Model 46

The Hewlett-Packard Company Calculator Products Division

The HP-46 is a desk-top printing calculator power packed for scientists and engineers. With its 9 data storage registers and up to 10 digit accuracy (depending upon the calculation) it is a truly versatile machine. This booklet contains examples you can do on the HP-46 to show yourself how this calculator will solve your problems.

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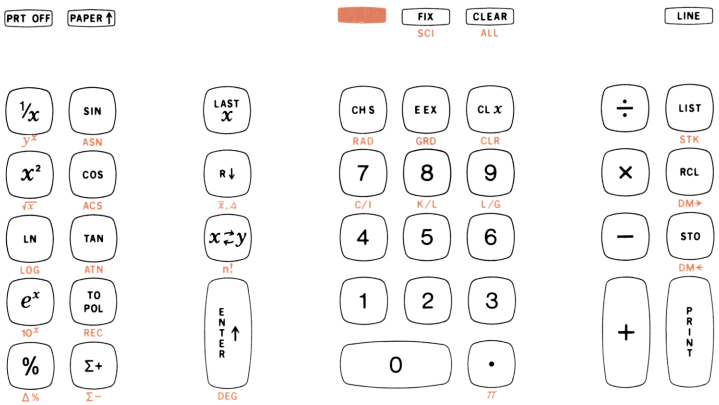
KEYBOARD



PRINTER/DISPLAY

The basic HP-46 has impact printer with special alpha-numeric capability. The easy to read symbols make the hard copy a truly valuable permanent record. Certain errors, such as division by zero cause a printout telling you why the calculation cannot be continued.

The display is optional and can be used with the printer or by itself with the printer shut off.

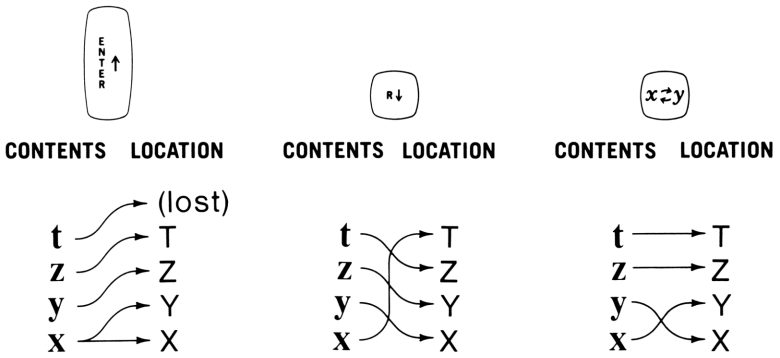
The format of printed and/or displayed numbers can be changed by pressing the FIX key followed with a numerical key between 0 and 9. FIX 5 , for example, rounds the number to show five decimal places after the decimal point. Scientific notation can be specified by pressing [shift] FIX (SCI) . The [shift] acts as a shift key; it gives two functions to one key.

The possible formats for the number 1.23456789 are shown below:

FIX 9	1.234567890 ◇
FIX 8	1.23456789 ◇
FIX 7	1.2345679 ◇
FIX 6	1.234568 ◇
FIX 5	1.23457 ◇
FIX 4	1.2346 ◇
FIX 3	1.235 ◇
FIX 2	1.23 ◇
FIX 1	1.2 ◇
FIX 0	1. ◇

MOVING DATA

The HP-46 has 4 working registers (locations) that hold the number you have entered and the results of calculations. The contents of these registers can be moved to and fro to permit greater operating flexibility. 3 keys are provided for manipulating (or moving) the contents as follows:



CLEARING AND STORING DATA

Clear Functions

- CL x — erases the current contents of X
- CLEAR — erases the contents of X, Y, Z and T (the stack)
- CLEAR ALL — erases the stack and the 9 storage locations
- CL x CLR — erases the statistics storage locations 5-8 and the stack.

Storing and Recalling Data

To store a value that is in X, press STO followed by the number key (1-9) specifying the location. That value is reproduced in the storage location leaving the original in X. To retrieve a value, press RCL followed by the applicable number key. A duplicate of the recalled value is placed in X, pushing the stack up; the original value remains in the constant storage location.

