Programmable Problem-Solving

–easy to learn...easy to use... and a tremendous time saver. Just press the keys

With the introduction of the HP-25—the lowest-priced Hewlett-Packard programmable pocket calculator—the speed and convenience of programming is now available to just about everyone who needs it. And if you deal with repetitive problems, you need it.

A program, in this case, is a sequence of keystrokes used to solve a problem. The HP-25 can retain and repeat a program up to 49 steps in length. So you don't have to press the same keys again and again when the same problem is worked with different data.

PRGM ▙▙▙▙▙ RUN

Simply set the HP-25 to PRO-GRAM mode by flipping a switch. Then press the keys you'd normally press to solve the problem. (But don't enter the data.) Your program is retained in the HP-25's program memory.

R/S

To solve the problem, switch to RUN mode and enter the data. Then press the "Run/Stop" key to run your program. Seconds later, your answer appears on the HP-25 display. To solve other problems using the same program, just enter the new data and press the "Run/Stop" key again.

Because your program does the calculation automatically—just sit back and watch it—there's less chance for error than if you had to repeat the keystroke sequence yourself step by step. Also, it takes but a fraction of the time.

Programming is easy with the HP-25. You don't have to learn "computer language." The keyboard controls are in plain English (abbreviations). Every step and function is clearly explained—with illustrated, step-by-step directions—in the HP-25 Owner's Handbook. To see just how easy it is to program the HP-25, review the example of a typical problem from the HP-25 Applications Programs Book in the box at right.

And it's easy to review, change or test your program . . .

The HP-25's program memory consists of 49 steps, numbered 01 through 49. Your program remains stored for as long as you leave the HP-25 turned on, or until you erase or change your program.

```
08    23  51  04
LINE     STO  +    REGISTER 4
NUMBER   CODE CODE  CODE
```

```
24         14  74
LINE       PREFIX f  PAUSE
NUMBER     CODE     CODE
```

The program memory uses a simple numeric code, based on the position of each key on the keyboard. For example, "31" means "3 rows down, 1st key"—the "ENTER" key. Some key codes will appear as two or three pairs of numbers. To conserve steps, each prefixed function (e.g., "f", "x̄") takes only one program memory step. When you single-step through a program, the code numbers are visible on the HP-25 display. This system lets you know where you are in the program memory and what your program looks like step-by-step. Testing and editing your programs—to make sure complex solutions are correct—is thus greatly simplified.

BST **SST** **GTO**

The "Back STep" and Single STep" keys let you review the entire memory one step at a time, in either direction. Or you can press the "Go TO" key, along with the number of the step you want.

If you want to change your program, simply stop it at the appropriate step and key in a new entry, which will overwrite the previous one. To test your program a step at a time, switch to RUN and press "SST" repeatedly. You will see the numeric code when you press the key and the intermediate solution when you release the key.

You can even program the HP-25 to do decision branching . . .

Like a computer, the HP-25 can be programmed to make decisions, because it can do conditional branching.

You can program it to test the relationship between two values, by means of these tests:

$x < y$ $x \geq y$ $x \neq y$ $x = y$

$x < 0$ $x \geq 0$ $x \neq 0$ $x = 0$

Depending on the outcome of the tests, the HP-25 will automatically skip a step of the program . . . or it will continue through the program in sequence.

Or, by means of the "Go TO" key, you can program the HP-25 to branch directly to a specified step, and then continue executing the program.

Both types of branching—conditional and direct—are useful in solving a variety of programming problems . . . and make your work easier.

You can also program the HP-25 to PAUSE during the running of your program . . .

PAUSE

Another new feature on the HP-25 is the "PAUSE" key. You can use it to momentarily interrupt (about one second per Pause command) the program execution and display the contents of the X register. This gives you the opportunity to review or write down intermediate results, data, the value of a counter or other output. The example at right shows one use.

The Absolute and Truncation functions make some programming even easier . . .

ABS

The ABSolute value function allows you to get the absolute value and magnitude of a number within a programmed calculation.

