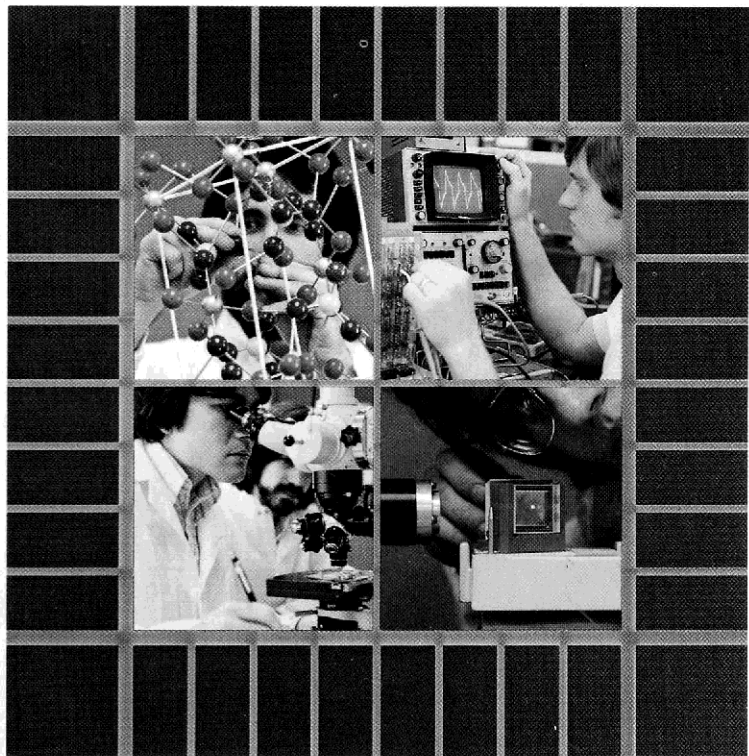


HEWLETT-PACKARD

SOLVING PROBLEMS
WITH YOUR
HEWLETT-PACKARD
CALCULATOR





Solving Problems With Your Hewlett-Packard Calculator

July 1978

5955-3015 Rev. B 7/78

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Solving Problems With Your Hewlett-Packard Calculator



ENTER↵

It's the "key" to solving problems with ease and confidence. It's part of the RPN logic system in your new Hewlett-Packard calculator. A logic system so amazing in its simplicity and power that, once you've tried it, you'll never be content with any other system.


This book describes the Hewlett-Packard RPN logic system. If you're new to HP calculators, taking the time to read it thoroughly will be the second best investment you've made (the first was purchasing your new HP calculator). Even if you already own another HP calculator, you may find some new features you're not familiar with.

If you're like most people who buy a new calculator, you can't wait to get started using it. We don't blame you. In fact, that's just what we want you to do. That's why we wrote this book. It's not very long and, when you've worked your way through it with your new calculator, you'll be well on your way to being an RPN expert like other HP owners. And, you'll wonder why anybody makes a scientific calculator without an **ENTER↵** key. We wonder too.

So, turn the page and get started.

Getting Started

Power On

To begin working with your HP calculator, set the power switch to ON. If your calculator has a PRGM  RUN switch, set it to RUN.

Operating Power

Your Hewlett-Packard calculator is shipped fully assembled, including a battery pack. You can run the calculator on battery power alone, or you can connect the battery recharger and use the calculator while the battery is charging. If you want to use the calculator on battery power only, charge the battery first (refer to Battery Charging, in your owner's handbook). Whether you operate from batteries or from the recharger, *the battery pack must be in the calculator.*

Self Check Routine

Your new Hewlett-Packard calculator is loaded with features that make it easy to use and give you confidence that the answers you calculate are right, every time. The self check routine, a feature found on many sophisticated electronic instruments and computers, was designed for just those reasons. We don't expect you to ever have a problem with your calculator, but if you think that it isn't operating properly, try this:

Keystrokes

Display

-8,8,8,8,8,8,8,8,8,

The display shown above will appear if your calculator is operating properly. Press any key to clear the display back to zero. If your calculator is not operating properly, your display will show **Error 9** or an erroneous display. This tells you that a problem exists in the calculator's circuitry and you should send it in for service (refer to Shipping Instructions in your owner's handbook). Pressing any key will replace the **Error 9** in the display with a number that tells a Hewlett-Packard Service Engineer which circuit in the calculator is at fault. That's right.

The calculator not only tells you it's having problems, it tells us where the problem is, so we can fix it as quickly and inexpensively as possible and return it to you without delay.

Note: Using the self check causes all memory to be cleared, including the stack, data registers and program memory.

Keying In Numbers

Key in a number by pressing the digits in sequence, as though you were writing on paper. A decimal point must be keyed in if it is part of the number.

Example: Key in 10912.45 (the depth in meters reached by the Bathyscaphe *Trieste* in the Marianas Trench on January 23, 1960.)

Keystrokes	Display
10912.45	10,912.45

The resulting number 10,912.45 is seen in the display. Notice that commas are automatically inserted for you. Answers can be read quickly and easily, with less chance for error.

Negative Numbers

To key in a negative number, key in the digits, then press **CHS** (*change sign*). The number, preceded by a minus (–) sign, will appear in the display.

Example: Change the sign of the number now in the display.

Keystrokes	Display
CHS	–10,912.45

You can change the signs of negative or positive numbers in the display. Change the sign of –10,912.45 now in the display.

Keystrokes	Display
CHS	10,912.45

Clearing

Any number that is in the display can be cleared by pressing **CLX** (*clear x*). This key erases the displayed number and replaces it with zero.

Keystrokes

CLX

Display

0.0000

If a mistake is made while keying in a number, press **CLX** to clear the entire number. Then key in the correct number.

Note: The number shown in the display is always designated by *x* on the function key.

Functions

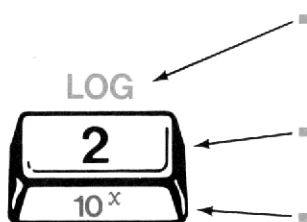
Keyboard

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

To select the function printed on the flat face of the key, press the key.

To select the function printed above the key, first press the prefix key **f**, then press the function key.

To select the function printed on the slanted face of the key, first press the prefix key **g**, then press the function key.



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

Some keystroke sequences may require the use of prefix keys to make them applicable to your calculator. Check your calculator keyboard for proper execution sequences.

One-Number Functions

One-number functions are functions that require only one number present in order for an operation to be performed, such as $\boxed{1/x}$, $\boxed{\text{LOG}}$, or $\boxed{\text{SIN}}$.

To execute one-number functions:

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

To use the one-number function $\boxed{1/x}$ (reciprocal) key, key in the X-number then press $\boxed{1/x}$.

Example: Calculate $1/8$.

Keystrokes

Display

8

8.

Key in X-number.

 $\boxed{1/x}$

0.1250

Press function key for answer.

Remember: First key in the number, then press the function key.

Try these other one-number function problems:

Solve

Display

 $1/35$

0.0286

 $\sqrt{3500}$

59.1608

Use the $\boxed{\sqrt{x}}$ key.

log 16.40291

1.2149

Use the $\boxed{\text{LOG}}$ key.

Two-Number Functions

Two-number functions are functions that must have two numbers present in order for an operation to be performed. Since you cannot add, subtract, multiply, or divide unless two numbers are present in the calculator, $\boxed{+}$, $\boxed{-}$, $\boxed{\times}$, and $\boxed{\div}$ are examples of two-number function keys.

Two number functions work the same way as one number functions—operations are performed only when the function key is pressed. Therefore, *both numbers must be in the calculator before the function key is pressed.*

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.

All arithmetic functions are performed the same way:

Solve	Keystrokes	Display
$13 + 2$	13 ENTER 2 +	15.0000
$13 - 2$	13 ENTER 2 -	11.0000
13×2	13 ENTER 2 x	26.0000
$13 \div 2$	13 ENTER 2 ÷	6.5000

The **y^x** key is also a two-number operation. Used to raise a number to a power, it works in the same simple way as every other two-number function key:

1. Key in the first number (y).
2. Press **ENTER** to separate the first number from the second.
3. Key in the second number (power).
4. Perform the operation (if applicable, press the *prefix key*, then **y^x**).

