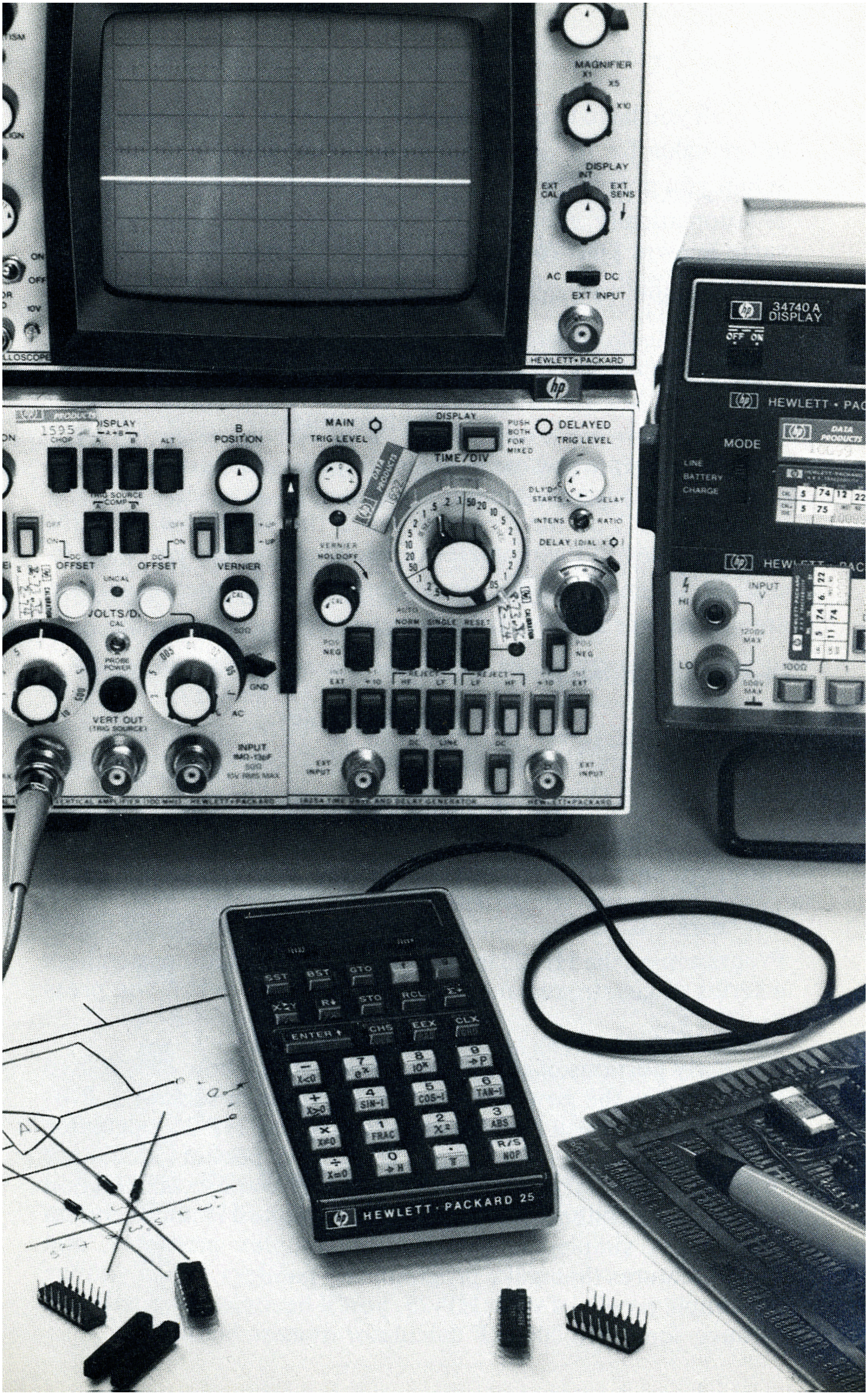
MAGNIFIER
DISPLAY
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POSITION
MAIN
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SINGLE
RESET
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SST
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GTO
STO
RCL
ENTER ↑
CHS
EEX
CLX
R/S
HEWLETT · PACKARD 25

Section 1

Getting Started

Your HP-25 is shipped fully assembled, including a battery. You can begin using your calculator immediately by connecting the cord from the ac adapter/battery charger to the calculator and plugging the charger into an ac outlet. If you want to use your HP-25 on battery power alone, you should charge the battery for 6 hours first. Whether you operate from battery power or from power supplied by the charger, *the battery must always be in the calculator*.

To begin:

- Slide the PRGM-RUN switch PRGM RUN to RUN.
- Slide the OFF-ON switch OFF ON to ON.

Display

With the PRGM-RUN switch set to RUN, the bright red display that you see when you turn the calculator ON gives you two kinds of information:

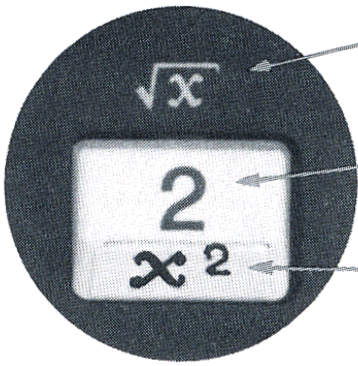
1. You see numbers as you key them in.
2. You see all intermediate and final answers as they are calculated.

When you first turn the calculator ON, the display is set to 0.00 to show you that all zeros are present there.

Keyboard

Most keys on the keyboard perform three functions. One function is indicated by the symbol on the flat face of the key, another by the blue symbol on the slanted key face, and a third by the gold symbol written above the key on the calculator case.

- To select the function printed in blue on the slanted face of the key, first press the blue prefix key g, then press the function key.
- To select the function printed on the flat face of the key, press the key.
- To select the function printed in gold above the key, first press the gold prefix key f, then press the function key.



To execute this function, first press f, then press 2.

To place this number into the display, press 2.

To execute this function, first press g, then press 2.

In this handbook, the selected key function will appear in the appropriate color (either gold or blue), like this: √x x^2 .

Keying in Numbers

Key in numbers by pressing the number keys in sequence, just as though you were writing on a piece of paper. The decimal point must be keyed in if it is part of the number.

For example:

Key in 148.84 by pressing the keys	**Display**
1 4 8 • 8 4	148.84

The resultant number 148.84 is seen in the display.