INT

FRAC

The INTeger/FRACtion truncation function allows you to keep only the integer or fractional portion of a number. This is especially useful in base conversion, random number generator and other specialized routines. In addition, you can integer-fractionalize your data and double the number of data points you can save in the registers.

Here's an example of keystro[ke]

Suppose you were asked to plot the trajectory of a stone which is hurled into the air with an initial velocity V at an angle to the horizontal of θ.

Neglecting drag due to friction with the atmosphere, the following equations describe the stone's x- and y- coordinates as functions of the time t;

$x = vt \cos \theta$
$y = vt \sin \theta - \frac{1}{2} gt^2$

Where x = the horizontal distance the stone has traveled
y = height of the stone
g = acceleration due to gravity (9.8 m/s² or 32 ft/s²)

Using a page from the HP-25 Applications Programs Book as a guide, here's how you would program the solution on the HP-25:

KEY ENTRY	
f→R	
x⇄y	
STO 2	
x⇄y	
STO 3	
STO 4	
RCL 0	
STO 4	
STO + 4	
RCL 4	
RCL 1	
x	
2	
÷	
CHS	
RCL 4	
RCL 3	
x	
+	
RCL 2	
RCL 4	
x	
f PAUSE	
R↓	
R/S	
x²⇄y	
R/S	
GTO 07	

STEP	INSTRUCTIONS	INPUT DATA
1	Key in program	
2	Store time interval	Δt
3	Store gravitational constant	g
4	Input angle and initial speed	
5	Perform steps 5 and 6 any number of times: Display time and horizontal distance	
6	Display height	
7	To change θ or v, go to step 4. To change Δt or g, go to appropriate step, store new value, then go to step 4.	

Problem:

Plot the trajectory of a stone cast up[ward at] 20 m/s at an angle of 30° to the hor[izontal.] ¼ second between points plotted. L[...]

Solution:

0.25 [STO] [0] 9.8 [STO] [1] 30 [⇅] 20 [f]

[R/S] _____

[R/S] _____

[R/S] _____

[R/S] _____

[R/S] _____

Continue until y becomes negativi[...]

The table of these results is show[n...]

t	0.25	0.50	0.75	1.00
x	4.33	8.66	12.99	17.32
y	2.19	3.78	4.74	5.10
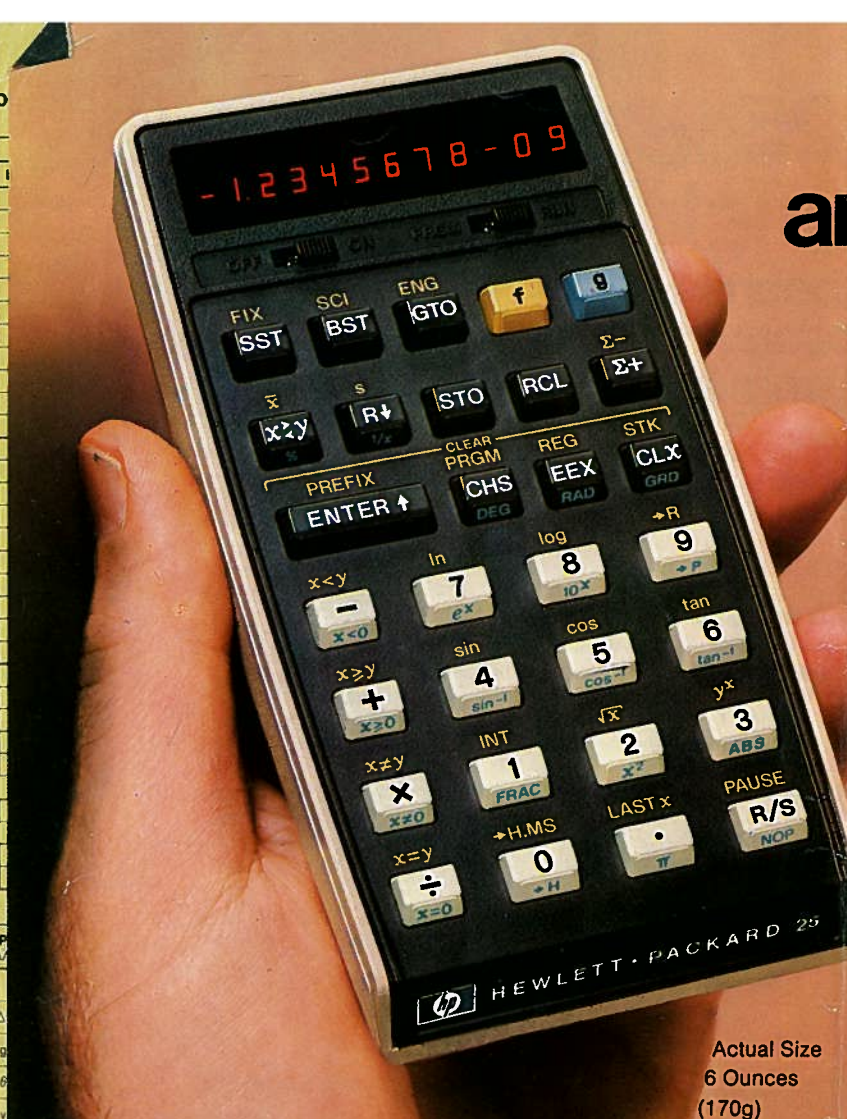
Actual Size
6 Ounces
(170g)

