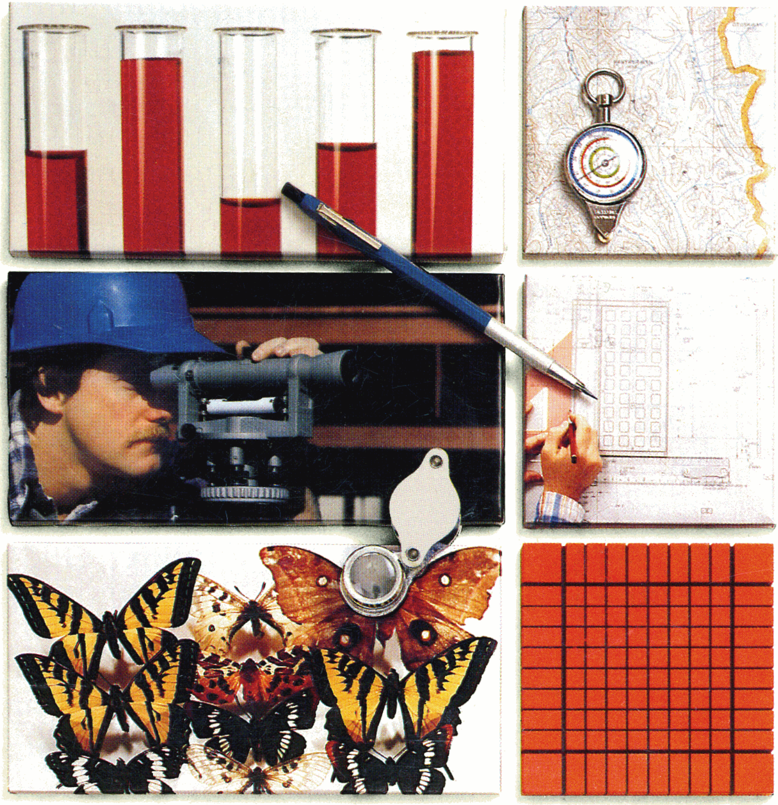
HEWLETT-PACKARD

HP-10C

OWNER'S HANDBOOK



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Introduction

Congratulations! Your selection of an HP-10C calculator with Continuous Memory demonstrates your interest in quality, capability, and ease of use. You may be an experienced HP calculator user or you may be using an HP calculator for the first time. The primary goals of this handbook are to introduce you to all of the HP-10C features and to help you learn as quickly as possible how to use these features, regardless of your prior experience. Your anticipated use of the HP-10C and your level of prior experience with HP programmable calculators will determine how much time you need to devote to this handbook.

This handbook is divided into eight main sections. However, before reading these sections, gain some experience using your HP-10C by working through the introductory material entitled Your HP-10C: A Problem Solver, on page 7.

Section 1, Getting Started, covers the general operating information that both new and experienced HP calculator users should know. Sections 2 through 4 cover information that is more important to new users.

Sections 5 through 8 describe how to use the programming capabilities of the HP-10C.

The various appendices describe additional details of calculator operation, as well as warranty and service information.

The Function Key Index and Program Key Index at the back of the handbook can be used for quick reference to each function key and as a handy page reference to the comprehensive information inside the manual.

Contents

Your HP-10C: A Problem Solver

Your HP-10C Programmable Scientific Calculator is a powerful problem solver that you can carry with you almost anywhere. It handles problems ranging from the simple to the complex, and can remember data. The HP-10C is so easy to program and use that it requires no prior programming experience or knowledge of programming languages.

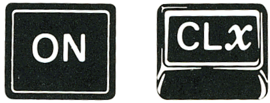
An important new feature of your HP-10C is its extremely low power consumption. This efficiency is responsible for the lightweight, compact model design, and eliminates the need for a cumbersome recharger. Power consumption in the HP-10C is so low that the average battery life in normal use is 6 to 12 months. In addition, the low-power indicator gives you plenty of warning before the calculator stops functioning.

The HP-10C also helps you to conserve power by automatically shutting its display off if it is left inactive for several minutes. But don't worry about losing data—any information you have keyed into your HP-10C is saved by Continuous Memory.

Your Hewlett-Packard calculator uses a unique operating logic, represented by the [ENTER] key, that differs from the logic in most other calculators. The power in HP calculator logic becomes obvious through use. Later we will cover the details of this logic, but right now let's get acquainted with [ENTER] in performing calculations.

For example, let's look at the arithmetic functions. First we have to get the numbers into the machine. To do this, key in the first number, press [ENTER] to separate the first number from the second, then key in the second number and press [+], [−], [×], or [÷]. Answers appear immediately after you press a numerical function key.

To get the feel of your new calculator, turn on the display by pressing the [ON] key. If any nonzero digits appear, you can press [CLx] to clear the display to 0.0000. If four digits are not displayed to the right of the decimal point, press [f] [FIX] 4 now so your display will match those in the following problems. (Displays illustrated in this handbook are set to the [FIX] 4 display setting unless otherwise specified.)



0.0000

Note: An asterisk (*) flashing in the lower left corner of the display when the calculator is turned on signifies that the available battery power is running low. To install new batteries, refer to appendix C.

Manual Solutions

It is not necessary to clear the calculator between problems. But if you make a digit entry mistake, press [CLx] and key in the correct number.*

To Solve:	Keystrokes	Display
$9+6=15$	9 [ENTER] 6 [+]	**15.0000**
$9-6=3$	9 [ENTER] 6 [−]	**3.0000**
$9\times6=54$	9 [ENTER] 6 [×]	**54.0000**
$9\div6=1.5$	9 [ENTER] 6 [÷]	**1.5000**

Notice that in the four examples:

- Both numbers are in the calculator before you press [+], [−], [×], or [÷].
- [ENTER] is used only to separate two numbers that are keyed in one after the other.

---

* If you are new to HP calculators, you will notice most keys have two labels. For the main function—printed in white on top of the key—just press that key. For the function printed in gold, press the [f] key first.

- Pressing a numerical function key, in this case [+], [−], [×], or [÷], causes the function to execute immediately and the result to be displayed.

To see the close relationship between manual and programmed problem-solving, let's first calculate the solution to a problem manually, that is, from the keyboard. Then we'll use a program to calculate the solution to the same problem and others like it.

Most conventional home water heaters are cylindrical in shape. You can easily calculate the heat loss from such a tank using the formula $q = h \times A \times T$, where:

> q is the heat loss from the water heater (Btu per hour).
>
> h is the heat-transfer coefficient.
>
> A is the total surface area of the cylinder.
>
> T is the temperature difference between the cylinder and the surrounding air.

Example: Assume you have a 52-gallon cylindrical water heater and you wish to determine how much energy is being lost because of poor insulation. In initial measurements, you found an average temperature difference between the heater surface and surrounding air of 15° F. The surface area of the tank is 30 square feet and the heat transfer coefficient is approximately 0.47. To calculate the heat loss of the water heater, simply press the following keys in order.

Keystrokes	Display	
15 [ENTER]	**15.0000**	Input temperature
30	**30.**	difference (T) and area of water heater (A).
[×]	**450.0000**	Calculates $A \times T$.
.47	**0.47**	Heat-transfer coefficient (h).
[×]	**211.5000**	Heat loss in Btu per hour ($h \times AT$).

Programmed Solutions

The heat loss for the water heater in the preceding example was calculated for a 15° temperature difference. But suppose you want to calculate the heat loss for several temperature differences? You could perform each heat loss calculation manually. However, an easier and faster method is to write a program that will calculate the heat loss for any temperature difference.

Writing the Program. The program is the same series of keystrokes you executed to solve the problem manually.

Loading the Program. To load the instructions of the program into the HP-10C press the following keys in order. The calculator records (remembers) the instructions as you key them in. (The display gives you information you will find useful later, but which you can ignore for now.)

Keystrokes	Display		
[P/R]	00-		Places the HP-10C in Program mode. (Program annunciator appears.)
[f] CLEAR [PRGM]	00-		Clears program memory.
[ENTER]	01-	36	The same keys you pressed to solve the problem manually.
3	02-	3	
0	03-	0	
[×]	04-	20	
.	05-	48	
4	06-	4	
7	07-	7	
[×]	08-	20	
[P/R]	211.5000		Places the HP-10C in Run mode. (Program annunciator cleared).

Running the Program. Press the following keys to run the program.

Keystrokes	Display	
15	15.	The first temperature difference.
[R/S]	211.5000	The Btu heat loss you calculated earlier by hand.
18 [R/S]	253.8000	The Btu heat loss for a new temperature difference.

With the program you have loaded, you can now quickly calculate the Btu heat loss for many temperature differences. Simply key in the desired difference and press [R/S]. For example, complete the table at the right.

Temp. Diff.	Btu Heat Loss
10	?
12	?
14	?
16	?
18	?
20	?

The answers you should see are 141.0000, 169.2000, 197.4000, 225.6000, 253.8000, and 282.0000.

Programming is that easy! The calculator remembers a series of keystrokes and then executes them whenever you wish. Now that you have had some experience in using your HP-10C, let's take a look at some of the calculator's important operating details.

Part I

HP-10C Basics

Section 1

Getting Started

Power On and Off

The ON key turns the HP-10C on and off.* To conserve power, the HP-10C automatically turns itself off after several minutes of inactivity.

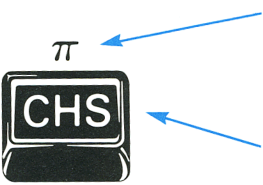
Low-Power Indication

When a flashing asterisk, which indicates low battery power, appears in the lower left-hand side of the display, there is no reason to panic. You still have plenty of calculator time remaining: at least 15 minutes if you continuously run programs, and at least an hour if you manually perform operations. Refer to appendix C (page 104) for information on replacing the batteries.

Keyboard Operation

Primary and Alternate Functions

Most keys on your HP-10C perform one primary and one alternate function. The primary function of any key is indicated by the character(s) on the upper face of the key. The alternate function is indicated by the character(s) printed in gold above the key.



- To select the alternate function printed in gold above a key, first press the gold prefix key f, then press the function key. For example: f π.
- To select the primary function printed on the face of a key, press only that key. For example: CHS.

---

* Note this key is shorter than the others to prevent its being inadvertently pressed.

Notice that when you press the [f] prefix key, the **f** annunciator appears and remains in the display until a function key is pressed to complete the sequence.

0.0000
f

Clearing Prefixes

Certain function commands require two parts: a prefix and a number or another key. The prefixes are [f], [STO], [RCL], and [GTO]; [f] [FIX], [f] [SCI], and [f] [ENG]. If you make a mistake while keying in a prefix for a function, press [f] CLEAR [PREFIX] to cancel the error. The [PREFIX] key is also used to show the mantissa of a displayed number, so all 10 digits of the number in the display will appear for a moment after the [PREFIX] key is pressed.

Negative Numbers

To make a displayed number negative—either one that has just been keyed in or one that has resulted from a calculation—simply press [CHS] (*change sign*). When the display shows a negative number, pressing [CHS] removes the minus sign from the display, making the number positive.