Negative Numbers

To key in a negative number, press the keys for the number, then press CHS *(change sign)*. The number, preceded by a minus (–) sign, will appear in the display. For example, to change the sign of the number now in the display:

Press	**Display**
CHS	–148.84

You can change the sign of either a negative or a positive number in the display. For example, to change the sign of the –148.84 now in the display back to positive:

Press	**Display**
CHS	148.84

Notice that only negative numbers are given a sign in the display.

Clearing

You can clear any numbers that are in the display by pressing **CLx** *(clear x)*. This key erases the number in the display and replaces it with 0 .

Press	Display
CLx	0.00

If you make a mistake while keying in a number, clear the entire number string by pressing **CLx** . Then key in the correct number.

Functions

In spite of the dozens of functions available on the HP-25 keyboard, you will find the calculator simple to operate by using a single, all-encompassing rule: *When you press a function key, the calculator immediately executes the function written on that key*.

> Pressing a function key causes the calculator to immediately perform that function.

For example, to calculate the square root of 148.84 merely:

Press	Display
148.84	148.84
f	148.84
$\sqrt{x}$	12.20

To square the result:

Press	Display
g	12.20
x^2	148.84

$\sqrt{x}$ and x^2 are examples of one-number function keys; that is, keys that execute upon a *single* number. All function keys in the HP-25 operate upon either one number or two numbers at a time (except for statistics keys like **Σ+** and s —more about these later).

> Function keys operate upon either one number or two numbers.

One-Number Functions

To use any one-number function key:

1. Key in the number.
2. Press the function key (or press the applicable prefix key, then the function key).

For example, to use the one-number function [1/x] key, you first key in the number represented by x, then press the function key. To calculate 1/4, key in 4 (the x-number) and press [g] [1/x].

Press	Display
4	4.
[g]	4.
[1/x]	0.25

Now try these other one-number function problems. Remember, *first key in the number, then press the function:*

$\frac{1}{25}$	=	0.04	
$\sqrt{2500}$	=	50.00	
10^5	=	100000.00	(Use the [10^x] key.)
$\sqrt{3204100}$	=	1790.00	
log 12.58925411	=	1.10	
71^2	=	5041.00	

Two-Number Functions

Two-number functions are functions that must have two numbers present in order for the operation to be performed. [+] [−] [×] and [÷] are examples of two-number function keys because you cannot add, subtract, multiply, or divide unless there are two numbers present in the calculator. Two-number functions work the same way as one-number functions—that is, the operation occurs when the function key is pressed. Therefore, *both numbers must be in the calculator before the function key is pressed.*

When more than one number must be keyed into the calculator before performing an operation, the [ENTER↑] key is used to separate the two numbers.

> Use the ENTER↑ key whenever more than one number must be keyed into the calculator before pressing a function.

If you key in only one number, you never need to press ENTER↑ .

To place two numbers into the calculator and perform an operation:

1. Key in the first number.
2. Press ENTER↑ to separate the first number from the second.
3. Key in the second number.
4. Press the function key to perform the operation.

For example, you add 12 and 3 by pressing:

12	The first number.
ENTER↑	Separates the first number from the second.
3	The second number.
+	The function.

The answer, 15.00 , is displayed.

Other arithmetic functions are performed the same way:

To perform	Press	Display
12 − 3	12 ENTER↑ 3 −	9.00
12 × 3	12 ENTER↑ 3 ×	36.00
12 ÷ 3	12 ENTER↑ 3 ÷	4.00

The y^x key is also a two-number operation. It is used to raise numbers to powers, and you can use it in the same simple way that you use every other two-number function key:

1. Key in the first number.
2. Press ENTER↑ to separate the first number from the second.
3. Key in the second number (power).
4. Perform the operation (press f , then y^x).

When working with any function key (including y^x), you should remember that the displayed number is always designated by x on the function key symbols.

> The number displayed is always x.

So, [$\sqrt{x}$] means square root of the displayed number, [$1/x$] means $\frac{1}{\text{displayed number}}$, etc.

Thus, to calculate 3^6:

Press	Display	
3	3.	
ENTER↑	3.00	
6	6.	X, the displayed number, is now 6.
f	6.	
[y^x]	729.00	The answer.

Now try the following problems using the [y^x] key, keeping in mind the simple rules for two-number functions:

16^4	(16 to the 4th power)	=	65536.00	
81^2	(81 squared)	=	6561.00	(You could also have done this as a one-number function using [x^2].)
$225^{.5}$	(Square root of 225)	=	15.00	(You could also have done this as a one-number function by using [$\sqrt{x}$].)
2^{16}	(2 to the 16th power)	=	65536.00	
$16^{.25}$	(4th root of 16)	=	2.00	

Chain Calculations

The speed and simplicity of operation of the HP-25's Hewlett-Packard logic system become most apparent during chain calculations. Even during the longest of calculations, *you still perform only one operation at a time*, and you see the results as you calculate—the Hewlett-Packard automatic memory stack stores up to four intermediate results inside the calculator until you need them, then inserts them into the calculation. This system makes the process of working through a problem as natural as it would be if you were working it out with pencil and paper, but the calculator takes care of the hard part.

For example, solve (12 + 3) × 7.

If you were working the problem with a pencil and paper, you would first calculate the intermediate result of (12 + 3). . . .

$$\cancel{(12 + 3)} \times 7 =$$

15

. . . and then you would multiply the intermediate result by 7.

$$\cancel{(12 + 3)} \times 7 = 105$$

15 X 7

You work through the problem exactly the same way with the HP-25, one operation at a time. You solve for the intermediate result first . . .

$$(12 + 3)$$

Press	Display	
12	12.	
ENTER↑	12.00	
3	3.	
+	15.00	Intermediate result.

. . . . and then solve for the final answer. You don't need to press ENTER↑ to store the intermediate result—the HP-25 automatically stores it inside the calculator when you key in the next number. To continue. . . .

Press	Display	
7	7.	The intermediate result from the preceding operation is automatically stored inside the calculator when you key in this number.
×	105.00	Pressing the function key multiplies the new number and the intermediate result, giving you the final answer.

Now try these problems. Notice that for each problem you only have to press ENTER↑ to insert a pair of numbers into the calculator—each subsequent operation is performed using a new number and an automatically stored intermediate result.