With the HP-25, you can solve problems faster and easier with fewer errors than before . . .

. . . and you can use it anywhere, anytime.

HP's newest and lowest priced Programmable Calculator...

Keystroke programming

Now you can solve repetitive or iterative problems quickly by creating the exact programs you need—right on the spot. Key in a problem-solving sequence of keystrokes (a program) just once. Then run your program as often as you wish . . . simply by pressing a key.

Dozens of keyboard commands

Advanced scientific, engineering and mathematical functions are conveniently pre-programmed in the calculator for use in your keyboard problem solving, or as a part of your programs. As a result, you'll do your problem solving in much less time and with greater accuracy.
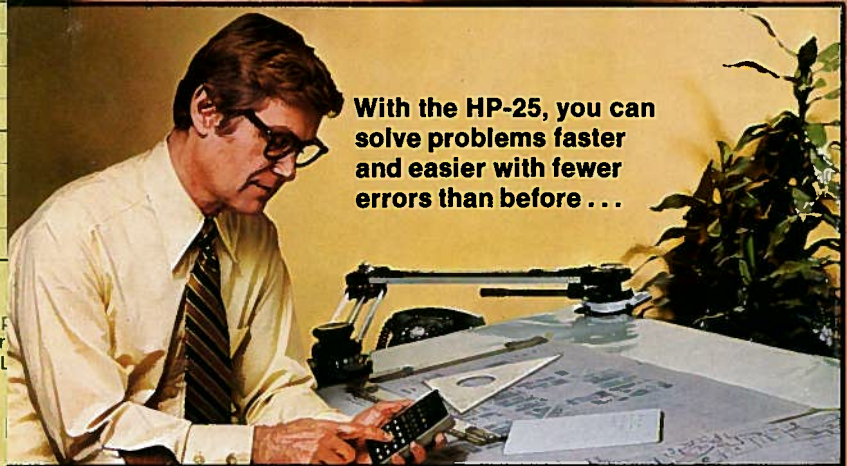
8 addressable memories plus register arithmetic

