HEWLETT-PACKARD

HP-45

Owner's Handbook

20.11.73

Hewlett-Packard's interest in computation evolved as a natural extension of our traditional involvement in measurement problem solving. At an early date, HP recognized the growing need for a family of computational products designed to work easily and effectively with scientific instruments.

In 1966 we introduced the first digital minicomputer specifically designed to meet this need. Soon after, we followed up with our first programmable calculator. From these beginnings, HP has now become an acknowledged leader in the field of computational problem solving. More than 20,000 HP programmable calculators and digital computers are at work in a wide range of applications in science, industry, education, medicine, and business. Their effectiveness is further enhanced by a complete line of accessory devices, ranging from digital tape and disc drives to card and tape readers, printers, and plotters.

Lately we've coupled our experience in scientific problem solving and computational technology to bring you new dimensions in personal computation—the HP-80 Business Pocket Calculator for solving problems in business and finance, the HP-35 Scientific Pocket Calculator for engineering/scientific applications, and now the HP-45 Advanced Scientific Pocket Calculator whose expanded functional capability and multiple storage registers allow complex problems to be handled with unprecedented ease.

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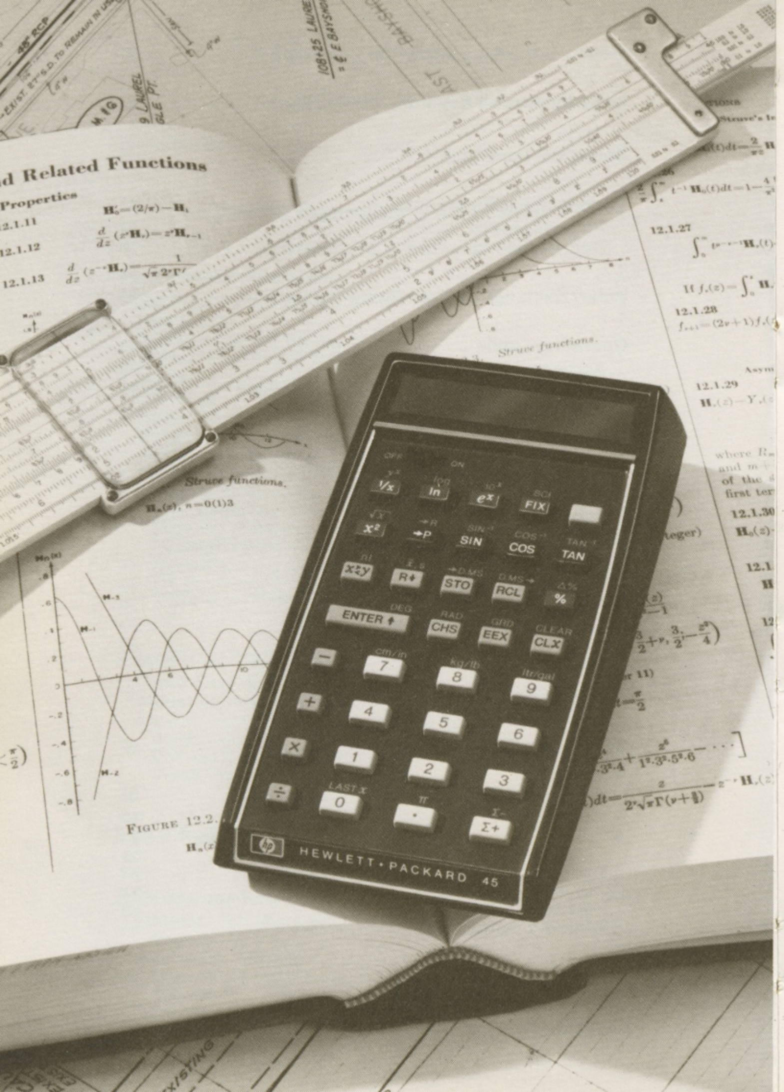


Introduction

Little is understood about the methods used by calculating prodigies to perform their awesome feats. The method used by 10-year-old Truman Henry Safford in 1846 to calculate 365365365365 365365^2 (as described by the Rev. H. W. Adams) shows that difficult problems are difficult even for prodigies—"*. . . he flew around the room like a top, pulled his pantaloons over the tops of his boots, bit his hands, rolled his eyes in their sockets, sometimes smiling and talking and then seeming to be in an agony, until, in not more than one minute said he, 133,491,850,208,566,925, 016,658,299,941,583,255!*"

Although your HP-45 might not be as much fun to watch, it makes calculating faster and less arduous, because the operational stack and the reverse "Polish" notation used in the HP-45 provide the most efficient way known to computer science for evaluating mathematical expressions.

The HP-45 has far more computing power than previous pocket calculators. Its accuracy exceeds the precision to which most of the physical constants of the universe are known. It will handle numbers as small as 10^{-99}, as large as 10^{99}, automatically places the decimal point, and allows 20 different options for rounding the display to provide greater flexibility and convenience in interpreting results. The HP-45 provides you with transcendental functions, such as logarithms, sines and cosines; polar/rectangular coordinate conversions for handling complex arithmetic, vectors; selective operating modes; and multiple storage registers. Additionally, constants for π and e are provided—as well as three metric/U.S. unit constants for conversions between centimeters/inches, kilograms/pounds, and liters/gallons. Furthermore, statistical capabilities for calculating the mean (arithmetic average) and standard deviation are incorporated in the HP-45.

To give you an idea of the scope and power of your HP-45, let's convert rectangular x, y coordinates (3, 4) to polar form (magnitude and angle). To solve, simply enter the known values as follows:

Key in 4 (y-coordinate) and press ENTER↑, then key in 3 (x-coordinate) and press →P (to polar) to display the magnitude: 5.00. Press x⇄y to display the angle: 53.13.

If you want to see the angle with 8 decimal places, press FIX, then key in 8 and see displayed: 53.13010235.

To obtain the magnitude, press x⇄y and see displayed: 5.00000000.

Now press FIX 2 to get back to 2 decimal places in the display.

Note that the result is accurate to 9 significant digits. Now compare that with the slide rule solution (accurate to 3 significant digits).

Slide Rule Method	**HP-45 Method**
Magnitude = $\sqrt{x^2 + y^2}$ Angle = $\tan^{-1}(y/x)$ where: $x = 3$ $y = 4$ Calculate magnitude: $x^2 = 3 \times 3 = 9$ $y^2 = 4 \times 4 = 16$ $x^2 + y^2 = 9 + 16 = 25$ $\sqrt{x^2 + y^2} = \sqrt{25} = 5.0$ Calculate angle: $\tan^{-1}(y/x) = \tan^{-1}(4/3) =$ $\tan^{-1}(1.3) = 53.1$	Key in: 4 ENTER↑ 3 Display magnitude: →P ⟶ 5.00 Display angle: x⇄y ⟶ 53.13

Incidentally, no calculator available today (including ours) can handle the problem given to our child prodigy. Isn't it comforting to know that people can still do things machines can't?

Fundamental Operations

Getting Started

Your HP-45 is shipped fully assembled with its battery pack in plac and is ready to operate. Slide the power switch to ON. If anything othe than 0.00 appears on the display, see *Service*, page 53 .

The display blinks when an improper operation is made. The blink ing will stop as soon as CLX is pressed and you may enter a new problem.

Keyboard

Figure 1 illustrates the keyboard layout. Almost every key perform two distinct functions. The symbol for the primary function appear on the key, and the symbol for the alternate function appears abov the key like this $\overset{\sqrt{x}}{x^2}$.

To use the primary function, merely press the selected key; to use th alternate function, press the gold key 🟧 (upper righthand corner) before pressing the associated key like this 🟧 $\overset{\sqrt{x}}{x^2}$. Alternate function are indicated like this 🟧 $\sqrt{x}$ throughout your Handbook.

A summary of all keys and an index to where they are used are provided at the back of your Handbook.