To solve	Press	Display
$\frac{(2 + 3)}{10}$	2	
	ENTER↑	
	3	
	+	
	10	
	÷	0.50
$3\,(16 - 4)$	16	
	ENTER↑	
	4	
	−	
	3	
	×	36.00
$\frac{14 + 7 + 3 - 2}{4}$	14	
	ENTER↑	
	7	
	+	
	3	
	+	
	2	
	−	
	4	
	÷	5.50

Problems that are even more complicated can be solved in the same simple manner, using the automatic storage of intermediate results. For example, to solve $(2 + 3) \times (4 + 5)$ with a pencil and paper, you would:

$$(2 + 3) \times (4 + 5)$$

First solve for the contents of these parentheses. . . .

. . . . and then for these parentheses

. . . . and then you would multiply the two intermediate answers together.

You work through the problem the same way with the HP-25. First you solve for the intermediate result of (2 + 3) . . .

	Press	Display	
$\cancel{(2 + 3)} \times (4 + 5)$	2	2.	
5	ENTER↑	2.00	
	3	3.	
	$\boxed{+}$	5.00	Intermediate result.

Then add 4 and 5:

(Since you must now key in another *pair* of numbers before you can perform a function, you use the ENTER↑ key again to separate the first number of the pair from the second.)

Procedure	Press	Display
$\cancel{(2 + 3)} \times \cancel{(4 + 5)}$ 5 9	4 ENTER↑ 5 $\boxed{+}$	9.00

Then multiply the intermediate answers together for the final answer:

Procedure	Press	Display
$\cancel{(2 + 3)} \times \cancel{(4 + 5)}$ 5 × 9	$\boxed{\times}$	45.00

Notice that you didn't need to write down or key in the intermediate answers from inside the parentheses before you multiplied—the HP-25 automatically stacked up the intermediate results inside the calculator for you and brought them out on a last-in, first-out basis when it was time to multiply.

No matter how complicated a problem may look, it can always be reduced to a series of one- and two-number operations. Just work through the problem in the same logical order you would use if you were working it with a pencil and paper.

For example, to solve:

$$\frac{(9 \times 8) + (7 \times 2)}{(4 \times 5)}$$

Press	Display	
9 ENTER↑ 8 ×	72.00	Intermediate result of (9 × 8).
7 ENTER↑ 2 ×	14.00	Intermediate result of (7 × 2).
+	86.00	(9 × 8) added to (7 × 2).
4 ENTER↑ 5 ×	20.00	Intermediate result of (4 × 5).
÷	4.30	The final answer.

Now try these problems. Remember to work through them as you would with a pencil and paper, but don't worry about intermediate answers—they're handled automatically by the calculator.

Problems

$$(2 \times 3) + (4 \times 5) = \boxed{26.00}$$

$$\frac{(14 + 12) \times (18 - 12)}{(9 - 7)} = \boxed{78.00}$$

$$\frac{\sqrt{16.38 \times 5}}{.05} = \boxed{181.00}$$

$$4 \times (17 - 12) \div (10 - 5) = \boxed{4.00}$$

$$\sqrt{(2 + 3) \times (4 + 5)} + \sqrt{(6 + 7) \times (8 + 9)} = \boxed{21.57}$$