When working with any function key (including **y^x**), remember:

Note: The number shown in the display is always designated by x on the function key.

Example: Calculate 7^8 .

Keystrokes	Display	
7	7.	
ENTER	7.0000	
8	8.	8 is designated by X.
y^x	5,764,801.000	The answer.

Try the following problems using the **y^x** key. Keep the simple rules for two-number functions in mind.

15^3	(15 to the 3 rd power)	=	3,375.0000
72^2	(72 squared)	=	5,184.0000
$601^{.5}$	(601 to the $^{5/10}$ th power)	=	24.5153
3^{18}	(3 to the 18 th power)	=	387,420,489.0

Chain Calculations

The simplicity and power of the Hewlett-Packard RPN logic system becomes very apparent during chain calculations. Even during extremely long calculations, you still perform only one operation at a time. The automatic memory stack stores up to three intermediate results until you need them, then inserts them into the calculation. Thus, working through a problem is as natural as if you were working it out with pencil and paper—except the calculator takes care of the hard part.

Example: Solve $(13 + 2) \times 5$.

If working the problem with pencil and paper, you would first calculate the intermediate result of $(13 + 2)$...

$$\begin{array}{r} 15 \\ (13 + 2) \times 5 = \end{array}$$

...then you would multiply this intermediate result by 5.

$$\begin{array}{r} 15 \\ (13 + 2) \times 5 = 75 \end{array}$$

You work through the problem the same way with your calculator—one operation at a time. Solve for the intermediate result first...

$$(13 + 2)$$

Keystrokes	Display	
13	13.	
ENTER ▶	13.0000	
2	2.	
+	15.0000	Intermediate result.

...and then solve for the final answer. **ENTER**▶ does not need to be pressed to store the intermediate result. It is automatically stored inside the calculator when you key in the next number. To continue...

Keystrokes	Display	
5	5.	Intermediate result from preceding operation is automatically stored when you key in this number.
×	75.0000	Pressing the function key gives you the final answer.

Try these problems. Notice that you have to press **ENTER**▶ to separate only the first pair of numbers—each subsequent operation is performed using the new number and an automatically stored intermediate result.

Solve	Keystrokes	Display
$\frac{(2 + 4)}{12}$	2	2.
	ENTER ▶	2.0000
	4	4.
	+	6.0000
	12	12.
	÷	0.5000
$(18 - 6) \times 3$	18	18.
	ENTER ▶	18.0000
	6	6.
	-	12.0000
	3	3.
	×	36.0000

$$\frac{13 + 6 + 4 - 5}{8}$$

13

13.

ENTER+

13.0000

6

6.

+

19.0000

4

4.

+

23.0000

5

5.

-

18.0000

8

8.

÷

2.2500

Even more complicated problems are solved in the same simple manner—using automatic storage of intermediate results.

Example: Solve $(3 + 4) \times (5 + 6)$.

Solving with pencil and paper, you would:

$$(3 + 4) \times (5 + 6)$$

First calculate for the result
of these parentheses...

...then for these parentheses...

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

The problem is solved the same way using your calculator.

First add 3 and 4:

Keystrokes

Display

3 **ENTER**+

4 **+**

7.0000

Then add 5 and 6:

Since another pair of numbers must be keyed in before you can perform a function, you must use the **ENTER**+

ENTER+

ENTER+

key in the 5. The intermediate result is stored automatically.

Keystrokes	Display
5 ENTER 6 +	11.0000

Then multiply the intermediate answers together for the final answer:

Solve	Keystrokes	Display	
$(7) \times (11)$	×	77.0000	The two intermediate results are multiplied together.

Notice that your calculator automatically stored the intermediate answers and brought them out when it was time to multiply. You didn't have to write down or key in the intermediate answers from inside the parentheses before you multiplied.

Now that you've done some calculating, you can begin to fully appreciate the benefits of the Hewlett-Packard logic system.

Here are just a few of the benefits of RPN:

- *You never have to work with more than one function at a time.* Your HP calculator cuts problems down to size instead of making them more complex.
- *Intermediate results appear as they are calculated.*
- *Pressing a function key executes that function immediately so each step can be checked as you go.*
- *Intermediate results are handled automatically.* There is no need to write down long intermediate answers when working on a problem.
- *You calculate in the same order as you do with pencil and paper.* Thinking the problem through ahead of time is unnecessary.

Now, continue on through the book to learn more about your calculator and the power of RPN.

Display Control

In your calculator, numbers in the display normally appear rounded to four decimal places.

For example, the fixed constant π , which is *actually* used in the calculator as 3.141592654, normally *appears in the display* as **3.1416** (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 four decimal places, your calculator always computes internally using 10 digits of each number. For example, when you compute $2 \times \pi$, you *see* the answer to only four decimal places:

Keystrokes	Display
2 [ENTER] π [x]	6.2832

However, inside the calculator all numbers have 10 digits. So the calculator *actually* calculates using full 10-digit numbers:

2.000000000 **[ENTER]** 3.141592654 **[x]**

yields an answer that is actually carried to 10 digits:

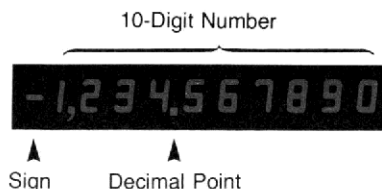
6.2831
85308

You see only these digits...
...but these digits are also present.

Display Control Keys

Depending upon your calculator up to four keys, **[FIX]** (*fixed point display*), **[SCI]** (*scientific notation display*), **[ENG]** (*engineering notation display*), and **[MANT]** (*mantissa*) allow you to control the manner in which a number is displayed. The number itself is not altered by these keys. Your calculator always calculates internally using full 10-digit numbers.

Fixed Point Display



Fixed point display is selected by pressing **FIX** followed by the appropriate number key to specify the number of decimal places (0 to 9) to which the display is to be rounded. Fixed point display allows answers to be shown with the same number of places after the decimal point. The number begins at the left side of the display and includes trailing zeros within the setting selected.

Keystrokes

123.45678 **ENTER**

Display

123.4568

Display is rounded off to 4 decimal places. Internally, however, the number maintains its original value to 10 digits.

Normal fix 4 display.

FIX 4

123.4568

FIX 6

123.456780

FIX 2

123.46

FIX 0

123.

Scientific Notation Display



This means $-1.234567 \times 10^{-23}$

Scientific notation display is useful when you are working with large or very small numbers and allows all answers to be displayed with a specific number of digits after the decimal point. It is selected by pressing **[SCI]** followed by the appropriate number key to specify the number of decimal places to which the number is seen rounded. Again, the display is left-justified and includes trailing zeros within the selected setting. For example:

Keystrokes	Display	
123.45678	123.4568	
[SCI] 2	1.23 02	Equals 1.23×10^2 .
[SCI] 4	1.2346 02	Equals 1.2346×10^2 .
[SCI] 7	1.234567 02	Equals 1.234567×10^2 .

In scientific notation display, your HP calculator shows only seven digits plus the two-digit exponent of 10. So even though you may try to carry the digits out farther, the calculator will display a maximum of seven digits unless you use the mantissa feature discussed on page 20. For example, continuing the above operation results in no apparent change in the display:

Keystrokes	Display	
[SCI] 8	1.234567 02	No change in display.
[SCI] 9	1.234567 02	No change in display.

In scientific notation display, your calculator contains a 10-digit number and a two-digit exponent of 10 inside the calculator, even though it displays only out to six digits after the decimal point.

For example, if you key in 1.00000094 and specify full scientific notation display (**[SCI]** 6), the calculator rounds off to the sixth digit after the decimal point:

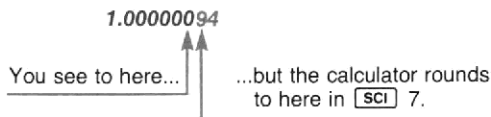
1.00000094



Calculator rounds to this digit in **[SCI]** 6.