Keying in Exponents

[EEX] (*enter exponent*) is used whenever an exponent is a part of a number you are keying in. To use [EEX], first key in the mantissa, then press [EEX] and key in the exponent. For example, to key in Avogadro's number (6.0225×10^{23}):

Keystrokes	Display		
6.0225	**6.0225**		
[EEX]	**6.0225**	**00**	The 00 prompts you to key in the exponent.
2	**6.0225**	**02**	
3	**6.0225**	**23**	(6.0225×10^{23}).
[ENTER]	**6.0225**	**23**	Enters number.

To key in a number having a negative exponent of 10, first key in the number, press [EEX], then key in the exponent, and then press [CHS] (*change sign*) to make the exponent negative.* For example, key in Planck's constant (6.6262×10^{-34} Joule-seconds) and multiply it by 50:

Keystrokes	Display	
6.6262 [EEX]	**6.6262 00**	
34	**6.6262 34**	
[CHS]	**6.6262 -34**	
[ENTER]	**6.6262 -34**	
50 [×]	**3.3131 -32**	Joule-seconds.

> **Note:** Decimal digits from the mantissa which spill into the exponent field will disappear from the display when you press [EEX], but will be retained internally.

[EEX] will not operate with a number having more than seven digits to the left of the decimal point or radix, or with a mantissa whose absolute value is smaller than 0.000001. To key in such a number, use a form having a higher or lower exponent value, as appropriate. For example, $123456789.8 \times 10^{23}$ can be keyed in as $1234567.898 \times 10^{25}$; $0.00000025 \times 10^{-15}$ can be keyed in as 2.5×10^{-22}.

Display Clearing

- In Run mode, pressing [CLx] (*clear X*) clears all digits in the display (X-register) to zero.
- In Program mode, [CLx] is programmable; it does *not* delete the currently displayed instruction. It is stored in the calculator as a programmed instruction.

One-Number Functions

A one-number function is any numeric function that performs an operation using only one number. To use any one-number function:

1. Key the number into the display (if it is not already there).
2. Press the function key(s).

---

* [CHS] may also be pressed *before* the exponent, with the same result (unlike the mantissa, whose number entry must precede [CHS]).

Keystrokes	Display
45	45.
[f] [LOG]	1.6532

Two-Number Functions and the [ENTER] Key

A two-number function must have two numbers present in the calculator before executing the function. [+], [−], [×], and [÷] are examples of two-number functions.

As in basic arithmetic, the two numbers should be keyed into the calculator in the order they would appear if the calculation were written down on paper from left to right.

The [ENTER] Key. If one of the numbers you need for a two-number function is already in the calculator as the result of a previous operation, you do not need to use the [ENTER] key. However, when you must key in two numbers before performing a function, use the [ENTER] key to separate the two numbers.

To place two numbers into the calculator and perform a two-number function such as 2 ÷ 3:

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(s).

Keystrokes	Display
2	2.
[ENTER]	2.0000
3	3.
[÷]	0.6667

Now try this problem. Notice that you have to press [ENTER] to separate numbers only when they are being keyed in one immediately after the other. A previously calculated result (intermediate result) will be automatically separated from a new number you key in.

To solve (9 + 17 − 4 + 23) ÷ 4:

Keystrokes	Display	
9 [ENTER]	9.0000	
17 [+]	26.0000	$(9 + 17)$.
4 [−]	22.0000	$(9 + 17 - 4)$.
23 [+]	45.0000	$(9 + 17 - 4 + 23)$.
4 [÷]	11.2500	$(9 + 17 - 4 + 23) \div 4$.

Even more complicated problems are solved in the same simple manner—using automatic storage of intermediate results. (For problems with nested parentheses, refer to Chain Calculations, page 26.)

Example: Solve $(6 + 7) \times (9 - 3)$.

First solve for the intermediate result of $(6 + 7)$:

Keystrokes	Display	
6	6.	
[ENTER]	6.0000	
7	7.	
[+]	13.0000	$(6 + 7)$.

Now perform $(9 - 3)$. Since another pair of numbers must be keyed in, one immediately after the other, use the [ENTER] key again to separate the first number (9) from the second (3). (There is no need to press [ENTER] to separate the 9 from the previous intermediate result of 13 that is already in the calculator—the results of previous calculations are stored automatically.) To solve $(9 - 3)$:

Keystrokes	Display	
9	9.	
[ENTER]	9.0000	
3	3.	
[−]	6.0000	$(9 - 3)$.

Then multiply the intermediate results (13 and 6) together for the final answer.

Keystrokes	Display	
[×]	78.0000	$(6 + 7) \times (9 - 3) = 78$.

Notice that the HP-10C automatically stored the intermediate results for you and used them 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.

Remember:

- The [ENTER] key is used for separating the second number from the first in any operation requiring the sequential entry of two numbers.
- Any new digits keyed in following a calculation are automatically treated as a new number.
- Intermediate results are stored on a last-in, first-out basis.

Now try these problems. Work through them as you would with pencil and paper. Don't be concerned about intermediate answers—they are handled automatically by your HP-10C.

$$(16 \times 38) - (13 \times 11) = 465.0000$$

$$(27 + 63) \div (33 \times 9) = 0.3030$$

$$\sqrt{(16.38 \times 0.55)} \div 0.05 = 60.0300$$

$$4 \times (17 - 12) \div (10 - 5) = 4.0000$$

Special Displays

Annunciators

Your HP-10C display contains five annunciators that tell you the status of the calculator during certain operations. The annunciators are described, with the operations they refer to, in the appropriate sections of this handbook.

* f RAD GRAD PRGM

Display Annunciator Set

Radix Mark and Digit Separator

A radix mark is the divider between the integer and fractional portions of a number. A digit separator distinguishes the groups of digits in a large number. In some countries the radix is a decimal point and the digit separator is a comma, while in other countries the reverse is true. To interchange the radix and digit separator conventions on your HP-10C, turn off the calculator, then hold down the [·] key, turn the calculator back on, and release the [·] key ([·]/[ON]).

[·]/[ON] → 12,345,678.91
→ 12.345.678,91

Radix Mark/Digit Separator Interchange

Error Messages

If you attempt a calculation using an improper parameter, such as attempting to find the square root of a negative number, an error message will appear in the display. For a complete listing of error messages and their causes, refer to appendix B.

Keystrokes	Display
4 [CHS] [$\sqrt{x}$]	Error 0
[CLx]	-4.0000

To clear any error message, press [CLx] (or any other key), then resume normal calculator operation.

Overflow and Underflow

Overflow. When the result of a calculation in the display (X-register) is a number with a magnitude greater than $9.999999999 \times 10^{99}$, all 9's are displayed with the appropriate sign. When overflow occurs in a running program, execution halts and the overflow display appears.

(–) 9.999999 99

Overflow Display

Underflow. If the result of a calculation is a number with a magnitude less than $1.000000000 \times 10^{-99}$, zero will be substituted for that number. Underflow will not halt the execution of a calculation or a running program.

Memory

Continuous Memory

The Continuous Memory feature in your HP-10C retains the following in the calculator, even when the display is turned off:

- All numeric data stored in the calculator.
- All programs stored in the calculator.
- Display mode and setting.
- Trigonometric mode (Degrees, Radians, or Grads).

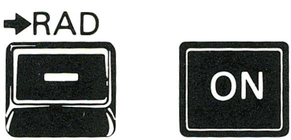
When the HP-10C is turned on, it always "wakes up" in Run mode (**PRGM** annunciator cleared), even if it was in Program mode (**PRGM** annunciator displayed) when last turned off.

If the calculator is turned off, Continuous Memory is preserved for a few minutes when the batteries are removed. Data and programs are preserved longer than the calculator's status is. Refer to appendix C for instructions on changing batteries.

Resetting Memory

If at any time you want to reset (entirely clear) the HP-10C Continuous Memory, do the following:

1. Turn the HP-10C off.
2. Hold down the [−] key, and press [ON].



When you perform the memory reset operation, the error message shown to the right is displayed. Press [CLx] to clear the message.

Pr Error

Note: Continuous Memory can be inadvertently reset if the calculator is dropped or otherwise traumatized.

Section 2

The Automatic Memory Stack, LAST X, and Data Storage

The Automatic Memory Stack and Stack Manipulation

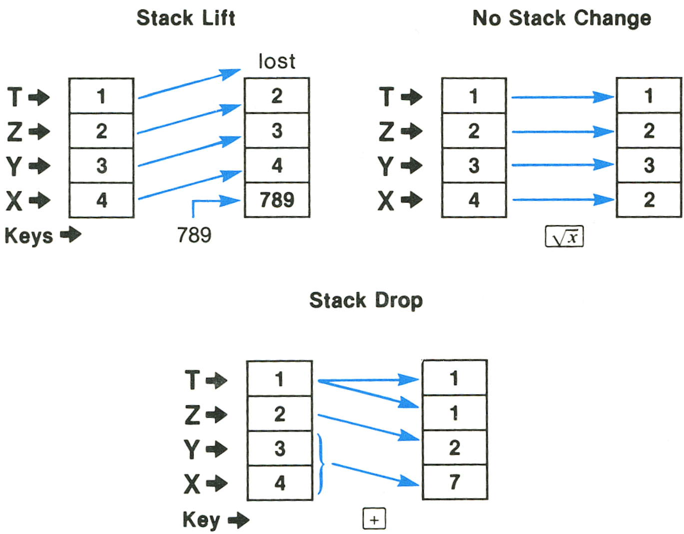
Your HP-10C can take you through complex calculations easily because it automatically retains and returns intermediate results. These features are based on the automatic memory stack and the ENTER key.

The Automatic Memory Stack Registers

T →	0.0000	
Z →	0.0000	
Y →	0.0000	
X →	0.0000	Always displayed.

When your HP-10C is in Run mode (that is, when the **PRGM** annunciator is not displayed) the number that appears in the display is the number in the X-register.

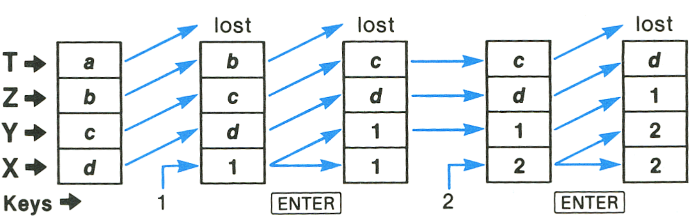
Any number keyed in or resulting from the execution of a numeric function is placed in the display (X-register). Executing a function or keying in a number will cause numbers already in the stack to lift, remain in the same register, or drop, depending upon the type of operation being performed. Numbers in the stack are available on a last-in, first-out basis. If, for example, the stack were loaded as shown on the left of each of the three illustrations shown below, pressing the indicated keys would result in the stack rearrangement shown on the right of each illustration.

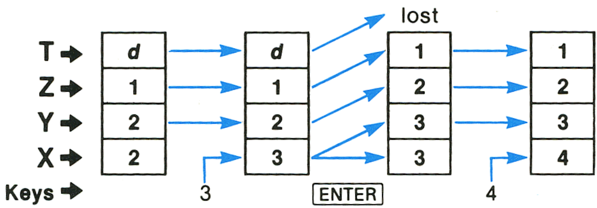


Notice the number in the T-register remains there when the stack drops, allowing this number to be used as an arithmetic constant.