You can store and retrieve numbers as constants or for use in later calculations directly from the keyboard, or automatically as part of your program. And, you can do register arithmetic—directly add to, subtract from, divide into, or multiply the contents within each register. This makes data manipulation easy.
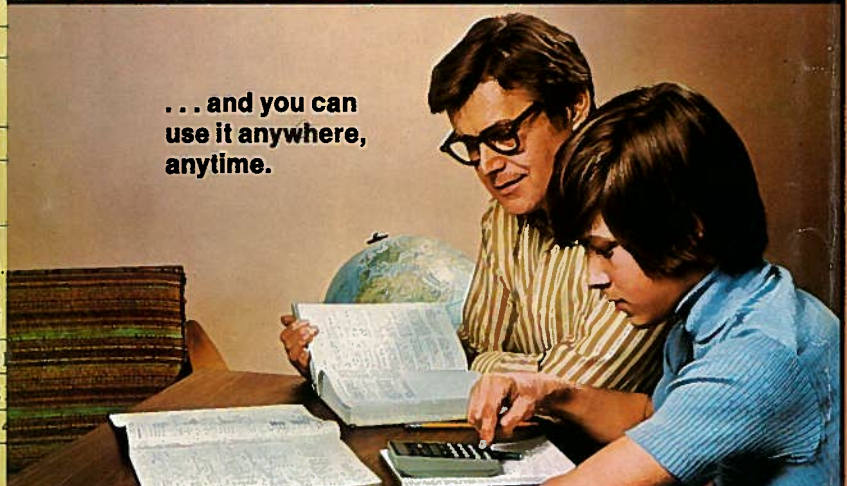
Plus . . . some new HP additions

• You can now choose engineering notation in addition to fixed point and scientific notations when formatting the display to fit your particular problems.
• There are now *eight* relational tests that you can include as conditional functions in your program.
• A new "PAUSE" key allows you to momentarily interrupt the program execution and display the contents of the X – register so you can review or write down an intermediate answer.
• Now, to conserve steps, each prefixed function takes only one program memory step.

The HP-25 has all of these features . . . in addition to HP's advanced design, four-register stack, RPN logic, and quality engineering . . . at $195.00.

DISPLAY		
E	CODE	COMMENTS
	14 09	Use polar-to-rectangular for $v_x = v \cos\theta$ = horiz. vel.
	23 02	
	21	
	23 03	$v_y = v \sin\theta$ = vert. vel.
	00	
	23 04	Initialize: $t = 0$
	24 00	Start of loop
	23 51 04	Next time interval: $t \leftarrow t + \Delta t$
	24 04	
	15 02	
	24 01	
	61	
	02	
	71	
	32	
	51	$y = v_y\,t - 1/2\,g\,t^3$
	24 04	
	24 02	
	61	
	24 04	$x = v_x\,t$
	14 74	Pause to display t
	22	
	74	Halt and display x
	21	
	74	Halt and display y
	13 07	Branch back for next t

ITS	KEYS		OUTPUT DATA/UNITS
	STO	0	
	STO	1	
	↑		
	f	PRGM	
	R/S		(t)
			x
	R/S		y

ards with a velocity of ontal. Use intervals of $g = 9.8$ m/s².

	RGM	R/S	➤ 0.25 (t₁)

$$\rightarrow 0.25 \ (t_1)$$
$$4.33 \ (x_1)$$
$$\rightarrow 2.19 \ (y_1)$$
$$\rightarrow 0.50 \ (t_2)$$
$$8.66 \ (x_2)$$
$$\rightarrow 3.78 \ (y_2)$$
$$\rightarrow 0.75 \ (t_3)$$
$$12.99 \ (x_3)$$
$$\rightarrow 4.74 \ (y_3)$$

low:

5	1.50	1.75	2.00	2.25
5	25.98	30.31	34.64	38.97
4	3.98	2.49	0.40	−2.31

Keyboard Problem-Solving

–with advanced scientific functions pre-programmed for you

Advanced scientific capabilities

The HP-25 is an advanced scientific pocket calculator with dozens of keyboard commands —including the functions most used by scientists and engineers.

To make the HP-25 smaller, one row of keys was eliminated. But, to keep the advanced capability, most keys now perform three commands. Some commands are labeled in gold above a key, or labeled in blue on the underside of a key, and activated by first pressing the appropriate gold or blue prefix key(s). (All functions may be incorporated into a program for automatic operation.)