Keystrokes	Display
1.00000094	1.00000094
[SCI] 6	1.000001 00

In **[SCI] 7**, the calculator rounds off to the seventh digit after the decimal point, but you see only out to six digits after the decimal:

**Keystrokes****[SCI] 7****Display**

1.000000 00

You can see that if you had keyed in 1.00000095, **[SCI] 7** would also have caused the sixth and final displayed digit to be rounded to a 1.

Mantissa

When, in scientific notation display, you wish to view the contents of the true mantissa (all decimal places), press **[MANT]** and hold down the key. This operation will clear the exponent and display all the digits of the mantissa held internally. Release the key and the display will revert back to scientific notation display. This can also be used with the display set for engineering and fixed point notation.

Engineering Notation Display

Specified significant
digits after the first one

-12.34 -09

One significant
digit always present

Exponent always a
multiple of three

Engineering notation allows all numbers to be shown 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 three. Refer to the prefix table 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 **[ENG]** followed by a number key. The first significant digit is always present in the display, and the number key specifies the number of *additional* significant digits to which the display is rounded. The decimal point always appears in the display. For example:

Keystrokes**Display**

.012345

0.012345**[ENG]** 1**12. -03**

Engineering notation display. Number appears in the display rounded off to one significant digit after the first significant figure that is always present. Power of 10 is proper multiple of three.

[ENG] 3**12.35 -03**

Display is rounded off to third significant digit after the first one.

[ENG] 6**12.34500-03****[ENG]** 0**10. -03**

Display rounded off to first significant digit.

Notice that rounding can occur to the *left* of the decimal point, as in the case of **[ENG]** 0 specified above.

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:

Keystrokes	Display
ENG 2	12.3 -03
10 x	123. -03

However, multiplying again by 10 causes the exponent to shift to another multiple of three. Since you specified **ENG** 2 earlier, the calculator maintains two significant digits after the first one when you multiply by 10.

Keystrokes	Display	
10 x	1.23 00	Decimal point shifts. Power of 10 shifts to 10^0 . Display maintains two significant digits after the first one.

Automatic Display Switching

Your Hewlett-Packard calculator features automatic overflow and underflow that switch the display to scientific notation display whenever the number is too large or too small for the selected fixed decimal point display. For example, compute $(.005)^2$:

Keystrokes	Display	
.005 FIX 4		
ENTER +	0.0050	FIX 4 display.
x	2.5000 -05	The display automatically switches to scientific notation display to let you see the answer. (If your calculator has the x² function key, you could have used it instead of ENTER x).

Another way of displaying the answer would be **0.000025** (in **FIX** 6).

Your calculator also switches to scientific notation if the answer is too large for fixed point display ($>10^{10}$). For example, compute 1582000×1842 .

Keystrokes	Display	
1582000 ENTER	1,582,000.000	
1842 x	2,914,044,000.	Fixed point display.

The answer does not overflow, so it remains in fixed notation. However, multiply by 10.

Keystrokes	Display	
10 x	2.9140 10	Scientific display.

The number is too large for fixed point display, so it is automatically displayed in scientific notation. Four places are shown to the right of the decimal point (**SCI** 4) since your display is set in **FIX** 4.

Keying In Exponents

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

Keystrokes	Display	
15.6	15.6	
EEX	15.6 00	
12	15.6 12	This means 15.6×10^{12} .

Now Press

ENTER	1.5600 13
25 x	3.9000 14

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

Keystrokes**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

ENTER+1. 06
1,000,000.000

Since you have not specified scientific notation, the answer reverts to fixed point display when you press **ENTER+**.

52 **÷**

19,230.7692

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

Keystrokes**Display****SCI** 6

1.923077 04

Revert back to **SCI** 4.

Keystrokes**Display****SCI** 4

1.9231 04

Press **FIX** 4 to revert back to fixed point display.

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 seconds—and multiply it by 50.

Keystrokes**Display**6.625 **EEX**

6.625 00

CHS

6.625 -00

27

6.625 -27

ENTER+

6.6250 -27

50 **x**

3.3125 -25

Erg seconds.

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, your calculator displays each number as a seven 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**.

If you key in a number whose mantissa contains more than seven digits to the left of the decimal point, the exponent field is overwritten and the **EEX** key will not operate. To key in the number correctly, begin again and key in the number in a form that displays the mantissa with seven 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 $1234567.891 \times 10^{25}$.)

If you key in a number whose first significant digit occurs *after* the first seven digits of the display, the **EEX** key will not operate. 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 seven digits of the display, then proceed using the **EEX** key. (Thus, $0000.000025 \times 10^{55}$ must not be keyed in in that form. It could be keyed in as 0.000025×10^{55} , or as 00.00025×10^{54} , for example.)

EEX and **y^x**

Do not confuse the use of the **EEX** (*enter exponent*) key with the use of the **y^x** key. **EEX** is used to specify the power of 10 by which a number is multiplied. **y^x** is used to raise a number to a power.

For example, compute the cube of Avogadro's number: $(6.02 \times 10^{23})^3$.

Keystrokes	Display	
6.02	6.02	
EEX 23	6.02	23
ENTER +	6.0200	23
3	3.	
y^x	2.1817	71

2.1817 $\times 10^{71}$ is the cube of Avogadro's number.

Overflow Calculations

When the number displayed would be greater than 9.999999×10^{99} , your calculator 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 calculator will display the answer.

Keystrokes	Display
EE X 49 ENTER +	1.0000 49
EE X 50 x	1.0000 99

But if you attempt to multiply the above result by 100, the calculator display indicates that the calculator range has overflowed by showing you all 9's.

Keystrokes	Display
100 x	9.999999 99

Error Display

If you attempt an improper operation, the word **Error** followed by a number will appear in the display. These numbers correspond to a particular error condition.

For example, find the square root of -2 (your calculator will recognize this as an illegal operation):

$$\sqrt{-2}$$

Keystrokes	Display
2	2.
CHS	-2.
\sqrt{x}	Error 0

You can clear the error by pressing **CLX** or any other key. The next key pressed after an **Error** display is not executed.

Keystrokes	Display	
7	-2.0000	The argument (-2) just before the Error occurred is now back in the display. The "7" is ignored.

All those operations that cause the word **Error** and a corresponding number to appear in the display are listed in your owner's handbook.

The Automatic Memory Stack

Automatic storage of intermediate results is the reason your calculator slides so easily through the most complex equations. The key to automatic storage is the Hewlett-Packard automatic memory stack. To get the most from your calculator you must have a good understanding of how the stack works. So read this section carefully.

Initial Display

Numbers are stored and manipulated in the machine “registers.” The displayed X-register—the only visible register—is one of four registers positioned inside the calculator to form the automatic memory stack. These registers are labelled X, Y, Z, and T. Each number, no matter how many digits comprise it, occupies one entire register.

Registers are “stacked” one on top of the other with the displayed X-register on the bottom.

Name	Register
T (top)	0.0000
Z	0.0000
Y	0.0000
X	0.0000 Always displayed.



Manipulating Stack Contents

The **[R↓]** (*roll down*) and **[X↔Y]** (*X exchange Y*) keys enable you to review the stack contents or shift data within the stack for computation at any time.

Reviewing the Stack

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

4 **[ENTER↑]** 3 **[ENTER↑]** 2 **[ENTER↑]** 1

These numbers are now loaded into the stack. Its contents look like this:

T	4.0000	
Z	3.0000	
Y	2.0000	
X	1.	Display.

Each time the **[R↓]** key is pressed, stack contents shift downward one register. By pressing **[R↓]**, the last number keyed in will be rotated to the T-register.