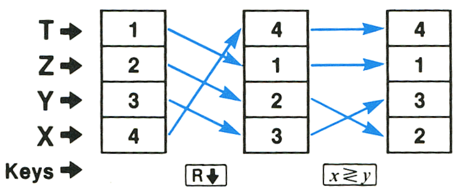
Stack Manipulation Functions

ENTER. Pressing ENTER separates two numbers keyed in one after the other. When ENTER is pressed, the calculator lifts the stack by copying the number in the display (X-register) into the Y-register. The example below shows what typically happens when the stack is filled with the numbers 1, 2, 3, 4. Assume *a*, *b*, *c*, *d* represent any numbers which may be in the stack. (The illustration continues on the next page.)

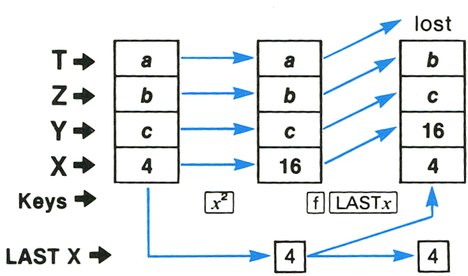




R↓ ***(roll down)*, and** **x≷y** ***(X exchange Y)*.** Pressing R↓ rotates the contents of the stack registers down one register (the X-register value moves to the T-register). No values are lost. x≷y exchanges the numbers in the X- and Y-registers. If the stack were loaded with the sequence 1, 2, 3, 4, the following shifts would result from pressing R↓ and x≷y.



LASTx ***(LAST X)*.** When a numeric function is executed, a copy of the value occupying the display (X-register) before the function was executed is stored in the LAST X register. Pressing f LASTx places a copy of the current contents of the LAST X register into the display (X-register). Refer to appendix A, Stack Lift and LAST X, for a listing of the functions that save x in the LAST X register.

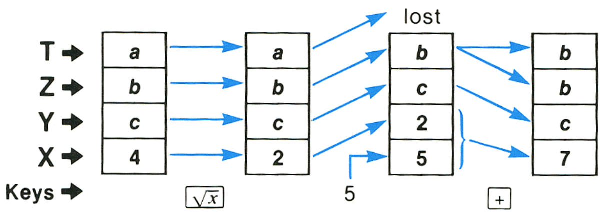


Calculator Functions and the Stack

When you want to key in two numbers, one after the other, you press [ENTER] between entries of the numbers. However, when you want to key in a number immediately following a calculation or other function (like [x≷y], [R↓], etc.) you do not need to use [ENTER]. Why? Executing most HP-10C functions has two results:

1. The specified function is executed.

2. The automatic memory stack is *enabled*; that is, the stack will lift automatically when the *next* number is keyed in or recalled.



There are four functions—[ENTER], [CLx], [Σ+], and [Σ-]—which *disable* the stack. They do *not* provide for the lifting of the stack when the *next* number is keyed in or recalled. Following the execution of one of these functions, a new number will simply write over the currently displayed number instead of causing the stack to lift. (Although the stack lifts when [ENTER] is pressed, it will *not* lift when the *next* number is keyed in or recalled. The operation of [ENTER] illustrated on page 23 shows how [ENTER] disables the stack.) In most cases, the above effects will come so naturally that you won't even think about them.*

Two-Number Functions

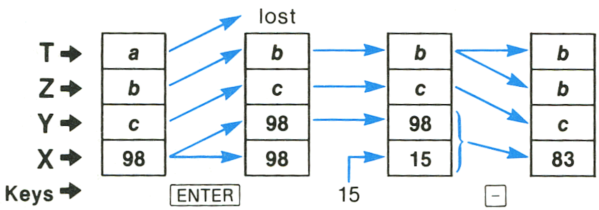
An important aspect of two-number functions is the positioning of the numbers in the stack. To execute an arithmetic function, the numbers should be positioned in the stack in the same way that you would vertically position them on paper. For example:

---

* For a further discussion of the stack, refer to appendix A.

$$\begin{array}{r}98\\ -15\\ \hline\end{array}\qquad\begin{array}{r}98\\ +15\\ \hline\end{array}\qquad\begin{array}{r}98\\ \times 15\\ \hline\end{array}\qquad\frac{98}{15}$$

The numbers are positioned in the calculator in the same way, with the first (or top) number in the Y-register, and the second (or bottom) number in the X-register. When the arithmetic operation is performed, the stack drops, leaving the result in the X-register. Here is how an entire subtraction operation is executed:



The same number positioning would be used to add 15 to 98, multiply 98 by 15, or divide 98 by 15.

Chain Calculations

The simplicity and power of your HP-10C logic system are very apparent during chain calculations. The automatic stack lift and stack drop make it possible to do chain calculations without the necessity of keying in parentheses or storing intermediate results. An intermediate result in the X-register is automatically copied into the Y-register when a number is keyed in after a function key is pressed.*

Virtually every chain calculation you are likely to encounter can be done using only the four stack registers. To avoid having to store an intermediate result in a storage register, you should begin every chain calculation at the innermost number or pair of parentheses and then work outward—just as you would if you were doing the calculation with pencil and paper. For example, consider the calculation of

* Except for [ENTER], [CLx], [Σ+], and [Σ-].

$$3[4+5(6+7)]$$

Keystrokes	Display	
6 [ENTER] 7 [+]	13.0000	Intermediate result of $(6+7)$.
5 [×]	65.0000	Intermediate result of $5(6+7)$.
4 [+]	69.0000	Intermediate result of $[4+5(6+7)]$.
3 [×]	207.0000	Final result: $3[4+5(6+7]$.

As you can see, we worked through the problem one operation at a time. The stack automatically dropped after each two-number calculation. And, after each calculation, the stack automatically lifted when a new number was keyed in. The next example illustrates this.

Example: Instead of the arrow diagrams we've used earlier, we'll use a table to follow stack operation as we solve the expression

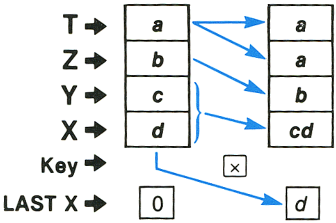
$$(3+4)\times(6-4)\div 2:$$

	1	2	3	4	5	6
T →	*a*	*b*	*b*	*b*	*b*	c
Z →	*b*	c	c	*b*	c	7
Y →	c	3	3	c	7	6
X →	3	3	4	7	6	6
Keys →	3	[ENTER]	4	[+]	6	[ENTER]

	7	8	9	10	11
T →	c	c	c	c	c
Z →	7	c	c	c	c
Y →	6	7	c	14	c
X →	4	2	14	2	7
Keys →	4	[−]	[×]	2	[÷]

LAST X

The HP-10C LAST X register, a separate data storage register, preserves the value that was last in the display before execution of a numeric function.* This feature allows you to perform constant arithmetic (reusing a number without re-entering it). It can also assist you in error recovery.



Example: To multiply two separate values, such as 45.575 meters and 25.331 meters, by π:

	1	2	3	4
T →	*a*	*b*	*b*	*b*
Z →	*b*	*c*	*c*	*b*
Y →	*c*	45.5750	45.5750	*c*
X →	45.575	45.5750	3.1416	143.1781
Keys →	45.575	ENTER	f π	×
LAST X →				3.1416

	5	6	7
T →	*b*	*c*	*c*
Z →	*c*	143.1781	*c*
Y →	143.1781	25.3310	143.1781
X →	25.331	3.1416	79.5797
Keys →	25.331	f LASTx	×
LAST X →	3.1416	3.1416	3.1416

---

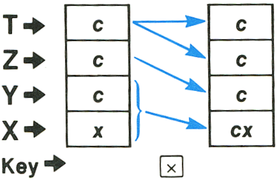
* The exceptions are the statistics functions $\boxed{\bar{x}}$, $\boxed{s}$, and $\boxed{\text{L.R.}}$, which ignore the value in the display (X-register) and calculate a result from data in the statistics storage registers (R_0-R_5).

[LASTx] also makes it easy to recover from keystroke mistakes, such as executing the wrong function or keying in the wrong number. For example, to divide 287 by 13.9 after you have mistakenly divided by 12.9:

Keystrokes	Display	
287 [ENTER]	287.0000	
12.9 [÷]	22.2481	Oops! The wrong divisor.
[f] [LASTx]	12.9000	Retrieves from LAST X the last entry to the X-register (the incorrect divisor) before [÷] was executed.
[×]	287.0000	Performs the reverse of the function that produced the wrong answer.
13.9 [÷]	20.6475	The correct answer.

Constant Arithmetic

Using the LAST X register (described above) is one way to perform arithmetic with a constant. Another way is by filling the stack with the constant number. The method used depends on the type of calculation (refer to examples above and below).



Because the number in the T-register remains there when the stack drops, this number can be used as a constant in arithmetic operations.

Load the stack with a constant by keying the constant into the X-register and pressing [ENTER] three times. Use the constant by keying in your initial factor and executing your planned series of arithmetic operations. Each time the stack drops, a copy of the constant will be made available for your next calculation and a new copy of the constant is reproduced in the T-register.

Example: A bacteriologist tests a certain strain of microorganisms whose population typically increases by 15% each day (a growth factor of 1.15). If he starts with a sample culture of 1000, what will be the bacteria population at the end of each day for five consecutive days?

Method: Use [ENTER] to put the constant growth factor (1.15) in the Y-, Z-, and T-registers and put the original population (1000) in the display (X-register). Thereafter, you get the new daily population whenever you press [×]. In [FIX] 2 mode (press [f] [FIX] 2), your stacks would look like this:

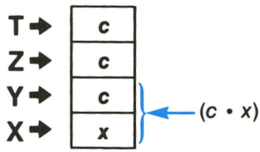
	1	2	3	4
T →	*a*	*b*	*c*	*d*
Z →	*b*	*c*	*d*	1.15
Y →	*c*	*d*	1.15	1.15
X →	*d*	1.15	1.15	1.15
Keys →		1.15	[ENTER]	[ENTER]

	5	6	7	8
T →	1.15	1.15	1.15	1.15
Z →	1.15	1.15	1.15	1.15
Y →	1.15	1.15	1.15	1.15
X →	1.15	1,000.	1,150.00	1,322.50
Keys →	[ENTER]	1000	[×]	[×]

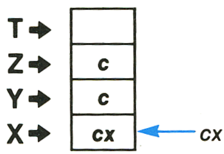
	9	10	11
T →	1.15	1.15	1.15
Z →	1.15	1.15	1.15
Y →	1.15	1.15	1.15
X →	1,520.88	1,749.01	2,011.36
Keys →	[×]	[×]	[×]

When you press [×] the first time, you calculate 1.15 × 1000. The result (1,150.00) is displayed in the X-register, the stack drops, and a new copy of the constant is generated in the T-register. That is, given a constant *c* and a variable *x*, each time you press [×]:

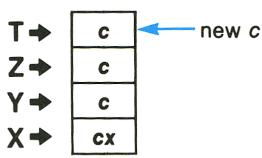
1. A new calculation involving the X- and Y-registers takes place.



2. The result of the calculation is placed in the display (X-register) and the contents of the rest of the stack drop.



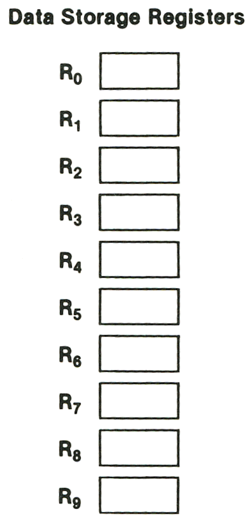
3. A new copy of the number last in T (in this case, our constant) is generated in T.