Extra trigonometric capability

→R
→P

Rectangular/polar coordinate conversions: You can convert rectangular coordinates to polar coordinates or vice versa, enabling you to do vector arithmetic quickly, easily and accurately.
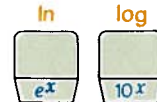
→H.MS
→H

Angle (time) conversions: You can convert angles (times) in decimal degrees (hours) to angles (times) in degrees (hours)/minutes/seconds . . . or vice versa.

Of course the HP-25 is also preprogrammed with the six basic trig functions—sin x, arc sin x, cos x, arc cos x, tan x, arc tan x.

Logarithmic functions

ln   log
eˣ   10ˣ

The HP-25 computes both natural and common logarithms as well as their inverse functions (antilogarithms).

Extra statistical capability

Σ−
Σ+

Summations: The "Σ+" key automatically calculates n, Σ x, Σ x², Σ y, Σ xy for statistical and vector calculations. Data may be deleted via the "Σ−" key.

x̄   s

Mean and standard deviation: The HP-25 calculates the mean and standard deviation.

Your choice of display formats

FIX   SCI   ENG

When you first turn on the HP-25, the display "wakes up" in fixed point notation, with the display rounded to two decimal places. By pressing "f", "FIX" and a number key (0 to 9), you can specify the number of decimal places. Or you can select scientific notation, by pressing "f", "SCI" and a number key to specify the number of decimal places (up to seven digits after the decimal point).

− 1 4 6 4 1 2 7 8 − 1 2
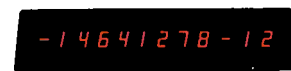
New to HP pocket calculators is engineering notation, which allows all numbers to be shown in a modified scientific notation with exponents of 10 that are multiples of three (e.g., 10^3, 10^6, 10^{12}). This is particularly useful in scientific and engineering calculations, where units of measure are often specified in multiples of 10^3. When the HP-25 is in engineering notation, the first three digits are always present but you can display up to 8 total.

Whichever notation is selected, the HP-25 always maintains the complete 10-digit number internally. Also, the HP-25 switches the display automatic-

ally from fixed point notation to full scientific notation whenever a number is too large or too small to be seen in fixed point notation.

Superior HP memory power

In addition to the 49-step program memory the HP-25 has . . .

8 addressable registers

R₀
R₁
R₂
R₃
R₄
R₅
R₆
R₇
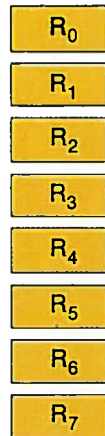
Instead of writing down and re-entering numbers manually, you can simply store them in any or all of the eight addressable memory registers, and recall them when needed. The registers may also be used for register arithmetic—directly adding to, subtracting from, dividing into or multiplying the register contents. Eight addressable registers and register arithmetic make data manipulation easy, especially with programmed problem-solving.

"RPN" and 4-register stack
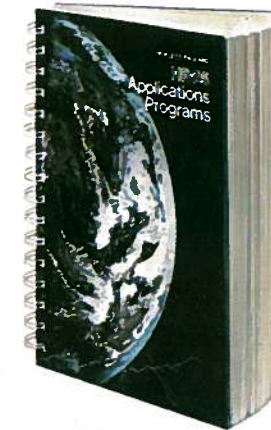
T
Z
Y
X	↔	LAST X
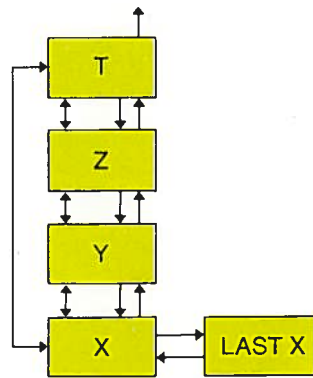
Like all other HP pocket calculators, the HP-25 uses HP's famous "RPN logic" system and a four-register stack. Intermediate answers are automatically stored, then automatically re-entered into the calculation. The "Last x" register stores the last input for instant recall, to correct a keystroke error or for use in another calculation.