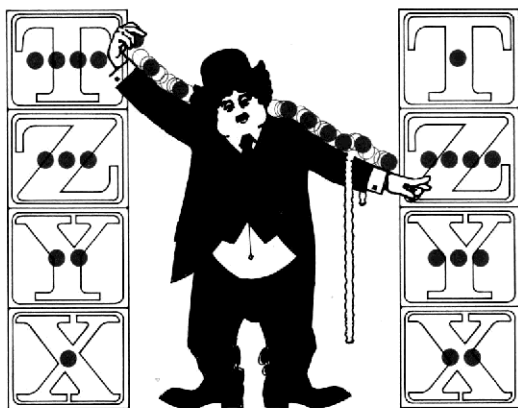
Press the **[R↓]** key. Stack contents are rotated

from this...		...to this.	
T	4.0000	T	1.0000
Z	3.0000	Z	4.0000
Y	2.0000	Y	3.0000
X	1.	X	2.0000

Display. Display.

The registers themselves maintain their positions. The contents of the X-register are always displayed, so **2.0000** is now visible.

Each time you press **[R↓]** the stack contents are shifted.

**Keystrokes****R+****Stack****2.0000****1.0000****4.0000****3.0000**

Display.

R+**3.0000****2.0000****1.0000****4.0000**

Display.

R+**4.0000****3.0000****2.0000****1.0000**

Display.

The number 1.0000 is in the displayed X-register once again. The **[R↓]** key can be used to review the stack contents to see what is in the calculator. Remember, *you must press the **[R↓]** key four times to return the contents to their original registers.* The stack should not be reviewed immediately after **[ENTER↓]** or **[CLX]**. You'll see the reason for this a little later.

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. It is used to reposition numbers in the stack or to view the Y-register.

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 4.0000

Z 3.0000

Y 2.0000

X 1.0000

Display.

...to this.

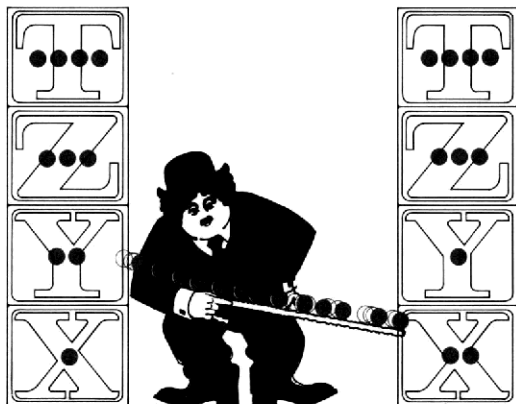
T 4.0000

Z 3.0000

Y 1.0000

X 2.0000

Display.



Pressing **[X↔Y]** again will return the numbers in the X- and Y-registers to their original positions.

It is not necessary to clear the stack or the displayed X-register when starting a new calculation. This will become obvious when you see how intermediate results in the stack are automatically lifted into the stack by new entries.

For clarity, the following examples are shown with the stack cleared to all zeros initially. If you want the contents of your stack registers to match the ones here, first clear the stack by pressing **CLEAR [STK]** or by pressing **0 [ENTER+] [ENTER+] [ENTER+]**. All examples will be as if the stack registers are filled with zeros.

Keystrokes	Stack
CLEAR [STK]	T 0.0000
	Z 0.0000
	Y 0.0000
	X 0.0000

Stack cleared to zeros initially.

The **[ENTER+]** Key

When a number is keyed into the calculator, its contents are placed in the displayed X-register.

Key in 314.3272.

The stack registers look like this:

T	0.0000
Z	0.0000
Y	0.0000
X	314.3272

To key in a second number, 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+]**.

The contents of the registers change

from this...

T 0.0000

Z 0.0000

Y 0.0000

X 314.3272 Display.

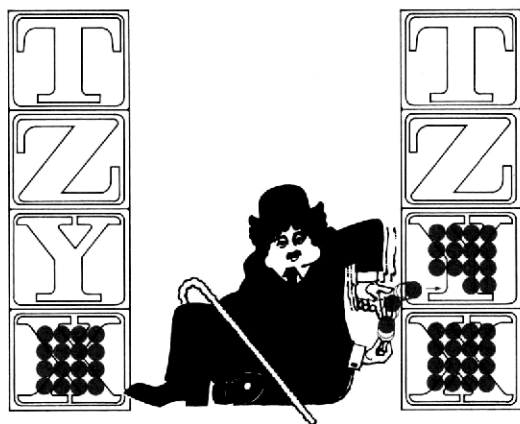
...to this.

T 0.0000

Z 0.0000

Y 314.3272

X 314.3272 Display.



The number in the displayed X-register is copied into Y. Numbers in Y and Z have also been pushed up into the Z- and T-registers, respectively. The number in T has been lost off the top of the stack. This process will be more apparent when different numbers are in all four stack registers.

After pressing **ENTER**, the X-register is prepared for a new number. That new number writes over the current number in X.

Key in 543.28.

Contents of the stack registers change

from this...		...to this.	
T	0.0000	T	0.0000
Z	0.0000	Z	0.0000
Y	314.3272	Y	314.3272
X	314.3272	X	543.28
	Display.		Display.

CLX replaces any displayed number with zero. If new number is keyed in, it will write over the zero in X.

For example, if you wanted to key in 689.4 instead of 543.28, you would press **CLX** to change the stack

from this...		...to this.	
T	0.0000	T	0.0000
Z	0.0000	Z	0.0000
Y	314.3272	Y	314.3272
X	543.28	X	0.0000
	Display.		Display.

Then key in 689.4 to change the stack

from this...		...to this.	
T	0.0000	T	0.0000
Z	0.0000	Z	0.0000
Y	314.3272	Y	314.3272
X	0.0000	X	689.4
	Display.		Display.

Note: Numbers in the stack do not move when a number is keyed in immediately after pressing **ENTER** or **CLX**. However, numbers in the stack do lift when a new number is keyed in immediately after pressing **R**. This is why we earlier recommended not reviewing the stack with **R** immediately after **ENTER** or **CLX**.

Arithmetic—How the Stack Does It

Your Hewlett-Packard calculator does arithmetic by positioning numbers in the stack the same way they would be positioned on paper. For instance, to add 34 and 21, 34 would first be written down with 21 placed beneath it like this:

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

then added together like this:

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

Numbers are positioned the same way in the calculator. Here's how it is done. Clear the stack as described earlier.

Keystrokes	Display	
34	34.	34 is keyed into X.
ENTER	34.0000	34 is copied into Y.
21	21.	21 writes over the 34 in X.

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

T	0.0000	
Z	0.0000	
Y	34.0000	
X	21.	Display.

Keystrokes	Display	
+	55.0000	The answer.

Position both numbers in the stack first; then execute the operation by pressing the key. *There are no exceptions to this rule.* Subtraction, multiplication, and division work the same way.

Subtract 21 from 34.

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

Keystrokes**Display**

34	34.	34 is keyed into X.
ENTER	34.0000	34 is pushed up into Y.
21	21.	21 writes over the 34 in X.
=	13.0000	The answer.

Multiply 34 by 21:

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

Keystrokes**Display**

34	34.	34 is keyed into X.
ENTER	34.0000	34 is pushed up into Y.
21	21.	21 writes over the 34 in X.
x	714.0000	The answer.

Divide 34 by 21.

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

Keystrokes**Display**

34	34.	34 is keyed into X.
ENTER	34.0000	34 is copied into Y.
21	21.	21 writes over the 34 in X.
÷	1.6190	The answer.

Chain Arithmetic

In each calculation just performed, numbers were manually positioned in the stack using the **ENTER** key. However, the stack also performs many movements automatically.

These automatic movements add to the stack's computing efficiency and ease of use. It is these movements that automatically store intermediate results.

Every number that resulted from a calculation in the stack is "lifted" automatically when a new number is keyed in. The stack knows that after it completes a calculation, any new digits keyed in are a part of a new number. The stack also "drops" automatically when you perform an operation.

Example: Calculate $16 + 30 + 11 + 17 = ?$
Clear stack.

Keystrokes**Stack Contents**

16

T 0.0000

Z 0.0000

Y 0.0000

X 16.