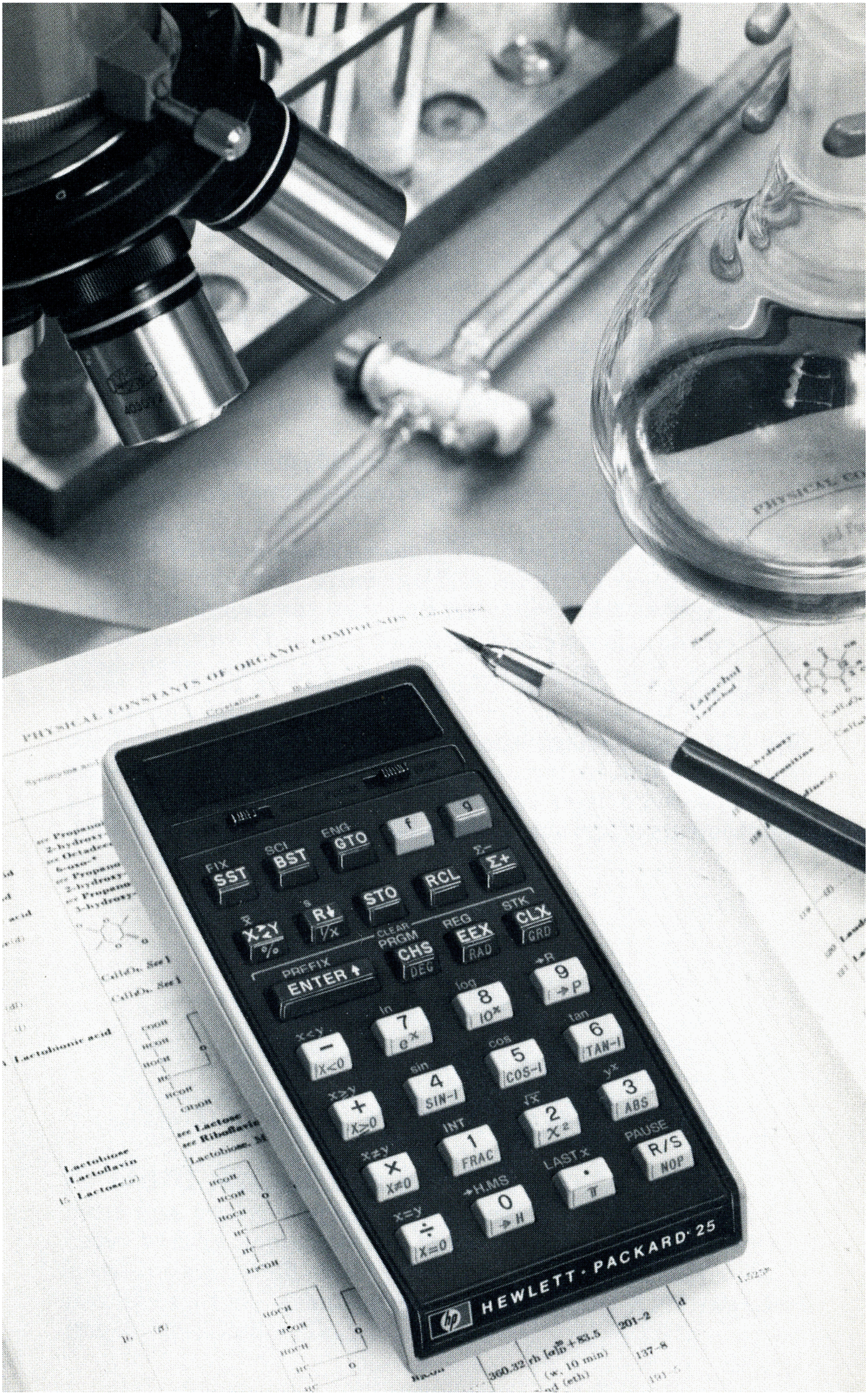
A Word About the HP-25

Now that you've learned how to use the calculator, you can begin to fully appreciate the benefits of the Hewlett-Packard logic system. With this system, you enter numbers using a parenthesis-free, unambiguous method called RPN (Reverse Polish Notation).

It is this unique system that gives you all these calculating advantages whether you're writing keystrokes for an HP-25 program or using the HP-25 under manual control:

- *You never have to work with more than one function at a time*. The HP-25 cuts problems down to size instead of making them more complex.
- *Pressing a function key immediately executes the function.* You work naturally through complicated problems, with fewer keystrokes and less time spent.
- *Intermediate results appear as they are calculated.* There are no "hidden" calculations, and you can check each step as you go.
- *Intermediate results are automatically handled.* You don't have to write down long intermediate answers when you work a problem.
- *Intermediate answers are automatically inserted into the problem on a last-in, first-out basis.* You don't have to remember where they are and then summon them.
- *You can calculate in the same order you do with pencil and paper.* You don't have to think the problem through ahead of time.

The HP system takes a few minutes to learn. But you'll be amply rewarded by the ease with which the HP-25 solves the longest, most complex equations. With HP, the investment of a few moments of learning yields a lifetime of mathematical bliss.



FIX SST
SCI BST
ENG GTO
f
g
Σ- Σ+
RCL
STO
x≷y %
R↓ 1/x
CLEAR PRGM CHS DEG
REG EEX RAD
STK CLX GRD
PREFIX ENTER↑
log 8 10x
→R 9 →P
ln 7 ex
tan 6 TAN-1
x<y − x<0
cos 5 COS-1
sin 4 SIN-1
yx 3 ABS
x≥y + x≥0
√x 2 x2
INT 1 FRAC
PAUSE R/S NOP
x≠y × x≠0
LAST x · π
→H.MS 0 →H
x=y ÷ x=0
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Section 2

Controlling the Display

In the HP-25, numbers in the display normally appear rounded to only two decimal places. For example, the fixed constant π, which is *actually* in the calculator as 3.141592654, normally *appears in the display as* 3.14 (unless you tell the calculator to show you the number rounded to a greater or lesser number of decimal places).

Although a number is normally shown to only two decimal places, the HP-25 always computes internally using each number as a 10-digit mantissa and a two-digit exponent of 10. For example, when you compute 2×3, you *see* the answer to only two decimal places:

Press	Display
2 ENTER↑ 3 ×	6.00

However, inside the calculator all numbers have 10 digit mantissas and two-digit exponents of 10. So the calculator *actually* calculates using full 10-digit numbers:

$2.000000000 \times 10^{00}$ ENTER↑ $3.000000000 \times 10^{00}$ ×

yields an answer that is actually carried to 10 digits:

6.000000000 x 10 00

You see only these digits. . .

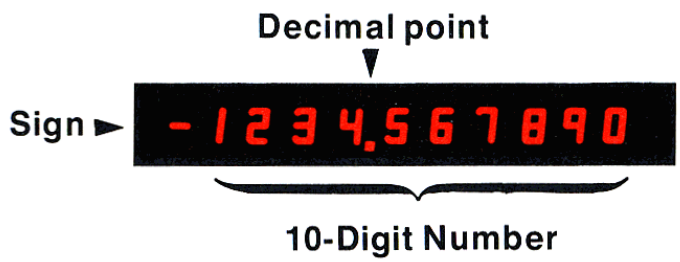
. . . but these digits are also present.

Display Control Keys

FIX allows numbers to be displayed in fixed decimal point format, SCI displays numbers in scientific notation format, and ENG displays numbers in engineering notation, with exponents of 10 shown in multiples of three (e.g., 10^3, 10^{-6}, 10^9).

Display control alters only the *manner* in which numbers are displayed in the HP-25. The actual number itself is not altered by any of the display control keys. No matter what notation you select, these rounding options affect the display only—the HP-25 always calculates internally with a full 10-digit number (multiplied by 10 raised to a two-digit exponent).

Fixed Point Display



Fixed Point Display

Using fixed point display you can specify the number of places to be shown after the decimal point. It is selected by pressing f FIX, followed by a number key to specify the number of decimal places (0-9) to which the display is to be rounded. The displayed number begins at the left side of the display and includes trailing zeros within the setting selected. When the calculator is turned OFF, then ON, it "wakes up" in fixed point notation with the display rounded to two decimal places. For example:

Press	Display	
(Turn the calculator OFF, then ON.)	0.00	
123.4567 ENTER↑	123.46	Display is rounded off to two decimal places. Internally, however, the number maintains its original value of 123.4567.
f FIX 4	123.4567	
f FIX 7	123.4567000	
f FIX 0	123.	
f FIX 2	123.46	Normal FIX 2 display.

Scientific Notation Display

Scientific Notation Display

(This means $-1.2345678 \times 10^{-23}$)

In scientific notation each number is displayed with a single digit to the left of the decimal point followed by a specified number of digits (up to seven) to the right of the decimal point and multiplied by a power of 10. It is particularly useful when working with very large or small numbers.

Scientific notation is selected by pressing f [SCI] followed by a number key to specify the number of decimal places to which the number is rounded. The display is left-justified and includes trailing zeros within the selected setting. For example:

Press	Display	
123.4567 [ENTER↑]	123.46	Normal FIX 2 display.
f [SCI] 2	1.23 02	Displays 1.23×10^2.
f [SCI] 4	1.2346 02	Displays 1.2346×10^2.
f [SCI] 7	1.2345670 02	Displays 1.2345670×10^2.

