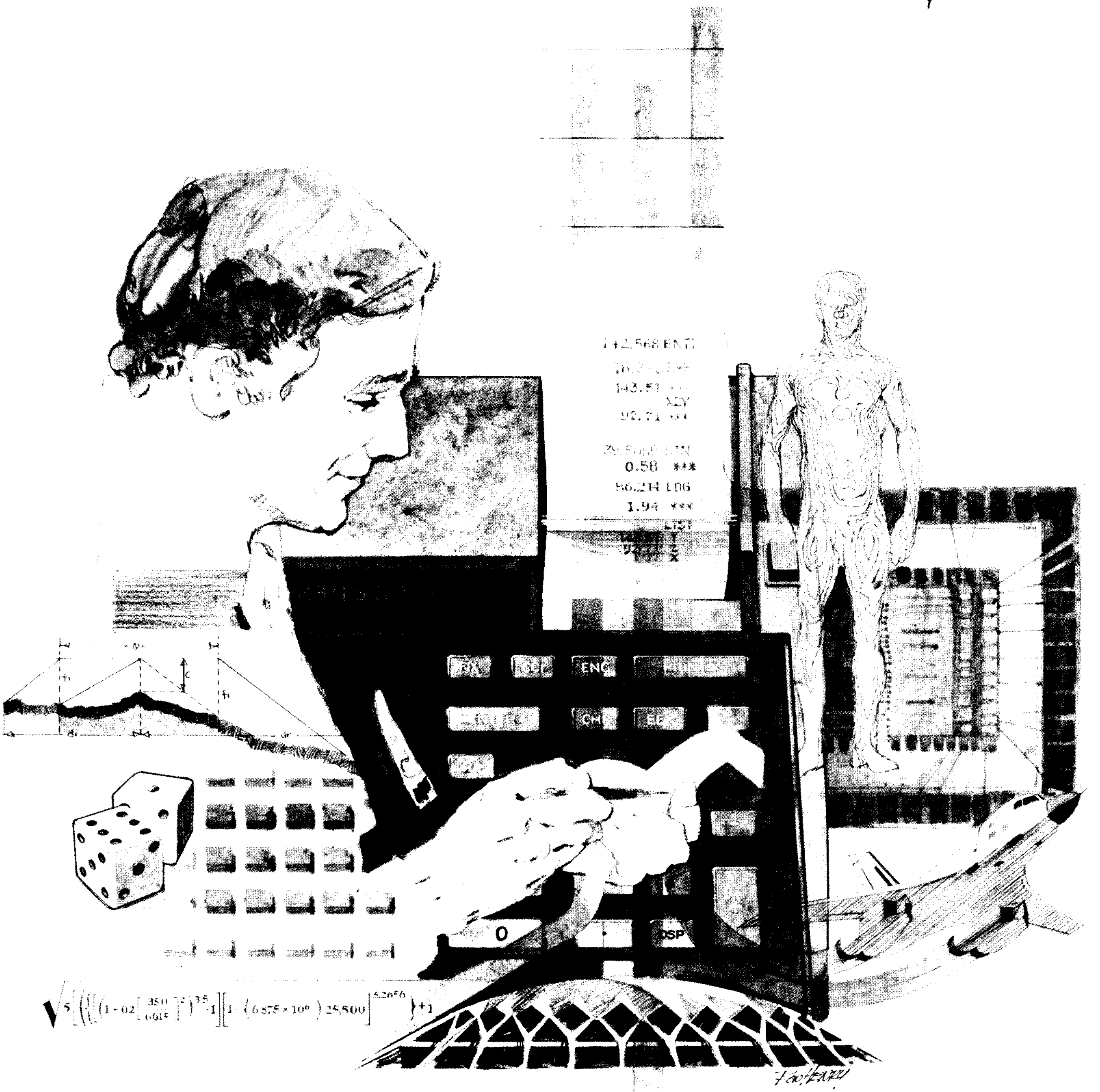
HEWLETT-PACKARD

HP67 HP97

Users' Library Solutions

Avigation

$30



INTRODUCTION

In an effort to provide continued value to it's customers, Hewlett-Packard is introducing a unique service for the HP fully programmable calculator user. This service is designed to save you time and programming effort. As users are aware, Programmable Calculators are capable of delivering tremendous problem solving potential in terms of power and flexibility, but the real genie in the bottle is program solutions. HP's introduction of the first handheld programmable calculator in 1974 immediately led to a request for program **solutions** — hence the beginning of the HP-65 Users' Library. In order to save HP calculator customers time, users wrote their own programs and sent them to the Library for the benefit of other program users. In a short period of time over 5,000 programs were accepted and made available. This overwhelming response indicated the value of the program library and a Users' Library was then established for the HP-67/97 users.

To extend the value of the Users' Library, Hewlett-Packard is introducing a unique service—a service designed to save you time and money. The Users' Library has collected the best programs in the most popular categories from the HP-67/97 and HP-65 Libraries. These programs have been packaged into a series of low-cost books, resulting in substantial savings for our valued HP-67/97 users.

We feel this new software service will extend the capabilities of our programmable calculators and provide a great benefit to our HP-67/97 users.

A WORD ABOUT PROGRAM USAGE

Each program contained herein is reproduced on the standard forms used by the Users' Library. Magnetic cards are not included. The Program Description I page gives a basic description of the program. The Program Description II page provides a sample problem and the keystrokes used to solve it. The User Instructions page contains a description of the keystrokes used to solve problems in general and the options which are available to the user. The Program Listing I and Program Listing II pages list the program steps necessary to operate the calculator. The comments, listed next to the steps, describe the reason for a step or group of steps. Other pertinent information about data register contents, uses of labels and flags and the initial calculator status mode is also found on these pages. Following the directions in your HP-67 or HP-97 **Owners' Handbook and Programming Guide,** "Loading a Program" (page 134, HP-67; page 119, HP-97), key in the program from the Program Listing I and Program Listing II pages. A number at the top of the Program Listing indicates on which calculator the program was written (HP-67 or HP-97). If the calculator indicated differs from the calculator you will be using, consult Appendix E of your **Owner's Handbook** for the corresponding keycodes and keystrokes converting HP-67 to HP-97 keycodes and vice versa. No program conversion is necessary. The HP-67 and HP-97 are totally compatible, but some differences do occur in the keycodes used to represent some of the functions.

A program loaded into the HP-67 or HP-97 is not permanent—once the calculator is turned off, the program will not be retained. You can, however, permanently save any program by recording it on a blank magnetic card, several of which were provided in the Standard Pac that was shipped with your calculator. Consult your **Owner's Handbook** for full instructions. A few points to remember:

> The Set Status section indicates the status of flags, angular mode, and display setting. After keying in your program, review the status section and set the conditions as indicated before using or permanently recording the program.
>
> REMEMBER! To save the program permanently, **clip** the corners of the magnetic card once you have recorded the program. This simple step will protect the magnetic card and keep the program from being inadvertently erased.

As a part of HP's continuing effort to provide value to our customers, we hope you will enjoy our newest concept.

TABLE OF CONTENTS

Program Description I

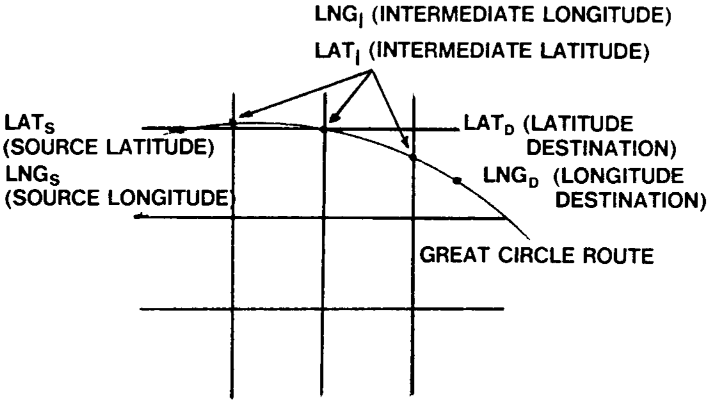
Program Title Great Circle Plotting

Contributor's Name Hewlett-Packard Company, HP-67/97 Users' Library

Address 1000 N. E. Circle Boulevard

City Corvallis **State** OR **Zip Code** 97330

Program Description, Equations, Variables Given the latitude and longitude of two points on the globe and an intermediate longitude, this program calculates the latitude corresponding to the intersection of the great circle route and the intermediate longitude.



$$LAT_I = \tan^{-1} \frac{(A - B)}{\sin(LNG_D - LNG_S)}$$

$$A = (\tan(LAT_D) \cos(LNG_S)-\tan(LAT_S) \cos(LNG_D)) \sin(LNG_I)$$

$$B = (\tan(LAT_D) \sin(LNG_S)-\tan(LAT_S) \sin(LNG_D)) \cos(LNG_I)$$

Operating Limits and Warnings No leg may pass exactly half way around the earth, and lines of longitude may not be plotted.

Program Description II

Sketch(es)

Sample Problem(s) On a flight from St. Helena to Bermuda, what is the latitude at 35° 17' west longitude?

	LAT	LNG
St. Helena	15° 55' S	5° 44' W
Bermuda	32° 19' N	64° 51' W

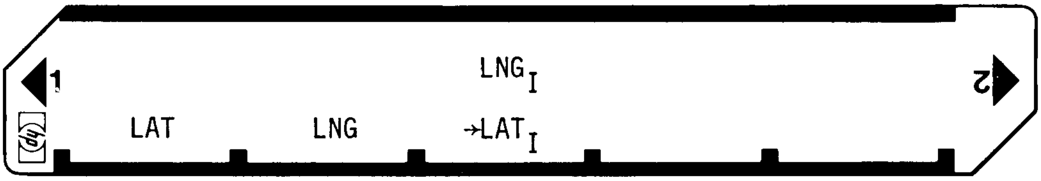
Solution(s) LAT_I = 11° 17' N

Keystrokes:	See Displayed:
15.55 [CHS] [A] 5.44 [B] 32.19 [A]	
64.51 [B] 35.17 [C]	11.17

Reference(s)

This program is a direct translation of a program from the HP-65 Aviation Pac.

User Instructions



STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1	Enter program				
2	Input source latitude*	DD.MMSS**	A		degrees
	and longitude	DDD.MMSS	B		degrees
3	Input destination latitude	DD.MMSS	A		degrees
	and longitude	DDD.MMSS	B		degrees
4	Input an intermediate longitude and calculate				
	the corresponding latitude	DDD.MMSS	C		LAT (degrees)
5	For new intermediate point go to step 4, for				
	new case go to step 2.				
	*Southern latitudes and eastern longitudes are				
	expressed as negative values.				
	**DDD.MMSS means degrees, decimal point,				
	minutes and seconds. 120.0713 is 120 degrees,				
	7 minutes and 13 seconds.				

