB(X)=(X-AINT(X))*P5
PI=3.1415926535
P5=2.*PI
D5=180./PI
H5=PI/180.

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0016

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C READ STATION IDENT, LAT DEGS, LAT MINS, LONG DEGS, LONG MINS
READ (5,1) IDENT,LATD,LATM,LONGD,LONGM
1 FORMAT (10A1,4I10)
L5=(LATD+LATM/60.)*H5
L6=(LONGD+LONGM/60.)*H5
10 CONTINUE

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0023

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C READ YEAR,MONTH,DAY,(START TIME GMT),(END TIME GMT),(TIME INCREMENT MINS),
C (MAXIMUM ELEVATION DEGS )
READ (5,2) Y,M,D,D,E1,I,I6
2 FORMAT(7I10)
IF(Y.EQ.U) STOP
IF(I.EQ.U) I=10
IF(I6.EQ.U) I6=100
IF(E1.EQ.U) E1=2400
I1=2

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C CALCULATE JULIAN DATE
IF (M.GE.3) GO TO 16
C1=-1
IF(((Y-1853)/4).LT.11) C1=0
J1=365*(Y-1853) + 30*(M+9) + ((M+10)/2) + D
J2=((Y-1853)/4) + C1 + 1
GO TO 27
16 C1=-1
IF (((Y-1852)/4).LT.11) C1=0
IF (M.EQ.9.OR.M.EQ.11) GO TO 24
22 C2=0
GO TO 25
24 C2=1
25 J1=365*(Y-1852) + 30*(M-3) + ((M-2)/2) + D
J2= ((Y-1852)/4) + C1 + C2
27 J=J1+J2

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0039 T1=FLOAT(J)-17472.5
0040 JD=FLOAT(J)+2397547.5
0041 WRITE (6,3) IDENT,LATD,LATM,LANGD,LANGM,Y,M,D,JD
0042 3 FORMAT ('1LUNAR COORDINATES FOR ',10A1,' STATION LAT: ',214,'
+LONG: ',214,' DATE ',14,' ',12,' ',12,' JD=',F12.1//)
0043 WRITE (6,5)
0044 5 FORMAT(' GMT AZ EL GHA DEC'//)
0045 29 D9=B - (B/100)*100 + (B/1000)*60
0046 D6= E1 - (E1/100)*100 + (E1/1000)*60
0047 D7=D9-D6
0048 D8=D7-1
0049 IF(D7.LE.0) GO TO 38
0050 IF(D8.GE.0) GO TO 10
0051 B=E1
C CALCULATE LUNAR LAT AND LONG
0052 38 T=FLOAT(B-(B/100)*100)/1440.+FLOAT(B/100)/24.
0053 T5=T1+T
0054 K1=FNB(0.751213+0.036601102*T5)
0055 K2=FNB(0.822513+0.0362916457*T5)
0056 K3=FNB(0.995766+0.00273777852*T5)
0057 K4=FNB(0.974271+0.0338631922*T5)
0058 K5=FNB(0.0312525+0.0367481957*T5)
0059 L8=K1+0.658*R5*SIN(2.*K4)+6.289*R5*SIN(K2)
0060 L8=L8-1.274*R5*SIN(K2-2.*K4)-0.186*R5*SIN(K3)
0061 L8=L8+0.214*R5*SIN(2.*K2)-0.114*R5*SIN(2.*K5)
0062 L8=L8-0.059*R5*SIN(2.*K2+2.*K4)-0.057*R5*SIN(K2+K3-2.*K4)
0063 K6=K5+.6593*R5*SIN(2.*K4)+6.2303*R5*SIN(K2)-1.272*R5*SIN(K2-2.*K4)
0064 L7=5.144*R5*SIN(K6)-0.146*R5*SIN(K5-2.*K4)
C CALCULATION OF RA AND DEC
0065 D1=COS(L7)*SIN(L8)*0.397821+SIN(L7)*0.917463
0066 D1=ATAN2(D1,SQRT(1.-D1**2))
0067 A2=COS(L7)*COS(L8)/COS(D1)
0068 A1=(COS(L7)*SIN(L8)*0.917463-SIN(L7)*0.397821)/COS(D1)
0069 A=ATAN2(A1,A2)
0070 R1=A
0071 L1=0.065709822*11
0072 L=T*24.*1.002738+6.646055+(L1-AINT(L1/24))*24.)
0073 L=(L-AINT(L/24))*24)
C CALCULATION OF GREENWICH HOUR ANGLE G FROM LOCAL SIDERIAL TIME
0074 G=(L/24)*P5-R1
0075 IF(G.LT.P5) GO TO 67
0076 G=G-P5
0077 GO TO 71
0078 67 IF(G.LT.0.) GO TO 69
0079 GO TO 71
0080 69 G=G+P5
C CALCULATION OF LOCAL HOUR ANGLE H FROM GHA
0081 71 H=L6-G
C CALCULATION OF ELEVATION E
0082 E3=COS(L5)*COS(H)*COS(D1)+SIN(D1)*SIN(L5)
0083 E2=SQRT(1.-E3**2)
0084 E=ATAN2(E3,E2)
0085 IF(E.LT.0.) GO TO 117
0086 IF(E.GT.(16*R5)) GO TO 117
C CALCULATION OF AZIMUTH A
0087 A2=SIN(D1)/(COS(L5)*COS(E))
0088 A2=A2-(SIN(L5)/COS(L5))*(SIN(E)/COS(E))
0089 A1=SIN(L5)*SIN(D1)+COS(L5)*COS(D1)*COS(H)
0090 A1=(SIN(H)*COS(D1))/SQRT(1.-A1**2)
0091 A=ATAN2(A1,A2)
0092 AZ=FNA(A)
0093 EL=FNA(E)
0094 GHA=FNA(G)
0095 DEC=FNA(D1)
0096 GMT(1)=B/1000
0097 GMT(2)=B/100-(B/1000)*10
0098 GMT(3)=B/10-(B/100)*10
0099 GMT(4)=B-(B/10)*10
0100 IF((I-1).GT.(2.*I/1440.)) WRITE (6,7)
0101 7 FORMAT(1H )
0102 104 WRITE(6,6) GMT,AZ,EL,GHA,DEC
0103 6 FORMAT(3H ,4I1,4F12.1)
0104 I1=I
0105 117 B=B+I