In scientific notation, although the calculator displays a maximum of seven digits after the decimal point, it always maintains the full 10-digit number and the two-digit exponent of 10 internally. The portion of the number that is not displayed affects the rounding of the displayed portion.

For example, if you key in 1.000000094 and specify full scientific notation display (f [SCI] 7), the calculator display rounds off to the seventh digit after the decimal point:

1.000000094

Calculator rounds to this digit in SCI 7.

Press	Display
1.000000094	1.000000094
f SCI 7	1.0000001 00

In SCI 8, the display would round off to the eighth digit after the decimal point, but you can see only out to seven digits after the decimal:

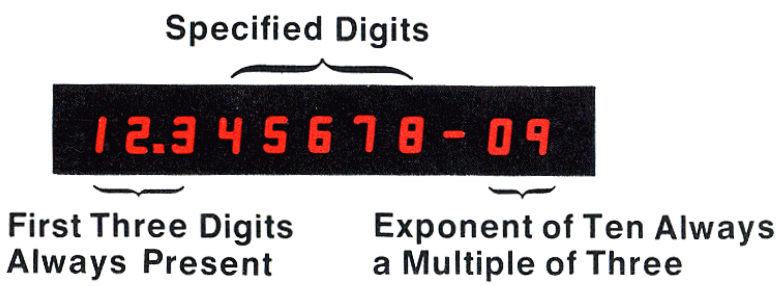
1.000000094

You see to here . . . . . . but the calculator display rounds to here in SCI 8.

Press	Display
f SCI 8	1.0000000 00

You can see that if you had keyed in 1.000000095, SCI 8 would also have caused the display to round the seventh and final digit after the decimal to a one (1).

Engineering Notation Display



Engineering Notation Display

Engineering notation allows all numbers to be shown with exponents of ten that are multiples of three (e.g., 10^3, 10^{-6}, 10^9). This is particularly useful in scientific and engineering calculations, where units of measure are often specified in multiples of three. See the prefix chart below.

Multiplier	Prefix	Symbol
10^{12}	tera	T
10^{9}	giga	G
10^{6}	mega	M
10^{3}	kilo	k
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n
10^{-12}	pico	p
10^{-15}	femto	f
10^{-18}	atto	a

Engineering notation is selected by pressing [f] [ENG] followed by a number key. In engineering notation, the first three digits are always present, and the number key specifies the number of *additional* digits displayed after the first three. For example:

Press	Display	
0.000012345	0.000012345	
[f] [ENG] 0	12.3 -06	Engineering notation display. First three digits visible and power of 10 is the proper multiple of three.
[f] [ENG] 2	12.345 -06	The number key specifies the number of digits displayed beyond the first three.
[f] [ENG] 4	12.34500 -06	

Notice that because the first three digits are always present, the greatest number of additional digits that can be specified in engineering notation is five.

Press	Display	
[f] [ENG] 5	12.345000 -06	Maximum number of digits displayed.
[f] [ENG] 6	12.345000 -06	No change in display.
[f] [ENG] 7	12.345000 -06	No change in display.

Rounding of displayed numbers in ENG 5 and ENG 6 is similar to the rounding of numbers in SCI 7 and SCI 8, discussed earlier. As with all display formats, engineering notation display does not affect the *actual* number as it is held internally by the calculator, but only alters the manner in which the number is displayed.

When engineering notation has been selected, the decimal point shifts to show the mantissa as units, tens, or hundreds in order to maintain the exponent of 10 as a multiple of three. For example, multiplying the number now in the calculator by 10 causes the decimal point to shift to the right without altering the exponent of 10:

Press	Display	
[f] [ENG] 0	12.3 -06	
10 [×]	123. -06	Decimal point shifts. Power of 10 remains at 10^{-6}.

However, multiplying again by 10 causes the exponent to shift to another multiple of three and the decimal point to move to the units position:

Press	Display	
10 [×]	1.23 -03	Decimal point shifts. Power of 10 shifts to 10^{-3}.

Automatic Display Switching

The HP-25 switches the display from fixed point notation to full scientific notation (SCI 7) whenever the number is too large or too small to be seen with a fixed decimal point. This feature keeps you from missing unexpectedly large or small answers. For example, if you try to solve $(.05)^3$ in normal FIX 2 display, the answer is automatically shown in scientific notation:

Press	Display	
CLx	0.00 00	ENG 0 from previous example.
f FIX 2	0.00	Normal FIX 2 display.
.05 ENTER↑	0.05	
3 f y^x	1.2500000-04	Display automatically switched to SCI 7 to show answer.

Another way of displaying the answer would be 0.000125, but in normal FIX 2 display, you would have seen only [0.00] displayed.

After automatically switching from fixed to scientific, when a new number is keyed in or CLx is pressed the display automatically reverts back to the fixed point display originally selected.

The HP-25 also switches to scientific notation if the answer is too large ($>10^{10}$) for fixed point display. The display will not switch from fixed if you solve 1582000 × 1842:

Press	Display	
1582000 ENTER↑	1582000.00	
1842 [×]	2914044000.	Fixed decimal point display.

However, if you multiply the result by 10, the answer is too large for fixed point notation, and switches automatically to scientific notation:

Press	Display	
10 ×	2.9140440 10	Scientific notation display.

Notice that automatic switching is between fixed and scientific notation display modes only—engineering notation display must be selected from the keyboard.

Keying in Exponents of Ten

You can key in numbers multiplied by powers of 10 by pressing EEX (*enter exponent of ten*). For example, to key in 15.6 trillion (15.6×10^{12}), and multiply it by 25:

Press	Display	
15.6	15.6	
EEX	15.6 00	
12	15.6 12	(This means 15.6×10^{12}.)

Now Press	Display
ENTER↑	1.5600000 13
25 ×	3.9000000 14

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

Press	Display	
EEX	1. 00	You do not have to key in the number 1 before pressing EEX when the number is an exact power of 10.
6	1. 06	
ENTER↑	1000000.00	Since you have not specified scientific notation, the answer reverts to fixed point notation when you press ENTER↑ .
52 ÷	19230.77	

To see your answer in scientific notation with six decimal places:

Press	Display
f SCI 6	1.923077 04

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

Press	Display	
CLX	0.000000 00	
f FIX 2	0.00	
6.625 EEX	6.625 00	
CHS	6.625 -00	
27	6.625 -27	
ENTER↑	6.6250000 -27	
50 ×	3.3125000 -25	Erg sec.