16 is keyed into the
displayed X-register.

ENTER+

T 0.0000

Z 0.0000

Y 16.0000

X 16.0000

16 is copied into Y.

30

T 0.0000

Z 0.0000

Y 16.0000

X 30.

30 writes over the 16 in X.

+

T 0.0000

Z 0.0000

Y 0.0000

X 46.0000

16 and 30 are added
together. The answer
is displayed.

11

T 0.0000

Z 0.0000

Y 46.0000

X 11.

11 is keyed into the dis-
played X-register. The 46
in the stack is automatically
lifted.

+

T 0.0000

Z 0.0000

Y 0.0000

X 57.0000

46 and 11 are added
together. The answer,
57, is displayed.

17	T	0.0000	17 is keyed into the X-register. 57 is automatically lifted into Y.
	Z	0.0000	
	Y	57.0000	
	X	17.	

+	T	0.0000	57 and 17 are added together for the final answer.
	Z	0.0000	
	Y	0.0000	
	X	74.0000	

After any calculation or number manipulation, the stack automatically lifts when a new number is keyed in. Length of chain problems is unlimited until a number in one of the stack registers exceeds the range of the calculator (up to $9.99999999 \times 10^{99}$).

In addition to the automatic stack lift after a calculation, the stack automatically drops during calculations involving both X- and Y-registers. It happened in the above example. You can see this better by doing the problem differently.

Solve $16 + 30 + 11 + 17 = ?$

Keystrokes	Stack Contents		
16	T	0.0000	16 is keyed into the displayed X-register.
	Z	0.0000	
	Y	0.0000	
	X	16.	

ENTER+	T	0.0000	16 is copied into Y.
	Z	0.0000	
	Y	16.0000	
	X	16.0000	

30	T	0.0000	30 is written over the 16 in X.
	Z	0.0000	
	Y	16.0000	
	X	30.	

ENTER

T 0.0000
Z 16.0000
Y 30.0000
X 30.0000

30 is copied into Y. 16 is lifted up to Z.

11

T 0.0000
Z 16.0000
Y 30.0000
X 11.

11 is keyed into the displayed register.

ENTER

T 16.0000
Z 30.0000
Y 11.0000
X 11.0000

11 is copied into Y. 16 and 30 are lifted up to T and Z respectively.

17

T 16.0000
Z 30.0000
Y 11.0000
X 17.

17 is written over the 11 in X.

+

T 16.0000
Z 16.0000
Y 30.0000
X 28.0000

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.

+

T 16.0000
Z 16.0000
Y 16.0000
X 58.0000

30 and 28 are added together. The stack drops again. Now 16 and 58 are ready to be added.

+

T 16.0000
Z 16.0000
Y 16.0000
X 74.0000

16 and 58 are added together for the final answer. The stack continues to drop.

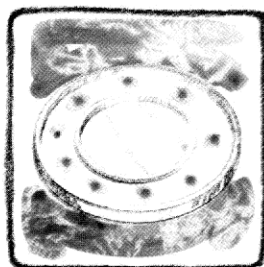
This same dropping action also occurs with $\boxed{-}$, $\boxed{\times}$, and $\boxed{\div}$. The numbers in Y and X combine to give the answer—visible in the X-register. The number in Z drops to Y and the number in T duplicates in T and drops to Z.

The automatic stack lift and drop afford tremendous computing power. Intermediate results can be retained and positioned in long calculations without reentering numbers.

Constant Arithmetic

Whenever the stack drops because of a two-number operation (not because of $\boxed{R\downarrow}$), the number in the T-register drops to Z and is reproduced in T. You saw this in the previous example where 16, the number in T, was dropped into Z and Y.

Example: Bacteriologist Darwin Inquire tests a certain strain whose population increases by 15% each day under ideal conditions. 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: The growth factor is 1.15. Put 1.15 in the Y-, Z- and T-registers. Put 1000 (the original population) in the X-register. Each time $\boxed{\times}$ is pressed the new population is given.

Keystrokes

Display

1.15

1.15

Growth factor.

$\boxed{\text{ENTER}\downarrow}$

1.1500

$\boxed{\text{ENTER}\downarrow}$

1.1500

$\boxed{\text{ENTER}\downarrow}$

1.1500

Growth factor now in T.

1000

1,000.

Starting population.

$\boxed{\times}$

1,150.0000

Population after 1st day.

$\boxed{\times}$

1,322.5000

Population after 2nd day.

$\boxed{\times}$

1,520.8750

Population after 3rd day.

$\boxed{\times}$

1,749.0063

Population after 4th day.

$\boxed{\times}$

2,011.3572

Population after 5th day.

$\boxed{\times}$

2,313.0608

Population after 6th day.

When $\boxed{\times}$ is pressed for the first time, $1.15 \times 1,000$ is calculated. The result (1,150.0000) 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, reentering it is unnecessary.

Performing a two-number operation such as $\boxed{\times}$ causes the number in the T-register to be duplicated each time the stack drops. The $\boxed{R\downarrow}$ key cannot perform this function. It *rotates* the contents of the stack registers, but does not *rewrite* any number. It merely shifts numbers that are already in the stack.

Order of Execution

When solving a problem like this one:

$$5 \times \frac{[(3 \div 4) - (5 \div 2) + (4 \times 3)]}{(3 \times .213)}$$

you must decide where to start before pressing any keys. By starting *every* problem at its innermost number or set of parentheses and working outward, the calculator's power and efficiency will be maximized.

The problem above *could* be worked by beginning at the left side of the equation and using the left-to-right order of execution. However, not all problems can be solved by this method. The best order for solving any problem is to begin with the innermost set of parentheses and work outward, just as you would working the problem with pencil and paper.

To solve the problem above:

Keystrokes	Display	
3	3.	
$\boxed{\text{ENTER}\blacktriangleright}$	3.0000	
4	4.	
$\boxed{\div}$	0.7500	Intermediate result of (3 \div 4).
5	5.	
$\boxed{\text{ENTER}\blacktriangleright}$	5.0000	
2	2.	
$\boxed{\div}$	2.5000	Intermediate result of (5 \div 2).
$\boxed{-}$	-1.7500	Intermediate result of (3 \div 4) - (5 \div 2).

4	4.	
ENTER	4.0000	
3	3.	
x	12.0000	Intermediate result of
		(4×3) .
+	10.2500	Intermediate result of
		$(3 \div 4) - (5 \div 2) + (4 \times 3)$.
3	3.	
ENTER	3.0000	
.213	0.213	
x	0.6390	Intermediate result of
		$(3 \times .213)$.
÷	16.0407	Intermediate result of
		$[(3 \div 4) - (5 \div 2) + (4 \times 3)] \div (3 \times .213)$.
5	5.	Outermost number keyed in.
x	80.2034	The answer.

LST x

In addition to the four stack registers that automatically store intermediate results, the calculator also contains a separate automatic register, the **LST x** (*last x*) register. This register preserves the value that was last displayed in the X-register before the performance of a function. To place the contents of the LAST X register into the display again, press **LST x**.

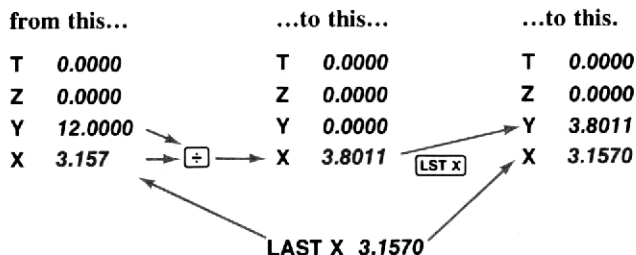
Recovering from Mistakes

LST x makes it easy to recover from keystroke mistakes, such as pressing the wrong function key or keying in the wrong number.

Example: Divide 12 by 2.157 after you have mistakenly divided by 3.157.