Example: Store the numbers one through nine in the storage locations 9 through 1:

Press: 1 STO 9 2 STO 8

3 STO 7 4 STO 6 5 STO 5

6 STO 4 7 STO 3 8 STO 2

9 STO 1

```
1.    → 9
2.    → 8
3.    → 7
4.    → 6
5.    → 5
6.    → 4
7.    → 3
8.    → 2
9.    → 1
```

List the contents of the storage locations by pressing LIST. Your printout should match the one below:

```
LIST
9.    → 1
8.    → 2
7.    → 3
6.    → 4
5.    → 5
4.    → 6
3.    → 7
2.    → 8
1.    → 9
```

ARITHMETIC OPERATIONS

In the HP-46, arithmetic answers appear immediately after pressing one of the arithmetic keys [+], [−], [×], [÷]. This means the operation follows the number entry.

A number is changed from positive to negative or vice versa with the change sign key [CHS].

How much is 6 plus 2? Next, subtract 5 from the result, then multiply by 4, divide by 6, and change the sign of the final answer.

Step	Key Strokes	Printer Tape	Description
1	6 [ENTER↑] 2 [+]	6.00 ↑ 2.00 +	add.
2	5 [−]	5.00 −	sub.
3	4 [×]	4.00 ×	multi.
4	6 [÷]	6.00 ÷	div.
5	[CHS]	⇄S	changes positive number to a negative number
		− 2.00 ◇	

t STATISTICS

The first example is a statistical problem where the mean of one sample is compared to another sample to find out if they are statistically equivalent. This problem uses the stat functions on the HP-46 plus the storage registers and direct register arithmetic.

$$t = \frac{\bar{x}-\bar{y}}{\sqrt{\frac{(n_x-1)\sigma x^2+(n_y-1)\sigma y^2}{n_x+n_y-2}}\sqrt{\frac{1}{n_x}+\frac{1}{n_y}}}$$

To use the t value .398 the user must refer to a statistical table which has degrees of freedom and level of significance. Degrees of freedom equal $n_1+n_2-2=17$. The user may determine his own level of significance, in this case 10%. The table value is 1.333. Since the t statistic .398 is less than 1.333 there is no statistical difference between $\bar{x}$ and $\bar{y}$.

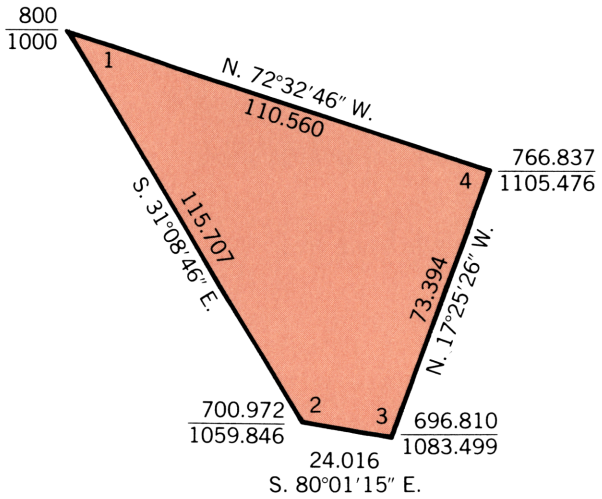
Step	Key Strokes	Printer Tape	Description
1	[ ] [CL x] (CLR) [FIX] 3	CLEAR	
2	Enter each number of the first set of data followed by [Σ+]. 6 [Σ+] 5 [Σ+] · · · 5.680 [Σ+] [ ] [R↓] (x̄,Δ)	6.000 Σ+ 5.000 Σ+ 8.000 Σ+ 9.000 Σ+ 6.500 Σ+ 8.600 Σ+ 9.500 Σ+ 5.680 Σ+ # 8.000 ◇ 1.697 σ◇ 7.285 x̄ ◇	number of entries standard deviation mean

t STATISTICS

Step	Key Strokes	Printer Tape	Description
3	STO 1 $x\rightleftarrows y$ x^2	→ 1	
		⇄	
		✱	
	RCL 5 STO 3	→ 5	number of entries
		8.000	
		→ 3	
4	1 − × STO 2	1.000 −	
		×	
		→ 2	
5	Repeat steps 1 and 2 for second set of data.	CLEAR	
		4.000 Σ+	
		3.000 Σ+	
		5.600 Σ+	
		10.000 Σ+	
		8.000 Σ+	
		7.000 Σ+	
		6.200 Σ+	
		9.800 Σ+	
		4.250 Σ+	
		11.500 Σ+	
		6.000 Σ+	
		# 11.000 ◇	
		2.720 σ◇	
		6.850 x̄ ◇	
6	RCL − 1 $x\rightleftarrows y$	←−1	
		⇄	
	x^2 RCL 5	✱	
		← 5	
		11.000	
7	1 − × RCL	1.000 −	
		×	
	+ 2 RCL 3 RCL 5	←+2	
		← 3	
		8.000	
		← 5	
8	+ 2 − ÷	11.000	
		+	
	x^2 ÷	2.000 −	
		÷	
		√	
	RCL 3	÷	
		← 3	
		8.000	
		← 5	
9	$\frac{1}{x}$ RCL 5	$\frac{1}{x}$	
		11.000	
10	$\frac{1}{x}$ + x^2	$\frac{1}{x}$	
		+	
		√	
	÷ PRINT	÷	
		− 0.398 ◇	t value