97 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS

```
001  *LBLA    21 11
002  HMS→     16 36
003  RCL1     36 01
004  STO2     35 02
005   X⇄Y       -41
006  STO1     35 01
007   RTN        24
008  *LBLB    21 12
009  HMS→     16 36
010  RCL3     36 03
011  STO4     35 04
012   X⇄Y       -41
013  STO3     35 03
014   RTN        24
015  *LBLC    21 13
016  HMS→     16 36
017  STO7     35 07
018  RCL4     36 04
019  RCL1     36 01
020  GSBE     23 15
021  RCL7     36 07
022  RCL3     36 03
023  RCL2     36 02
024  GSBE     23 15
025    -        -45
026  RCL4     36 04
027  RCL7     36 07
028  RCL1     36 01
029  GSBE     23 15
030    -        -45
031  RCL3     36 03
032  RCL7     36 07
033  RCL2     36 02
034  GSBE     23 15
035    +        -55
036  RCL3     36 03
037  RCL4     36 04
038    -        -45
039   SIN        41
040    ÷        -24
041  TAN⁻¹    16 43
042  STO8     35 08
043  →HMS     16 35
044   RTN        24
045  *LBLE    21 15
046   TAN        43
047   X⇄Y       -41
048   COS        42
049    ×        -35
050   X⇄Y       -41
051   SIN        41
052    ×        -35
053   RTN        24
```

FLAGS	
0	
1	
2	
3	

SET STATUS					
FLAGS			TRIG		DISP
	ON	OFF			
0	☐	☒	DEG	☒	FIX ☒
1	☐	☒	GRAD	☐	SCI ☐
2	☐	☒	RAD	☐	ENG ☐
3	☐	☒			n 2

LABELS

A LAT	B LNG	C →LAT LNG	D	E
a	b	c	d	e
0	1	2	3	4
5	6	7	8	9

REGISTERS

0	1 LAT_D	2 LAT_S	3 LNG_D	4 LNG_S	5	6	7	8	9
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I

Program Description I

Program Title Rhumb Line Navigation

Contributor's Name Hewlett-Packard Company, HP-67/97 Users' Library

Address 1000 N. E. Circle Boulevard

City Corvallis **State** OR **Zip Code** 97330

Program Description, Equations, Variables This program accepts the coordinates of two points on the globe and calculates the rhumb line heading (HDG) and distance (DIST) between them. The program inputs are latitude and longitude of the source (LAT_S, LNG_S) and latitude and longitude of the destination (LAT_D, LNG_D) in degrees, minutes, and seconds. The program outputs are heading in degrees and distance in nautical miles.

Since the rhumb line is the constant heading path between points on the globe, it forms the basis of short distance navigation. In low and mid latitudes the rhumb line is sufficient for virtually all course and distance calculations which private pilots encounter. However, as distance increases or at high latitudes, the rhumb line ceases to be an efficient flight path since it is not the shortest distance between points.

The shortest distance between points is the great circle. However, in order to fly great circles, an infinite number of heading changes are necessary. Since it is impractical to calculate an infinite number of headings at an infinite number of points, several rhumb lines may be used to approximate a great circle. The more rhumblines that are used the closer to the great circle distance the sum of the rhumb-line distances will be. Great Circle Plotting, may be used to calculate intermediate heading change points which can be linked by rhumb lines.

Operating Limits and Warnings

Program Description I

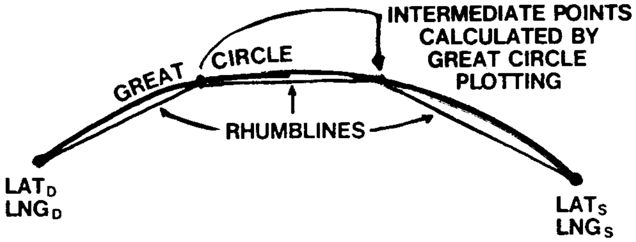
Program Title Rhumb Line Navigation

Contributor's Name Hewlett-Packard Company, HP-67/97 Users' Library

Address 1000 N. E. Circle Boulevard

City Corvallis **State** OR **Zip Code** 97330

Program Description, Equations, Variables



$$HDG = \tan^{-1}\left[\frac{\pi (LNG_S - LNG_D)}{180(\ln \tan(45 + 1/2LAT_D)-\ln \tan(45 + 1/2LAT_S))}\right]$$

$$DIST = 60 (LAT_D - LAT_S)/\cos (HDG)$$

or, if cos (HDG) = 0

$$DIST = 60 (LNG_D - LNG_S) \cos (LAT)$$

Operating Limits and Warnings No course should pass through either the south or north pole. Errors in distance calculations may be encountered as the cos (HDG) approaches zero.

Accuracy deteriorates for legs shorter than two or three miles.

Program Description II

Sketch(es)

Sample Problem(s) Find the leg lengths and headings for a flight from St. Helena to Bermuda using the intermediate point calculated in <u>Great Circle Plotting</u>, as an intermediate point of heading change.

	LAT	LNG
St. Helena	15° 55' S	5° 44' W
Intermediate Point	11° 17' N	35° 17' W
Bermuda	32° 19' N	64° 51' W

Solution

	DIST	HDG
LEG 1	2396.39 n.m.	312.92 Degrees
LEG 2	2065.29 n.m.	307.67 Degrees

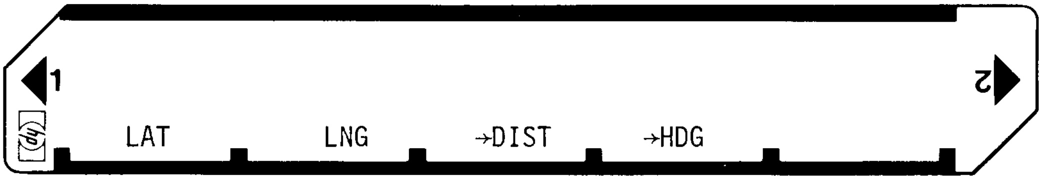
Solution(s)

Keystrokes:	See Displayed:
15.55 [CHS] [A] 5.44 [B] 11.17 [A]	
35.17 [B] [C]	2396.39
[D]	312.92
32.19 [A] 64.51 [B] [C]	2065.29
[D]	307.67

Reference(s)

This program is a direct translation of a program from the HP-65 <u>Aviation Pac</u>.

User Instructions



STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Enter program			
2	Input source latitude*	DD.MMSS**	A	degrees
	and source longitude	DDD.MMSS	B	degrees
3	Input destination latitude	DD.MMSS	A	degrees
	and destination longitude	DDD.MMSS	B	degrees
4	Calculate distance		C	DIST(n.m.)
	and/or heading		D	HDG(deg)
5	If next leg starts at end of last leg go to			
	step 3			
6	For an entirely new case go to step 2			
	*Southern latitudes and eastern longitudes			
	are expressed as negative values.			
	**DDD.MMSS means degrees, decimal point,			
	minutes and seconds. 120.0713 is 120			
	degrees, 7 minutes and 13 seconds.			

97 Program Listing I

```
STEP   KEY ENTRY   KEY CODE      COMMENTS
001    *LBLA       21 11
002    HMS+        16 36
003    RCL1        36 01
004    STO2        35 02
005    X⇄Y           -41
006    STO1        35 01
007    2              02
008    ÷             -24
009    4              04
010    5              05
011    +             -55
012    TAN            43
013    LN             32
014    RCL5        36 05
015    STO6        35 06
016    X⇄Y           -41
017    STO5        35 05
018    RCL1        36 01
019    RTN            24
020    *LBLB       21 12
021    HMS+        16 36
022    RCL3        36 03
023    STO4        35 04
024    X⇄Y           -41
025    STO3        35 03
026    RTN            24
027    *LBLD       21 14
028    RCL4        36 04
029    RCL3        36 03
030    -             -45
031    STO7        35 07
032    2              02
033    ÷             -24
034    SIN            41
035    SIN⁻¹       16 41
036    9              09
037    0              00
038    ÷             -24
039    Pi          16-24
040    ×             -35
041    RCL5        36 05
042    RCL6        36 06
043    -             -45
044    →P             34
045    R↓            -31
046    STO8        35 08
047    RCL7        36 07
048    SIN            41
049    SIN⁻¹       16 41
050    0              00
051    X>Y?        16-34
052    GSBd     23 16 14
053    RCL8        36 08
054    ABS         16 31
055    -             -45
056    ABS         16 31
057    RTN            24
058    *LBLC       21 13
059    GSBD        23 14
060    RCL7        36 07
061    RCL1        36 01
062    COS            42
063    ×             -35
064    RCL1        36 01
065    RCL2        36 02
066    -             -45
067    RCL8        36 08
068    COS            42
069    0              00
070    X≠Y?        16-32
071    GSBc     23 16 13
072    X=Y?        16-33
073    R↑          16-31
074    6              06
075    0              00
076    ×             -35
077    ABS         16 31
078    RTN            24
079    *LBLc    21 16 13
080    R↓            -31
081    ÷             -24
082    RTN            24
083    *LBLd    21 16 14
084    3              03
085    6              06
086    0              00
087    RTN            24
090
100
110
```

FLAGS
0
1
2
3

SET STATUS

FLAGS	ON	OFF	TRIG		DISP	
0	☐	☒	DEG	☒	FIX	☒
1	☐	☒	GRAD	☐	SCI	☐
2	☐	☒	RAD	☐	ENG	☐
3	☐	☒			n	2

REGISTERS

0	1	2	3	4	5	6	7	8	9
	LAT_D	LAT_S	LNG_D	LNG_S	USED	USED	$LNG_S - LNG_D$	HDG	
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I

Program Description I

Program Title Great Circle Navigation

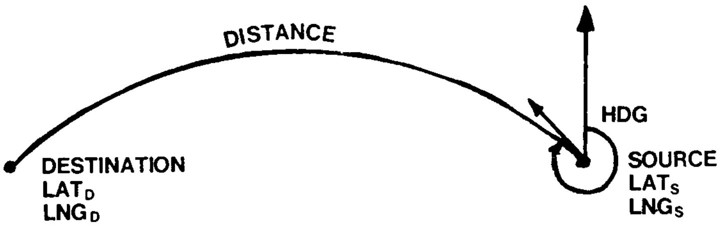
Contributor's Name Hewlett-Packard

Address 1000 N.E. Circle Blvd.