Since a new copy of the growth factor is duplicated in the T-register each time the stack drops, you never have to re-enter it.

Storage Register Operations

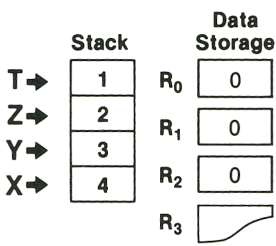
Storing and recalling numbers are operations involving the display (X-register) and the 10 data storage registers of the HP-10C. Data storage registers are entirely separate from the stack and LAST X registers.



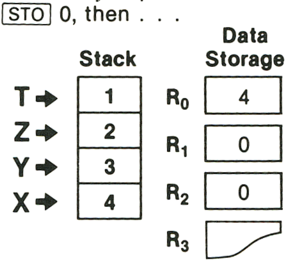
Storing Numbers

[STO] (*store*). When followed by a storage register address (0 through 9), this key copies a number from the display (X-register) into the data storage register specified by the address number.

If . . .



. . . and you press [STO] 0, then . . .

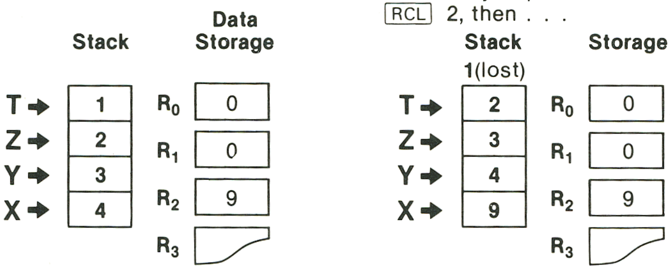


A copy of the stored number remains in the storage register until a new number is stored there or until the storage registers are cleared or Continuous Memory is reset.

Recalling Numbers

[RCL] (*recall*). When followed by a storage register address (0 through 9), this key places a copy of the number in the specified data storage register into the display (X-register). If the stack is not disabled, executing a [RCL] operation causes the stack to lift.

If . . .   . . . and you press [RCL] 2, then . . .



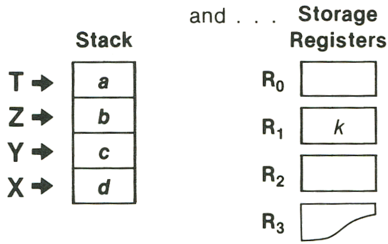
Clearing Data Storage Registers

Pressing [f] CLEAR [REG] (*clear registers*) clears the contents of all data storage registers, the stack, and the LAST X register to zero. To clear a single data storage register, store zero in that register.

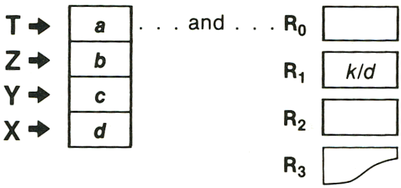
Storage Register Arithmetic

[STO] ([+], [−], [×], [÷]) *n* (*storage register arithmetic*). This sequence uses the number in the display (X-register) to perform arithmetic upon the contents of a specified storage register *n*. The key sequence is [STO] followed by an arithmetic function key, followed in turn by the register address (0 through 9). The result of any storage register arithmetic operation is placed in the specified data storage register.

If . . .   and . . .



represent the current status of the memories, then executing [STO] [÷] 1 results in:



No change in stack.

Contents of R_1 changed from k to k/d. New R_1 = (Old R_1)/(Display).

Storage Register Arithmetic Exercises

Keystrokes	Display	
[f] [FIX] 4		Display shows result of previous calculation.
18 [STO] 0	**18.0000**	Stores 18 in R_0.
3 [STO] [÷] 0	**3.0000**	Divides number in R_0 (18) by 3.
[RCL] 0	**6.0000**	Recalls copy of new number in R_0.
4 [STO] [×] 0	**4.0000**	Multiplies new number in R_0 (6.0000) by 4.
[RCL] 0	**24.0000**	Recalls copy of new number in R_0.
[STO] [+] 0	**24.0000**	Adds what is in display (24) to number in R_0.
[RCL] 0	**48.0000**	Recalls copy of new number in R_0.
40 [STO] [−] 0	**40.0000**	Subtracts 40 from number in R_0.
[RCL] 0	**8.0000**	Recalls copy of new number in R_0.

Problems

1. Calculate the value of x in the following equation.

$$x = \frac{8.33\,(4 - 5.2) \div ((8.33 - 7.46) \times 0.32)}{4.3\,(3.15 - 2.75) - (1.71 \times 2.01)}$$

Answer: 20.9104.

A possible keystroke solution is:

4 [ENTER] 5.2 [−]
8.33 [×] [f] [LSTx] 7.46
[−] .32 [×] [÷]
3.15 [ENTER] 2.75 [−]
4.3 [×] 1.71 [ENTER]
2.01 [×] [−] [÷]

2. Use constant arithmetic to calculate the remaining balance of a \$1000 loan after six payments of \$100 each and an interest rate of 1% (0.01) per payment period.

Procedure: Load the stack with $(1 + i)$, where i = interest rate, and key in the initial loan balance. Use the following formula to find the new balance after each payment:

$$\text{New Balance} = (\text{Old Balance}) \times (1 + i) - \text{Payment}.$$

The initial key sequence would be:

1.01 [ENTER] [ENTER] [ENTER] 1000

For each payment, continue with:

[×] 100 [−]

Balance after six payments: \$446.32.

3. Store 100 in R_5. Then:
   1. Divide the contents of R_5 by 25.
   2. Subtract 2 from the contents of R_5.
   3. Multiply the contents of R_5 by 0.75.
   4. Add 1.75 to the contents of R_5.
   5. Recall the contents of R_5.

   Answer: 3.2500.

Section 3

Numeric Functions

Your HP-10C numeric function set enables you to perform a wide range of operations involving number alteration, math, and statistics. Each function is used in the same way for both keyboard and program execution.

Pi

Pressing [f] [π] places the first 10 digits of π (3.141592654) in the display (X-register). If the stack is not disabled, pressing [f] [π] causes the stack to lift.

Number Alteration Functions

In addition to [CHS] (*change sign*, refer to page 15) your HP-10C has two functions for altering numbers: [INT] and [FRAC].

Integer Portion. Pressing [f] [INT] replaces the number in the display (X-register) with its integer portion, that is, replaces all digits to the right of the decimal with zeros.

Fractional Portion. Pressing [f] [FRAC] replaces the number in the display (X-register) with its decimal portion, that is, any digits to the left of the decimal are replaced with zeros.

To Calculate	Keystroke Example	Display
Integer portion	123.4567 [f] [INT]	**123.4567** **123.0000**
Fractional portion	123.4567 [f] [FRAC]	**123.4567** **0.4567**

One-Number Functions

The one-number math functions on the HP-10C have the following characteristics:

- Use the number in the display (X-register) as the argument for the function.
- Replace the number in the display (X-register) with the result of executing the function.
- Do not affect numbers in the Y-, Z-, and T-registers.

General Functions

Reciprocal. Pressing [1/x] calculates the reciprocal of the number in the display (X-register), that is, divides 1 by the number in the display.

Factorial. Pressing [f] [n!] calculates the factorial value as follows: when n, a positive integer $\leqslant 69$ is in the display (X-register), [n!] calculates the product of the integers from 1 to n. Also, $0! = 1$.

Square Root. Pressing [$\sqrt{x}$] calculates the square root of the number in the display (X-register).

Squaring. Pressing [f] [x^2] calculates the square of the number in the display (X-register).

To Calculate	Keystroke Example	Display
Reciprocal	25 [1/x]	25. 0.0400
Factorial	8 [f] [n!]	8. 40,320.0000
Square Root	3.9 [$\sqrt{x}$]	3.9 1.9748
Square	12.3 [f] [x^2]	12.3 151.2900

Trigonometric Operations

The six basic trigonometric functions operate in the trigonometric mode you select.

Trigonometric Modes. Selecting a specific trigonometric mode does not convert any number already in the calculator to that mode; it merely tells the calculator what unit of measure (degrees, radians, or grads) to assume a number is expressed in for a trigonometric function.

Degrees Mode. Pressing [f] [DEG] selects the Degrees trigonometric mode. No annunciator appears in the display.

Radians Mode. Pressing [f] [RAD] selects the Radians trigonometric mode. While Radians mode is set, the **RAD** annunciator appears in the display.

```
0.0000
        RAD
```

Grads Mode. Pressing [f] [GRD] selects the Grads trigonometric mode. When Grads mode is set, the **GRAD** annunciator appears in the display.

```
0.0000
       GRAD
```

The calculator is always set to one of the three trigonometric modes. Continuous Memory maintains the last mode selected, even when the calculator is turned off and on again. If Continuous Memory is reset (refer to page 21), the calculator will automatically reset to Degrees mode.

Trigonometric Functions.

Pressing	Calculates
x [SIN]	sine x
x [f] [SIN^{-1}]	arc sine x
x [COS]	cosine x
x [f] [COS^{-1}]	arc cosine x
x [TAN]	tangent x
x [f] [TAN^{-1}]	arc tangent x

To use any of the trigonometric functions, ensure that the calculator is set to the desired trigonometric mode (Degree, Radian, or Grad), then execute the desired function.

Time and Angle Conversions

Numbers representing time or angles are interpreted by the HP-10C in a decimal or minutes-seconds format, depending upon the conversion being executed:

Hours.Decimal Hours (H.h)	⇄	Hours.Minutes Seconds Decimal Seconds (H.MMSSs)
or		or
Degrees.Decimal Degrees (D.d)	⇄	Degrees.Minutes Seconds Decimal Seconds (D.MMSSs)

Hours (or Degrees)-Minutes-Seconds Conversion. Pressing [f] [→H.MS] converts the number in the display (X-register) from a decimal hours (or decimal degrees) format to an hours (or degrees)-minutes-seconds-decimal seconds format.

For example, press [f] [→H.MS] to convert

$\underbrace{1.2345}_{\text{hours}}$ to 1.1404 (hours, minutes, seconds)

Press [f] [PREFIX] to display decimal seconds to all possible places:

$114042\underbrace{0000}_{\text{to the hundred-thousandths of a second}}$

Decimal Hours (or Degrees) Conversion. Pressing [f] [→H] converts the number in the display (X-register) from an hours (or degrees)-minutes-seconds-decimal seconds format to a decimal hour (or degrees) format.

Degrees/Radians Conversions

The [➜DEG] and [➜RAD] functions are used to convert angles between decimal degrees and radians (D.d → R.r and R.r → D.d).

To Convert	Example Keystrokes	Display
Decimal Degrees to Radians	40.5 [f] [➜RAD]	40.5 0.7069
Radians to Decimal Degrees	[f] [➜DEG]	40.5000

Logarithmic Functions

Natural Logarithm. Pressing [f] [LN] calculates the natural logarithm of the number in the display (X-register), that is, the logarithm to the base *e* (2.718281828) of the number in the X-register.