BEARING TRAVERSE WITH AREA & CLOSURE

Example:



Step	Key Strokes	Printer Tape	Description
1	[■] [CL x] [FIX] 4	CLEAR	
2	800 [ENTER ↑] [STO] 1	800.0000 ↑ → 1	starting northing
3	1000 [STO] 2 [STO] 3 [Σ+]	1000.0000 → 2 → 3 Σ+	starting easting
4	31.0846 [■] [RCL]	31.0846 DMS→	bearing (DMS)
5	[CHS] 180 [+]	≠S 180.0000 + 115.7070	add 180 since SE
6	115.7070 [■] [TO POL]	TO RECT 59.8462 ◇ − 99.0280 ◇	departure latitude
7	[x⇄y] [Σ+] [RCL] 3	≠ Σ+ ← 3 1000.0000	
8	[RCL] 7 [STO] 3	← 7 1059.8462 → 3	
9	[+] [×] [STO] [+] 4	+ × →+4 700.9720 AC◇	new northing
10	[RCL] [Σ+] 80.0115 [■] [RCL]	1059.8462 AC◇ 80.0115 DMS→	new easting next bearing

Return to step 5 for successive courses; continue on to step 11 for closure and area.

11	[RCL] 1 [RCL] 2 [■] [Σ+]	← 1 800.0000 ← 2 1000.0000 Σ−	
12	[RCL] [Σ+]	− 0.0022 AC◇ 0.0062 AC◇ ← 4	closing latitude closing departure
13	[RCL] 4 2 [÷] [PRINT]	10203.7546 2.0000 ÷ 5101.8773 ◇	area (sq.ft.)

COMPLEX ARITHMETIC

Complex arithmetic is used in many areas, but has particularly large usage in the field of electrical engineering. In this area, it is often necessary to multiply or divide complex quantities. The methods for doing this by hand are somewhat involved and quite tedious. The HP-46 Calculator with its polar, rectangular, logarithmic, and summation keys makes this problem very simple.

$$\frac{(A+jB)}{(C+jD)} = (X+jY)$$

By Hand:

$$\frac{(A+jB)}{(C+jD)} = \frac{(A+jB)}{(C+jD)} \cdot \frac{(C-jD)}{(C-jD)}$$

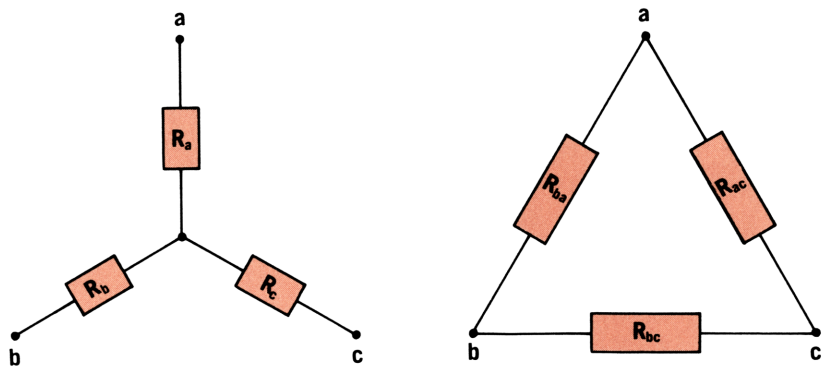
$$= \frac{(AC+BD)+j(-AD+BC)}{C^2+D^2}$$

$$X = \frac{AC+BD}{C^2+D^2}$$

$$Y = \frac{-AD+BC}{C^2+D^2}$$

Step	Key Strokes	Printer Tape	Description
1	[CL x] (CLR) [FIX] 3	CLEAR	
2	41 [ENTER↑] 12 [CHS] [TO POL]	41.000 ↑ - 12.000 TO POLAR 106.314 ◇ 42.720 ◇	B A
3	[LN] [Σ+]	ln Σ+	
4	3 [ENTER↑] 4 [TO POL] [LN] [Σ+] (Σ−)	3.000 ↑ 4.000 TO POLAR 36.870 ◇ 5.000 ◇ ln Σ−	D C
5	[RCL] [Σ+] [e^x]	69.444 AC◇ 2.145 AC◇ e^x	
6	[TO POL] (REC)	TO RECT 8.000 ◇ 3.000 ◇	Y X