Using the EEX key, you can key in numbers made up of 10-digit mantissas and two-digit exponents of 10. However, when you use the EEX key, the HP-25 displays each number as an eight-digit mantissa and a two-digit exponent of 10. In a few cases, a number may have to be altered slightly in form before you can key it in using the EEX key:

- If you key in a number whose mantissa contains more than eight digits to the left of the decimal point, the EEX key is overridden and does not operate. Begin again and key in the number in a form that displays the mantissa with eight digits or less to the left of the decimal point before pressing the EEX key. (Thus, $123456789.1 \times 10^{23}$ could be keyed in as $12345678.91 \times 10^{24}$.)

- If you key in a number whose first significant digit occurs *after* the first eight digits of the display, the EEX key does not operate upon that number. To key in the number correctly, begin again and place the number in a form such that its first significant digit is one of the first eight digits of the display, then proceed using the EEX key. (Thus, $0000.000025 \times 10^{55}$ cannot be keyed in in that form. It could be keyed in as $0000.00025 \times 10^{54}$, or as 0.000025×10^{55}, for example.)

Calculator Overflow

When the number in the display would be greater than 9.9999999 $\times 10^{99}$, the HP-25 displays all 9's to indicate that the problem has exceeded the calculator's range. For example, if you solve $(1 \times 10^{49}) \times (1 \times 10^{50})$, the HP-25 will display the answer:

Press	Display
EEX 49 ENTER↑	1.0000000 49
EEX 50 ×	1.0000000 99

But if you attempt to multiply the above result by 100, the HP-25 display indicates overflow by showing you all 9's:

Press	Display
100 ×	9.9999999 99

A display of OF indicates that one of the calculator's *storage registers* has overflowed. See section 4, Function Keys, for a description of the HP-25 storage registers.

Error Display

If you happen to key in an improper operation, the word *Error* will appear in the display.

For example, try to divide 1 by 0 (the HP-25 will recognize this as an improper operation):

Press	Display
1 ENTER↑	1.00
0 ÷	Error

You can clear the error by pressing CLx or by keying another number into the displayed X-register.

Press	Display
CLx	0.00

All those operations that cause Error to appear in the display are listed in appendix B.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Section 3

The Automatic Memory Stack

The Stack

Automatic storage of intermediate results is the reason that the HP-25 slides so easily through the most complex equations. And automatic storage is made possible by the Hewlett-Packard automatic memory stack.

Initial Display

When you first switch the calculator ON, the display shows 0.00. This represents the contents of the display, or X-register.

Basically, numbers are stored and manipulated in the machine "registers." Each number, no matter how few digits (e.g., 0, 1, or 5) or how many (e.g., 3.141592654, −23.28362, or 2.87148907 $\times 10^{27}$), occupies one entire register.

The displayed X-register, which is the only visible register, is one of four registers inside the calculator that are positioned to form the automatic memory stack. We label these registers X, Y, Z, and T. They are "stacked" one on top of the other with the displayed X-register on the bottom. When the calculator is switched ON, these four registers are cleared to 0.00.

Name	Register	
T	0.00	
Z	0.00	
Y	0.00	
X	0.00	Always displayed.

Manipulating Stack Contents

The R↓ *(roll down)* and x⇄y *(x exchange y)* keys allow you to review the stack contents or to shift data within the stack for computation at any time.

Reviewing the Stack

To see how the **R↓** key works, first load the stack with numbers 1 through 4 by pressing:

4 **ENTER↑** 3 **ENTER↑** 2 **ENTER↑** 1

The numbers that you keyed in are now loaded into the stack, and its contents look like this:

T	4.00	
Z	3.00	
Y	2.00	
X	1.	Display

Each time you press the **R↓** key, the stack contents shift downward one register. So the last number that you have keyed in will be rotated around to the T-register when you press **R↓** .

When you press the R↓ key, the stack contents are rotated . . .

. . . from this . . .

T	4.00	
Z	3.00	
Y	2.00	
X	1.	Display

. . . to this.

T	1.00	
Z	4.00	
Y	3.00	
X	2.00	Display

Notice that the *contents* of the registers are shifted. The registers themselves maintain their positions. The contents of the X-register are always displayed, so 2.00 is now visible.

Press R↓ again and the stack contents are shifted . . .

. . . from this . . .

T	1.00	
Z	4.00	
Y	3.00	
X	2.00	Display

. . . to this.

T	2.00	
Z	1.00	
Y	4.00	
X	3.00	Display

Press R↓ twice more . . . and the stack shifts . . .

. . . through this . . .

T	3.00	
Z	2.00	
Y	1.00	
X	4.00	Display

. . . back to the start again.

T	4.00	
Z	3.00	
Y	2.00	
X	1.00	Display

Once again the number 1.00 is in the displayed X-register. Now that you know how the stack is rotated, you can use the R↓ key to review the contents of the stack at any time so that you can always tell what is in the calculator. Always remember, though, that it takes four presses of the R↓ key to return the contents to their original registers.

Exchanging X and Y

The x⇄y *(x exchange y)* key exchanges the contents of the X- and Y-registers without affecting the Z- and T-registers. If you press x⇄y with data intact from the previous example, the numbers in the X- and Y-registers will be changed . . .

. . . from this . . .

T	4.00
Z	3.00
Y	2.00
X	1.00

. . . to this.

T	4.00
Z	3.00
Y	1.00
X	2.00

Similarly, pressing x⇄y again will restore the numbers in the X- and Y-registers to their original places. This key is used to position numbers in the stack or simply to view the Y-register.

Clearing the Stack

To clear the displayed X-register only, press CLx. To clear the entire automatic memory stack, including the displayed X-register, press f STK *(clear stack)*. This replaces all numbers in the stack with zeros. When you turn the calculator OFF, then ON, it "wakes up" with all zeros in the stack registers.

Although it may be comforting, *it is never necessary to clear the stack or the displayed X-register when starting a new calculation*. This will become obvious when you see how old results in the stack are automatically lifted by new entries.

Press CLx now, and the stack contents are changed . . .