Natural Antilogarithm. Pressing [e^x] calculates the natural antilogarithm of the number in the display (X-register), that is, raises *e* (2.718281828) to the power of the number in the X-register.

Common Logarithm. Pressing [f] [LOG] calculates the common logarithm of the number in the display (X-register), that is, the logarithm to the base 10.

Common Antilogarithm. Pressing [10^x] calculates the common antilogarithm of the number in the display (X-register), that is, raises 10 to the power of that number.

To Calculate	Example Keystrokes	Display
Natural Log	45 [f] [LN]	45. 3.8067
Natural Antilog	3.4012 [e^x]	3.4012 30.0001
Common Log	12.4578 [f] [LOG]	12.4578 1.0954
Common Antilog	3.1354 [10^x]	3.1354 1,365.8405

Two-Number Functions

Your HP-10C two-number math functions use the values in the display (X-register) and in the Y-register to calculate a result. To use any of these functions, key in the Y-register value first, press [ENTER] to lift the value into the Y-register, key in the displayed X-register value, then execute the function.

Percentages

To find a specified percentage of a number:

1. Key in the base number.
2. Press [ENTER].
3. Key in the percent rate.
4. Press [%].

(5. To add that percentage to the base number, press [+].)

For example, to find the sales tax (at 3%) and total cost of a $15 item:

Keystrokes	Display	
15 [ENTER]	15.0000	Enters the base number (price).
3 [%]	0.4500	Calculates 3% of $15 (45 cents).
[+]	15.4500	Total cost of item is $15.45.

The Power Function

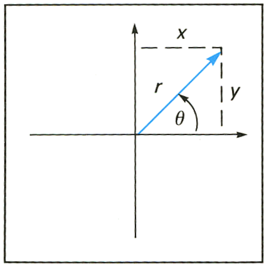
Pressing [y^x] calculates a power of a number—that is, y^x. The y-value is keyed in before the x-value.

1. Key in the base number, which is designated by the y on the key.
2. Press [ENTER] to separate the second number (the exponent) from the first number (the base).
3. Key in the exponent, which is designated by the x on the key.
4. Press [y^x] to calculate the power.

To Calculate	Keystrokes	Display
$2^{1.4}$	2 [ENTER] 1.4 [y^x]	2.6390
$2^{-1.4}$	2 [ENTER] 1.4 [CHS] [y^x]	0.3789
$(-2)^3$	2 [CHS] [ENTER] 3 [y^x]	-8.0000
$\sqrt[3]{2}$ or $2^{1/3}$	2 [ENTER] 3 [$1/x$] [y^x]	1.2599

Polar/Rectangular Coordinate Conversions

Two functions ([→P], [→R]) are provided in your HP-10C for polar/rectangular coordinate conversions.



The angle θ is assumed to be in decimal degrees, radians, or grads, depending upon which trigonometric mode (Degrees, Radians, or Grads) the calculator is set to. Angle θ is measured as shown in the illustration to the right. The answer returned for θ is between 180° and −180°.

Polar Conversion. Pressing [f] [→P] (*polar*) converts values in the X- and Y-registers representing rectangular coordinates (x,y) to polar coordinates (magnitude r, angle θ). First displayed is r; press [$x \gtrless y$] (*x exchange y*) to display θ. (For a discussion of memory registers, refer to section 2.)

Rectangular Conversion. Pressing [f] [→R] (*rectangular*) converts values in the X- and Y-registers representing polar coordinates (magnitude r, angle θ) to rectangular coordinates (x,y). First displayed is x; press [$x \gtrless y$] (*x exchange y*) to display y.

To Convert	Example Keystrokes	Display
Rectangular coordinates to polar:		
y	5 [ENTER]	5.0000
x	10	10.
r	[f] [→P]	11.1803
θ	[$x \gtrless y$]	26.5651
Polar coordinates to rectangular:		
θ	30 [ENTER]	30.0000
r	12	12.
x	[f] [→R]	10.3923
y	[$x \gtrless y$]	6.0000

Statistics Functions

Accumulating Statistics

The HP-10C can perform one- or two-variable statistical calculations. The data are entered into the calculator using the [Σ+] key, which automatically calculates and stores statistics of the data in storage registers R_0 through R_5. (These registers are therefore referred to as the *statistics registers*.)

Before beginning to accumulate statistics for a new set of data, you should clear the statistics registers by pressing [f] CLEAR [REG].*

In one-variable statistical calculations, to enter each data point—referred to as an x-value—key the x-value into the display, then press [Σ+].

In two-variable statistical calculations, to enter each data pair—referred to as the x- and y-values:

1. Key the y-value into the display first.
2. Press [ENTER].

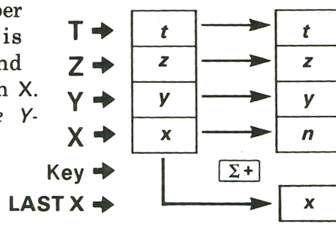
* This also clears R_6 through R_9, the stack registers, and the display. However, it will not clear any of registers R_0 through R_9 that are currently converted to program lines. If the statistics registers have been converted to program lines, **Error 3** will be displayed when you try to use [Σ+]. The [MEM] function (page 67) can be used to determine memory status.

3. Key the x-value into the display.
4. Press $\boxed{\Sigma+}$.

The data are compiled as follows:

Register	Contents	
R_0	n	Number of data points (pairs) accumulated (n also appears in the display).
R_1	Σx	Summation of x-values.
R_2	Σx^2	Summation of squares of x-values.
R_3	Σy	Summation of y-values.
R_4	Σy^2	Summation of squares of y-values.
R_5	Σxy	Summation of products of x- and y-values.

When you execute $\boxed{\Sigma+}$, the number previously in the X-register is placed in the LAST X register and the updated n-value is placed in X. *The number previously in the Y-register is not changed.*



You can recall any of the accumulated statistics to the display (X-register) by pressing $\boxed{\text{RCL}}$ and the number of the data storage register containing the desired statistic.

Example. Electrical energy researcher Helen I. Voltz suspects a possible relationship between the rise in worldwide coal production in the years 1972 through 1976 and a similar rise in worldwide electricity output for the same period. To assist in a study of the data, Voltz will use her HP-10C to accumulate the coal production and electrical output sta-

tistics. Find Σx, Σx^2, Σy, Σy^2, and Σxy for the paired x- and y-values of Voltz's data.

Year	1972	1973	1974	1975	1976
Coal Production (y) (billions of metric tons)	1.761	1.775	1.792	1.884	1.943
Electricity Output (x) (billions of megawatt-hours)	5.552	5.963	6.135	6.313	6.713

Keystrokes	Display	
[f] CLEAR [REG]	**0.0000**	Clears data storage registers (R_0 through R_9 and stack).
[f] [FIX] 3	**0.000**	Limits display to correspond to the significant figures of data.
1.761 [ENTER]	**1.761**	
5.552 [Σ+]	**1.000**	1972 data.
1.775 [ENTER]	**1.775**	
5.963 [Σ+]	**2.000**	1973 data.
1.792 [ENTER]	**1.792**	

Note: Some sets of data points consist of a series of x-values (or y-values) that differ from each other by a comparatively small amount. You can maximize the precision of any statistical calculation involving such data by keying in only the differences between each value and a number approximating the average of the values. This number must be added to the result of calculating $\bar{x}$, $\hat{y}$, $\hat{x}$, or the y-intercept of [L.R.]. For example, if your x-values consist of 665999, 666000, and 666001, you should enter the data as −1, 0, and 1. If afterwards you calculate $\bar{x}$, add 666000 to the answer. In some cases the calculator cannot compute s, r, [L.R.], $\hat{y}$, or $\hat{x}$ with data values that are too close to each other; and if you attempt to do so, the calculator will display **Error 2**. This will not happen, however, if you normalize the data as described above.

Note: Unlike storage register arithmetic, the [Σ+] and [Σ-] operations allow overflow to occur in storage registers R_0 through R_5 without indicating **Error 1** in the display.

Keystrokes	Display	
6.135 [Σ+]	**3.000**	1974 data.
1.884 [ENTER]	**1.884**	
6.313 [Σ+]	**4.000**	1975 data.
1.943 [ENTER]	**1.943**	
6.713 [Σ+]	**5.000**	1976 data.
[RCL] 1	**30.676**	Sum of x-values (Σx) from register R_1.
[RCL] 2	**188.939**	Sum of squares of x-values (Σx^2) from register R_2.
[RCL] 3	**9.155**	Sum of y-values (Σy) from register R_3.
[RCL] 4	**16.788**	Sum of squares of y-values (Σy^2) from register R_4.
[RCL] 5	**56.292**	Sum of products of x- and y-values (Σxy) from register R_5.

Correcting Accumulated Statistics

If you discover that you have entered data incorrectly, the accumulated statistics can be easily corrected. If one value of an (x, y) data pair is incorrect, you must delete and re-enter both values.

1. Key the incorrect data pair into the X- and Y-registers.
2. Press [f] [Σ-] to delete the incorrect data.
3. Key in the correct values for x and y.
4. Press [Σ+].

Alternatively, if the incorrect data point or pair is the most recent one entered and [Σ+] has been pressed, you can press [f] [LASTx] [f] [Σ-] to remove the incorrect data.

Note: Although [f] [Σ-] can be used to delete an erroneous (x, y) pair, it will not delete any rounding errors that may have occurred when the statistics of that pair were added into registers R_1 through R_5. Consequently, subsequent results may be different than they would have been if the erroneous pair had not been entered with [Σ+]. However, the difference will not be serious unless the erroneous pair has a magnitude that is enormous compared with the correct pair; and in such a case it may be wise to start over again and re-enter the data carefully.

Example: After keying in the preceding data, Voltz found new information indicating that the coal output for the last data pair should have been 1.946 instead of 1.943. Use [Σ-] to remove the statistical data that were accumulated as a result of using the older, incorrect data pair; then key in the correct data pair.

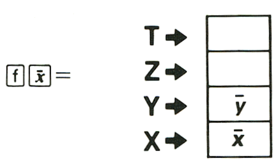
Keystrokes	Display	
1.943 [ENTER] 6.713 [f] [Σ-]	**1.943** **4.000**	Keys in the data pair we want to replace and deletes the pair's unwanted statistics. Number of pair entries then drops to four.
1.946 [ENTER] 6.713 [Σ+]	**1.946** **5.000**	Keys in and accumulates the replacement data pair. Number of pairs accumulated is again five.

Retain these statistics in your calculator for use in the following examples.

Mean

The [$\bar{x}$] function computes the arithmetic mean (*average*) of the x- and y-values using the accumulated statistics in registers R_1 and R_3, respectively. When you press [f] [$\bar{x}$]:

1. The contents of the stack registers lift in the same way as if you keyed in two numbers in sequence. (The mean of x is simultaneously copied into the X-register as the mean of y is copied into the Y-register.)



2. The mean of the x-values ($\bar{x}$) is calculated using the statistics accumulated in R_1 (Σx) and R_0 (n). The mean of the y-values ($\bar{y}$) is calculated using the data accumulated in registers R_3 (Σy) and R_0 (n). The formulas used are shown below:

$$\bar{x} = \frac{\Sigma x}{n}$$

$$\bar{y} = \frac{\Sigma y}{n}$$

Example: From the 5-year statistical data you accumulated (and corrected) in the preceding examples, calculate the average coal production and electrical output for the entire period.