WYE TO DELTA TRANSFORMATION



$$R_{ab} = \frac{R_aR_b+R_bR_c+R_cR_a}{R_c}$$

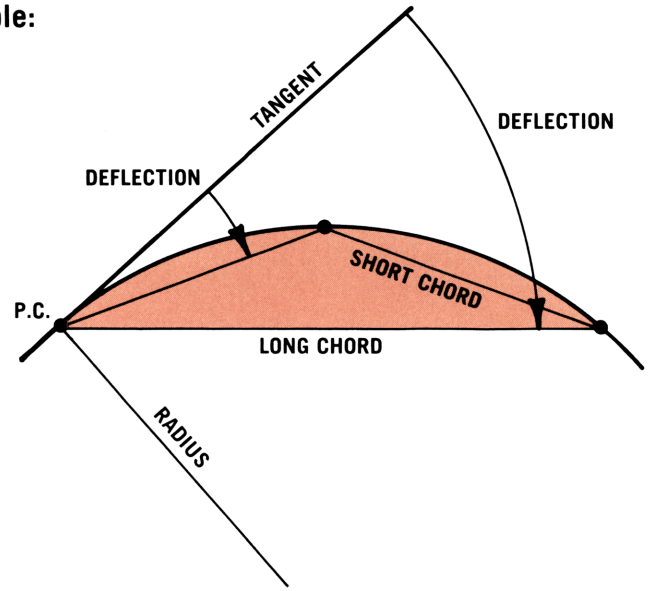
$$R_{bc} = \frac{R_aR_b+R_bR_c+R_cR_a}{R_a}$$

$$R_{ca} = \frac{R_aR_b+R_bR_c+R_cR_a}{R_b}$$

Step	Key Strokes	Printer Tape	Description
1	[ ] [CL x] (CLR) [FIX] 2	CLEAR	
2	83 [STO] 1 91 [STO] 2 [×]	83.00 → 1 91.00 → 2 ×	R_a R_b
3	[RCL] [LAST x] 30 [STO] 3 [×] [+] [RCL] 3	← 0 91.00 30.00 → 3 × + ← 3 30.00	R_c
4	[RCL] [×] 1 [+] [RCL] [÷] 1 [PRINT]	←×1 + ←÷1 153.89 ◇	R_{bc}
5	[RCL] [LAST x] [RCL] [÷] 2 [PRINT]	← 0 12773.00 ←÷2 140.36 ◇	R_{ca}
6	[RCL] [LAST x] [RCL] [÷] 3 [PRINT]	← 0 12773.00 ←÷3 425.77 ◇	R_{ab}

HORIZONTAL CURVE LAYOUT

Example:



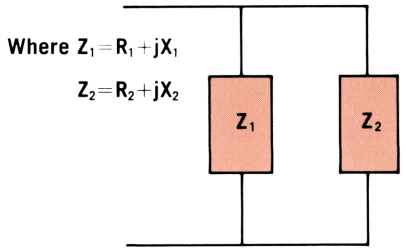
Radius = 900.000 Ft.

STATION	ARC	DEFLECTION	LONG CHORD
12+57.00	(Point of Curvature (P.C.))		
12+75.00	18.00	00°34′22″	18.000
13+00.00	43.00	01°22′07″	42.996
13+25.00	68.00	02°09′52″	67.984
13+50.00	93.00	02°57′37″	92.959
13+75.00	118.00	03°45′21″	117.915
13+89.00	132.00	04°12′06″	131.882

Step	Key Strokes	Printer Tape	Description
1	[CL x] (CLR) [FIX] 3	CLEAR	
2	900 [ENTER↑]	900.000 ↑	radius
3	2 [×] [ENTER↑] [ENTER↑]	2.000 × ↑ ↑	
4	180 [ENTER↑]	180.000 ↑	
5	[•] (π) [÷] [÷] [1/x] [Σ+]	3.142 ÷ ÷ 1/x Σ+	
6	[RCL] [Σ+]	1800.000 AC◇ 0.032 AC◇	
7	43 [×]	43.000 ×	arc length from P.C.
8	[STO] (DM←) [PRINT]	DMS← 1.2207 ◇	deflection angle (DMS)
9	[CL x] [LAST x]	← 0 1.369	
10	[SIN] [×] [PRINT]	S × 42.996 ◇	chord