Keystrokes	Display	
12	12.	
ENTER	12.0000	
3.157 ÷	3.8011	
LST x	3.1570	Oops! You made a mistake.
		Retrieves that last entry
x	12.0000	(3.157) .
		You're back at the
2.157 ÷	5.5633	beginning.
		The correct answer.

In the above example, when the first $\boxed{\div}$ is pressed, followed by $\boxed{\text{LST X}}$, the contents of the stack and LAST X registers are changed



This makes possible the correction illustrated in the example above.

Recovering a Number for Calculation

The LAST X register is useful in calculations where a number occurs more than once. By recovering a number using $\boxed{\text{LST X}}$, you do not have to key that number into the calculator again.

Example: Calculate

$$\frac{7.32 + 3.6501123}{3.6501123}$$

Keystrokes

7.32

$\boxed{\text{ENTER}}$

3.6501123

$\boxed{+}$

$\boxed{\text{LST X}}$

$\boxed{\div}$

Display

7.32

7.3200

3.6501123

10.9701

3.6501

3.0054

Intermediate answer.
Recalls 3.6501123 to
X-register.
The answer.

Storing and Recalling Numbers

Storage Registers

In addition to automatic storage of intermediate results that is provided by the four-register automatic memory stack and the LAST X register, your calculator also has addressable storage registers that are unaffected by operations within the stack. These storage registers allow you to set aside numbers as constants or for use in later calculations, and they can be used either manually or as part of a program if you have a programmable calculator.

Storing Numbers

To copy a number from the display into one of the storage registers, press the **[STO]** (*store*) key followed by the number key of the register address. For example, to store Avogadro's number (6.02×10^{23}) in register 2:

Keystrokes	Display	
6.02 [EEX] 23	6.02 23	
[STO] 2	6.0200 23	The number is now stored in register R ₂ .

When a number is stored, it is merely *copied* into the storage register, so 6.0200×10^{23} also remains in the displayed X-register.

Recalling Numbers

To copy a number from one of the storage registers into the display, press the **[RCL]** (*recall*) key followed by the number key of the register address.

For example, to recall Avogadro's number.

Keystrokes	Display
[CLX]	0.0000
[RCL] 2	6.0200 23

Recalling a number causes the stack to lift unless the preceding keystroke was **ENTER**, **CLX**, or **$\Sigma+$** (more about **$\Sigma+$** in your owner's handbook if this key is on your calculator).

When you recall a number, it is copied from the storage register into the display, and it also remains in the storage register. You can recall a number from a storage register any number of times without altering it—the number will remain in the storage register as a 10-digit number with a two-digit exponent of 10 until you overwrite it by storing another number there, or until you clear the storage registers.

Clearing Storage Registers

To clear the number from a single storage register, simply store the quantity zero in the register by pressing 0 **STO** followed by the number key of the register address. To clear register 2 (R_2) press 0 **STO** 2.

To clear data from *all* manual storage registers at once, without affecting data in other portions of the calculator, press **CLEAR** **REG**. This places zero in all of the storage registers. Of course, turning the calculator OFF also clears all registers unless you have a Continuous Memory calculator.

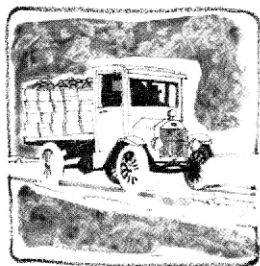
Storage Register Arithmetic

Arithmetic is performed *upon the contents of the storage register* by pressing **STO** followed by the arithmetic function key followed in turn by the register address. For example:

Keystrokes	Result
STO + 0	Number in displayed X-register added to contents of storage register R_0 , and sum placed into R_0 .
STO - 1	Number in displayed X-register subtracted from contents of storage register R_1 , and difference placed into R_1 .
STO x 2	Number in displayed X-register multiplied by contents of storage register R_2 , and the product placed into R_2 .
STO ÷ 3	Contents of storage register R_3 divided by number in displayed X-register, and quotient placed into R_3 .

When storage register arithmetic operations are performed, the answer is written into the selected storage register, while the contents of the displayed X-register and the rest of the stack remain unchanged.

Example: During harvest, a farmer trucks tomatoes to the cannery for three days. On Monday and Tuesday he hauls loads of 25 tons, 27 tons, 19 tons, and 23 tons, for which the cannery pays him \$55 per ton. On Wednesday the price rises to \$57.50 per ton, and he ships loads of 26 tons and 28 tons. If the cannery deducts 2% of the price on Monday and Tuesday and 3% on Wednesday because of blight on the tomatoes, what is the farmer's total net income?



Method: Keep total amount in a storage register while using the stack to add tonnages and calculate amounts of loss.

Keystrokes

Display

25 **ENTER** 27 **+**

19 **+** 23 **+**

94.0000

Total of Monday's and Tuesday's tonnage.

55 **x**

5,170.0000

Gross amount for Monday and Tuesday.

STO 1

5,170.0000

Gross placed in storage register R_1 .

2 **%**

103.4000

Deductions for Monday and Tuesday.

STO **-** 1

103.4000

Deductions subtracted from total in storage register R_1 .

26 **ENTER** 28 **+**

54.0000

Wednesday's tonnage.

57.50 **x**

3,105.0000

Gross amount for Wednesday.

STO **+** 1

3,105.0000

Wednesday's gross amount added to total in storage register R_1 .

3 **%**

93.1500

Deduction for Wednesday.

[STO] [=] 1	93.1500	Wednesday deduction subtracted from total in storage register R_1 .
[RCL] 1	8,078.4500	The farmer's total net income from his tomatoes—\$8,078.45.

(You could also work this problem using the stack alone, but it illustrates how storage register arithmetic works.)

Storage Register Overflow

If the magnitude of a number in any of the storage registers exceeds $9.99999999 \times 10^{99}$, the display immediately shows **Error 1** to indicate that a storage register has overflowed.

For example, if you use storage register arithmetic to attempt to calculate the product of 1×10^{50} and 7.5×10^{50} in register R_0 , the register overflows and the display shows **Error 1**. To see the result of storage register overflow:

Keystrokes	Display		
[EE] 50	1.	50	
[STO] 0	1.0000	50	1×10^{50} placed into storage register R_0 .
7.5 [EE] 50	7.5	50	
[STO] [X] 0	Error 1		When you multiplied using storage register arithmetic, register R_0 overflowed.

The **[STO]** **[X]** 0 instruction is not executed and 1×10^{50} remains in R_0 .

To clear the **Error 1** display, merely press any key and the last displayed number will reappear in the display.

Function Keys

Some of the functions listed in this section may not be applicable to your calculator.

Keystroke sequences in the following examples may require the use of prefix keys to make them applicable to your calculator. See page 9 for further explanation.

Prefix Clear

The CLEAR **PREFIX** (clear prefix) key will cancel any of the following keys: **FIX**, **SCI**, **ENG**, **f**, **g**, **STO**, **RCL**, **STO** (+ - ÷ ×), **GSB** or **GTO**. To clear a prefix key mistakenly pressed, press the shift key, then CLEAR **PREFIX**. Then press the correct key.

For example, to change a prefix keystroke to that of another key during the calculation of (6-2).

Keystrokes	Display	
6 ENTER	6.0000	
2 STO	2.	Oops! You meant to subtract 2 from 6, but pressed STO by mistake.
CLEAR PREFIX	2.	Clears the STO .
-	4.0000	The correct operation, subtract, is performed.

Many errors can be corrected without using the CLEAR **PREFIX**. This is because *the calculator executes the first legitimate key sequence you give it, ignoring all previous, incomplete keystrokes*. If, in the example above, when you pressed **STO**, you really meant to press **CHS**, you can just go ahead and press **CHS**. Since you didn't complete the **STO** keystroke by following it with a register number or an arithmetic operation and register number, the **STO** would be ignored and the **CHS** would be executed.

Reciprocals

To calculate the reciprocal of a number in the displayed X-register, press $\boxed{1/x}$.

Example: Find the reciprocal of 33.