Keystrokes	Display	
[f] [$\bar{x}$]	**6.135**	Average electrical output (average of X-register inputs) for the 5-year period.
[$x \gtrless y$]	**1.832**	Average coal production (average Y-register inputs) for the 5-year period.

Retain these statistics in the calculator for use in the next example.

Standard Deviation

Pressing [f] [s] computes the *standard deviation* (a measure of dispersion around the mean) of the accumulated statistical data. The formulas used by the HP-10C to compute s_x, the standard deviation of the accumulated x-values, and s_y, the standard deviation of the accumulated y-values are:

$$s_x = \sqrt{\frac{n\Sigma x^2 - (\Sigma x)^2}{n(n-1)}} \qquad s_y = \sqrt{\frac{n\Sigma y^2 - (\Sigma y)^2}{n(n-1)}}$$

These formulas give the best estimates of the population standard deviations from the sample data. Consequently, the standard deviation given by these formulas is termed by convention the *sample* standard deviation. When you press [f] [s]:

1. The contents of the stack registers are lifted as they are when you press [f] [$\bar{x}$], as described on page 47.

2. The standard deviation of the x-values (s_x) is calculated using the data accumulated in registers R_2 (Σx^2), R_1 (Σx), and R_0 (n) according to the formula shown above. The resultant value for s_x is placed in the X-register.

3. The standard deviation of the y-values (s_y) is calculated using the statistical data accumulated in registers R_4 (Σy^2), R_3 (Σy), and R_0 (n) according to the formula shown above. The resultant value for s_y is available in the Y-register.

Example: Calculate the standard deviation for the corrected coal production and for the electrical output accumulations used in the preceding examples.

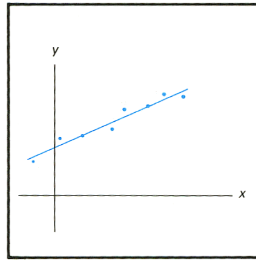
Keystrokes	**Display**	
[f] [s]	**0.429**	Standard deviation of electrical output (X-register inputs) for the five-year period.
[$x \gtrless y$]	**0.080**	Standard deviation of coal production (Y-register inputs) for the five-year period.

Retain the preceding statistics in your HP-10C for use in the next example.

When your data constitute not just a sample of a population but rather *all* of the population, the standard deviation of the data is the *true* population standard deviation (denoted σ). The formula for the true population standard deviation differs by a factor of $\sqrt{(n-1)/n}$ from the formula used for the [s] function. For large n, the difference between the values is small, and for most applications can be ignored. Nevertheless, if you want to calculate the exact value of the population standard deviation for an entire population, you can easily do so: simply add, using the [$\Sigma+$] key, the mean ($\bar{x}$) of the data to the data and press [f] [s]. The result will be the true population standard deviation of the original data.

Linear Regression

Linear regression is a statistical method for finding a straight line that best fits a set of two or more data pairs, thus providing a relationship between two variables. After the statistics of a group of data pairs have been accumulated in registers R_0 through R_5, you can calculate the coefficients in the linear equation $y = Ax + B$ using the least squares method by pressing [f] [L.R.].



To use the linear regression function on your HP-10C, use the [Σ+] key to accumulate the statistics of a series of two or more data pairs. Then execute [L.R.]. When you press [f] [L.R]:

1. The contents of the stack registers are lifted as they are when you press [f] [$\bar{x}$], as described on page 47.

2. The slope (A) and the y-intercept (B) of the least squares line of the data are calculated using the equations:

$$A = \frac{n\Sigma xy - \Sigma x \Sigma y}{n\Sigma x^2 - (\Sigma x)^2} \qquad B = \frac{\Sigma y\, \Sigma x^2 - \Sigma x\, \Sigma xy}{n\Sigma x^2 - (\Sigma x)^2}$$

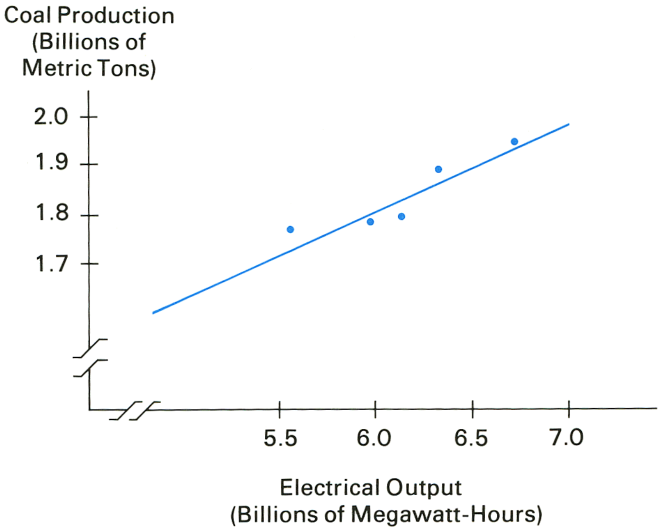
The slope A is placed in the Y-register; the y-intercept, B, is placed in display (X-register).

[f] [L.R.] =

T →	t	
Z →	z	
Y →	A	slope
X →	B	y-intercept

Example: Calculate the y-intercept and slope of Voltz's corrected data.

Solution: Voltz *could* draw a plot of coal production against electrical output like the one shown below. However, with her HP-10C, Voltz has only to accumulate the statistics (as we have already done) using the [Σ+] key, then press [f] [L.R.].



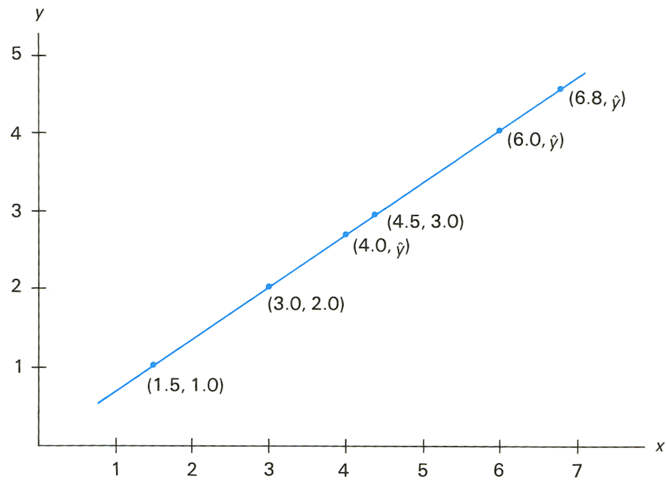
Keystrokes	**Display**	
[f] [L.R.]	**0.777**	*y*-intercept of the line.
[$x \gtrless y$]	**0.172**	Slope of the line.

Retain these statistics in your calculator for use in the next example.

Linear Estimation and Correlation Coefficient

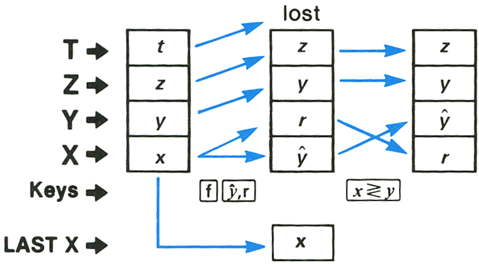
When you execute the [$\hat{y}$,r] or [$\hat{x}$,r] function, the *linear estimate* ($\hat{y}$ or $\hat{x}$) is placed in the X-register, and the *correlation coefficient* (r) is placed in the Y-register.

Linear Estimation. With statistics accumulated in registers R_0 through R_5, a predicted value for y (denoted $\hat{y}$) can be calculated by keying in a known value for x and pressing [f] [$\hat{y}$,r]. Similarly, a predicted value for x (denoted $\hat{x}$) can be calculated by keying in a known value for y and pressing [f] [$\hat{x}$,r].



Correlation Coefficient. Both linear regression and linear estimation presume that the relationship between the x- and y-data values can be approximated, to some degree, by a linear function (that is, a straight line). The correlation coefficient (r) is a determination of how closely your data fit a straight line. The correlation coefficient can range from $r = +1$ to $r = -1$. At $r = +1$, the data fall exactly onto a straight line with positive slope. At $r = -1$, the data fall exactly onto a straight line with negative slope. At $r = 0$, the data cannot be approximated at all by a straight line. With statistics accumulated in registers R_0 through R_5, the correlation coefficient r is calculated by pressing [f] [$\hat{y}$,r] (or [f] [$\hat{x}$,r]).

The number that appears in the display will be a $\hat{y}$-value (or $\hat{x}$-value) (which is meaningless if you did not key in a specific x-value (or y-value), as described above). To view the correlation coefficient value (r), exchange the contents of the X- and Y-registers by pressing [$x \gtrless y$].



Example. Using the statistics saved from the previous example, if Voltz wishes to predict coal production (y) for 1977, she keys in an estimate of electrical production (a "known" x-value) for 1977 and presses [f] [ŷ,r]. Because the correlation coefficient for Voltz's data is automatically included in the calculation, she can view how closely her data fit a straight line by simply pressing [x≷y] after the $\hat{y}$ prediction appears in the display.

Keystrokes	Display	
7.142	7.142	Voltz's estimate of 1977 electrical output.
[f] [ŷ,r]	2.005	Predicted coal production for 1977.
[x≷y]	0.921	The original data closely approximate a straight line.

Conversely, suppose Voltz wishes to estimate the electrical output should there be a future drop in coal production to 1.800 billion metric tons.

Keystrokes	Display	
1.8	1.8	Hypothetical future coal production.
[f] [x̂,r]	5.951	Predicted electrical output for that year.
[x≷y]	0.921	Again, the correlation coefficient for the original data.

Display Control

Owing to Continuous Memory, when you turn on your HP-10C, the display setting will be the same as it was before you last turned off the calculator. Regardless of the display options in effect, the HP-10C always internally represents each number as a 10-digit mantissa and a two-digit exponent of 10. Thus when the calculator is set to display only four digits past the decimal point, the fixed constant π is always represented internally as $3.141592654 \times 10^{00}$.

$$\underbrace{3.1415}_{\text{You see only these digits (rounded to the fourth decimal).}}\underbrace{92654 \times 10^{00}}_{\text{But these digits are also present.}}$$

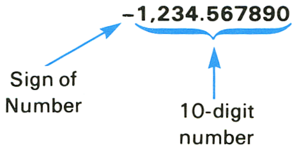
Display Mode Control

Your HP-10C has three display modes—FIX, SCI, and ENG—that use a specified constant (0 through 9) to specify display setting. The illustration below shows how the number 123,456 would be displayed by a four-digit setting in each of the three types of modes.

Keystrokes	Display
f FIX 4	**123,456.0000**
f SCI 4	**1.2346 05**
f ENG 4	**123.46 03**
f FIX 4	**123,456.0000**

Fixed Decimal Display

FIX (*fixed decimal*) displays numbers using a fixed decimal mode without exponents. In any FIX display setting, the calculator will automatically switch to SCI mode to allow viewing of a displayed number that is too large or too small to be viewed in the current FIX mode.



Fixed decimal display is selected or modified by pressing [f] [FIX] followed by the appropriate number key to specify the number of decimal places (0 to 9) you want the display rounded to.