PARALLEL IMPEDANCES

$$Z_{eq} = \frac{Z_1 Z_2}{Z_1 + Z_2} = \frac{1}{\frac{1}{Z_1} + \frac{1}{Z_2}}$$



By Hand:

$$Z_{eq} = R_{eq} + jX_{eq} = \frac{Z_1 Z_2}{Z_1 + Z_2}$$

$$R_{eq} = \frac{(R_1R_2 - X_1X_2)(R_1 + R_2) - (R_1X_2 + R_2X_1)(X_1 + X_2)}{(R_1 + R_2)^2 + (X_1 + X_2)^2}$$

$$X_{eq} = \frac{(R_1R_2 - X_1X_2)(X_1 + X_2) + (R_1X_2 - R_2X_1)(R_1 + R_2)}{(R_1 + R_2)^2 + (X_1 + X_2)^2}$$

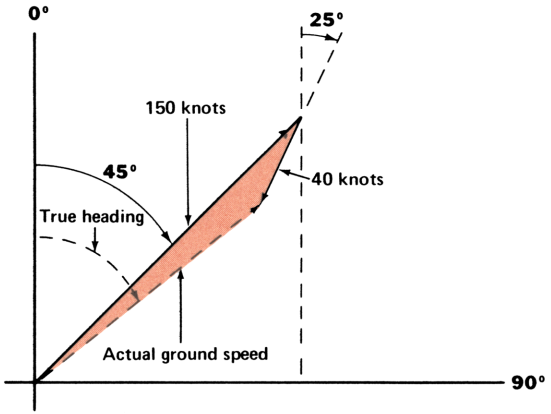
Step	Key Strokes	Printer Tape	Description
1	[f] [CL x] (CLR) [FIX] 2	CLEAR	
2	.12 [ENTER↑] 200 [TO POL] [1/x] [x≷y] [CHS] [x≷y]	0.12 ↑ 200.00 TO POLAR 0.03 ◇ 200.00 ◇ 1/x ⇄ ⇄S ⇄	X_1 R_1
3	[f] [TO POL] (REC) [STO] 1 [x≷y] [STO] 2	TO RECT − 0.00 ◇ 0.00 ◇ → 1 ⇄ → 2	
4	.45 [ENTER↑] 150 [TO POL] [1/x] [x≷y] [CHS] [x≷y]	0.45 ↑ 150.00 TO POLAR 0.17 ◇ 150.00 ◇ 1/x ⇄ ⇄S ⇄	X_2 R_2
5	[f] [TO POL] (REC) [RCL] [+] 1 [x≷y] [RCL] [+] 2 [x≷y]	TO RECT − 0.00 ◇ 0.01 ◇ ←+1 ⇄ ←+2 ⇄	
6	[TO POL] [1/x] [x≷y] [CHS] [x≷y]	TO POLAR − 0.11 ◇ 0.01 ◇ 1/x ⇄ ⇄S ⇄	
7	[f] [TO POL] (REC)	TO RECT 0.17 ◇ 85.71 ◇	X_{eq} R_{eq}

NAVIGATION

An aircraft has a true air speed of 150 knots and an estimated heading of 45°. There is a head wind of 40 knots and 25°. What is the actual ground speed and true heading?

Solution: The true heading and actual ground speed are equal to the difference of the vectors:

45°, 150 knots
25°, 40 knots



The true heading is 51.94°. The actual ground speed is 113.24 knots.

The calculator uses storage location number 9 to store intermediate results while performing coordinate conversions. Any data in this location stored previous to using these functions is erased.

Step	Key Strokes	Printer Tape	Description
1	[ ] [CL x] (CLR) [FIX] 2	CLEAR	
2	45 [ENTER↑] 150 [ ]	45.00 ↑ 150.00	heading true air speed
	[TO POL] (REC) [Σ+]	TO RECT 106.07 ◇ 106.07 ◇ Σ+	
3	25 [ENTER↑] 40 [ ]	25.00 ↑ 40.00	headwind direction headwind speed
	[TO POL] (REC) [ ] [Σ+] (Σ−)	TO RECT 16.90 ◇ 36.25 ◇ Σ−	
4	[RCL] [Σ+] [TO POL]	89.16 AC◇ 69.81 AC◇ TO POLAR 51.94 ◇ 113.24 ◇	true heading actual ground speed