Keystrokes	Display
33 $\boxed{1/x}$	<i>0.0303</i>

Reciprocals of a value in a previous calculation may be calculated without reentering the number because the stack retains your intermediate results.

Example: Calculate

$$\frac{1}{1/5 + 1/7}$$

Keystrokes	Display	
5 $\boxed{1/x}$	<i>0.2000</i>	Reciprocal of 5.
7 $\boxed{1/x}$	<i>0.1429</i>	Reciprocal of 7.
$\boxed{+}$	<i>0.3429</i>	Sum of reciprocals.
$\boxed{1/x}$	<i>2.9167</i>	Reciprocal of sum.

Square Roots

Press $\boxed{\sqrt{x}}$ to calculate the square root of a number in the displayed X-register.

Example: Find the square root of 32.

Keystrokes	Display
32 $\boxed{\sqrt{x}}$	<i>5.6569</i>

Now find the square root of the result.

Keystrokes	Display
$\boxed{\sqrt{x}}$	<i>2.3784</i>

Squaring

To square a number in the displayed X-register, press $\boxed{x^2}$.

Example: Calculate the square of 53.

Keystrokes	Display
53 $\boxed{x^2}$	2,809.0000

Now square the result.

Keystrokes	Display
$\boxed{x^2}$	7,890,481.000

Using Pi

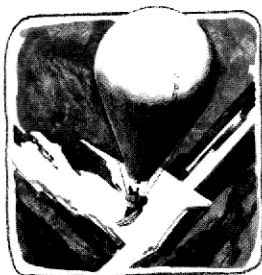
The value π accurate to 10 places (3.141592654) is a fixed constant in the calculator. Press $\boxed{\pi}$ whenever it is needed in a calculation.

Example: Calculate 8π .

Keystrokes	Display
8 $\boxed{\pi}$ $\boxed{\times}$	25.1327

You did not have to press $\boxed{\text{ENTER}}$ between 8 and π . Since π is built in, when it is pressed, the calculator knows you are through keying in the first number.

Example: Finding himself floating dangerously close to the jagged peaks of the Canadian Rockies, intrepid balloonist Chauncy Donn frantically cranks open the helium valve on his spherical balloon. Gas from the helium tank increases the balloon's radius from 7.5 meters to 8.25 meters. Donn clears the mountain tops safely. How much did the volume of the balloon increase?



Solution: Volume of a sphere is equal to $\frac{4}{3} \pi r^3$.

Increased volume equals $(\frac{4}{3}) \pi (8.25)^3$ minus $(\frac{4}{3}) \pi (7.5)^3$

Simplified: $\frac{4}{3} \pi [(8.25)^3 - (7.5)^3]$.

Keystrokes

8.25 **ENTER** 3 **y^x**

7.5 **ENTER** 3 **y^x**

=

4 **x**

3 **÷**

π

x

Display

561.5156

421.8750

139.6406

558.5625

186.1875

3.1416

584.9253

Cubic meter increase of
balloon's volume.

Percentages

The **%** key is a two-number function used to calculate percentages. To find the percentage of a number:

1. Key in the base number.
2. Press **ENTER**.
3. Key in the percentage rate.
4. Press **%**.

Example: Hollywood starlet Sheila Standish purchased a new evening gown for \$1,500. Sales tax is 6.5%. How much will Sheila pay in sales tax? What is the total cost of her gown?



Keystrokes

1500 **ENTER**

6.5

%

Display

1,500.0000

6.5

97.5000

Base number.

Percent rate.

The answer.

6.5% of \$1,500 is \$97.50 (sales tax).

When $\boxed{\%}$ is pressed, the answer is written over the percentage rate in the X-register. The base number is preserved in the Y-register. The stack contents were changed

from this...		...to this.	
T	0.0000	T	0.0000
Z	0.0000	Z	0.0000
Y	1,500.0000	Y	1,500.0000
X	6.5	X	97.5000
	Display.		Display.

Since the purchase price is now in the Y-register and the amount of tax is in the X-register, total cost can be obtained by adding:

Keystrokes	Display	
$\boxed{+}$	1,597.5000	Total of price and sales tax combined. Read as \$1,597.50.

Trigonometric Functions

Six basic trigonometric functions are provided by the calculator:

$\boxed{\text{SIN}}$	(sine)
$\boxed{\text{SIN}^{-1}}$	(arc sine)
$\boxed{\text{COS}}$	(cosine)
$\boxed{\text{COS}^{-1}}$	(arc cosine)
$\boxed{\text{TAN}}$	(tangent)
$\boxed{\text{TAN}^{-1}}$	(arc tangent)

Trigonometric Modes

Each trig function assumes angles in decimal degrees, radians, or grads. The calculator turns on in degrees mode. Set the calculator to mode desired by pressing $\boxed{\text{DEG}}$, $\boxed{\text{RAD}}$, or $\boxed{\text{GRD}}$. Note: 360 degrees = 2π radians = 400 grads. Once a mode is selected the calculator will remain in that mode until it is changed or the calculator is turned off. Trigonometric functions are one-number functions. To use them key in the number, then press the appropriate function key.

Example: Find cosine of 35° . *Set the calculator to degrees mode.*

Keystrokes	Display
35	35.
DEG	35.0000
COS	0.8192

Example: Find the sine of π radians. *Set calculator to radians mode.*

Keystrokes	Display	
π	3.1416	
RAD	3.1416	
SIN	-4.1000 -10	The sine of π is really zero. However, since the calculator can hold 10 digits, you didn't calculate the sine of π . You calculated the sine of a 10 digit approximation (3.141592654) of π .

Example: Find the arc sine in grads of .374. *Set calculator to grads mode.*

Keystrokes	Display
.374	0.374
GRD	0.3740
SIN⁻¹	24.4028

Degrees/Radians Conversions

The **\leftrightarrow DEG** and **\leftrightarrow RAD** functions are used to convert angles between decimal degrees and radians. To convert an angle from decimal degrees to radians, key in the angle and press **\leftrightarrow RAD**.

Example: Change 45° to radians.

Keystrokes	Display	
45	45.	
\leftrightarrowRAD	0.7854	Radians.

To convert an angle from radians to decimal degrees, key in angle and press **\leftrightarrow DEG**.

Example: Convert 4 radians to decimal degrees.

Keystrokes	Display	
4	4.	
[◀DEG]	229.1831	Decimal degrees.

This conversion works as shown above regardless of which trigonometric mode (**[DEG]**, **[RAD]**, **[GRD]**) you set on your calculator.

Hours, Minutes, Seconds

The **[◀HMS]** (*to hours, minutes, seconds*) key converts decimal hours to the format of hours, minutes and seconds.

Example: Convert 17.63 hours to hours, minutes, seconds.

Keystrokes	Display	
17.63	17.63	Decimal hours.
[◀HMS]	17.3748	This is read as 17 hours, 37 minutes, 48 seconds.

Conversely, the **[▶H]** (*to decimal hours*) key is used to change hours, minutes, seconds into decimal hours.

Example: Convert 17 hours, 37 minutes, 48 seconds (the 17.3748 showing in the display) back into decimal hours.

Keystrokes	Display	
[▶H]	17.6300	Decimal hours.

The **[▶H]** and **[◀HMS]** keys also allow changing degrees, minutes, seconds to decimal degrees, and vice versa.

Example: Convert $137^{\circ}45'12''$ to decimal degrees.

Keystrokes	Display	
137.4512	137.4512	
[▶H]	137.7533	Decimal degrees.

Example: Convert 137.7533 decimal degrees to degrees, minutes, seconds.

Keystrokes

→HMS

Display

137.4512

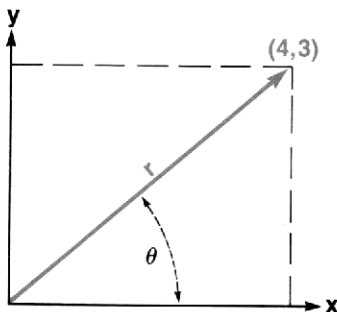
This conversion is important because trigonometric functions operate on angles in *decimal degrees*, but not in *degrees, minutes, seconds*. To calculate any trigonometric functions of an angle given in degrees, minutes, seconds, the angle must first be converted to decimal degrees.