City Corvallis **State** Oregon **Zip Code** 97330

Program Description, Eq

This program computes the great circle distance between two points and computes the initial heading from the first point. Coordinates are input in degrees, minutes and seconds north or south of the equator and east or west of the prime meridian. Outputs are distances in nautical miles and headings in degrees and decimal fractions of a degree.



The great circle distance in nautical miles between two points is given by

$$\mathrm{DIST} = 60 \cos^{-1} \left[\sin \mathrm{LAT_S} \sin \mathrm{LAT_D} + \cos \mathrm{LAT_S} \cos \mathrm{LAT_D} \cos(\mathrm{LNG_D} - \mathrm{LNG_S})\right]$$

Where

$\mathrm{LAT_S}$ and $\mathrm{LAT_D}$ are the source and destination latitudes and
$\mathrm{LNG_S}$ and $\mathrm{LNG_D}$ are the source and destination longitudes.

Correspondingly, the initial heading from the source to destination is

$$\mathrm{HDG} = \cos^{-1} \left[\frac{\sin \mathrm{LAT_D} - \sin \mathrm{LAT_S} \cos (\mathrm{DIST}/60)}{\sin (\mathrm{DIST}/60) \cos \mathrm{LAT_S}}\right]$$

NOTE: If $\sin (\mathrm{LNG_S} - \mathrm{LNG_D}) < 0$ then HDG = 360 - HDG

Operating Limits and W

Limits and Warnings

Truncation and round off errors occur when the source and destination are very close together (1 mile or less). Input data is in degrees, minutes and seconds, not degrees, minutes and tenths of minutes. North latitudes and west longitudes are positive numbers, south latitudes and east longitudes are negative numbers.

Do not use coordinates located at diametrically opposite sides of the earth. Do not use latitudes at +90° or -90° (i.e., North and South Poles).

This program may give flashing zeros when trying to compute headings along lines of longitude.

Program Description II

Sketch(es)

Sample Problem(s)

Find the great circle distance from St. Helena to Bermuda.

	LAT	LNG
St. Helena	15° 55' S	5° 44' W
Bermuda	32° 19' N	64° 51' W

Solution(s)

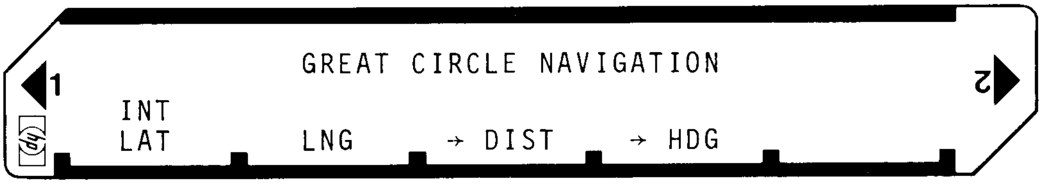
4458.19 n.m. (note that this is only slightly shorter than the sum of the rhumb lines in Rhumb Line Navigation).

Keystrokes	See Display
[f] [A] 15.55 [CHS] [A] 5.44 [B] 32.19 [A] 64.51 [B] [C]	4458.19
[D]	311.12

Reference(s)

This program is a direct translation of a program from the HP-65 Aviation Pac.

User Instructions



STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1.	Enter program				
2.	Initialize		f	A	
3.	Input source latitude*	DD.MMSS**	A		LAT_S(deg)
	and source longitude	DDD.MMSS	B		LNG_S(deg)
4.	Input destination latitude	DD.MMSS	A		LAT_D(deg)
	and destination lognitude	DDD.MMSS	B		LNG_D(deg)
5.	Calculate leg distance		C		DIST(n.m.)
	and initial heading		D		HDG (deg)
6.	If next leg starts at last leg end point go to step 4.				
7.	To restart for an entirely new leg go to step 2.				
*	Positive numbers indicate north latitude and west longitudes. Negative numbers indicate south latitudes and east longitudes.				
**	DDD.MMSS means degrees, decimal point, minutes and seconds. 120.0713 is 120 degrees, 7 minutes and 13 seconds.				

97 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	*LBLa	21 16 11	
002	CF2	16 22 02	
003	CLRG	16-53	
004	DEG	16-21	
005	CLX	-51	
006	RTN	24	
007	*LBLA	21 11	
008	HMS→	16 36	
009	RCL1	36 01	
010	STO2	35 02	
011	X⇄Y	-41	
012	STO1	35 01	
013	RTN	24	
014	*LBLB	21 12	
015	HMS→	16 36	
016	RCL3	36 03	
017	STO4	35 04	
018	X⇄Y	-41	
019	STO3	35 03	
020	RTN	24	
021	*LBLC	21 13	
022	RCL4	36 04	
023	RCL3	36 03	
02	-	-45	
025	ENT↑	-21	
026	SIN	41	
027	0	00	
028	X>Y?	16-34	
029	SF2	16 21 02	
030	+	-55	
031	CLX	-51	
032	+	-55	
033	COS	42	
034	RCL2	36 02	
035	COS	42	
036	STO6	35 06	
037	×	-35	
038	RCL1	36 01	
039	COS	42	
040	×	-35	
041	RCL1	36 01	
042	SIN	41	
043	STO7	35 07	
044	RCL2	36 02	
045	SIN	41	
046	STO8	35 08	
047	×	-35	
048	+	-55	
049	COS⁻¹	16 42	
050	ENT↑	-21	
051	ENT↑	-21	
052	6	06	
053	0	00	
054	×	-35	
055	RTN	24	
056	*LBLD	21 14	
057	3	03	
058	6	06	
059	0	00	
060	GSBC	23 13	
061	R↓	-31	
062	ENT↑	-21	
063	COS	42	
064	RCL8	36 08	
065	×	-35	
066	RCL7	36 07	
067	X⇄Y	-41	
068	-	-45	
069	X⇄Y	-41	
070	SIN	41	
071	÷	-24	
072	RCL6	36 06	
073	÷	-24	
074	COS⁻¹	16 42	
075	F2?	16 23 02	
076	-	-45	
077	RTN	24	
080			
090			
100			
110			

FLAGS
0
1
2
3

SET STATUS

FLAGS			TRIG		DISP	
	ON	OFF				
0	☐	☑	DEG	☑	FIX	☑
1	☐	☑	GRAD	☐	SCI	☐
2	☐	☑	RAD	☐	ENG	☐
3	☐	☑			n 2	

REGISTERS

0	1	2	3	4	5	6	7	8	9
	LAT D	LAT S	LNG D	LNG S		USED	USED	USED	

S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I

Program Description I

Program Title Position Given Heading, Speed, and Time

Contributor's Name Hewlett-Packard

Address 1000 N.E. Circle Blvd.

City Corvallis **State** Oregon **Zip Code** 97330

Program Descriptior

Given the starting position (LAT_S, LNG_S), the heading, the speed and the time of travel, the destination position (LAT_D, LNG_D) is calculated by a rhumbline.

$$LAT_D = \left(\frac{\text{Time x Speed x cos HDG}}{60}\right) + LAT_S$$

$$LNG_D = LNG_S - \frac{180}{\pi}\Big[(\tan HDG) \times (\ln \tan(45 + ½\, LAT_D)$$

$$- \ln \tan(45 + ½\, LAT_S))\Big]$$

If HDG = 90° or 270° then

$$LNG_D = \frac{DIST}{60 \cos LAT} + LNG_S$$

HDG = Heading

Speed = Speed in knots

Time = Time in hours

DIST = Speed x Time

Operating Limits and Warnings

Limits and Warnings

The path of flight may not cross a pole.

Program Description II

Sketch(es)

Sample Problem(s)

Sample Problem

Starting at 30° N, 140° W, flying at 500 knots with a heading of 237 degrees what is the position after two hours?

Solution(s)

Solution

20° 55′ N, 155° 30′ W

Keystrokes	See Displayed
30 A 140 A 237 B 500 C 2 D	155.30
D	20.55

Reference(s)

This program is a direct translation of a program from the HP-65 Aviation Pac.

User Instructions

Position Given Heading, Speed and Time

LAT_S LNG.	HDG	SPEED	Time $\rightarrow LNG_D \rightarrow LAT_D$	

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1.	Enter program			
2.	Input latitude of starting point then	DD.MMSS	A	LAT_S
	longitude of starting point*	DDD.MMSS	A	LNG_S
3.	Input both of the following: true heading ,	HDG(deg)	B	HDG
	speed	speed(knots)	C	Speed
4.	Input time at speed and heading and			
	calculate final longitude and	H.MMSS**	D	LNG_D
	latitude (both in degrees, minutes, seconds)		D	LAT_D
5.	For new time go to step 4, for new heading			
	or speed go to step 3, for new starting			
	position go to step 2.			
*	Southern latitudes and eastern longitudes are			
	expressed as negative values.			
**	H.MMSS means hours, decimal point, minutes,			
	seconds. 2.0355 is 2 hours minutes and 55			
	seconds.			