Keystrokes	Display	
123.4567895 [ENTER]	**123.4568**	Display is rounded to four decimal places. However, internally the number is maintained in its original value to 10 digits.
[f] [FIX] 6	**123.456790**	The display is rounded upward if the first undisplayed digit is 5 or greater.
[f] [FIX] 0	**123.**	
[f] [FIX] 4	**123.4568**	Usual [FIX] 4 display.

Scientific Notation Display

[SCI] (*scientific*) displays numbers in scientific notation mode. To select or modify a [SCI] mode, press [f] [SCI] followed by the number key (0 through 6) that specifies the number of decimal places you want the display rounded to.

Keystrokes	Display		
123.4567895 [ENTER]	**123.4568**		Display is rounded to four decimal places.
[f] [SCI] 2	**1.23**	**02**	1.23×10^2; display rounded down.
[f] [SCI] 4	**1.2346**	**02**	1.2346×10^2; display rounded up.
[f] [SCI] 6	**1.234568**	**02**	1.234568×10^2; display rounded up.

As indicated in the above examples, display rounding occurs on numbers with more decimal places than the number specified by your mode setting. In [SCI] mode, specifying seven or more digits to the right of the decimal point ([SCI] 7, 8, or 9) will move rounding to the *internally held* decimal place that cannot be displayed.*

Keystrokes	Display		
[f] [SCI] 7	**1.234567**	**02**	Rounding occurs at seventh decimal digit; display cannot show seventh decimal digit in [SCI] mode, so no rounding occurs in the display.
[f] [SCI] 8	**1.234567**	**02**	Rounds to eighth decimal digit. No change in displayed decimal digits.
[f] [SCI] 9	**1.234567**	**02**	Rounds to ninth decimal digit. No change in displayed decimal digits.

---

* If one or more trailing 9's exist internally following the last digit allowed in the display setting, rounding may be propagated in the displayed digits for [SCI] 7 and 8 display settings. For example, 1.00000094 in [SCI] 7 will not cause rounding in the displayed version of the number, but 1.00000095 (...95 to...99) in [SCI] 7 will cause rounding in the displayed digits.

Engineering Notation Display

[ENG] (*engineering*) displays numbers in an engineering notation format which operates the same as [SCI] notation format except:

- In engineering notation, the first significant digit is always present in the display. The number key you press after [f] [ENG] specifies the number of *additional* digits to which you want to round the display.
- Engineering notation shows all exponents in multiples of three.

Keystrokes	Display		
.012345	0.012345		
[f] [ENG] 1	12.	-03	Engineering notation display. Display is rounded to one significant digit after the leading digit. Power of 10 is multiple of three.
[f] [ENG] 3	12.35	-03	Display is rounded to third significant digit after the leading digit.
[f] [ENG] 2	12.3	-03	Display changed to [ENG] 2 format.
10 [×]	123.	-03	Decimal shifts to maintain multiple of three in exponent.
[f] [FIX] 4	0.1235		Usual [FIX] 4 format.

Mantissa Display

All numbers held in the calculator's stack and data storage registers are represented internally as 10-digit mantissas with two-digit exponents. When you want to view the full 10-digit mantissa of a number held in the X-register, press [f] CLEAR [PREFIX] and hold the [PREFIX] key. The mantissa of the currently displayed number will appear and remain in the display until you release the [PREFIX] key.

Keystrokes	Display
[f] [π]	**3.1416**
[f] CLEAR [PREFIX] (hold)	**3141592654**

Rounding at the Tenth Digit

As mentioned earlier, your HP-10C holds every value to 10 digits internally, regardless of the number of places specified in the current [FIX], [SCI], or [ENG] display setting. The final result of every calculation or series of calculations is rounded to the tenth digit. For example, π and 2/3 have nonterminating decimal representations (3.1415926535 ... and 0.6666666666 ...). Because the HP-10C can provide only a finite approximation of such numbers (10 digits), a small error due to rounding can occur in the tenth digit. This error can be increased through lengthy calculations, but in the majority of cases it does not enter the range of significant digits. To accurately assess the effects of rounding error for a given calculation requires the use of numerical analysis methods that are beyond the scope of this handbook.

Part II
Programming

Section 5

Programming Basics

Why Use Programs?

A program is simply a sequence of keystrokes that is stored in the calculator. Whenever you have to calculate with the same sequence of keystrokes several times, you can save a great deal of time by incorporating these keystrokes into a program. Instead of pressing all the keys each time, you press just one key to start the program: the calculator does the rest automatically! No prior programming experience is necessary to learn HP-10C programming.

Creating a Program

Creating a program consists simply of *writing* the program, then *storing* it:

1. Write down the sequence of keystrokes that you would use to calculate the quantity or quantities desired.

2. Press [P/R] to set the calculator to *Program mode*. When the calculator is in Program mode, functions are not executed when the keys are pressed. Instead, the keystrokes are stored inside the calculator. The **PRGM** status indicator in the display is lit when the calculator is in Program mode.

3. Press [f] CLEAR [PRGM] to erase any previous programs that may be stored inside the calculator. If you want to create a new program without erasing a program already stored, skip this step (refer to section 8, Multiple Programs).

4. Key in the sequence of keystrokes that you wrote down in step 1. Skip the beginning keystrokes that enter data which would differ each time the program is used.

Example: Lerner Student has noticed that all the physiology literature refers to temperature in degrees Celsius. This is confusing to Lerner who has grown up using degrees Fahrenheit in everyday life. Write a program that converts degrees Celsius to degrees Fahrenheit for Lerner.

The formula is: °F =(°C × 1.8) + 32

First we'll manually calculate the degrees Fahrenheit of a 24°C room:

Keystrokes	Display	
24	**24.**	Keys in room temperature in degrees Celsius.
[ENTER]	**24.0000**	Separates temperature from factor to be keyed in next.
1.8	**1.8**	
[×]	**43.2000**	
32	**32.**	
[+]	**75.2000**	Room temperature in degrees Fahrenheit.

Next, set the calculator to Program mode and erase any program(s) already stored:

Keystrokes	Display	
[P/R]	**00-**	Sets calculator to Program mode.
[f] CLEAR [PRGM]	**00-**	Clears program(s).

Finally, press the keys that we used above to solve the problem manually. Do not key in 24; this number will vary each time the program is used. Don't be concerned right now about what appears in the display as you press the keys; we'll discuss that later in this section.

Keystrokes	Display	
[ENTER]	01–	36
1	02–	1
[.]	03–	48
8	04–	8
[×]	05–	20
3	06–	3
2	07–	2
[+]	08–	40

Running a Program

To run (or "execute") a program:

1. Press [P/R] to set the calculator back to Run mode. This also sets the program back to line 00. If the calculator is already in Run mode (that is, the **PRGM** status indicator in the display is not lit), skip this step.
2. Key any required data into the calculator, just as if you were calculating manually. When a program is run, it uses the data already keyed into the display and the registers inside the calculator.
3. Press [R/S] (*run/stop*) to begin program execution. During execution, **running** will flash in the display.

Example: Run the program created above to calculate the temperature in degrees Fahrenheit of a water bath at 35.7°C and a refrigerator at 4.3°C.

Keystrokes	Display	
[P/R]		Sets calculator to Run mode. Display shows number previously calculated.
35.7	35.7	Water bath temperature in degrees Celsius.
[R/S]	96.2600	Temperature in degrees Fahrenheit.
4.3	4.3	Refrigerator temperature in degrees Celsius.

[R/S]	**39.7400**	Temperature in degrees Fahrenheit.

That's all there is to creating and running simple programs! But if you want to use programs frequently, you'll want to know more about programming—such as how to check what keystrokes are stored in program memory, how *many* keystrokes can be stored in program memory, how to correct or otherwise modify programs, how to skip keystrokes when running a program, and so on. Before you can understand these aspects of programming, we need to briefly discuss how keystrokes are treated by the calculator when they are stored in Program mode and when they are executed in Run mode.

Program Memory

Keystrokes entered into the calculator in Program mode are stored in *program memory*. Each digit, decimal point, or function key is called an *instruction* and is stored in one *line* of program memory—usually referred to simply as a *program line*. Keystroke sequences beginning with the [f], [STO], and [GTO] prefix keys are considered to comprise a *complete instruction* and are stored in only one program line.

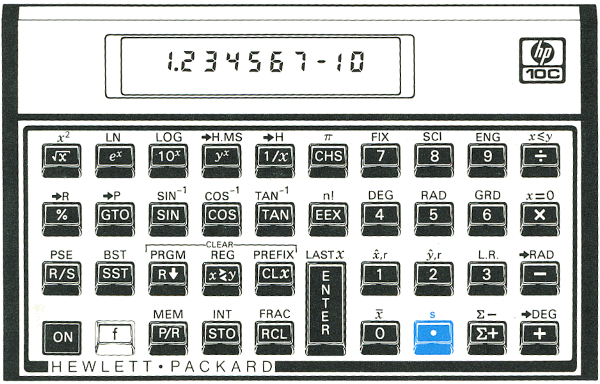
When a program is run, each instruction in program memory is executed—that is, the keystroke in that program line is performed, just as if you were pressing the key manually—beginning with the current line in program memory and proceeding sequentially with the higher numbered program lines.

Whenever the calculator is in Program mode, the display shows information about the program line to which the calculator is currently set. At the left of the display is the number of the program line within program memory. The remaining digits in the display comprise a code that indicates what instruction has been stored in that program line. No code is shown for program line 00, since no instruction is stored there.

Identifying Instructions in Program Lines

Each key on the HP-10C keyboard—except for the digit keys 0 through 9—is identified by a two-digit "keycode" that corresponds to the key's position on the keyboard. The first digit in the keycode is the number of the key row, counting from row 1 at the top; the second digit is the number of the key in that row, counting from left to right: 1 for the first key through 9 for the ninth key and 0 for the tenth key in the row. The keycode for each digit key is simply the digit on the key. Thus, when you keyed the instruction [.] into program memory, the calculator displayed:

03- 48



Fourth row, eighth key

This indicates that the key for the instruction in program line 03 is in the fourth row on the keyboard and is the eighth key in that row: the [.] key. When you keyed the instruction [+] into program memory, the calculator displayed:

08- 40

This indicates that the key for the instruction in program line 08 is in the fourth row on the keyboard and is the tenth key in that row: the [+] key. When you keyed the digit 3 into program memory, the keycode displayed was only the digit 3.

Since keystroke sequences beginning with [f], [STO], [RCL], and [GTO] are stored in only one program line, the display of that line would show the keycodes for all the keys in the keystroke sequence.

Instruction	Keycode
[f] [LOG]	*nn*– 42 13
[STO] [+] 1	*nn*–44 40 1
[GTO] 00	*nn*– 22 00

Displaying Program Lines

Pressing [P/R] to set the calculator from Run mode to Program mode displays the line number and keycode for the program line to which the calculator is currently set.

Occasionally you'll want to check several or all of the instructions stored in program memory. The HP-10C enables you to review program instructions either forward or backward through program memory:

- Pressing [SST] (*single step*) while the calculator is in Program mode advances the calculator to the next line in program memory, then displays that line number and the keycode of the instruction stored there.
- Pressing [f] [BST] (*back step*) while the calculator is in Program mode sets the calculator back to the previous line in program memory, then displays that line number and the keycode of the instruction stored there.