HP-25 Functions and Features

Programming:
Program writing capability • Single step execution or inspection of a program • Pause (to display intermediate result) • Program editing capability • 8 relational tests: $x < y$, $x \geq y$, $x \neq y$, $x = y$, $x < 0$, $x \geq 0$, $x \neq 0$, $x = 0$ • Conditional branching • Direct branching

Keyboard commands:
Trigonometric functions: 3 angular modes (degrees, radians, grads) • Sin x • Arc sin x • Cos x • Arc cos x • Tan x • Arc tan x • Rectangular coordinates ↔ Polar coordinates • Decimal angle (time) ↔ Angle in degrees (hours)/minutes/seconds
Logarithmic functions: Log x • Ln x • e^x • 10^x
Statistical functions: Mean and standard deviation • Positive and negative summation giving n, Σx, Σx^2 Σy, Σxy
Other functions: Integer (gives only integer portion of number) • Fraction (gives only fractional portion of number) • Absolute (gives absolute value of x) • y^x • $\sqrt{x}$ • $1/x$ • π • x^2 • % • Register arithmetic in all 8 addressable registers • Addition, subtraction, multiplication or division in serial, mixed serial, chain or mixed chain calculations
Data storage and positioning operations: Data entry • Stack roll down • x,y interchange • Data storage • Data recall • Change sign • Enter exponent

Memory:
4-register stack • "Last x" register • 8 addressable registers • Program memory for storage of up to 49 steps

Light-emitting diode display:
Displays up to 10 significant digits, 8 plus two-digit exponent in scientific and engineering notation, and appropriate signs. Three selectable display modes: fixed point (with automatic overflow and underflow into scientific), engineering and scientific, with dynamic range of 10^{99} to 10^{-99}. Automatic decimal point positioning. Selective round-off; range 0-10 digits in fixed point; 0-8 digits in scientific; 0-8 in engineering notation. "Error" appearing in display indicates improper operation; low battery indicator.

HP-25 Scientific Programmable Calculator $195.00*

General specifications:
Operates on fast-charge battery pack or AC. (Battery recharges in 6-17 hours.) Tactile feedback keyboard. Polyethelene liquid-barrier shield under keyboard. Compact case of high-impact plastic with recessed display. Recessed recharger/AC plug receptacle. Solid state electronics.

Operating specifications:
Power:
AC: 115 or 230 V, ±10%, 50 to 60 Hz, 5 watts. Battery: 500 mw derived from nickel-cadmium rechargeable battery pack.
Weight:
HP-25: 6 ounces (170 g) with battery pack. Recharger: 5 ounces (142 g). Shipping wt.: Approx. 1.5 lbs. (.7 kg).

Dimensions:
Length: 5.1 inches (13.0 cm).
Width: 2.7 inches (6.2 cm).
Height: 1.2 inches (3.0 cm).
Temperature range:
Operating: 32°F to 113°F (0°C to 45°C). Charging: 59° to 104°F (15°C to 40°C).

The HP-25 continues the Hewlett-Packard tradition of quality and innovative features, backed up by prompt world-wide service.

Ever since 1939, Hewlett-Packard has been a leading designer and manufacturer of special-purpose electronic equipment for measurement and computation.

Hewlett-Packard pocket calculators have become the standard of excellence in the industry, and more than 1,000,000 are in use throughout the world.

This excellence is achieved via advanced technology . . . final assembly in HP's own facilities . . . and thorough testing—not only for mechanical operation, but for accuracy in computation.

Full one-year warranty
The HP-25 is warranted against defects in materials and workmanship for one year from the date of delivery. During the warranty period, Hewlett-Packard will repair, or at its option, replace at no charge components which prove to be defective, provided the calculator is returned shipping prepaid, to Hewlett-Packard's Customer Service facility.

This warranty does not apply if the calculator has been damaged by accident or misuse, or as a result of service or modification by other than an authorized Hewlett-Packard Customer Service facility. No other express warranty is given by Hewlett-Packard. HEWLETT-PACKARD SHALL NOT BE LIABLE FOR CONSEQUENTIAL DAMAGES.

Hewlett-Packard reserves the right to make changes in materials and specifications without notice.

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