97 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	*LBLA	21 11	
002	HMS→	16 36	
003	RCL4	36 04	
004	STO2	35 02	
005	X⇄Y	-41	
006	STO4	35 04	
007	RTN	24	
008	*LBLB	21 12	
009	STO5	35 05	
010	RTN	24	
011	*LBLC	21 13	
012	STO6	35 06	
013	RTN	24	
014	*LBLD	21 14	
015	HMS→	16 36	
016	RCL6	36 06	
017	×	-35	
018	STO7	35 07	
019	RCL5	36 05	
020	COS	42	
021	×	-35	
022	6	06	
023	0	00	
024	÷	-24	
025	RCL2	36 02	
026	+	-55	
027	SIN	41	
028	SIN^{-1}	16 41	
029	STO1	35 01	
030	GSBE	23 15	
031	RCL2	36 02	
032	GSBE	23 15	
033	X=Y?	16-33	
034	GTO1	22 01	
035	-	-45	
036	RCL5	36 05	
037	TAN	43	
038	×	-35	
039	Pi	16-24	
040	÷	-24	
041	1	01	
042	8	08	
043	0	00	
044	×	-35	
045	GTO2	22 02	
046	*LBL1	21 01	
047	RCL7	36 07	
048	RCL2	36 02	
049	COS	42	
050	÷	-24	
051	6	06	
052	0	00	
053	÷	-24	
054	*LBL2	21 02	
055	CHS	-22	
056	RCL4	36 04	
057	+	-55	
058	1	01	
059	→R	44	
060	→P	34	
061	R↓	-31	
062	STO3	35 03	
063	→HMS	16 35	
064	RTN	24	
065	*LBLD	21 14	
066	RCL1	36 01	
067	→HMS	16 35	
068	RTN	24	
069	*LBLE	21 15	
070	2	02	
071	÷	-24	
072	4	04	
073	5	05	
074	+	-55	
075	TAN	43	
076	LN	32	
077	RTN	24	
080			
090			
100			
110			

FLAGS	
0	
1	
2	
3	

SET STATUS

FLAGS	ON	OFF	TRIG		DISP	
0	☐	☒	DEG	☒	FIX	☒
1	☐	☒	GRAD	☐	SCI	☐
2	☐	☒	RAD	☐	ENG	☐
3	☐	☒			n 2	

REGISTERS

0	1	2	3	4	5	6	7	8	9
	LAT$_D$	LAT$_S$	LNG$_D$	LNG$_S$	HDG	SPEED	DIST		

S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I

Program Description I

Program Title Line of Sight Distance

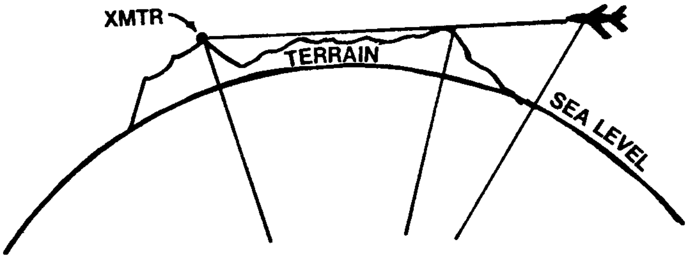
Contributor's Name Hewlett-Packard

Address 1000 N.E. Circle Blvd.

City Corvallis **State** Oregon **Zip Code** 97330

Program Descriptioi

This program calculates either the aircraft altitude or the line-of-sight distance from an aircraft to a transmitting station. The inputs are the transmitter height (MSL), terrain height (MSL), and either the line-of-sight distance (n.m.) or the aircraft altitude in feet above MSL.



If

$R_p = R + ALT$
$R_g = R + TER$
$R_t = R + XTMR$

where

R = earth's radius = 3440 n.m.
ALT = aircraft altitude
TER = terrain altitude
XMTR = transmitter altitude

Operating Limits and Warnings

Program Description I

Program Title

Contributor's Name

Address

City **State** **Zip Code**

Program Description, Equations, Variables

Since R_g is perpendicular to the line-of-sight

$$\text{DIST} = \sqrt{R_p{}^2 - R_g{}^2} + \sqrt{R_t{}^2 - R_g{}^2}$$

and

$$\text{ALT} = \sqrt{R_g{}^2 + (D - \sqrt{R_t{}^2 - R_g{}^2})^2}$$

Operating Limits and Warnings Terrain input must not exceed either transmitter height or aircraft altitude. Any attempts to do so will result in an "error" display. This program does not account for refraction of radio waves.

The terrain input yields a worst case answer. If the terrain is close to either the station or the aircraft, the program will calculate a shorter distance or higher altitude than is actually necessary.

Program Description II

Sketch(es)

Sample Problem(s)

An omnidirectional antenna is 2000 feet high. The surrounding terrain is 1000 feet high. How high must you be to receive the transmission from a distance of 100 n.m?

Solution(s)

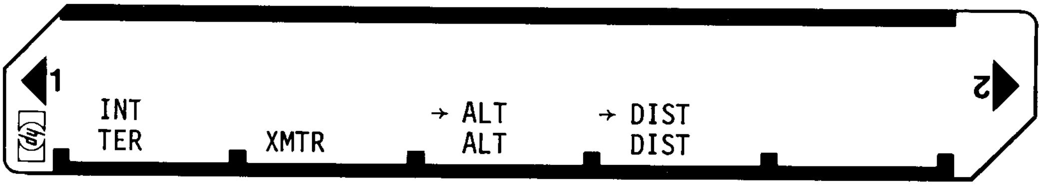
ALT = 4887.18 feet

Keystrokes	See Display
[f] [A] 1000 [A] 2000 [B] 100 [D] [f] [C]	4887.18

Reference(s)

This program is a direct translation of a program from the HP-65 Aviation Pac.

User Instructions



STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1.	Enter program				
2.	Initialize		f	A	1.00
3.	Input the following:				
	height of terrain between aircraft and transmitter	TER(feet)	A		TER
	and transmitter height	XMTR(feet)	B		XMTR
	and either airplane altitude	ALT(feet)	C		$R_p{}^2$(feet^2)
	or line of sight distance	DIST(n.m)	D		DIST(feet)
4.	Calculate either aircraft altitude		f	C	ALT (feet)
	or line of sight distance		f	D	DIST(n.m.)
5.	To change inputs go to step 3 and change desired values. For a new case go to step 2.				

97 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	*LBLa	21 16 11	
002	CLRG	16-53	
003	6	06	
004	0	00	
005	7	07	
006	6	06	
007	STO6	35 06	
008	3	03	
009	4	04	
010	4	04	
011	0	00	
012	×	-35	
013	STO7	35 07	
014	1	01	
015	RTN	24	
016	*LBLA	21 11	
017	STO1	35 01	
018	RCL7	36 07	
019	+	-55	
020	X²	53	
021	STO8	35 08	
022	RCL1	36 01	
023	RTN	24	
024	*LBLB	21 12	
025	STO2	35 02	
026	RCL7	36 07	
027	+	-55	
028	X²	53	
029	STO4	35 04	
030	RCL2	36 02	
031	RTN	24	
032	*LBLC	21 13	
033	RCL7	36 07	
034	+	-55	
035	X²	53	
036	STO3	35 03	
037	RTN	24	
038	*LBLc	21 16 13	
039	RCL4	36 04	
040	RCL8	36 08	
041	-	-45	
042	√X	54	
043	RCL5	36 05	
044	-	-45	
045	RCL8	36 08	
046	√X	54	
047	→P	34	
048	RCL7	36 07	
049	-	-45	
050	RTN	24	
051	*LBLD	21 14	
052	RCL6	36 06	
053	×	-35	
054	STO5	35 05	
055	RTN	24	
056	*LBLd	21 16 14	
057	RCL4	36 04	
058	RCL8	36 08	
059	-	-45	
060	√X	54	
061	RCL3	36 03	
062	RCL8	36 08	
063	-	-45	
064	√X	54	
065	+	-55	
066	RCL6	36 06	
067	÷	-24	
068	RTN	24	
070			
080			
090			
100			
110			

FLAGS	
0	
1	
2	
3	

SET STATUS

FLAGS	ON	OFF	TRIG		DISP	
0	☐	☑	DEG	☑	FIX	☑
1	☐	☑	GRAD	☐	SCI	☐
2	☐	☑	RAD	☐	ENG	☐
3	☐	☑			n	2

REGISTERS

0	1	2	3	4	5	6	7	8	9
	TER	XMTR	$(ALT+R)^2$	$(XMTR+R)^2$	DIST(ft)	6076	R=20901440	$(TER+R)^2$	

S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I

Program Description I

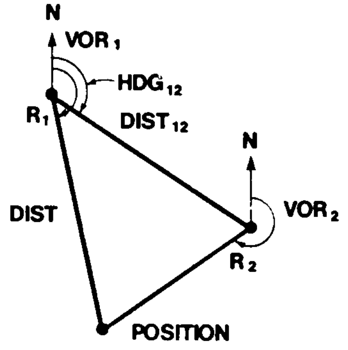
Program Title Position and/or Navigation by Two VOR's

Contributor's Name Hewlett-Packard

Address 1000 N.E. Circle Blvd.

City Corvallis **State** Oregon **Zip Code** 97330

Program Description, Equations, Variables This program finds the distance from one of two VOR's to an aircraft and may be used to navigate between any two points, provided signals can be received from two VOR stations.



$$DIST = \left| \frac{DIST_{12} \sin(R_2 - HDG_{12})}{\sin(R_2 - R_1)} \right|$$

where

R_1 = Radial from VOR_1
R_2 = Radial from VOR_2
HDG_{12} = Heading between VORs
$DIST_{12}$ = Distance between VORs
DIST = Distance from VOR_1 to aircraft

Operating Limits and Warnings

Program Description I

Program Title **Navigation by Two VORs**

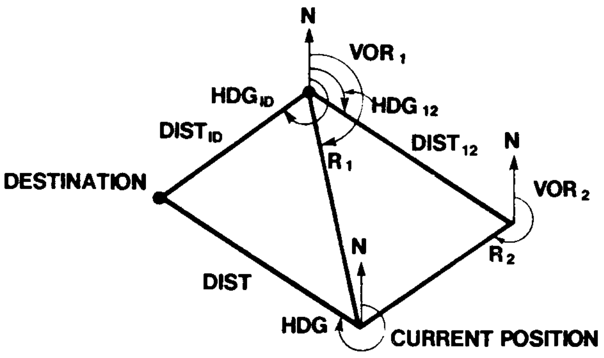
Contributor's Name

Address

City **State** **Zip Code**

Program Description, Equations, Variables

This program may be used to navigate between any two points provided signals can be received from two VOR stations.



$$D_1 = \left| \frac{DIST_{12} \sin(R_2 - HDG_{12})}{\sin(R_2 - R_1)} \right|$$

$$\overrightarrow{DIST} = \vec{D}_1 + \overrightarrow{DIST}_{1D}$$

where

$DIST_{12}$ = Distance between VORs
HDG_{12} = Heading between VORs
R_1 = Radial from VOR_1
R_2 = Radial from VOR_2
D_1 = Distance from VOR_1 to aircraft
$\vec{D}_1$ = Aircraft position vector with respect to VOR_1
$\overrightarrow{DIST}_{1D}$ = Destination position vector with respect to VOR_1
$\overrightarrow{DIST}$ = Required flight vector to destination

Operating Limits and Warnings

The VORs must not be in a straight line from the aircraft.

Program Description II

Sketch(es)

Sample Problem(s)

1. Sample Problem

R_1 = 170 degrees
R_2 = 240 degrees
$DIST_{12}$ = 27 n.m.
HDG_{12} = 125 degrees

What is the distance from VOR_1?

2. Sample Problem

R_1 = 170 degrees
R_2 = 250 degrees
$DIST_{12}$ = 13 n.m.
HDG_{12} = 145 degrees
HDG_{1D} = 255 degrees
$DIST_{1D}$ = 20 n.m.