. . . from this . . .			. . . to this.		
T	4.00		T	4.00	
Z	3.00		Z	3.00	
Y	1.00		Y	1.00	
X	2.00	Display	X	0.00	Display

You can verify that only the X-register contents are affected by CLx by using the R↓ key to review the other stack contents.

If you press f STK, the contents of the stack are changed . . .

. . . from this . . .			. . . to this.		
T	4.00		T	0.00	
Z	3.00		Z	0.00	
Y	1.00		Y	0.00	
X	0.00	Display	X	0.00	Display

The ENTER↑ Key

When you key a number into the calculator, its contents are written into the displayed X-register and the other registers remain unchanged. For example, if you keyed in the number 314.32, your stack registers would look like this:

Name	Register	
T	0.00	
Z	0.00	
Y	0.00	
X	314.32	Display

In order to key in a second number at this point, you must separate the digits of the first number from the digits of the second.

One way to separate numbers is to press ENTER↑ . Press ENTER↑ to change the contents of the registers . . .

. . . from this . . .			. . . to this.		
T	0.00		T	0.00	
Z	0.00		Z	0.00	
Y	0.00		Y	314.32	
X	314.32	Display	X	314.32	Display

As you can see, the number in the displayed X-register is copied into Y. (The numbers in Y and Z have also been transferred to Z and T, respectively, and the number in T has been lost off the top of the stack. But this will be more apparent when we have different numbers in all four registers.)

Immediately after pressing **ENTER↑**, the X-register is prepared for a new number, and that new number writes over the number in X. For example, key in the number 543.28 and the contents of the stack registers change. . .

. . . from this . . .			. . . to this.		
T	0.00		T	0.00	
Z	0.00		Z	0.00	
Y	314.32		Y	314.32	
X	314.32	Display	X	543.28	Display

CLx replaces any number in the display with zero. Any new number then writes over the zero in X.

For example, if you had meant to key in 689.4 instead of 543.28, you would press **CLx** now to change the stack . . .

. . . from this . . .			. . . to this.		
T	0.00		T	0.00	
Z	0.00		Z	0.00	
Y	314.32		Y	314.32	
X	543.28	Display	X	0.00	Display

and then key in 689.4 to change the stack . . .

. . . from this . . .			. . . to this.		
T	0.00		T	0.00	
Z	0.00		Z	0.00	
Y	314.32		Y	314.32	
X	0.00	Display	X	689.4	Display

Notice that numbers in the stack do not move when a number is keyed in immediately after pressing **ENTER↑** or **CLx**. (However, the numbers in the stack *do* lift when a new number is keyed in immediately after pressing **R↓**.)

One-Number Functions and the Stack

One-number functions execute upon the number in the X-register only, and the contents of the Y-, Z-, and T-registers are unaffected when a one-number function key is pressed.

For example, with numbers positioned in the stack as in the earlier example, pressing the **f** **√x** keys changes the stack contents . . .

. . . **from this . . .**

T	*0.00*	
Z	*0.00*	
Y	*314.32*	
X	*689.4*	Display

. . . **to this.**

T	*0.00*	
Z	*0.00*	
Y	*314.32*	
X	*26.26*	Display

The one-number function executes upon only the number in the displayed X-register, and the answer writes over the number that was in the X-register. No other register is affected by a one-number function.

Two-Number Functions and the Stack

Hewlett-Packard calculators do arithmetic by positioning the numbers in the stack the same way you would on paper. For instance, if you wanted to add 34 and 21 you would write 34 on a piece of paper and then write 21 underneath it, like this:

$$\begin{array}{r} 34 \\ 21 \\ \hline \end{array}$$

and then you would add, like this:

$$\begin{array}{r} 34 \\ +21 \\ \hline 55 \end{array}$$

Numbers are positioned the same way in the HP-25. Here's how it is done. (If you clear the previous number entries first by pressing **f** **STK** the numbers in the stack will correspond to those shown in the example below.)

Press	Display	
34	34.	34 is keyed into X.
ENTER↑	34.00	34 is copied into Y.
21	21.	21 writes over the 34 in X.

Now 34 and 21 are sitting vertically in the stack as shown below, so we can add.

T	0.00	
Z	0.00	
Y	34.00	
X	21.	Display

Press	Display	
+	55.00	The answer.

The simple, old-fashioned math notation helps explain how to use your calculator. Both numbers are always positioned in the stack in the natural order first; then the operation is executed when the function key is pressed. *There are no exceptions to this rule*. Subtraction, multiplication, and division work the same way. In each case, the data must be in the proper position before the operation can be performed.

To subtract 21 from 34:

$$\begin{array}{r} 34 \\ -21 \\ \hline \end{array}$$

Press	Display	
34	34.	34 is keyed into X.
ENTER↑	34.00	34 is copied into Y.
21	21.	21 writes over the 34 in X.
−	13.00	The answer.

To multiply 34 by 21:

$$\begin{array}{r} 34 \\ \times 21 \\ \hline \end{array}$$

Press	Display	
34	34.	34 is keyed into X.
ENTER↑	34.00	34 is copied into Y.
21	21.	21 writes over the 34 in X.
×	714.00	The answer.

To divide 34 by 21:

$$\frac{34}{21}$$

Press	Display	
34	34.	34 is keyed into X.
ENTER↑	34.00	34 is copied into Y.
21	21.	21 writes over the 34 in X.
÷	1.62	The answer.

Chain Arithmetic

You've already learned how to key numbers into the calculator and perform calculations with them. In each case you first needed to position the numbers in the stack manually using the ENTER↑ key. However, the stack also performs many movements automatically. These automatic movements add to its computing efficiency and ease of use, and it is these movements that automatically store intermediate results. The stack automatically "lifts" every calculated number in the stack when a new number is keyed in because it *knows* that after it completes a calculation, any new digits you key in are a part of a new number. Also, the stack automatically "drops" when you perform a two-number operation. For example, calculate 16 + 30 + 11 + 17 = ?

Note: If you press f STK first, you will begin with zeros in all of the stack registers, as the example below.

Press	Stack Contents		
	T	0.00	
16	Z	0.00	
	Y	0.00	16 is keyed into the displayed
	X	16.	X-register.
	T	0.00	
	Z	0.00	
ENTER↑	Y	16.00	
	X	16.00	16 is copied into Y.