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0106 Z=B-(B/100)*100 - 60
0107 IF(Z.LT.0) GO TO 29
0108 B=(B/100)*100 + 100 + Z
0109 GO TO 29
0110 END

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LUNAR COORDINATES FOR G3NAQ  
 STATION LAT: 51 34 LONG: 1 18  
 DATE 1978/ 5/20 JD= 2443648.0

GMT	AZ	EL	GHA	DEC
0000	-143.7	24.3	34.2	-7.7
0010	-141.3	23.3	36.6	-7.7
0020	-138.9	22.4	39.0	-7.7
0030	-136.6	21.3	41.5	-7.8
0040	-134.4	20.3	43.8	-7.8
0050	-132.1	19.1	46.3	-7.8
0100	-129.9	18.0	48.7	-7.8
0110	-127.7	16.8	51.1	-7.9
0120	-125.6	15.6	53.4	-7.9
0130	-123.4	14.3	56.0	-7.9
0140	-121.4	13.0	58.4	-7.9
0150	-119.4	11.7	60.7	-8.0
0200	-117.4	10.4	63.3	-8.0
0210	-115.4	9.0	65.5	-8.0
0220	-113.3	7.6	68.0	-8.0
0230	-111.5	6.2	70.4	-8.1
0240	-109.6	4.8	72.8	-8.1
0250	-107.6	3.3	75.2	-8.1
0300	-105.8	1.9	77.6	-8.2
0310	-103.9	0.4	80.0	-8.2
1720	107.2	0.1	285.0	-10.5
1730	109.1	1.5	287.4	-10.5
1740	111.0	2.8	289.7	-10.5
1750	113.0	4.2	292.1	-10.6
1800	114.9	5.5	294.6	-10.6
1810	116.9	6.9	297.1	-10.6
1820	118.9	8.1	299.4	-10.6
1830	120.9	9.4	301.8	-10.7
1840	122.9	10.7	304.2	-10.7
1850	125.0	11.9	306.6	-10.7
1900	127.1	13.1	309.0	-10.7
1910	129.2	14.2	311.4	-10.8
1920	131.4	15.4	313.9	-10.8
1930	133.5	16.5	316.3	-10.8
1940	135.8	17.5	318.7	-10.8
1950	138.1	18.5	321.1	-10.9
2000	140.4	19.5	323.5	-10.9
2010	142.7	20.4	325.9	-10.9
2020	145.0	21.2	328.3	-10.9
2030	147.4	22.0	330.8	-11.0
2040	149.9	22.8	333.3	-11.0
2050	152.3	23.5	335.6	-11.0
2100	154.7	24.1	337.9	-11.1
2110	157.3	24.7	340.4	-11.1
2120	159.9	25.2	342.8	-11.1
2130	162.4	25.7	345.1	-11.1
2140	165.0	26.1	347.5	-11.1
2150	167.7	26.4	350.0	-11.1
2200	170.3	26.7	352.5	-11.2
2210	172.8	26.9	354.8	-11.2
2220	175.5	27.0	357.2	-11.2
2230	178.2	27.1	359.7	-11.2
2240	-174.5	27.0	2.0	-11.3
2250	-176.5	27.0	4.4	-11.3
2300	-178.8	26.8	6.8	-11.3
2310	-171.2	26.8	9.3	-11.4
2320	-168.6	26.8	11.7	-11.4
2330	-166.0	26.3	14.1	-11.4
2340	-163.4	25.5	16.5	-11.4
2350	-160.8	25.1	18.9	-11.5
2400	-158.3	24.5	21.3	-11.5