Find the heading and distance to the destination.

Solution(s)

1. Solution

DIST = 26 n.m.

2. Solution

HDG = 289
DIST = 23 n.m.

Reference(s)

This program is a direct translation of a program from the HP-65 Aviation Pac.

Program Description II

Sketch(es)

Sample Problem(s)

Solution(s)

	Keystrokes	See Displayed
1.	[f] [A] 170 [A] 240 [A] 27 [B] 125 [C] [f] [C]	26
2.	[f] [A] 170 [A] 250 [A] 13 [B] 145 [C] 255 [D]	
	20 [D] [E]	289
	[E]	23

Reference(s)

User Instructions

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1.	Enter program				
2.	Initialize		f	A	
3.	Input all of the following:				
	Present position radial from VOR$_1$	R$_1$(DEG)	A		R$_1$
	Present position radial from VOR$_2$	R$_2$(DEG)	A		R$_2$
	Distance between VORS	DIST 12	B		DIST 2
	Heading of VOR$_2$ from VOR$_1$	HDG$_{12}$(DEG)	C		HDG$_{12}$
4.	Calculate distance from VOR$_1$ or continue inputs		f	C	DIST
	Heading from VOR$_1$ to destination	HDG$_{1D}$(DEG)	D		HDG$_{1D}$
	Distance from VOR$_1$ to destination	DIST$_{1D}$	D		DIST$_{1D}$
5.	Calculate magnetic heading		E		HDG
6.	Calculate distance to destination		E		DIST
	For new case return to steps 3 and 4 and change appropriate inputs.				

97 Program Listing I

```
STEP  KEY ENTRY  KEY CODE     COMMENTS
001   *LBLa      21 16 11
002   DSP0         -63 00
003   CLX             -51
004   RTN              24
005   *LBLA         21 11
006   STO1          35 01
007   RTN              24
008   *LBLA         21 11
009   STO2          35 02
010   RTN              24
011   *LBLB         21 12
012   STO3          35 03
013   RTN              24
014   *LBLC         21 13
015   STO4          35 04
016   RTN              24
017   *LBLc      21 16 13
018   RCL2          36 02
019   RCL4          36 04
020   -               -45
021   SIN              41
022   RCL3          36 03
023   ×               -35
024   RCL2          36 02
025   RCL1          36 01
026   -               -45
027   SIN              41
028   ÷               -24
029   ABS           16 31
030   RTN              24
031   *LBLD         21 14
032   STO5          35 05
033   RTN              24
034   *LBLD         21 14
035   STO6          35 06
036   RTN              24
037   *LBLE         21 15
038   RCL3          36 03
039   RCL1          36 01
040   RCL2          36 02
041   -               -45
042   SIN              41
043   ÷               -24
044   RCL2          36 02
045   RCL4          36 04
046   -               -45
047   SIN              41
048   ×               -35
049   ABS           16 31
050   2                02
051   7                07
052   0                00
053   RCL1          36 01
054   -               -45
055   X⇄Y             -41
056   →R               44
057   STO7          35 07
058   X⇄Y             -41
059   STO8          35 08
060   9                09
061   0                00
062   RCL5          36 05
063   -               -45
064   RCL6          36 06
065   →R               44
066   ST+7       35-55 07
067   X⇄Y             -41
068   ST+8       35-55 08
069   RCL8          36 08
070   RCL7          36 07
071   →P               34
072   X⇄Y             -41
073   9                09
074   0                00
075   X⇄Y             -41
076   -               -45
077   0                00
078   X⇄Y             -41
079   X≤Y?          16-35
080   GSBe       23 16 15
081   STO7          35 07
082   R↓              -31
083   R↓              -31
084   STO8          35 08
085   RCL7          36 07
086   RTN              24
087   *LBLE         21 15
088   RCL8          36 08
089   RTN              24
090   *LBLe      21 16 15
091   3                03
092   6                06
093   0                00
094   +               -55
095   RTN              24

100

110
```

FLAGS
0
1
2
3

SET STATUS

FLAGS	ON	OFF
0	☐	☑
1	☐	☑
2	☐	☑
3	☐	☑

TRIG	
DEG	☑
GRAD	☐
RAD	☐

DISP	
FIX	☑
SCI	☐
ENG	☐
n_	0

REGISTERS

0	1 R_1	2 R_2	3 $DIST_{12}$	4 HDG_{12}	5 HDG_{1D}	6 $DIST_{1D}$	7 USED	8 USED	9
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I

Program Description I

Program Title Position by One Vor

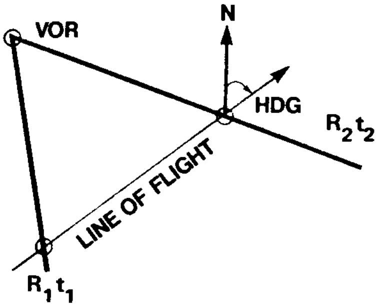
Contributor's Name Hewlett-Packard

Address 1000 N.E. Circle Blvd.

City Corvallis **State** Oregon **Zip Code** 97330

Program Description, Equations, Variables

This program computes the distance from a VOR station to an aircraft. The distance is found in a manner similar to the classical situation where one flies at right angles to the VOR radial and computes the time to the VOR from the time between bearings and the degrees of bearing change. This program offers a more complete solution in that it is unnecessary to fly at right angles to the VOR station and it includes the effect of winds.



The distance from the VOR station to the airplane is given by

$$S = \frac{(GS \times \Delta t)\sin(C - R_1)}{\sin(R_1 - R_2)} \quad (1)$$

where GS = ground speed of aircraft

Δt = time between readings = $t_2 - t_1$

C = magnetic course of aircraft

R_1 = first radial to the VOR

R_2 = second radial to the VOR

t_1 = time of the first VOR radial intercept.

t_2 = time of the second VOR radial intercept.

Operating Limits and Warnings

Program Description I

Program Title Position by One VOR

Contributor's Name Hewlett-Packard

Address 1000 N.E. Circle Blvd.

City Corvallis **State** Oregon **Zip Code** 973330

Program Description, Equations, Variables

Ground speed and course are found from the polar representation:

$$\frac{GS}{60} \angle C = TAS \angle HDG - W \angle D - V \qquad (2)$$

where V = magnetic variation
TAS = true airspeed
HDG = aircraft heading
W = wind velocity
D = wind direction (true)
∠ should be read as "at angle".

Although the ground speed vector is the true airspeed vector *plus* the wind vector, equation (2) is correct because the wind direction D indicates the direction the wind is coming from, not the direction it is blowing toward.

Operating Limits and Warnings

Limits and Warnings

Overall accuracy is limited by VOR receiver resolution. The difference in VOR readings should be at least 5° and preferably 10° to obtain accurate results. Times must be input to the nearest second.

Program Description II

Sketch(es)

Sample Problem(s)

An airplane is flying at a heading of 35°. Its true airspeed is 150 knots. The reported winds are 240° at 19 knots. Magnetic variation is 15° west. At 3:22:10 the OMNI indicates a heading of 330° to the station. At 3:34:30 the VOR reads 240° to the station. What is the distance to the station at the time of the second reading?

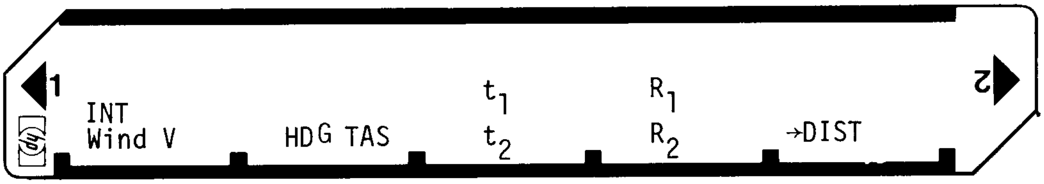
Solution(s) 31.72 nautical miles

Keystrokes	See Display
[f] [A] 240.19 [A] 15 [CHS] [A] 35 [B] 150 [B]	
3.2210 [C] 330 [D] 3.3430 [c] 240 [D] [E]	31.72

Reference(s)

This program is a direct translation of a program from the HP-65 Aviation Pac.

User Instructions



STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1.	Enter program				
2.	Initialize		f	A	0.00
3.	Optional: Input wind vector then	DDD.KK	A		DDD.KK
	magnetic variation (+E,-W)	V(Deg)	A		V
4.	Input all of the following:				
	Aircraft heading	HDG(Deg)	B		HDG
	then true airspeed	TAS(n.m.)	B		TAS
	Intersection time of first radial	t_1 (H.MMSS)*	C		t_1
	first radial heading to the VOR	R_1(Deg)	D		R_1
5.	Input intersection time of second VOR radial	t_2(H.MMSS)	C		t_2
	and second radial heading to the VOR	R_2(deg)	D		R_2
6.	Calculate distance to VOR		E		DIST(n.m.)
7.	For a second fix using the same station go to step 5. For a new case go to step 3.				
*	H.MMSS means hours, decimal point, minutes, seconds. 2.0355 is 2 hours 3 minutes and 55 seconds.				