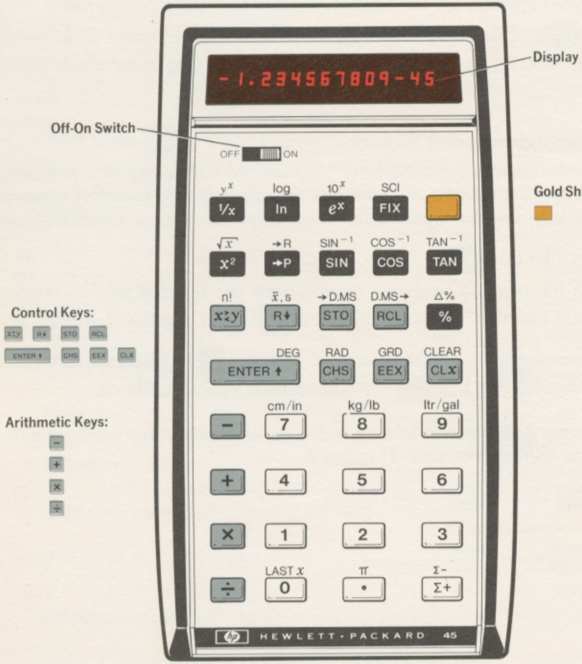


Figure 1. *Keyboard Layout*

Keying In and Entering Numbers

Each time a number key is pressed, that number appears left-justified on the display in the order as pressed. Note that a decimal point symbol is included with the number entry keys; it must be keyed in if it is part of the number. For example, 314.32 would be keyed as 3 1 4 • 3 2 . To signal that the number string keyed in is complete, press ENTER ↑ . Now you may key in another number string.

If you make a mistake when keying in a number, clear the entire number string by pressing CLX . Then key in the correct number.

Performing Simple Arithmetic

In the HP-45, arithmetic answers appear on the display immediately after pressing an arithmetic key: + , − , × , ÷ . In an adding machine, the + key adds whatever is already in the machine to the last entry, and the − key subtracts this last entry. The HP-45 not only adds and subtracts the same way as the old familiar adding machine, it also multiplies and divides this way too—the × key multiplies whatever is already in the machine by the last entry, and the ÷ key divides by the last entry. For example, add 12 and 3.

Press:		**See displayed:**
12 ENTER ↑ 3 +	⟶	15.00

Did you notice that you calculated this sum in the same order in which you would ordinarily do it with pencil and paper? That's right—you keyed in 12, terminated the number string and loaded the number by pressing ENTER ↑ . Then you pressed 3 followed by + to get the answer.

This same principle is used for calculating any arithmetic problem having two numbers and one arithmetic operator. For example, subtract 3 from 12.

Press:		**See displayed:**
12 ENTER ↑ 3 −	⟶	9.00

To multiply 12 by 3,

Press:	**See displayed:**
12 ENTER↑ 3 × →	36.00

To divide 12 by 3,

Press:	**See displayed:**
12 ENTER↑ 3 ÷ →	4.00

Correcting Input Errors

The HP-45 automatically stores the last number displayed (last input argument) that precedes the last function performed. For example, if you wanted to verify the last input argument from the example above,

Press:	**See displayed:**	
🟧 LAST *x* →	3.00	last input argument

A special storage register—Last *x*—is provided for this purpose. As each new function is keyed (executed), the contents of Last *x* are overwritten with the new value.

LAST *x* is a very useful feature for correcting errors, such as pressing the wrong arithmetic operator key or entering the wrong number. For example, if you were performing a long calculation where you meant to *subtract* 3 from 12 and *divided instead*, you could compensate as follows:

Press:	**See displayed:**	
12 ENTER↑ 3 ÷ →	4.00	oops—you wanted to subtract
🟧 LAST *x* →	3.00	retrieves last number displayed preceding operation (division)
× →	12.00	reverses division operation; you're back where you started
🟧 LAST *x* →	3.00	retrieves last number displayed before operation (multiplication)
− →	9.00	correct operation produces desired results

If you want to correct a number in a long calculation, LAST *x* can save you from starting over. For example, divide 12 by 2.157 after you have divided by 3.157 in error.

Press:	**See displayed:**	
12 ENTER↑ 3.157 ÷ →	3.80	you wanted to divide by *2.157* not *3.157*
🟧 LAST *x* →	3.16	retrieves last number displayed preceding operation
× →	12.00	you're back at the beginning
2.157 ÷ →	5.56	Eureka!

Clearing

To clear the display, press CLX. To clear the entire calculator (except for certain data storage registers—more about that later), press 🟧 CLEAR. (Notice that it isn't necessary—*although it may be comforting*—to clear the calculator when starting a new calculation.) To clear *everything, including all data storage registers*, turn the HP-45 off then on.

Using Display And Rounding Options

Up to 15 characters can be displayed: mantissa sign, 10-digit mantissa, decimal point, exponent sign, and 2-digit exponent.

Two display modes (fixed decimal and scientific notation) and a variety of rounding options are provided. Rounding options affect the display only; the HP-45 always maintains full accuracy internally.

Fixed decimal notation is specified by pressing FIX followed by the appropriate number key to specify the number of decimal places (0–9) to which the display is to be rounded. The display is left-justified and includes trailing zeros within the setting specified. When the calculator is turned on it "defaults" to FIX 2; that is, the mode and decimal place settings revert to predesignated ones (FIX 2) automatically.

For example,

Press:	See displayed:
123.456	123.456
FIX 4	123.4560
FIX 1	123.5
FIX 0	123.

Scientific notation is useful when you are working with very large or very small numbers. It is specified by pressing ■ SCI , followed by the appropriate number key to specify the number of decimal places (0–9) to be displayed. Again, the display is left-justified and includes trailing zeros. For example,

Press:	See displayed:
■ SCI 6	1.234560 02
■ SCI 3	1.235 02

Now return to 2 decimal places in fixed decimal notation.

Press:	See displayed:
FIX 2	123.46

Keying In Negative Numbers

To enter a negative number, key in the number, then press CHS (change sign key). The number, preceded by a minus (—) sign, will appear on the display. For example,

Press:	See displayed:
12 CHS	−12.
ENTER ↑ 23 −	−35.00

To change the sign of a negative or positive number on the display, press CHS . For example, to change the sign of —35.00 now in the display,

Press:	See displayed:
CHS	35.00

Keying In Exponents

You can key in numbers having exponents by pressing EEX (Enter Exponent). For example, key in 15.6 trillion (15.6×10^{12}), and multiply it by 25.

Press:	See displayed:
15.6 EEX	15.6 00
12	15.6 12
ENTER ↑	1.560000000 13
25 ×	3.900000000 14

You can save time when keying in exact powers of ten by pressing EEX and then pressing the desired power of ten. For example, key in 1 million (10^6) and divide by 52.

Press:	See displayed:
EEX 6	1. 06
ENTER ↑	1000000.00
52 ÷	19230.77

To see your answer in scientific notation with 6 decimal places,

Press:	See displayed:
■ SCI 6	1.923077 04

To key in negative exponents, key in the number, press EEX , press CHS to make the exponent negative, then key in the power of ten. For example, key in Planck's constant (h)—roughly, 6.625×10^{-27} erg. sec. —and multiply it by 50.

Press:	See displayed:
6.625 EEX	6.625 00
27	6.625 27
CHS	6.625 −27
ENTER ↑	6.625000 −27
50 ×	3.312500 −25

If you return to a FIX 2 setting, the result is rounded to zero. For example,

Press:	See displayed:
FIX 2	0.00

Performing Simple Functions

Finding Reciprocals

To calculate reciprocals of a displayed number, key in the number, then press 1/x . For example, find the reciprocal of 25.

Press:	See displayed:
25 1/x	0.04

You can also calculate the reciprocal of a value in a previous calculation without reentering the number. For example, calculate $\frac{1}{1/3 + 1/6}$.

Press:	See displayed:	
3 1/x	0.33	reciprocal of 3
6 1/x	0.17	reciprocal of 6
+	0.50	sum of reciprocals
1/x	2.00	reciprocal of sum

Finding Square Roots

To calculate the square root of any displayed value, press 🟧 $\sqrt{x}$. For example, find the square root of 16.

Press:	See displayed:
16 🟧 $\sqrt{x}$	4.00

Now find the square root of the result.

Press:	See displayed:
🟧 $\sqrt{x}$	2.00

Squaring Numbers

x^2 permits you to square numbers with a single keystroke. For example, what is the square of the result in the previous example?

Press:	See displayed:	
x^2	4.00	2 squared

Raising Numbers to Powers

y^x permits you to raise a positive number (both integers and decimals) to any power. For example, calculate 2^9 (2 × 2 × 2 × 2 × 2 × 2 × 2 × 2 × 2).

Press:	See displayed:
2 ENTER↑ 9 🟧 y^x	512.00

Check different decimal settings.

FIX 6	512.000000
FIX 7	511.9999999

Because a logarithmic routine is used internally to compute y^x, the results may not be accurate to the last decimal place—as illustrated in the example above (see *Accuracy*, page 42).