Polar/Rectangular Coordinate Conversions

Two functions (**→P**, **→R**) are provided for polar/rectangular coordinate conversion. Press **→P** to convert values in the X- and Y-registers representing rectangular coordinates (x , y), to polar coordinates (r , θ). Magnitude r then appears in the X-register, with the angle θ appearing in the Y-register.

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

Example: Convert rectangular coordinates (4, 3) to polar form with the angle expressed in radians. *Set the calculator to radians mode.*



Keystrokes3 **ENTER** 4**Display**

4.

Rectangular coordinates y and x placed in Y- and X-registers, respectively.

RAD

4.0000

↔P

5.0000

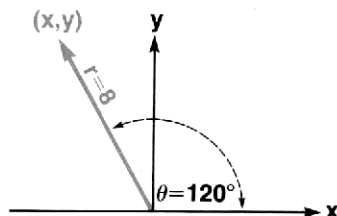
Magnitude r

x↔y

0.6435

Angle θ in radians.

Example: Convert polar coordinates $(8, 120^\circ)$ to rectangular coordinates. *Set calculator to degrees mode.*

**Keystrokes**120 **ENTER** 8**Display**

8.

Polar coordinates θ and r placed in Y- and X-registers respectively.

DEG

8.0000

↔R

-4.0000

X-coordinate.

x↔y

6.9282

Y-coordinate.

Metric Conversions

The eight functions provided for converting English measurements and SI measurements are:

↔in

(millimeters to inches)

↔mm

(inches to millimeters)

↔°F

(degrees Celsius to degrees Fahrenheit)

↔°C

(degrees Fahrenheit to degrees Celsius)

↔lbm

(kilograms to pounds mass)

↔kg

(pounds mass to kilograms)

↔gal

(liters to U.S. gallons)

↔ltr

(U.S. gallons to liters)

All measurement conversion functions are one-number functions. To use them, key in the number, then press the function key.

Example: Convert 98.6 degrees Fahrenheit to degrees Celsius.

Keystrokes	Display
98.6	98.6
$\boxed{+^{\circ}\text{C}}$	37.0000 $^{\circ}\text{C}$.

Example: Convert 7 pounds (mass) to kilograms.

Keystrokes	Display
7	7.
$\boxed{+ \text{kg}}$	3.1751 Kilograms.

Example: Convert 843 millimeters to inches.

Keystrokes	Display
843	843.
$\boxed{+ \text{in}}$	33.1890 Inches.

All other conversions work in the same way as those shown above.

Logarithmic and Exponential Functions

Natural and common logarithms (as well as their inverses—antilogarithms) can be computed by the calculator.

- $\boxed{\text{LN}}$ is \log_e (*natural log*). It computes the logarithm of the value in the X-register to base e ((2.718281828)).
- $\boxed{e^x}$ is antilog_e (*natural antilog*). It raises e (2.718281828) to the power of the value in the X-register. (To display the value of e , press $\boxed{e^x}$.)
- $\boxed{\text{LOG}}$ is \log_{10} (*common log*). It computes the logarithm of the value in the X-register to base 10.
- $\boxed{10^x}$ is antilog_{10} (*common antilog*). It raises 10 to the power of the value in the X-register.

Example: The 1906 San Francisco earthquake had a magnitude of 8.25 on the Richter scale. This was estimated to be 105 times greater than the 1972 Nicaraguan quake. What was the magnitude of the Nicaraguan earthquake on the Richter Scale using the following equation if R = rating on Richter Scale and M = magnitude of the earthquake.



$$R_1 = R_2 - \log \frac{M_2}{M_1} = 8.25 - \left(\log \frac{105}{1} \right)$$

Solution:

Keystrokes

Display

8.25 **ENTER**

8.2500

105 **LOG**

2.0212

=

6.2288

Rating on Richter Scale.

Example: With most of his equipment lost in an avalanche, mountaineer Wallace Quagmire must use an ordinary barometer as an altimeter. Knowing the pressure at sea level is 760 mm of mercury, Quagmire continues his ascent until the barometer indicates 238 mm of mercury. Although the exact relationship of pressure and altitude is a function of many factors, Quagmire knows that an approximation is given by the formula:



$$\text{Altitude in meters} = 7620 \ln \frac{760}{\text{Pressure}} = 7620 \ln \frac{760}{238}$$

Where is Wallace Quagmire?

Solution:

Keystrokes	Display	
760 ENTER+	760.0000	
238 ÷	3.1933	
LN	1.1610	
7620	7,620.	
×	8,847.1839	Altitude in meters.

Quagmire appears to be near the summit of Mount Everest (8848 meters).

Raising Numbers to Powers

The **y^x** key enables a number to be raised to a power.

When y is positive, x can be any number—an integer, a fraction, or a mixed number. However when y is negative, x must be an integer.

Example: Calculate 3^9 .

Keystrokes	Display
3 ENTER+ 9	9.
y^x	19,683.0000

Example: Calculate $8^{-1.2345}$.

Keystrokes	Display
8 ENTER+	8.0000
1.2345 CHS	-1.2345
y^x	0.0768

Example: Calculate $(-2.7)^5$.

Keystrokes	Display
2.7 CHS ENTER+	-2.7000
5	5.
y^x	-143.4891

In conjunction with $\boxed{\sqrt{x}}$, $\boxed{y^x}$ provides a simple way to extract roots.

Example: Find the cube root of 6. (This is equivalent to $6^{1/3}$.)

Keystrokes**Display**6 $\boxed{\text{ENTER}}$

6.0000

3 $\boxed{\sqrt{x}}$

0.3333

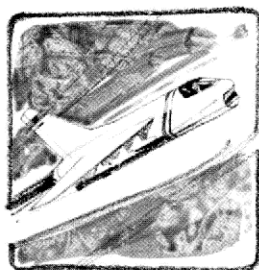
 $\boxed{y^x}$

1.8171

Reciprocal of 3.

Cube root of 6.

Example: In an attempt to shatter the sound barrier, ace test pilot Charles Yeager cranks open the throttle of his surplus Hawker Siddeley Harrier aircraft. Glancing at his instruments, Yeager reads a pressure altitude (PALT) of 25,500 feet with a calibrated airspeed (CAS) of 350 knots. What is the flight Mach number?



$$M = \frac{\text{Speed of aircraft}}{\text{Speed of sound}}$$

if the following formula is applicable?

$$M = \sqrt[5]{\left[\left(\left(\left(1 + 0.2 \left[\frac{350}{661.5} \right]^2 \right)^{3.5} - 1 \right) \left[1 - (6.875 \times 10^{-6}) 25,500 \right]^{-5.2656} \right) + 1 \right]^{0.286} - 1}$$

Method: Begin work in this problem at the innermost set of brackets.

Start with $\left[\frac{350}{661.5} \right]^2$ and proceed outward.

Keystrokes	Display	
350 ENTER	350.0000	
661.5 ÷	0.5291	
x²	0.2799	Square of bracketed quantity.
.2 x	0.0560	
1 +	1.0560	
3.5 y^x	1.2101	
1 -	0.2101	Contents of left-hand set of brackets are in the stack.
1 ENTER	1.0000	
6.875 EEX CHS 6	6.875 -06	
ENTER	6.8750 -06	
25500 x	0.1753	
-	0.8247	
5.2656 CHS y^x	2.7592	Contents of right-hand set of brackets are in the stack.
x	0.5796	
1 +	1.5796	
.286 y^x	1.1397	
1 -	0.1397	
5 x	0.6984	
√x	0.8357	Mach number of Yeager's Harrier.

While working through complex equations like the one above which contains six levels of parentheses, the value of the Hewlett-Packard RPN logic system becomes evident. You calculate one step at a time. You don't get lost within the problem. You see every intermediate result. You emerge from the calculation confident of the final answer.



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