97 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	*LBLa	21 16 11	
002	CLX	-51	
003	STO1	35 01	
004	STO2	35 02	
005	DEG	16-21	
006	RTN	24	
007	*LBLA	21 11	
008	STO2	35 02	
009	RTN	24	
010	*LBLA	21 11	
011	STO1	35 01	
012	RTN	24	
013	*LBLB	21 12	
014	STO4	35 04	
015	RTN	24	
016	*LBLB	21 12	
017	STO3	35 03	
018	RTN	24	
019	*LBLC	21 13	
020	RCL6	36 06	
021	STO5	35 05	
022	X⇄Y	-41	
023	STO6	35 06	
024	RTN	24	
025	*LBLD	21 14	
026	RCL8	36 08	
027	STO7	35 07	
028	X⇄Y	-41	
029	STO8	35 08	
030	RTN	24	
031	*LBLE	21 15	
032	RCL2	36 02	
033	INT	16 34	
034	RCL1	36 01	
035	-	-45	
036	RCL2	36 02	
037	FRC	16 44	
038	EEX	-23	
039	2	02	
040	x	-35	
041	CHS	-22	
042	→R	44	
043	RCL4	36 04	
044	RCL3	36 03	
045	→R	44	
046	X⇄Y	-41	
047	R↑	16-31	
048	+	-55	
049	R↓	-31	
050	+	-55	
051	R↑	16-31	
052	X⇄Y	-41	
053	→P	34	
054	RCL6	36 06	
055	RCL5	36 05	
056	CHS	-22	
057	HMS+	16-55	
058	HMS→	16 36	
059	ENT↑	-21	
060	CLX	-51	
061	X>Y?	16-34	
062	GSBe	23 16 15	
063	+	-55	
064	x	-35	
065	X⇄Y	-41	
066	RCL7	36 07	
067	-	-45	
068	SIN	41	
069	x	-35	
070	RCL7	36 07	
071	RCL8	36 08	
072	-	-45	
073	SIN	41	
074	÷	-24	
075	RTN	24	
076	*LBLe	21 16 15	
077	CLX	-51	
078	2	02	
079	4	04	
080	RTN	24	

FLAGS	
0	
1	
2	
3	

SET STATUS

FLAGS	ON	OFF	TRIG		DISP	
0	☐	☑	DEG	☑	FIX	☑
1	☐	☑	GRAD	☐	SCI	☐
2	☐	☑	RAD	☐	ENG	☐
3	☐	☑			n	2

REGISTERS

0	1	2	3	4	5	6	7	8	9
	V(DEG)	DDD.KK	TAS	HDG	T_1	T_2	R_1	R_2	

S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I

Program Description I

Program Title D M E Speed Correction

Contributor's Name Hewlett-Packard
Address 1000 N.E. Circle Blvd.
City Corvallis **State** Oregon **Zip Code** 97330

Program Description, Equ

The program calculates ground speed from the DME speed indicator when the airplane course is not directly to or from a DME station.

The DME speed indicator reads the component of velocity that is on a line between the plane and the DME station. The component V_1 is given by:

$$V_1 = GS \times |\cos(D - C)|$$

where

GS = The aircraft speed
D = Direction to (or from) the DME station
C = Aircraft ground course

solving for GS

$$GS = \frac{V_1}{|\cos(D-C)|}$$

The program will also correct for aircraft altitude

$$GS' = \frac{GS\sqrt{\Delta h^2 + DIST^2}}{DIST}$$

where

GS' = Aircraft ground speed corrected for heading and elevation
Δh = Difference between aircraft and DME altitude.
DIST = Distance to DME

Operating Limits and Warnings

Limits and Warnings

The accuracy of the DME and the limits of measuring D and C cause errors when angles to DME radials approach 90 degrees. To obtain accurate values, you should only use data obtained when crossing DME radials at an angle less than 60°.

The program uses ground course as an input, not aircraft heading. Aircraft headings must be corrected by the wind correction angle to obtain ground course.

Program Description II

Sketch(es)

Sample Problem(s)

An airplane flying a course of 265° intercepts the 220° TO radial of a DME station. The indicated DME speed is 123 knots. What is the ground speed.

If you are 10,000 feet above the DME station and 7 n.m. away what is your ground speed?

Solution(s)

GS = 174 knots
GS'= 179 knots

Keystrokes	See Display
[f] [A] 265 [A] 220 [B] 123 [C]	174
7 [D] 10000 [E]	179

Reference(s)

This program is a direct translation of a program from the HP-65 Aviation Pac.

User Instructions

1					2
INT Course	Radial	DME SPD → GS	DIST		Δ h →GS

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1.	Enter program				
2.	Initialize		f	A	
3.	Input course (degrees)	course	A		course
	and radial (degrees)	radial	B		radial
4.	Input DME speed and calculate ground speed	V_1(knots)	C		GS(knots)
5.	Optional:* Input distance to DME	DIST(n.m.)	D		DIST
	Input altitude above DME and calculate GS	Δh(ft)	E		GS(knots)
6.	For new case with same course and radial go to step 4. Go to step 3 for new case.				
*	Step 5 corrects for elevation effects and is not necessary unless the aircraft is very high or very close to the DME station.				

97 Program Listing I

```
001  *LBLa    21 16 11
002   DSP0      -63 00
003    CLX         -51
004    RTN          24
005  *LBLA       21 11
006   STO1       35 01
007    RTN          24
008  *LBLB       21 12
009   STO2       35 02
010    RTN          24
011  *LBLC       21 13
012   RCL2       36 02
013   RCL1       36 01
014      -         -45
015    COS          42
016      ÷         -24
017    ABS       16 31
018   STO3       35 03
019    RTN          24
020  *LBLD       21 14
021   STO4       35 04
022    RTN          24
023  *LBLE       21 15
024   ENT↑         -21
025      6          06
026      0          00
027      7          07
028      6          06
029      ÷         -24
030     X²          53
031   RCL4       36 04
032     X²          53
033      +         -55
034     √X          54
035   RCL4       36 04
036      ÷         -24
037   RCL3       36 03
038      x         -35
039    RTN          24
```

FLAGS	
0	
1	
2	
3	

SET STATUS

FLAGS	ON	OFF	TRIG		DISP	
0	☐	☑	DEG	☑	FIX	☑
1	☐	☑	GRAD	☐	SCI	☐
2	☐	☑	RAD	☐	ENG	☐
3	☐	☑			n	0

REGISTERS

0	1	2	3	4	5	6	7	8	9
	COURSE	TO RADIAL	GS	DIST					

S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I

Program Description I

Program Title Average Wind Vector

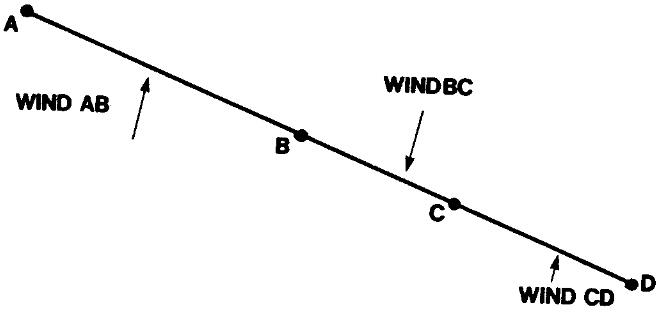
Contributor's Name Hewlett-Packard

Address 1000 N.E. Circle Blvd.

City Corvallis **State** Oregon **Zip Code** 97330

Program Description, Equations, Variables

When planning a flight it may be helpful to reduce several reported wind vectors along the flight path to one average wind. By weighting each wind vector along the flight path according to the distance it acts, an approximate average wind vector can be found. For a flight from A to D with forecast winds as shown:



$$\overrightarrow{\text{Wind Ave}} = \frac{1}{\text{Dist}_{AD}}\left[(\text{Dist}_{AB})(\overrightarrow{\text{Wind}}_{AB}) + (\text{Dist}_{BC})(\overrightarrow{\text{Wind}}_{BC}) + (\text{Dist}_{CD})(\overrightarrow{\text{Wind}}_{CD})\right]$$

Operating Limits and Warnings

Limits and Warnings

The greater the aircraft velocity as compared to that of the wind, the closer the approximation is to the actual case.

The velocity of input winds must be less than 100.

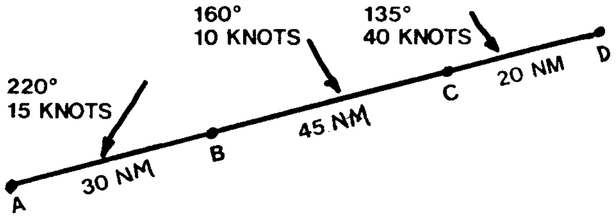
Program Description II

Sketch(es)

Sample Problem(s)

Sample Problem

Suppose a pilot wants to fly from A to D given the following wind pattern along his flight path. What is the approximate average wind?



Solution(s)

Solution

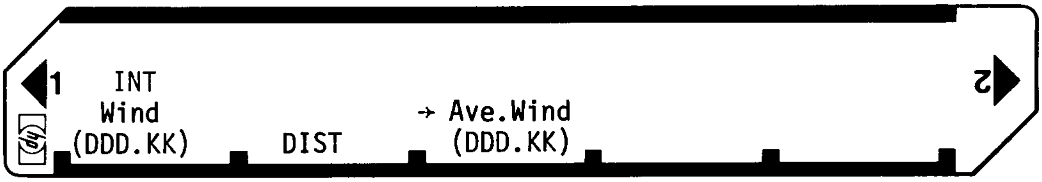
$\overrightarrow{\text{Wind Ave}}$ = 162.15 or a 15 knot wind at 162 degrees

Keystrokes	See Displayed
[f][A] 220.15 A 30 B 160.10 A 45 B	
135.40 A 20 B C	162.15

Reference(s)

This program is a direct translation of a program from the HP-65 Aviation Pac.

User Instructions



STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1.	Enter program				
2.	Initialize		f	A	0.00
3.	Input wind vector for a particular flight				
	segment and input distance along segment	DDD.KK*	A		DDD.KK
	over which wind vector acts	DIST	B		DIST
4.	Repeat step 3 for each segment				
5.	Calculate average wind		C		DDD.KK
6.	For new case go to step 2				
*	DDD.KK means direction, decimal point, wind				
	speed. 325.08 means a direction of 325				
	degrees and a speed of 8 knots.				