Now change the decimal setting back to 2 places and find $8^{1.2567}$.

Press:	See displayed:
FIX 2	512.00
8 ENTER↑	8.00
1.2567 🟧 y^x	13.64

In conjunction with 1/x , y^x provides a simple way to extract roots. For example, find the cube root of 5.

Press:	See displayed:	
5 ENTER↑	5.00	
3 1/x	0.33	reciprocal of 3
🟧 y^x	1.71	cube root of 5

Sample Case: Assume that a body moves along a straight line according to the equation $S = \frac{1}{2} t^6 - 4t$. Determine its velocity ($V = 3t^5 - 4$) and acceleration ($A = 15t^4$) at t = 2 seconds, where

$$V = 3 \cdot 2^5 - 4$$
$$A = 15 \cdot 2^4$$

Solution:

Press:	See displayed:	
2 ENTER↑ 5 🟧 y^x	32.00	
3 ×	96.00	
4 −	92.00	velocity
2 ENTER↑ 4 🟧 y^x	16.00	
15 ×	240.00	acceleration

Using π

π is one of the fixed constants provided in the HP-45. Merely press 🟧 π whenever you need it in a calculation before executing the applicable operation. For example, calculate 3π.

Press:	See displayed:
3 ENTER↑ 🟧 π ×	9.42

Sample Case 1: Find the area A of a circle with a 3-foot radius r, where

$$A = \pi r^2$$
$$r = 3$$

Solution:

Press:	See displayed:	
🟧 π	3.14	
3 x^2	9.00	
×	28.27	sq. ft.

Sample Case 2: Find the increase in the volume of a spherical balloon when its radius is increased from 2 to 3 inches. Volume of a sphere is equal to $4/3\ \pi r^3$. Therefore, $4/3\ \pi(3)^3$ minus $4/3\ \pi(2)^3$ is the increase in volume. The equation can be written

$$\frac{4}{3}\pi((3)^3 - (2)^3)$$

Solution:

Press:	See displayed:	
3 ENTER↑ 3 🟧 y^x	27.00	
2 ENTER↑ 3 🟧 y^x	8.00	
−	19.00	
4 ×	76.00	
3 ÷	25.33	
🟧 π	3.14	
×	79.59	cubic inches

Using Factorials

The n! function permits you to handle combinations and permutations with ease. To calculate the factorial of a displayed number merely press 🟧 n!. For example, find the factorial of 5.

Press:	See displayed:	
5 🟧 n!	120.00	5!

Factorials can be calculated for positive integers from 0 through 69. Attempting to calculate the factorial of a fractional or negative value is an improper operation and will result in a blinking display.

Sample Case 1, Permutations: How many different ways may a coach assign players, from a squad of 12, to the 9 positions on a baseball lineup? The equation for permutations of 12 things taken 9 at a time is

$$P\,(12, 9) = \frac{12!}{(12-9)!}$$

Solution:

Press:	See displayed:	
12 🟧 n!	4.790016000 08	12!
🟧 LAST x	12.00	value is retrieved from previous operation
9 −	3.00	
🟧 n!	6.00	3!
÷	79833600.00	number of different lineups possible

Sample Case 2, Combinations: Let a fair die be tossed ten times. What is the probability that you will obtain the number 3 exactly 4 times in the 10 tosses? The required probability is given by the binomial law

$$C^{10}_{4}\,(1/6)^4\,(5/6)^6 = C^{10}_{4}\,5^6/6^{10}$$

where

$$C^{10}_{4} = 10!/4!\ 6!$$

Solution:

Press:	See displayed:	
5 ENTER↑ 6 🟧 y^x	15625.00	5^6
6 ENTER↑ 10 🟧 y^x	60466175.86	6^{10}
÷	0.00	displayed value rounded to zero
FIX 4	0.0003	value extended to 4 decimal places

FIX 2 →	0.00	
10 ■ n! →	3628800.00	10!
× →	937.71	
4 ■ n! →	24.00	4!
÷ →	39.07	
6 ■ n! →	720.00	6!
÷ →	0.05	probability

Calculating Percentage Problems

The HP-45 simplifies the calculation of percentage problems because you don't have to convert percents to their decimal equivalents before using them; just press the % key after keying in the percent value. Three types of percentage problems are handled:

- Finding percentage of number (base × rate)
- Finding net amount (base + or − percentage)
- Finding percent difference between a number and a base $\left(\frac{\text{number} - \text{base}}{\text{base}}\right)$.

The equations used for percentage problems are included in Appendix D, *Calculation Equations.*

Finding Percentage: To find the percentage of a number, key in the base number and press ENTER ↑ . Then key in the percent and press % . For example, to find 14% of 300,

Press:	See displayed:	
300 ENTER ↑ 14 % →	42.00	percentage

Finding Net Amount: An additional feature is that after finding the percentage, the HP-45 still contains the original base number from which you may calculate the net amount by simply pressing + or − , respectively. For example,

Press:	See displayed:	
300 ENTER ↑ 14 % →	42.00	percentage
+ →	342.00	net amount (base plus percentage)

or

Press:	See displayed:	
300 ENTER ↑ 14 % →	42.00	percentage
− →	258.00	net amount (base less percentage)

Finding Percent Difference Between Two Numbers: To find the percent difference between a number and the base, enter the base number and press ENTER ↑ . Enter the second number, press ■ Δ% . For example, if you want to find the rate of increase of your current mortgage payment ($240/mo) over what you were paying in rent 15 years ago ($70/mo),

Press:	See displayed:	
70 ENTER ↑ 240 ■ Δ% →	242.86	% increase

Operational Stack

Stack Registers

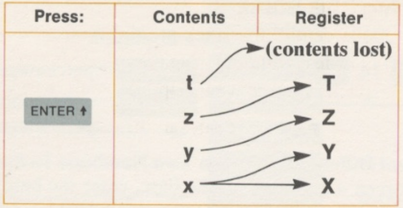
The HP-45 uses the most efficient way known to computer science for evaluating mathematical expressions: the operational stack and reverse "Polish" (Lukasiewicz) notation.

The four temporary memory locations (number registers)—arranged in the form of a vertical stack—are called **X** (bottom register), **Y**, **Z**, and **T** (top register), respectively.

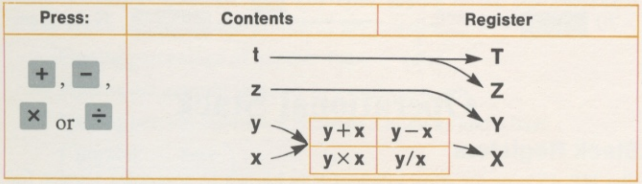
Contents	Register Name
t	T
z	Z
y	Y
x	X
NOTE: The contents of the **X** register are always displayed.	

To avoid confusion between the name of a register and its contents, the register is designated by a capital letter and the contents by a small letter. Thus, **x**, **y**, **z** and **t** are the contents of **X**, **Y**, **Z** and **T**, respectively.

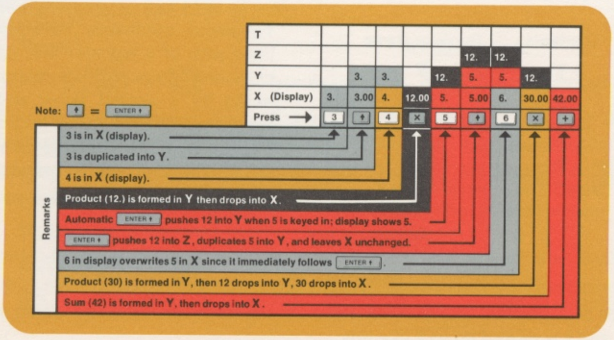
When you key in a number, it goes into the **X**-register—the bottom register and the only one displayed. When you press ENTER ↑ , this number is duplicated into the **Y**-register. At the same time, **y** is moved up to **Z** and **z** is moved up to **T** like this:



When you press +, x is added to y, and the entire stack drops to display the answer in X. The same thing happens for −, × and ÷. Whenever the stack drops, t is duplicated from T into Z, and z drops to Y, as follows:



Look at the contents of the stack as we calculate (3 × 4) + (5 × 6). Directly above the keys pressed you see the information in X, Y, Z and T after the keystroke.



T									
Z						12.	12.		
Y		3.	3.		12.	5.	5.	12.	
X (Display)	3.	3.00	4.	12.00	5.	5.00	6.	30.00	42.00
Press →	3	↑	4	×	5	↑	6	×	+

Note: ↑ = ENTER ↑

Remarks

3 is in X (display).