	T	0.00	
30	Z	0.00	
	Y	16.00	
	X	30.	30 writes over the 16 in X.
	T	0.00	
	Z	0.00	
[+]	Y	0.00	16 and 30 are added together.
	X	46.00	The answer, 46, is displayed.
	T	0.00	
11	Z	0.00	11 is keyed into the displayed
	Y	46.00	X-register. The 46 in the stack
	X	11.	is automatically raised.
	T	0.00	
	Z	0.00	
[+]	Y	0.00	46 and 11 are added together.
	X	57.00	The answer, 57, is displayed.
	T	0.00	
17	Z	0.00	17 is keyed into the X-register.
	Y	57.00	57 is automatically entered
	X	17.00	into Y.
	T	0.00	
	Z	0.00	
[+]	Y	0.00	57 and 17 are added together
	X	74.00	for the final answer.

After any calculation or number manipulation, the stack automatically lifts when a new number is keyed in. Because operations are performed when the operations are pressed, the length of such chain problems is unlimited unless a number in one of the stack registers exceeds the range of the calculator (up to $9.999999999 \times 10^{99}$).

In addition to the automatic stack lift after a calculation, the stack automatically drops *during* calculations involving both the X- and Y-registers. It happened in the above example, but let's do the problems differently to see this feature more clearly. First press **CLX** to clear the X-register. Now, again solve 16 + 30 + 11 + 17 = ?

Press	Stack Contents		
16	T	0.00	16 is keyed into the displayed X-register.
	Z	0.00	
	Y	0.00	
	X	16.	
ENTER↑	T	0.00	16 is copied into Y.
	Z	0.00	
	Y	16.00	
	X	16.00	
30	T	0.00	30 is written over the 16 in X.
	Z	0.00	
	Y	16.00	
	X	30.	
ENTER↑	T	0.00	30 is entered into Y. 16 is lifted up to Z.
	Z	16.00	
	Y	30.00	
	X	30.00	
11	T	0.00	11 is keyed into the displayed register.
	Z	16.00	
	Y	30.00	
	X	11.	
ENTER↑	T	16.00	11 is copied into Y. 16 and 30 are lifted up to T and Z respectively.
	Z	30.00	
	Y	11.00	
	X	11.00	
17	T	16.00	17 is written over the 11 in X.
	Z	30.00	
	Y	11.00	
	X	17.	

Key	Register	Value	Explanation
	T	16.00	17 and 11 are added together and the rest of the stack drops. 16 drops to Z and is also duplicated in T. 30 and 28 are ready to be added.
$\boxed{+}$	Z	16.00	
	Y	30.00	
	X	28.00	
	T	16.00	30 and 28 are added together and the stack drops again. Now 16 and 58 are ready to be added.
$\boxed{+}$	Z	16.00	
	Y	16.00	
	X	58.00	
	T	16.00	16 and 58 are added together for the final answer and the stack continues to drop.
$\boxed{+}$	Z	16.00	
	Y	16.00	
	X	74.00	

The same dropping action also occurs with $\boxed{-}$, $\boxed{\times}$ and $\boxed{\div}$. The number in T is duplicated in T and Z, the number in Z *drops* to Y, and the numbers in Y and X *combine* to give the answer, which is visible in the X-register.

This automatic lift and drop of the stack give you tremendous computing power, since you can retain and position intermediate results in long calculations without the necessity of reentering the numbers.

Order of Execution

When you see a problem like this one:

$$5 \times \left[(3 \div 4) - (5 \div 2) + (4 \times 3)\right] \div (3 \times .213),$$

you must decide where to begin before you ever press a key.

Hewlett-Packard applications engineers have determined that by starting *every* problem at its innermost number or parentheses and working outward, you maximize the efficiency and power of your HP calculator. Of course, with the HP-25 you have tremendous versatility in the order of execution.

For example, you *could* work the problem above by beginning at the left side of the equation and simply working through it in left-to-right order. All problems cannot be solved using left-to-right order, however, and the *best* order for solving any problem is to begin with the innermost parentheses and work outward. So, to solve the problem above:

Press	Display	
3	3.	
ENTER↑	3.00	
4	4.	
÷	0.75	Intermediate answer for (3 ÷ 4).
5	5.	
ENTER↑	5.00	
2	2.	
÷	2.50	Intermediate answer for (5 ÷ 2).
−	−1.75	Intermediate answer for (3 ÷ 4) − (5 ÷ 2).
4	4.	
ENTER↑	4.00	
3	3.	
×	12.00	Intermediate answer for (4 × 3)
+	10.25	Intermediate answer for (3 ÷ 4) − (5 ÷ 2) + (4 × 3).
3	3.	
ENTER↑	3.00	
.213	0.213	
×	0.64	Intermediate answer for (3 × .213).
÷	16.04	
5	5.	The first number is keyed in.
×	80.20	The final answer.

Constant Arithmetic

You may have noticed that whenever the stack drops because of a two-number operation (not because of R↓), the number in the T-register is reproduced there. This stack operation can be used to insert a constant into a problem.

Example: A bacteriologist tests a certain strain whose population typically increases by 15% each day. If he starts a sample culture of 1000, what will be the bacteria population at the end of each day for six consecutive days?

Method: Put the growth factor (1.15) in the Y-, Z-, and T-registers and put the original population (1000) in the X-register. Thereafter, you get the new population whenever you press [×].

Press	Display	
1.15	1.15	Growth factor.
ENTER↑	1.15	
ENTER↑	1.15	
ENTER↑	1.15	Growth factor now in T.
1000	1000.	Starting population.
[×]	1150.00	Population after 1st day.
[×]	1322.50	Population after 2nd day.
[×]	1520.88	Population after 3rd day.
[×]	1749.01	Population after 4th day.
[×]	2011.36	Population after 5th day.
[×]	2313.06	Population after 6th day.

When you press [×] the first time, you calculate 1.15 × 1000. The result (1150.00) is displayed in the X-register and a new copy of the growth factor drops into the Y-register. Since a new copy of the growth factor is duplicated from the T-register each time the stack drops, you never have to reenter it.

Notice that performing a two-number operation such as [×] causes the number in the T-register to be duplicated each time the stack is dropped. However, the R↓ key, since it *rotates* the contents of the stack registers, does not *rewrite* any number, but merely shifts the numbers that are already in the stack.