97 Program Listing I

```
STEP  KEY ENTRY  KEY CODE      COMMENTS

001   *LBLa     21 16 11
002    DSP2       -63 02
003    CLRG        16-53
004     CLX          -51
005     RTN           24
006   *LBLA        21 11
007    STO7        35 07
008    ENT↑          -21
009     FRC        16 44
010    STO2        35 02
011       -          -45
012    STO3        35 03
013    RCL7        36 07
014     RTN           24
015   *LBLB        21 12
016    STO7        35 07
017    ST+1     35-55 01
018    RCL2        36 02
019       x          -35
020    RCL3        36 03
021     X⇄Y          -41
022      →R           44
023    ST+4     35-55 04
024     X⇄Y          -41
025    ST+5     35-55 05
026    RCL7        36 07
027     RTN           24
028   *LBLC        21 13
029    RCL5        36 05
030    RCL1        36 01
031       ÷          -24
032    RCL4        36 04
033    RCL1        36 01
034       ÷          -24
035      →P           34
036    STO6        35 06
037      R↓          -31
038    STO7        35 07
039    ENT↑          -21
040     CLX          -51
041    X>Y?        16-34
042    GSBc     23 16 13
043       +          -55
044       .          -62
045       5           05
046       +          -55
047     INT        16 34
048    RCL6        36 06
049       +          -55
050     RTN           24
051   *LBLc     21 16 13
052     CLX          -51
053       3           03
054       6           06
055       0           00
056     RTN           24
```

STEP KEY ENTRY KEY CODE COMMENTS

060

070

080

090

100

110

FLAGS	SET STATUS		
	FLAGS	TRIG	DISP
0	ON OFF 0 ☐ ☑ 1 ☐ ☑ 2 ☐ ☑ 3 ☐ ☑	DEG ☑ GRAD ☐ RAD ☐	FIX ☑ SCI ☐ ENG ☐ n 2
1			
2			
3			

REGISTERS

0	1	2	3	4	5	6	7	8	9
	SUM D	V/100	WIND°	E_x	E_y	AVE V/100	USED		
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I

Program Description I

Program Title Course Correction

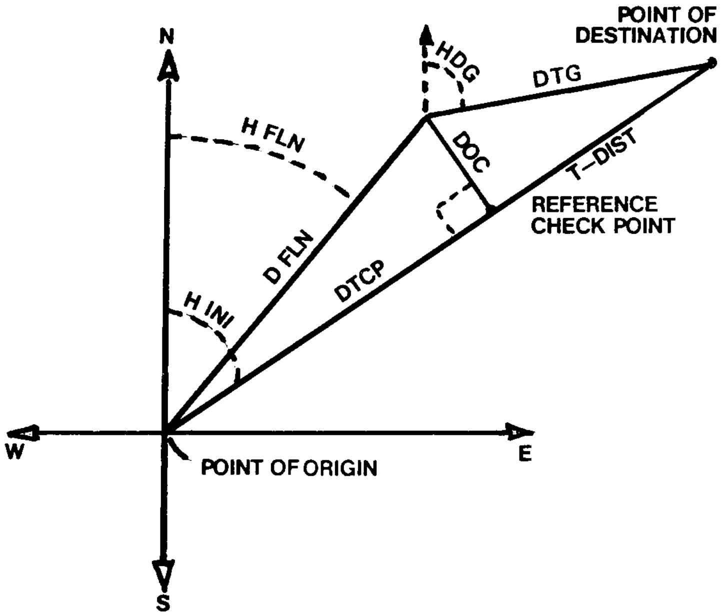
Contributor's Name Hewlett-Packard

Address 1000 N.E. Circle Blvd.

City Corvallis **State** Oregon **Zip Code** 97330

Program Description, Equations, Variables

The program calculates the new corrected heading and the distance to destination for an aircraft which has strayed a known distance off course.



Operating Limits and Warnings

Program Description I

Program Title

Contributor's Name

Address

City **State** **Zip Code**

Program Description, Equations, Variables

The following inputs are used in calculations.

DOC = Distance off course (this is input as a positive quantity if you are left of course and as a negative quantity if you are to the right of course);

T DIST = Total distance from the point of origin to the point of destination;

DTCP = Distance to checkpoint from point of origin;

D FLN = Distance actually flown from origin to point of course correction calculation. This value may be used instead of DTCP. When it is used it is input as a negative quantity;

H INI = The initial heading that should have been flown to arrive at the point of destination;

H FLN = The heading actually flown to arrive at the point of calculation for course correction. It may be used instead of H INI. If it is, it is input as a negative value;

The outputs of calculation are:

HDG = The new heading to be flown to arrive at the point of destination;

Operating Limits and Warnings

Program Description I

Program Title

Contributor's Name

Address

City **State** **Zip Code**

Program Description, Equations, Variables

DTG = The distance to go from the point of calculation;

$$DTCP = \sqrt{(-DF)^2 - (DOC)^2}$$

$$DTG = \sqrt{(DTCP - T\ DIST)^2 + (DOC)^2}$$

$$HDG = \sin^{-1}\left[\frac{DOC}{DTG}\right] + H\ INI$$

Operating Limits and Warnings

Limits and Warnings

This program assumes a flat earth. Large distances or calculations near the poles will yield inaccurate results.

Program Description II

Sketch(es)

Sample Problem(s)

Sample Problem

Suppose:

DOC = 15.6 (left)
T DIST = 180
H INI = 85.5 degrees
D FLN = 104 (input as – 104)

Find the heading which must be flown to reach the destination and the distance to destination.

Solution(s)

Solution

HDG = 96.93 degrees
DTG = 78.74 miles

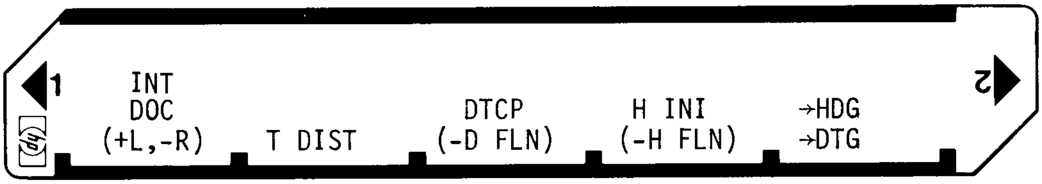
Course Correction

Keystrokes	**See Displayed**
[f][A] 15.6 A 180 B 85.5 D 104 CHS C E	96.93
E	78.74

Reference(s)

This program is a direct translation of a program from the HP-65 Aviation Pac.

User Instructions



STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1.	Enter program				
2.	Initialize		f	A	0.00
3.	Input distance off course (+left or -right)	DOC	A		DOC
	and total distance	T DIST	B		T DIST
	and distance from origin to checkpoint	DTCP	C		DTCP
	or distance flown (negative)	-D FLN	C		-D FLN
	and initial heading	H INI(Deg)	D		H INI (Deg)
	or heading flown (negative)	-H FLN (Deg)	D		-H FLN (Deg)
4.	Calculate new heading		E		HDG (Deg)
5.	Calculate distance to destination		E		DTG
	(Steps 4 and 5 may be repeated alternately to display HDG and DTG)				
6.	To modify problem go to step 3. For new case go to step 2.				

97 Program Listing I

```
STEP  KEY ENTRY   KEY CODE      COMMENTS
001   *LBLa       21 16 11
002   CLRG        16-53
003   CLX           -51
004   RTN            24
005   *LBLA       21 11
006   STO1        35 01
007   RTN            24
008   *LBLB       21 12
009   STO4        35 04
010   RTN            24
011   *LBLC       21 13
012   STO2        35 02
013   RTN            24
014   *LBLD       21 14
015   STO3        35 03
016   RTN            24
017   *LBLE       21 15
018   RCL2        36 02
019   0              00
020   X≤Y?        16-35
021   GTO3        22 03
022   RCL2        36 02
023   X²             53
024   RCL1        36 01
025   X²             53
026   -             -45
027   √X             54
028   ENT↑          -21
029   *LBL3       21 03
030   R↓            -31
031   STO5        35 05
032   RCL4        36 04
033   -             -45
034   X²             53
035   RCL1        36 01
036   X²             53
037   +             -55
038   √X             54
039   STO6        35 06
040   RCL1        36 01
041   X⇄Y           -41
042   ÷             -24
043   SIN⁻¹       16 41
044   STO7        35 07
045   RCL3        36 03
046   X>0?        16-44
047   GTO1        22 01
048   CHS           -22
049   RCL1        36 01
050   RCL5        36 05
051   ÷             -24
052   TAN⁻¹       16 43
053   +             -55
054   *LBL1       21 01
055   RCL7        36 07
056   +             -55
057   STO8        35 08
058   3              03
059   6              06
060   0              00
061   X≤Y?        16-35
062   GSBe        23 16 15
063   0              00
064   RCL8        36 08
065   X≤Y?        16-35
066   GSBd        23 16 14
067   0              00
068   +             -55
069   STO8        35 08
070   RTN            24
071   *LBLE       21 15
072   RCL6        36 06
073   RTN            24
074   *LBLe       21 16 15
075   -             -45
076   STO8        35 08
077   RTN            24
078   *LBLd       21 16 14
079   3              03
080   6              06
081   0              00
082   +             -55
083   RTN            24
```

FLAGS	
0	
1	
2	
3	

SET STATUS

FLAGS	ON	OFF	TRIG		DISP	
0	☐	☑	DEG	☑	FIX	☑
1	☐	☑	GRAD	☐	SCI	☐
2	☐	☑	RAD	☐	ENG	☐
3	☐	☑			n	2

REGISTERS

0	1	2	3	4	5	6	7	8	9
	DOC	-D FLN or DTCP	-H FLN or H INI	T DIST	DTCP	DTG	CORRECTION	HDG	

S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I

Program Description I

Program Title Time of Sunrise and/or Sunset

Contributor's Name Hewlett-Packard

Address 1000 N.E. Circle Blvd.

City Corvallis **State** Oregon **Zip Code** 97330

Program Description, Equations, Variables

Sunrise is computed from

$$S = [\theta_0 - \cos^{-1} (-\tan\phi_s \tan\phi_0)]/15 - E + 12 \qquad (1)$$

where

θ_0 = observer's longitude
ϕ_0 = observer's latitude
ϕ_s = subsolar latitude (declination of sun)
E = equation of time

ϕ_s and E are approximated by

$$\phi_s \doteq -23.5 \cos (t + 10) \qquad (2)$$

$$E \doteq 0.123 \cos (t + 87) - {}^1/_6 \sin (2t + 20) \qquad (3)$$

$$t \doteq 0.988 (D - 1 + 30.3 (m - 1)) \qquad (9)$$

where D and m are day and month respectively.

NOTE: Equation (1) computes the time at which the middle of the sun is on the horizon. Equation (1) does not account for atmopheric refractions. Refraction causes the sun to rise earlier than the value given by equation (1).

Operating Limits and Warnings

Program Description I

Program Title

Contributor's Name

Address

City **State** **Zip Code**

Program Description, Equations, Variables

Sunset is computed from

$$S = [\theta_0 + \cos^{-1}(-\tan\phi_s \tan\phi_0)]/15 - E + 12 \qquad (1)$$

where:

θ_0 = observer's longitude
ϕ_0 = observer's latitude
ϕ_s = subsolar latitude (declination of sun)
E = equation of time

ϕ_s and E are approximated by

$$\phi_s \doteq -23.5 \cos(t + 10)$$
$$E \doteq 0.123 \cos(t + 87) - {}^1/_6 \sin(2t + 20)$$
$$t \doteq 0.988 (D - 1 + 30.3 (m - 1))$$

where D and m are day and month respectively.

NOTE: Equation (1) computes the time at which the middle of the sun is on the horizon. Equation (1) does not account for atmospheric refractions. Refraction causes the sun to set later than the value given by equation (1).