3 is duplicated into Y.

4 is in X (display).

Product (12.) is formed in Y then drops into X.

Automatic ENTER ↑ pushes 12 into Y when 5 is keyed in; display shows 5.

ENTER ↑ pushes 12 into Z, duplicates 5 into Y, and leaves X unchanged.

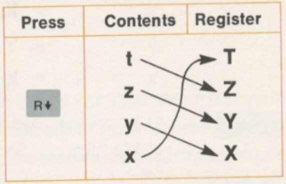
6 in display overwrites 5 in X since it immediately follows ENTER ↑.

Product (30) is formed in Y, then 12 drops into Y, 30 drops into X.

Sum (42) is formed in Y, then drops into X.

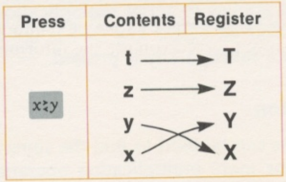
Manipulating The Stack

The R↓ key "rolls down" the stack and lets you review the contents (in last in-first out order) without losing data. It is also used to reposition data within the stack. Here is what happens each time you press R↓:



Example: Load the stack by pressing: 1 ENTER ↑ 2 ENTER ↑ 3 ENTER ↑ 4. (The stack now contains x = 4, y = 3, z = 2, and t = 1). To review the contents of the stack press R↓ four times. The fourth R↓ returns the stack to its original position (x = 4, y = 3, z = 2, and t = 1). Note: the stack is raised and t is lost when a keyboard entry or RCL operation follows R↓, unless that entry follows ENTER ↑, CLX, or Σ+.

The x⇄y key exchanges x and y as shown below.



You will often find that x and y should be exchanged before −, ÷, y^x operation.

Example: Find 2^9.

Press	See	Remarks
9	9.	
ENTER ↑	9.00	
2	2.	x and y are in wrong order.
x⇄y	9.00	x and y are in right order.
🟧 y^x	512.00	

Performing Combined Arithmetic Processes

The HP-45 performs combined arithmetic operations—serial, mixed and chained calculations—with ease. Since you now know how the operational stack works, you can apply that knowledge to the following examples.

Serial Calculation

Any time a new number is entered after any calculation, the HP-45 performs an automatic ENTER↑ on the result of the calculation. This feature permits a serial calculation having intermediate results to which a series of new values can be applied without your having to write down or store any of the intermediate results. For example, find the sum of 4, 6, 8 and 10.

Press:	**See displayed:**
4 ENTER↑ 6 +	10.00
8 +	18.00
10 +	28.00

The same principle applies to serial multiplication, division and subtraction too. Note that an equals key (=) is not needed since results are displayed when a function key is pressed.

Chained Calculation

Chained calculations can be used to find the sums of products (adding the results of two or more multiplication operations) or the product of sums (multiplying the results of two or more addition operations). For example, if you sold 12 items at $1.58 each, 8 items at $2.67 each and 16 items at $0.54 each, the total sale price is

$$(12 \times 1.58) + (8 \times 2.67) + (16 \times 0.54)$$

Press:	**See displayed:**	
12 ENTER↑ 1.58 ×	$ 18.96	
8 ENTER↑ 2.67 ×	$ 21.36	
+	$ 40.32	
16 ENTER↑ .54 ×	$ 8.64	
+	$ 48.96	total sale price

Mixed Chained Calculation

Chained calculations can use any arithmetic operator—divide and subtract as well as multiply and divide. Additionally, a problem may be calculated with any combination of arithmetic operators in both nested and linked operations. For example, to calculate

$$[\ \{\ (12 \times 5) - 2\ \} + \{\ (8 \div 2) + 10\ \}\ ] \times (213.08 \times 5 \div 1.33) \div 2$$

Press:	**See displayed:**
12 ENTER↑ 5 ×	60.00
2 −	58.00
8 ENTER↑ 2 ÷	4.00
10 +	14.00
+	72.00
213.08 ENTER↑ 5 ×	1065.40
1.33 ÷	801.05
×	57675.79
2 ÷	28837.89

You may find the flow chart in Appendix A interesting. It describes a procedure (an algorithm) that will allow you to evaluate any expression on a calculator, such as your HP-45, that uses an operational stack and reverse Polish notation.

Last x Register

The last input argument of a calculation is automatically stored in the Last x register when a function is executed. This feature provides a handy error correction device (see page 12 for examples)—as well as a facility for reusing the same argument in multiple calculations—since it allows recall of the argument by pressing ■ LAST x. The register is cleared only when the calculator is turned off or when a new argument replaces (or overwrites) the previous one.

Data Storage Registers

In addition to the operational stack and Last x register, the HP-45 provides 9 registers for user storage.

Unrestricted Storage

Registers $R_1 - R_4$

Registers $R_1 - R_4$ can be used for temporary storage without restriction. Values stored in these registers are not affected by calculations or by clearing operations. New values are entered by writing over the old contents; that is, by storing a new number. The contents are lost, however, when the HP-45 is turned off.

Restricted Storage

Registers $R_5 - R_8$

Registers $R_5 - R_8$ are used internally when performing summations using Σ+ and ■ $\bar{x}$,s. When summations are not being performed, these registers may be used for general purpose storage. However, since registers $R_5 - R_8$ are not overwritten by new values, they must be cleared of existing values by pressing ■ CLEAR before they are used in summations.

Register R_9

Register R_9 is required internally when performing trigonometric functions and polar/rectangular conversions; any values stored there will be lost. Otherwise, register R_9 may be used for general purpose storage in the same manner as registers $R_1 - R_5$.

Storing And Recalling Data

To store a value appearing on the display (whether the result of a calculation or a keyboard entry), press STO , then press the number key (1 – 9) specifying the storage register. To retrieve the value press RCL , then press the applicable number key. A copy of the recalled value appears on the display (**X**-register); the original value remains in the specified constant storage register. The number previously on the display is loaded into the **Y**-register unless the keystroke immediately preceding RCL was ENTER↑ , CLX or Σ+ (*these keys do not cause the stack to be pushed up by the next data entry*). For example, add 8, 20, 17, 43; store the result in R_1; and divide the individual numbers by the stored sum to find what part each is of the total.

Press:	**See displayed:**	
8 ENTER↑ 20 + 17 + 43 + →	88.00	total
STO 1 →	88.00	
8 RCL 1 ÷ →	0.09	or 9% of total
20 RCL 1 ÷ →	0.23	or 23% of total
17 RCL 1 ÷ →	0.19	or 19% of total
43 RCL 1 ÷ →	0.49	or 49% of total

Performing Register Arithmetic

. Invalid. See Addenda

Arithmetic operations (+, −, ×, ÷) can be performed between the **X**-register (first argument) and a storage register (second argument). To modify the contents of a storage register, press STO followed by the applicable operator key (− , + , × , ÷), then the number key specifying the storage register. For example, store 6 in register R_1 then increment it by 2.

Press:	**See displayed:**	
6 STO 1 →	6.00	$6 \rightarrow R_1$
2 STO + 1 →	2.00	$2 + r_1 \rightarrow R_1$

To see what is now stored in register R_1,

Press:	**See displayed:**	
RCL 1 →	8.00	$r_1 \rightarrow$ display

Now subtract the register contents (8) from a displayed value (make it 13) and store the result back in register R_1.

Press:	See displayed:	
13 STO − 1	13.00	$13 - r_1 \rightarrow R_1$
RCL 1	5.00	$r_1 \rightarrow$ display

Conversely, to alter a displayed value without affecting the stored value, press RCL, the applicable operator, then the number key specifying the storage register. For example, add the current value stored in register R_1 (5.00) to a new entry (2).

Press:	See displayed:	
2 RCL + 1	7.00	$2 + r_1 \rightarrow$ display
RCL 1	5.00	$r_1 \rightarrow$ display

Subtract the contents of register R_1 (5.00) from a new entry (11).

Press:	See displayed:	
11 RCL − 1	6.00	$11 - r_1 \rightarrow$ display
RCL 1	5.00	$r_1 \rightarrow$ display

Now combine several operations.

Press:	See displayed:	
3 STO 1	3.00	$3 \rightarrow R_1$
2 STO + 1	2.00	$2 + r_1 \rightarrow R_1$
35 STO ÷ 1	35.00	$35 \div r_1 \rightarrow R_1$
RCL 1	7.00	$r_1 \rightarrow$ display
5 RCL × 1	35.00	$5 \times r_1 \rightarrow$ display

To use a storage register as a counter or tally register, you must set that register to zero—either by clearing or by storing 0. To increment the counter, use a STO + operation sequence. To decrement the counter, press CHS to change the sign of the displayed value before continuing with the STO + sequence. For example,

Press:	See displayed:	
0 STO 4	0.00	$0 \rightarrow R_4$ (sets counter to 0)
1 STO + 4	1.00	$1 + r_4 \rightarrow R_4$ (increments counter)
1 STO + 4	1.00	$1 + r_4 \rightarrow R_4$ (increments counter)
1 STO + 4	1.00	$1 + r_4 \rightarrow R_4$ (increments counter)
1 CHS STO + 4	−1.00	$1 - r_4 \rightarrow R_4$ (decrements counter)
RCL 4	2.00	$r_4 \rightarrow$ display (current value of counter displayed)

Sample Case: Hardhat Construction Company must file a quarterly report showing payroll information. Produce a report sorting the raw data (hours worked) according to four applicable rates: #1 = \$6.735/hr. for straight time, #2 = \$10.1025/hr. for 1.5 time, #3 = \$13.47/hr. for double time, #4 = \$1.75/hr. for showup-no work time. Calculate the hours and gross payroll by rate and craft; use the data from the abbreviated time card in Figure 2.

Hardhat Construction, Inc.

Time Card Summary – Craft No. 7
Date: July 3, 1973

Name	Hours	Rate No.	Rate Amount
Peter Dickinson	2	1	(6.735/hr)
	1	2	(10.1025/hr)
	1	4	(1.75/hr)
France Rode	6	1	
	2	2	
	3	3	(13.47/hr)
Arlin Laymon	8	1	
	4	3	
	1	4	

Figure 2. *Time Card Data*

Solution:

Press:	See displayed:
OFF-ON (or store 0's in R_1, R_2, R_3, R_4)	
6.735 STO 5	
10.1025 STO 6	
13.47 STO 7	
1.75 STO 8	

2 STO + 1	2.00	sorts and stores hours according to applicable rate—keeps running tally of hours
1 STO + 2 +	3.00	
1 STO + 4 +	4.00	
6 STO + 1 +	10.00	
2 STO + 2 +	12.00	
3 STO + 3 +	15.00	
8 STO + 1 +	23.00	
4 STO + 3 +	27.00	
1 STO + 4 +	28.00	total craft hours
RCL 1	16.00	total hours, rate #1
RCL × 5	$ 107.76	total, rate #1 (straight-time pay)
RCL 2	3.00	total hours, rate #2
RCL × 6	$ 30.31	total, rate #2 (1.5-time pay)
+	$ 138.07	gross payroll subtotal
RCL 3	7.00	total hours, rate #3
RCL × 7	$ 94.29	total, rate #3 (double-time pay)
+	$ 232.36	gross payroll subtotal
RCL 4	2.00	total hours, rate #4
RCL × 8	$ 3.50	total, rate #4 (show-up pay)
+	$ 235.86	gross payroll for craft #7

Metric/U.S. Unit Conversion Constants†

The HP-45 provides built-in conversion constants (accurate to 10 digits) for:

- Centimeters-to-inches and inches-to-centimeters (1 inch = 2.540000000 centimeters) see Addenda
- Kilograms-to-pounds and pounds-to-kilograms (1 pound* = 0.453592370 kilograms)
- Liters-to-gallons and gallons-to-liters (1 gallon**=3.785411784 liters)

To use these constants, key in the measure to be converted, press 🟧, then press the desired constant key followed by the applicable operator: × to obtain metric equivalents, ÷ to obtain U.S. equivalents.

Note that it isn't necessary to press ENTER↑ after keying in the initial value; the HP-45 performs an automatic ENTER↑ when a preprogrammed constant key is pressed or when a user stored constant is recalled. For example,

Press:	See displayed:
12 🟧 cm/in	2.54
×	30.48

Sample Case 1: If an 8″ x 10″ drawing is to be reduced to 85% of its original size, what is the finished size in terms of centimeters?

Solution:

Press:	See displayed:	
8 ENTER↑ 85 %	6.80	inches
🟧 cm/in	2.54	conversion constant
×	17.27	centimeters
10 ENTER↑ 85 %	8.50	inches
🟧 cm/in	2.54	conversion constant
×	21.59	centimeters (the finished size is 17.27 cm × 21.59 cm)

---

† Ref: National Bureau of Standards, 1967
* Avoirdupois system
** U.S. liquid measure

Sample Case 2: If you needed a baby elephant for any reason (and could afford to maintain it), how much would shipping costs be in dollars if the baby weighs 500 kilograms and the shipping cost per pound were 23¢?

Solution:

Press:	**See displayed:**	
500 ■ kg/lb	0.45	conversion constant
÷	1102.31	pounds
.23 ×	$ 253.53	total shipping cost

Sample Case 3: An American in Germany purchases 16 liters of wine. Since the duty is figured on gallons, how many gallons does he have?

Solution:

Press:	**See displayed:**	
16 ■ ltr/gal	3.79	conversion constant
÷	4.23	gallons

Sample Case 4: If you pick up a Mercedes Benz in Germany and the mileage is quoted at 7 kilometers per liter, would this car be expensive to run by U. S. standards?

Solution:

Press:	**See displayed:**	
7 ■ ltr/gal	3.79	conversion constant
×	26.50	kilometers/gallon
■ cm/in	2.54	conversion constant
12 ×	30.48	cm/ft
5280 ×	160934.40	cm/mile
EEX 5 ÷	1.61	km/mile
÷	16.47	miles/gallon

Logarithmic and Exponential Functions

The HP-45 computes both natural and common logarithms as well as their inverse functions (antilogarithms):

ln is $\log_e$ (natural log); takes log of value in **X**-register to base e (2.718 . . .).

e^x is antilog_e (natural antilog); raises e ($e = 2.718 \ldots$) to the power of value in **X**-register. (To display the value of e, press 1 e^x .)

■ log is $\log_{10}$ (common log); takes log of value in **X**-register to base 10.

■ 10^x is antilog_{10} (common antilog); raises 10 to the power of value in **X**-register.

Sample Case 1: Suppose you wish to use an ordinary barometer as an altimeter. After measuring the sea level pressure (30 inches of mercury) you climb until the barometer indicates 9.4 inches of mercury. How high are you? Although the exact relationship of pressure and altitude is a function of many factors, *an approximation* is given by

$$\text{Altitude (feet)} = 25{,}000 \ln \frac{30}{\text{Pressure}} = 25{,}000 \ln \frac{30}{9.4}$$

Solution:

Press:	**See displayed:**	
25000 ENTER ↑ 30 ENTER ↑		
9.4 ÷	3.19	
ln	1.16	
×	29012.19	feet altitude (we suspect you are on Mt. Everest *—29,028 feet)*

Sample Case 2: The 1906 San Francisco earthquake, with a magnitude of 8.25 on the Richter Scale is estimated to be 105 times greater than the Nicaragua quake of 1972. What would be the magnitude of the latter on the Richter Scale? The equation is

$$8.25 - (\log 105)$$

Solution:

Press:	**See displayed:**	
8.25 ENTER ↑ 105		
■ log	2.02	
−	6.23	rating on Richter Scale

Statistical Functions

The statistical function x̄,s is used to find the mean (arithmetic average) and standard deviation (measure of dispersion around the mean) of data entered and summed. Options are provided to enable you to interact with and modify results by adding new data or correcting errors. Also, the number of entries and sum of the squares—*as well as the sum of entries in two dimensions*—can be obtained. Summation/averaging calculations also use the $\overset{\Sigma-}{\Sigma+}$ (sigma) key to sum the numbers used in calculating means and standard deviations. Because the Σ+ function uses storage registers R_5-R_8, these registers must be cleared with ■ CLEAR before pressing Σ+ or errors could result.

Information is entered as follows:

① **Press** ■ CLEAR to assure that registers R_5-R_8 are clear of previous data.

② Key in each value and sum with Σ+ key. To correct an incorrect value *before* it is loaded with the Σ+ keystroke, **press** CLX. *After* the value is summed, correct by (*a*) reentering incorrect value, then (*b*) pressing ■ Σ- , followed by (*c*) entering correct value, and finally (*d*) pressing Σ+ ; then continue entering values. The last Σ+ pressed provides the number of entries.