Operating Limits and Warnings

Limits and Warnings

The approximate values of ϕ_s and E cause s to exhibit a maximum error of + 4.7 minutes and –0.6 minutes at 45° north latitude, based on 1973 ephemeris data. Refraction and secular changes in the ephemeris can result in errors as large as +8 minutes from observed data at 45° north. Errors decrease as latitudes approach 0°. Large errors exist above 65°.

Program Description II

Sketch(es)

Sample Problem(s)

Sample Problems

What time does the sun rise in San Francisco (37° 37′ N, 122° 23′ W) on Christmas Day? What time does the sun rise on June 25?

Solution(s)

Solutions

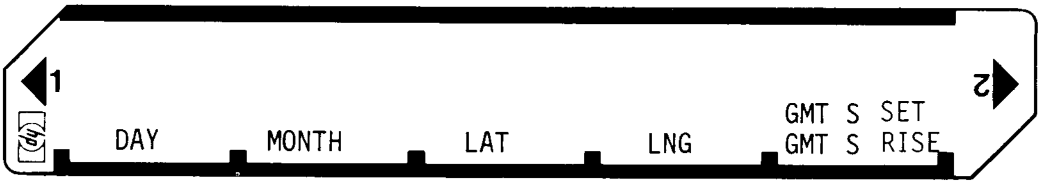
15:27 GMT (07:27 AM Pacific Standard Time)
12:53 GMT (05:53 AM Pacific Daylight Time)

Keystrokes	See Displayed
25 A 12 B 37.37 C 122.23 D	
E	15.27
6 B E	12.53

Reference(s)

This program is a direct translation of a program from the HP-65 <u>Aviation Pac</u>.

User Instructions



STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1.	Enter program				
2.	Enter all of the following:				
	Day of the month	Day	A		
	Month	Month	B		
	Observer Latitude **	DD.MMSS*	C		
	Observer Longitude	DDD.MMSS	D		
3.	Compute Sunrise		E		HH.MM
4.	Compute Sunset		f	E	HH.MM
5.	To change any variable, go to Step 2 and change				
	only those affected.				
*	DD.MMSS means degrees, decimal point, minutes				
	and seconds. 120.0713 is 120 degrees, 7				
	minutes and 13 seconds.				
**	Southern latitudes and eastern longitudes are				
	expressed as negative values.				
***	HH.MM means hours, decimal point, minutes.				
	2.03 is 2 hours 3 minutes.				

97 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	*LBLA	21 11	
002	STO1	35 01	
003	RTN	24	
004	*LBLB	21 12	
005	STO2	35 02	
006	RTN	24	
007	*LBLC	21 13	
008	STO3	35 03	
009	RTN	24	
010	*LBLD	21 14	
011	STO4	35 04	
012	RTN	24	
013	*LBLE	21 15	
014	3	03	
015	0	00	
016	.	-62	
017	3	03	
018	RCL2	36 02	
019	1	01	
020	-	-45	
021	x	-35	
022	RCL1	36 01	
023	+	-55	
024	1	01	
025	-	-45	
026	.	-62	
027	9	09	
028	8	08	
029	8	08	
030	x	-35	
031	STO5	35 05	
032	8	08	
033	7	07	
034	+	-55	
035	COS	42	
036	.	-62	
037	1	01	
038	2	02	
039	3	03	
040	x	-35	
041	RCL5	36 05	
042	ENT↑	-21	
043	+	-55	
044	2	02	
045	0	00	
046	+	-55	
047	SIN	41	
048	6	06	
049	÷	-24	
050	-	-45	
051	CHS	-22	
052	RCL5	36 05	
053	1	01	
054	0	00	
055	+	-55	
056	COS	42	
057	2	02	
058	3	03	
059	.	-62	
060	5	05	
061	x	-35	
062	TAN	43	
063	RCL3	36 03	
064	HMS→	16 36	
065	TAN	43	
066	x	-35	
067	COS^{-1}	16 42	
068	F2?	16 23 02	
069	GTOc	22 16 13	
070	CHS	-22	
071	RCL4	36 04	
072	HMS→	16 36	
073	+	-55	
074	1	01	
075	5	05	
076	÷	-24	
077	+	-55	
078	1	01	
079	2	02	
080	+	-55	
081	ENT↑	-21	
082	CLX	-51	
083	X>Y?	16-34	
084	GSBa	23 16 11	
085	+	-55	
086	→HMS	16 35	
087	RTN	24	
088	*LBLe	21 16 15	
089	SF2	16 21 02	
090	GTOE	22 15	
091	*LBLc	21 16 13	
092	RCL4	36 04	
093	HMS→	16 36	
094	+	-55	
095	1	01	
096	5	05	
097	÷	-24	
098	+	-55	
099	1	01	
100	2	02	
101	+	-55	
102	2	02	
103	4	04	
104	X>Y?	16-34	
105	GSBb	23 16 12	
106	-	-45	
107	→HMS	16 35	
108	RTN	24	
109	*LBLa	21 16 11	
110	2	02	
111	4	04	
112	RTN	24	

REGISTERS

0	1 DAY	2 MONTH	3 LAT	4 LNG	5 t	6	7	8	9
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I

97 Program Listing II

STEP	KEY ENTRY	KEY CODE	COMMENTS
113	*LBLb	21 16 12	
114	ENT↑	-21	
115	-	-45	
116	RTN	24	
120			
130			
140			
150			
160			
170			
180			
190			
200			
210			
220			

LABELS					FLAGS
A DAY	B MONTH	C LAT	D LNG	E SUNRISE	0
a	b	c	d	e Sunset	1
0	1	2	3	4	2
5	6	7	8	9	3

SET STATUS

FLAGS	ON	OFF	TRIG		DISP	
0	☐	☑	DEG	☑	FIX	☑
1	☐	☑	GRAD	☐	SCI	☐
2	☐	☑	RAD	☐	ENG	☐
3	☐	☑			n	2

Program Description I

Program Title Azimuth of Sunrise and Sunset

Contributor's Name Hewlett-Packard

Address 1000 N.E. Circle Blvd.

City Corvallis **State** Oregon **Zip Code** 97330

Program Description, Equations, Variables

This program computes the true heading (azimuth) of the sun as it rises or sets. Input data are day of the month, month of the year and latitude.

The azimuth of the sun is given by

$$Az = \cos^{-1} \frac{\sin \phi_s}{\cos \phi_0}$$

ϕ_s is the latitude of the subsolar point
ϕ_0 is the latitude of the observer
ϕ_s is approximated by

$\phi_s = 0.5 -23.5 \cos(0.986 \text{ day} + 9.66)$ where day is the day of the year.

Operating Limits and Warnings

The approximations used in this program limit the overall accuracy to = 1%. Significant errors can occur at or above the artic circles and their respective poles during certain times of the year.

Program Description II

Sketch(es)

Sample Problem(s)

Sample Problem

What is the azimuth of sunset on Christmas day for an observer in San Francisco (37° 37′ N)?

Solution(s)

Solution

Answer: 240.51 degrees

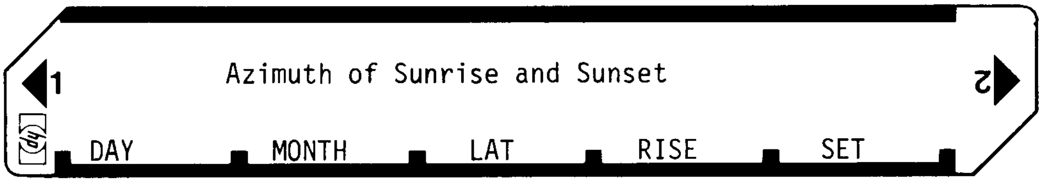
Azimuth of Sunrise and Sunset

Keystrokes	**See Displayed**
25 **A** 12 **B** 37.37 **C** **E**	240.51

Reference(s)

This program is a direct translation of a program from the HP-65 Aviation Pac.

User Instructions



STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1.	Enter program			
2.	Input all of the following			
	Day of the month	Day	A	
	Month (Jan = 1, Dec = 12)	Month	B	
	Observer's latitude	DD.MMSS*	C	
3.	Calculate either or both			
	Azimuth of Sunrise		D	
	Azimuth of Sunset		E	
4.	Go to step three to change any input variable			
	NOTE: Azimuth is given as a true azimuth, not magnetic.			
*	DD.MMSS means degrees, decimal point, minutes and seconds. 20.0713 is 20 degrees, 7 minutes and 13 seconds.			

97 Program Listing I

```
STEP  KEY ENTRY  KEY CODE        COMMENTS   STEP  KEY ENTRY  KEY CODE        COMMENTS
001   *LBLA      21 11                      057   HMS+       16 36
002   STO1       35 01                      058   COS           42
003   RTN           24                      059   ÷            -24
004   *LBLB      21 12                      060   COS-1      16 42
005   STO2       35 02                      061   3             03
006   RTN           24                      062   6             06
007   *LBLC      21 13                      063   0             00
008   STO3       35 03                      064   X⇄Y          -41
009   RTN           24                      065   F2?     16 23 02
010   *LBLD      21 14                      066   -            -45
011   RCL2       36 02                      067   RTN           24
012   .            -62                      068   *LBLE      21 15
013   4             04                      069   SF2     16 21 02
014   x            -35                      070   GTOD       22 14
015   2             02                      071   *LBLd   21 16 14
016   .            -62                      072   CLX          -51
017   3             03                      073   STO8       35 08
018   +            -55                      074   RTN           24
019   INT        16 34                      075   R/S           51
020   STO8       35 08
021   2             02
022   RCL2       36 02
023   X≤Y?       16-35
024   GSBd    23 16 14                      080
025   RCL1       36 01
026   RCL8       36 08
027   -            -45
028   RCL2       36 02
029   1             01
030   -            -45
031   3             03
032   1             01
033   x            -35
034   +            -55                      090
035   .            -62
036   9             09
037   8             08
038   6             06
039   x            -35
040   9             09
041   .            -62
042   6             06
043   6             06
044   +            -55                      100
045   COS           42
046   2             02
047   3             03
048   .            -62
049   5             05
050   x            -35
051   CHS          -22
052   .            -62
053   5             05
054   +            -55                      110
055   SIN           41
056   RCL3       36 03
```

FLAGS
0
1
2
3

SET STATUS

FLAGS	ON	OFF	TRIG		DISP	
0	☐	☑	DEG	☑	FIX	☑
1	☐	☑	GRAD	☐	SCI	☐
2	☐	☑	RAD	☐	ENG	☐
3	☐	☑			n 2	

REGISTERS

0	1	2	3	4	5	6	7	8	9
	DAY	MONTH	LAT					0.4m+2.3	
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I

NOTES

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