③ **Press** ■ x̄,s to obtain mean.

④ **Press** x⇄y to obtain standard deviation.

⑤ If there are more values to be included—say if you want to add to the data sample and modify results—key in and **press** Σ+ after each.

Additional information is also available by performing steps 6–10 (in any order).

⑥ **Press** RCL 5 to obtain number of entries.

⑦ **Press** RCL 6 to obtain sum of squares for **X**-register entries.

⑧ **Press** RCL 7 to obtain sum of **X**-register entries.

⑨ **Press** RCL 8 to obtain sum of **Y**-register entries.*

⑩ Alternatively, **press** RCL Σ+ to obtain sum of **X**-register entries, and x⇄y to obtain sum of **Y**-register entries.

Sample Case 1: In a recent survey to determine the average age of the 10 wealthiest people in the U.S., the following data were obtained:

62 84 47 58 68 60 62 59 71 73

Of the ages given, what is the mean; the standard deviation?

Solution:

Press:	**See displayed:**	
■ CLEAR	0.00	
62 Σ+ 84 Σ+ 47 Σ+ 58 Σ+ 68 Σ+ 60 Σ+ 62 Σ+ 59 Σ+ 71 Σ+ 73 Σ+	10.00	number of entries
■ x̄,s	64.40	mean
x⇄y	10.10	standard deviation

Add two more ages (87 and 49) after the initial calculation. What is the new mean and standard deviation?

Press:	**See displayed:**	
87 Σ+ 49 Σ+	12.00	number of entries
■ x̄,s	65.00	new mean
x⇄y	12.29	new standard deviation

Sample Case 2: Perform error recovery after entering the second value in error.

Solution:

Press:	**See displayed:**	
■ CLEAR	0.00	
62 Σ+ 44 Σ+ 44 ■ Σ- 84 Σ+ 47 Σ+ 58 Σ+ 68 Σ+ 60 Σ+ 62 Σ+ 59 Σ+ 71 Σ+ 73 Σ+	10.00	number of entries
■ x̄,s	64.40	mean
x⇄y	10.10	standard deviation

---

*A **Y**-register entry is any value residing in the **Y**-register at the time Σ+ is pressed; e.g., if the entry sequence is

n_1 ENTER↑ n_2 Σ+ where: n_1 = y-value
n_2 = x-value

Sample Case 3: Find the sum of the ages entered, sum of the squares, and the number of entries as well as the mean and standard deviation.

Solution:

Press:	See displayed:	
■ CLEAR	0.00	
62 Σ+ 84 Σ+ 47 Σ+ 58 Σ+ 68 Σ+		
60 Σ+ 62 Σ+ 59 Σ+ 71 Σ+ 73 Σ+	10.00	number of entries
■ $\bar{x}$,s	64.40	mean
x⇄y	10.10	standard deviation
RCL 7	644.00	sum of numbers entered (**x**-entries)
RCL 6	42392.00	sum of squares (**x**-entries)
RCL 5	10.00	number of entries

Sample Case 4: Assuming that every member of the sample over 65 is a female, calculate the mean, standard deviation, and the sum of ages—as well as the total number of females. Enter a 1 for female and 0 for male before keying in each value.

Solution:

Press:	See displayed:	
■ CLEAR	0.00	
0 ENTER↑ 62 Σ+ 1 ENTER↑ 84 Σ+		
0 ENTER↑ 47 Σ+ 0 ENTER↑ 58 Σ+		
1 ENTER↑ 68 Σ+ 0 ENTER↑ 60 Σ+		
0 ENTER↑ 62 Σ+ 0 ENTER↑ 59 Σ+		
1 ENTER↑ 71 Σ+ 1 ENTER↑ 73 Σ+	10.00	number of entries
■ $\bar{x}$,s	64.40	mean
x⇄y	10.10	standard deviation
RCL Σ+	644.00	sum of ages
x⇄y	4.00	number of females

Trigonometric Functions

The following trigonometric functions are provided:

SIN	(sine)
SIN^{-1}	(arc sine)
COS	(cosine)
COS^{-1}	(arc cosine)
TAN	(tangent)
TAN^{-1}	(arc tangent)

To use the SIN, COS and TAN functions, key in the number and press ■, then the appropriate function key. To use the arc functions, press ■, then press the associated function key. For example, find SIN^{-1} (.866).

Press:	See displayed:	
.866 ■ SIN^{-1}	60.00	degrees

Note that trigonometric functions use storage register 9; any value stored there will be overwritten during a trigonometric calculation.

Angular Modes

Trigonometric functions can be performed in any one of three angular modes: decimal degrees, decimal radians and decimal grads—the latter being a 100th part of a right angle in the centesimal system of measuring angles. Note that trigonometric functions assume decimal angles regardless of angular mode. To select a mode, press ■, then press the associated key: DEG or RAD or GRD.

The mode selected will remain operative until a different mode is selected, or until the calculator is turned off; when turned back on, the HP-45 automatically defaults to decimal degrees mode.

Sample Case 1: Find the cosine of 35°. If the HP-45 is not already in degrees mode, press ■ DEG before performing the calculation.

Solution:

Press:	See displayed:
35 COS	0.82

Sample Case 2: Find the tangent of 6 radians.

Solution:

Press:	See displayed:
■ RAD 6 TAN	−0.29

Sample Case 3: Find the arc sine of .5 in grads.

Solution:

Press:	See displayed:
■ GRD .5 ■ SIN^{-1}	33.33

Degrees-Minutes-Seconds Conversion

Displayed angles can be converted from any decimal angular mode to degrees-minutes-seconds, in the format dd.mmss, by pressing ■ →D.MS. Conversely, to convert an angle displayed in degrees-minutes-seconds to the decimal equivalent in the specified angular mode, press ■ D.MS→. **This feature is also useful in calculating problems dealing with time (hours-minutes-seconds) too.**

Note that the result of a →D.MS conversion is rounded to the nearest second both internally and on the display. Conversions involving angles $\geq 10^5$ degrees are an improper operation.

Sample Case 1: Assume a surveyor wants to add 2 angles: 10° 8′ 56″ and 2° 17′ 42″. These must first be converted to decimal degrees before adding and then converted back to degrees-minutes-seconds.

Solution:

Press:	See displayed:	
■ DEG 10.0856 ■ D.MS→	10.15	decimal degrees
2.1742 ■ D.MS→	2.30	decimal degrees
+	12.44	decimal degrees
■ →D.MS	12.2638	12° 26′ 38″

Sample Case 2: Find the arc sine of .55 in degrees mode and convert to degrees-minutes-seconds.

Solution:

Press:	See displayed:	
■ DEG .55 ■ SIN^{-1}	33.37	decimal degrees
■ →D.MS	33.2201	33° 22′ 01″

Sample Case 3: Using the data from Sample Case 2, above, calculate the arc sine of .55 in radians mode and convert the result to degrees-minutes-seconds.

Solution:

Press:	See displayed:	
■ RAD .55 ■ SIN^{-1}	0.58	radians
■ →D.MS	33.2201	33° 22′ 01″

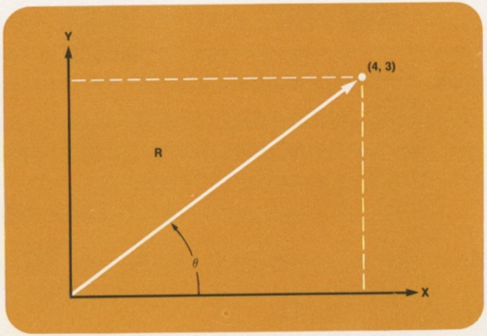
Polar/Rectangular Coordinate Conversion

Two functions are provided for polar/rectangular coordinate conversion. To convert values in **X** and **Y**-registers, (representing rectangular x, y coordinates, respectively) to polar r, θ coordinates (magnitude and angle, respectively), press →P.

Conversely, to convert values in **X** and **Y**-registers representing polar r, θ, respectively) to rectangular coordinates (x, y, respectively), press ■ →R

Because polar/rectangular conversions involve trigonometry, storage register 9 is used. Thus, any values previously stored in this register will be overwritten when coordinate conversions are performed.

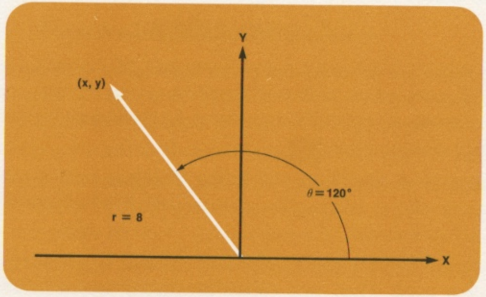
Sample Case 1: Convert rectangular coordinates (4, 3) to polar form with the angle expressed in degrees.



Solution:

Press:	See displayed:	
■ DEG 3 ENTER↑ 4 →P	5.00	magnitude
x⇄y	36.87	angle in degrees

Sample Case 2: Convert polar coordinates (8, 120°) to rectangular coordinates.



Solution:

Press:	See displayed:	
■ DEG 120 ENTER↑ 8 ■ →R	−4.00	x-coordinate
x⇄y	6.93	y-coordinate

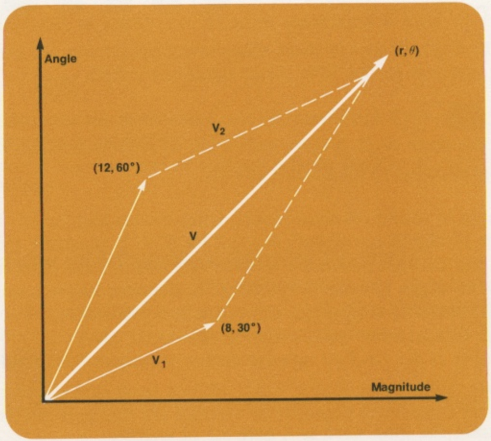
By combining the polar/rectangular function with the accumulation function, $\overset{\Sigma-}{\boxed{\Sigma+}}$, you can add and subtract vector components. The sums of these are contained in storage registers R_7 and R_8:

$$r_7 = \mathbf{x}_1 \pm \mathbf{x}_2 \pm \ldots \pm \mathbf{x}_n = \Sigma \mathbf{x}$$

$$r_8 = \mathbf{y}_1 \pm \mathbf{y}_2 \pm \ldots \pm \mathbf{y}_n = \Sigma \mathbf{y}$$

To display the contents of registers R_7 and R_8, press RCL Σ+ to obtain the sum of x-coordinates (register 7); then press x⇄y to obtain the sum of y-coordinates (register 8).

Sample Case 3: Sum 2 vectors V_1, V_2 having polar coordinates (8, 30°), (12, 60°), respectively. Represent the sum V in terms of polar coordinates (r, θ).



Solution:

Press:	See displayed:	
■ CLEAR	0.00	
60 ENTER↑ 12 ■ →R	6.00	
Σ+	1.00	
30 ENTER↑ 8 ■ →R	6.93	
Σ+	2.00	
RCL Σ+	12.93	
→P	19.35	magnitude r
x⇄y	48.07	° angle θ

Operating Limits

Accuracy

Accuracy specifications for the HP-45 depend on the operation performed. The elementary operations (+, −, ×, ÷, 1/x, √x, x², D.MS→) have a maximum error of ±1 count in the 10th (least significant) digit. Errors in these elementary operations are caused by rounding answers to the 10th (least significant) digit.

Percent (%, Δ%) and factorial (n!) functions are accurate to ± 1 count in the ninth digit. Values converted to degrees-minutes-seconds (→D.MS) are rounded to the nearest second.

An example of round off error is seen when evaluating $(\sqrt{5})^2$. Rounding $\sqrt{5}$ to 10 significant digits gives 2.236067977. Squaring this number gives the 19-digit product 4.999999997764872529. Rounding the square to 10 digits gives 4.999999998. If the next larger approximation (2.236067978) is squared, the result is 5.000000002237008484. Rounding this number to 10 significant digits gives 5.000000002. *There simply is no 10-digit number whose square is 5.000000000.*

Accuracy specifications for operations using the mean function ($\bar{x}$, s) depend upon the data used and number of entries.

The accuracy of the remaining operations (trigonometric, logarithmic and exponential) depends upon the argument. The answer that is displayed will be the correct answer for an input argument having a value that is within ±N counts (see table below) in the tenth (least significant) digit of the *actual* input argument. For example, 1.609437912 is given as the natural log of 5 when calculated on the HP-45. However, this is an approximation because the result displayed (1.609437912) is actually the natural log of a number *between* 4.999999998 and 5.000000002 which is ±2 counts (N = 2 for logarithms) in the 10th (least significant) digit of the *actual* input argument.

Values for N

OPERATION	**VALUE OF N**
log **x**, ln **x**, and e^x	2*
trigonometric	3**
y^x	4 for **y**, and 7 for **x**
10^x	7
→P, →R	4

* Logarithmic operations have an additional limitation of ±3 counts in the 10th (least significant) digit in the displayed answer.

** Trigonometric operations have an additional accuracy limitation of $\pm 1 \times 10^{-9}$ in the displayed answer.

Underflow and Overflow Display Formats

To ensure greater accuracy, the HP-45 performs all calculations by using a ten-digit number and a power of ten. This abbreviated form of expressing numbers is called *scientific notation;* i.e., 23712.45 = 2.371245×10^4 in scientific notation.

If a number is too large for the display format specified, the HP-45 automatically displays the number in scientific notation. For example, if you keyed in 100, and pressed FIX 8, the calculator will display the number in scientific notation because there isn't enough room to display 8 digits after the decimal point.

Press:	**See displayed:**
FIX 8	
100 ENTER↑ ⟶	1.000000000 02

Numbers whose magnitude is less than 1, and are too small to be displayed in the specified FIX format, are displayed as zero. For example, the number .000396 is displayed in FIX 3 format as follows:

Press:	See displayed:
FIX 3	
.000396 ENTER↑	0.000
■ SCI 3	3.960 −04
FIX 6	0.000396

When a SCI setting is used, values are displayed rounded to the number of decimal places specified. Values having a magnitude of $\geq 10^{99}$ are displayed as ± 9.999999999 99 . Values having a magnitude of $< 10^{-99}$ are displayed as zero.

Improper Operations

If you attempt a calculation containing an improper operation—say division by zero—an error signal is triggered and a blinking display appears. To clear, press CLX , or any other key that doesn't trigger another error.

The following are examples of improper operations:

÷ , where $\mathbf{x} = 0$

y^x , where $\mathbf{y} \leqslant 0$

$\sqrt{x}$, where $\mathbf{x} < 0$

1/x , where $\mathbf{x} = 0$

n! , where $\mathbf{x} < 0$ or is not an integer

$\bar{x}$,s , where number of entries is < 2

→D.MS , where angle converted $\geqslant$ 100,000° ($\geqslant 10^5$)

D.MS→ , where angle converted $\geqslant$ 100,000° ($\geqslant 10^5$)

log , where $\mathbf{x} \leqslant 0$

ln , where $\mathbf{x} \leqslant 0$

SIN⁻¹ , where $\mathbf{x}$ is > 1

COS⁻¹ , where $\mathbf{x}$ is > 1

Appendix A

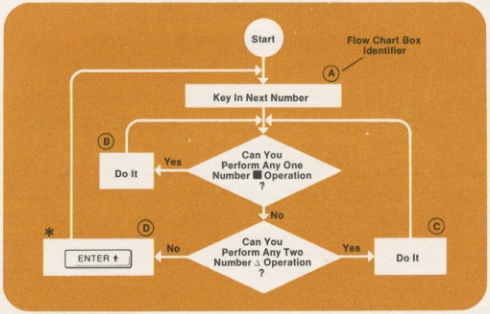
Stack Algorithm and Flow Chart

The flow chart in Figure 3 allows you to evaluate any expression on a calculator using an operational stack and reverse Polish (Lukasiewicz) notation. Although the general solution requires an operational stack of unlimited length, the four-register stack in your HP-45 is adequate for most practical problems. Before using the algorithm, write your expression in serial form. All expressions can be written in serial form. For example, $\frac{2}{3+(1/2)}$ becomes $2/(3+(1/2))$.

According to our algorithm, the solution can be obtained for any expression by entering the numbers in the order in which they occur. Use the algorithm to solve $(3+4)\ [\log(25\sqrt{7+9})+6]$.

Press	See Displayed	Flow Chart Reference
3	3.	A
ENTER↑	3.00	D
4	4.	A
+	7.00	C
ENTER↑ *	7.00	D
25	25.	A
ENTER↑	25.00	D
7	7.	A
ENTER↑	7.00	D
9	9.	A
+	16.00	C
■ $\sqrt{x}$	4.00	B
×	100.00	C
■ log	2.00	B
ENTER↑ *	2.00	D
6	6.	A
+	8.00	C
×	56.00	C

* You may omit these steps because your HP-45 performs an automatic ENTER↑ for you.



Legend:

- ■ One number (monadic) operations are things like √x, ln, etc.
- △ Two number (dyadic) operations are things like +, −, ×, ÷.
- * You may omit this step if you've done any operation on the last number entered.

Figure 3. *Stack Flow Chart*

Note that the expression could have been written: $(\log [\sqrt{(7 + 9)}.25] + 6) \cdot (3 + 4)$. Also, it could have been evaluated—using the algorithm—in fewer steps: (7 ENTER ↑ 9 + ■ √x 25 × ■ log 6 + 3 ENTER ↑ 4 + ×). Try it.

Appendix B

Hardware Specifications

Temperature Range

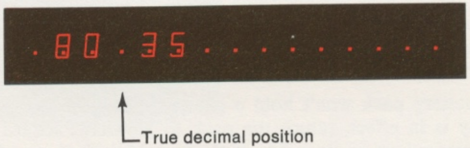
Mode	Temperature °C	Temperature °F
Operating	0°C to 50°C	32°F to 122°F
Charging	10°C to 40°C	50°F to 104°F
Storage	−40°C to 55°C	−40°F to 131°F

Battery Operation

Use only the HP Rechargeable Battery Pack, Model 82001A, which has been tested and is warranted for one year. The battery provides three to five hours of continuous operation. By turning off the power when the calculator is not in use, the HP-45 battery power will last easily throughout a normal working day.

All decimal points light in the display when 2 to 5 minutes of operation time remain in the battery pack. Even when all decimal points are turned on, the true decimal position is known because an entire digit position is allocated to it.

Example:



Operating the calculator for more than 2 to 5 minutes after this low power indication first occurs may result in calculation errors. The battery pack must be recharged by connecting the HP-45 to its battery charger (HP Model 82002A).

Recharging and AC Line Operation

The HP-45 should be turned off before plugging in the charger. It can be turned on again after the charger is plugged into the power outlet and can be used during the charging cycle. The HP-45 can be operated continuously from the AC line if desired. There is no danger of overcharging the battery.

After 14 hours, a completely discharged battery will be fully charged. Shorter charge periods will allow reduced battery operating time. For convenience, overnight charging is recommended.

CAUTION

To prevent damage to the calculator, the position of the line voltage select switch on the battery charger must be set to the proper line voltage.

1. Turn the HP-45 power switch to **OFF.**
2. Insert battery charger plug into the rear connector of the HP-45 and insert power plug of battery charger into the power outlet. **The HP-45 will not operate when connected to the recharger unless the recharger is connected to a live power outlet.**
3. Slide the power switch to **ON,** see that 0.00 is displayed.
4. Slide power switch to **OFF** if you don't want to use the calculator while it is charging.
5. At end of the charging period, you may continue using your HP-45 with AC power or proceed to next step for battery operation.
6. With the power switch at **OFF,** disconnect battery charger from power receptacle and the battery charger from HP-45.

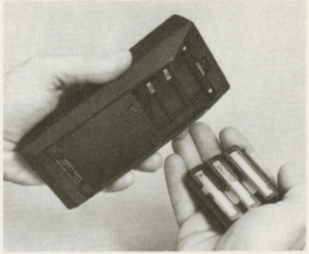
Temporary degradation, peculiar to nickel-cadmium batteries, may cause a decrease in the operating period of the battery pack. Should this happen turn the HP-45 on for at least five hours to discharge the batteries completely. Then put it on charge for at least 14 hours. This should correct the temporary degradation.

If the battery pack won't hold a charge, it may be defective. If the warranty is in effect, return the pack to Hewlett-Packard according to the instructions on page 54 . If the battery pack is out of warranty, use the accessory order card, provided with your HP-45, to order a new battery. **Remember, you can use your HP-45 on AC power until the replacement battery pack arrives.**

Battery Pack Replacement

1. Turn power switch to **OFF** and disconnect the battery charger.
2. Slide the two battery-door latches (the top feet) toward middle of calculator.

3. Let battery door and battery-pack fall into palm of hand.



4. See if the battery connector springs on the calculator have been inadvertently flattened inward. If so, bend them out and try the battery again.

5. Insert the battery pack so that its contacts face the calculator and contact is made with battery connectors.

6. Insert the bottom of the battery door behind the retaining groove and close the door.

7. Close the battery door by pressing it gently while sliding the two battery-door latches outward.

NOTE: If you use your HP-45 extensively in field work or during travel, you may want to order the Model 82004A Battery Holder and Pack, consisting of battery charging attachment and spare battery pack. This enables you to charge one pack while using the other.

CAUTION

Do not try to **burn old batteries.** They may ***EXPLODE!***

Appendix C

Accessories

Standard and optional accessories for the HP-45 can be ordered by completing and mailing the order card provided. We will send you additional order cards as new optional accessories are added to our product line.

Standard Accessories	Model/Part No.
HP-45 Quick Reference Guide	**00045-90303**
Battery Pack	**82001A**
Battery Charger/AC Adapter	**82002A**
Deluxe Travel Safety Case	**82014A**
Soft Carrying Case	**82012A**
HP-45 Owner's Handbook	**00045-90300**
Personalizing Labels (4 each)	**7120-2946**

Optional Accessories	Model/Part No.
Battery Holder and Pack	**82004A**
Security Cradle	**82007A**
Hard Leather Field Case	**82006A**

Appendix D

Calculation Equations

The following table shows the data flow and equations used in those calculations where the formula is not self-evident.

Function	Formula
%	$\frac{x \cdot y}{100} \rightarrow X; y \rightarrow Y$
Δ%	$100 \cdot \frac{x - y}{y} \rightarrow X; y \rightarrow Y$
→P	$\sqrt{x^2 + y^2} \rightarrow X$ $\tan^{-1}\frac{y}{x} \rightarrow Y$
→R	$x \cos y \rightarrow X$ $x \sin y \rightarrow Y$
Σ+	$r_5 + 1 \rightarrow R_5 \rightarrow X$ $r_6 + x^2 \rightarrow R_6$ $r_7 + x \rightarrow R_7$ $r_8 + y \rightarrow R_8$
Σ-	$r_5 - 1 \rightarrow R_5 \rightarrow X$ $r_6 - x^2 \rightarrow R_6$ $r_7 - x \rightarrow R_7$ $r_8 - y \rightarrow R_8$
x̄,s	$\frac{r_7}{r_5} \rightarrow X$ $\sqrt{\frac{1}{r_5 - 1}\left[r_6 - \frac{r_7^2}{r_5}\right]} \rightarrow Y$

Appendix E

Service and Warranty

Servicing

Low Power

All decimal points light to warn you that you have 2 to 5 minutes of operating time left. You must then either:

- Operate from AC power
- Charge the battery pack
- Insert a fully charged battery pack

Blank Display

If the display blanks out, turn the HP-45 off then on. If 0.00 does not appear on the display, check the following:

1. If battery charger is attached to HP-45, make sure it is plugged into outlet.
2. Examine battery pack to see if it is discharged or is not making contact.
3. If display is still blank, try operating the HP-45 from the AC line.
4. If, after step 3, display is still blank, the HP-45 is defective (see warranty section).

Warranty

In Warranty

The HP-45 is warranted against defects in materials and workmanship for one year from date of delivery. During the warranty period we will repair or replace components that prove to be defective, provided they are returned to Hewlett-Packard according to instructions (see *Shipping Instructions*). No other warranty is expressed or implied. We are not liable for consequential damage.

Out of Warranty

Beyond the one-year warranty period, your calculator will be repaired for a moderate charge. Return the HP-45 along with all standard accessories (see *Shipping Instructions*). If only the battery pack is defective, simply order a replacement on the Order Card provided.

Shipping Instructions

Malfunctions traced to the calculator or battery charger require that you return the following to us:

- Your HP-45 with all standard accessories in their travel safety case
- A completed Service Card (from back cover pocket of this manual)

If a battery pack is defective and within warranty, return the following to us:

- Only the defective battery pack
- A completed Service Card (from back cover pocket of this manual)

Send returned items safely packaged to the address shown on the Service Card.

Under normal conditions, your calculator will be repaired and reshipped within two days of receipt at this address. Should other problems or questions arise regarding service, please call the applicable service telephone number on the Service Card, or call **Advanced Products Division,** Customer Service, at (408) **996-0100.**

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