For example, to display the first two lines of the program now stored in program memory, set the calculator to Program mode and press [SST] twice:

Keystrokes	Display		
[P/R]	00–		Sets calculator to Program mode and displays current line of program memory.
[SST]	01–	36	Program line 01: [ENTER].
[SST]	02–	1	Program line 02: digit 1.

Pressing [f] [BST] does the reverse:

Keystrokes	Display		
[f] [BST]	01–	36	Program line 01.
[f] [BST]	00–		Program line 00.

If either the [SST] key or the [BST] key is held down, the calculator displays *all* of the lines in program memory. Press [SST] again now, but this time hold it down until program line 08 is displayed.

Keystrokes	Display		
[SST]	01–	36	Program line 01.
	⋮	⋮	
(Release [SST])	08–	40	Program line 08.

Program line 08 contains the last instruction you *keyed into* program memory. However, if you press [SST] again, you'll see that this is *not* the last line *stored* in program memory:

Keystrokes	Display		
[SST]	09–	22 00	Program line 09.

As you should now be able to tell from the keycodes displayed, the instruction in program line 09 is [GTO] 00.

The [GTO] 00 instruction and Program line 00

Whenever you run the program now stored in program memory, the calculator executes the instruction in line 09 after executing the eighth instruction you keyed in. This [GTO] 00 instruction—as its name implies—tells the calculator to "go to" program line 00 and execute the instruction in that line. Although line 00 does not contain a regular instruction, it does contain a "hidden" instruction that tells the calculator to halt program execution. Thus, after each time the program is run, the calculator automatically goes to program line 00 and halts, ready for you to key in new data and run the program again. (The calculator is also automatically set to program line 00 when you press [P/R] to set the calculator from Program mode to Run mode.)

The [GTO] 00 instruction was already stored in line 09—in fact, in *all* program lines—*before* you keyed in the program. If no instructions have been keyed into program memory, if Continuous

Memory is reset, or if [f] CLEAR [PRGM] is pressed (in Program mode), the instruction [GTO] 00 is automatically stored in program lines 01 through 09. As you key each instruction into program memory, it replaces the [GTO] 00 instruction in that program line.

If your program should consist of exactly nine instructions, there would be no [GTO] 00 instructions remaining at the end of program memory. Nevertheless, after such a program is executed the calculator automatically returns to program line 00 and halts, just as if there were a [GTO] 00 instruction following the program.

If you key in more than nine instructions, program memory automatically expands to accomodate the additional instructions.

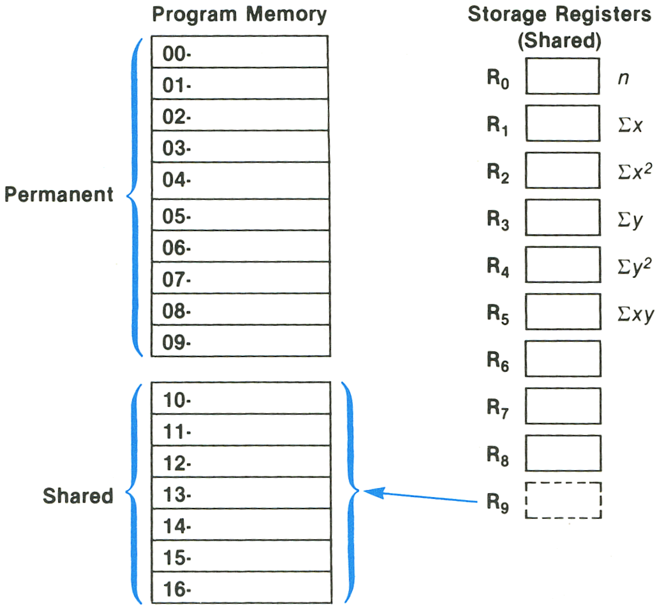
Expanding Program Memory; the [MEM] Key

If no instructions have been keyed into program memory, if Continuous Memory has been reset, or if [f] CLEAR [PRGM] has been pressed (in Program mode), program memory consists of nine program lines, and there are 10 storage registers available for storage of data.

Program Memory
00-
01-
02-
03-
04-
05-
06-
07-
08-
09-

Storage Registers	
R_0	
R_1	
R_2	
R_3	
R_4	
R_5	
R_6	
R_7	
R_8	
R_9	

As you key in a 10th instruction, storage register R_9 is automatically converted into seven new lines of program memory. The instruction you key in is stored in program line 10, and the GTO 00 instruction is automatically stored in program lines 11 through 16.

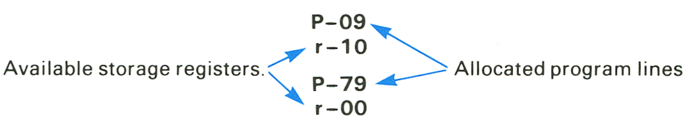


Program Memory Allocation:

Register	Line Number
R_9	10-16
R_8	17-23
R_7	24-30
R_6	31-37
R_5	38-44
R_4	45-51
R_3	52-58
R_2	59-65
R_1	66-72
R_0	73-79

Program memory is automatically expanded like this whenever another seven instructions have been keyed into program memory—that is, when you key an instruction into program line 17, 24, 31, etc. In each case, the additional program lines made available are converted, seven lines at a time, from the last available data storage register (whether or not a number has been stored in that register; if it has, it will be lost). Furthermore, the six new program lines (following the 17th, 24th, etc.) will each contain the instruction [GTO] 00.

To determine at any time (whether in Program or Run mode) how many program lines (including those containing [GTO] 00) are currently in memory and how many storage registers are currently available for conversion to program lines or for data storage, press and hold [f] [MEM] (*memory*). The calculator will respond with a display like the following:



Up to 79 instructions can be stored in program memory. Doing so would require the conversion of 10 data storage registers ($79 = 9 + [10 \times 7]$), leaving no storage registers available for data storage.

> **Note:** Your HP-10C converts storage registers to program lines in reverse numerical order, from R_9 to R_0. For this reason it is good practice to perform [STO] and [RCL] operations using data registers in the opposite order; that is, beginning with register R_0. This procedure helps avoid accidentally trying to use [STO] and [RCL] for data registers which have been converted to lines of program memory. Remember also that the calculator does not retain data previously stored in registers that are later converted to lines of program memory.

Setting the Calculator to a Particular Program Line

There will be occasions when you'll want to set the calculator directly to a particular program line—such as when you're storing a second program in program memory or when you're modifying an existing program. Although you can set the calculator to any program line by using [SST] as described above, you can do so more quickly as follows:

- With the calculator in Program mode, pressing [GTO] [.] followed by two digit keys sets the calculator to the program line specified by the digit keys, and then displays that line number and the keycode of the instruction stored there.
- With the calculator in Run mode, pressing [GTO] followed by two digit keys sets the calculator to the program line specified by the digit keys. Since the calculator is not in Program mode, the line number and keycode are not displayed.

The decimal point is not necessary if the calculator is in Run mode, but it *is* necessary if the calculator is in Program mode.

For example, assuming the calculator is still in Program mode, you can set it to program line 00 as follows:

Keystrokes	Display	
[GTO] [.] 00	**00-**	Program line 00.

Executing a Program One Line at a Time

Pressing [SST] repeatedly with the calculator in Program mode (as described earlier) enables you to verify that the program you have *stored* is identical to the program you *wrote*—that is, to verify that you have keyed the instructions in correctly. However, this does not ensure that the program you wrote *calculates* the desired results correctly: even programs created by the most experienced programmers often do not work correctly when they are first written.

To help you verify that your program works correctly, you can execute the program one line at a time, using the [SST] key. Pressing [SST] while the calculator is in Run mode advances the calculator to the next line in program memory, then displays that line's number and the keycode of the instruction stored there, just as in Program mode. In *Run* mode, however, when the [SST] key is released the instruction in the program line just displayed is executed and the display then shows the result of executing that line. (You can retain the program line information by holding the [SST] key down.)

For example, to execute the program stored in the calculator one line at a time:

Keystrokes	Display		
[P/R]	39.7400		Sets calculator to Run mode and to line 00 in program memory. (Display shown assumes results remain from previous calculation.)
35.7	35.7		Keys in temperature of water bath (degrees Celsius).
[SST]	01– 35.7000	36	Program line 01: [ENTER]. Result of executing program line 01.
[SST]	02– 1.	1	Program line 02: 1. Result of executing program line 02.
[SST]	03– 1.	48	Program line 03: [·]. Result of executing program line 03.
[SST]	04– 1.8	8	Program line 04: 8. Result of executing program line 04.
[SST]	05– 64.2600	20	Program line 05: [×]. Result of executing program line 05.
[SST]	06– 3.	3	Program line 06: 3. Result of executing program line 06.
[SST]	07– 32.	2	Program line 07: 2. Result of executing program line 07.
[SST]	08– 96.2600	40	Program line 08: [+]. Result of executing program line 08 (the last line of the program).

Pressing [f] [BST] while the calculator is in Run mode sets the calculator to the previous line in program memory, then displays that line's number and the keycode of the instruction stored there, just as in Program mode. In *Run* mode, however, when the [BST] key is released the display again shows the same number as it did before [f] [BST] was pressed: *no* instruction in program memory is executed.

Interrupting Program Execution

Occasionally you'll want a program to stop executing so that you can see an intermediate result or enter new data. The HP-10C provides two functions for doing so: [PSE] (*pause*) and [R/S] (*run/stop*).

Pausing During Program Execution

When a running program executes a [PSE] instruction, program execution halts for about 1 second, then resumes. During the pause, the calculator displays the last result calculated before the [PSE] instruction was executed.

If you press any key during a pause, program execution is halted indefinitely. To resume program execution at the program line following that containing the [PSE] instruction, press [R/S].

Stopping Program Execution Automatically

Program execution is automatically halted when the program executes a [R/S] instruction. To resume executing the program from the program line at which execution was halted, press [R/S].

Example: Mother's Kitchen, a canning company, wants to package a ready-to-eat spaghetti mix containing three cans: one of spaghetti sauce, one of grated cheese, and one of meatballs. Mother's needs to calculate the base areas, total surface areas, and volumes of the three cylindrically shaped cans. It would also like to know, per package, the total can base area, surface area, and volume.

The program to calculate this information uses these formulas and data:

base area $= \pi r^2$

volume = base area × height = $\pi r^2 h$
surface area = 2 × base area + side area = $2\pi r^2 + 2\pi r h$

Radius, *r*	Height, *h*	Base Area	Volume	Surface Area
2.5 cm	8.0 cm	?	?	?
4.0	10.5	?	?	?
4.5	4.0	?	?	?
	TOTALS	?	?	?

The keystroke sequence will use storage register arithmetic (described on page 33) in registers R_1, R_2, and R_3 to calculate area and volume sums. We will clear the registers before starting to ensure that the column sums are initialized to zero.

Since *r* must be used twice in the course of the calculations, we'll store *r* in R_0. We will do this *prior to running* the program, since *r* will vary with each run. We will then recall *r in the program* with a [RCL] instruction. We will enter *h* directly, right after the base area calculation is made. We will provide for the program to stop at this point, so that the data can be entered. This is accomplished with an [R/S] instruction in the program. We can then manually restart the program by pressing [R/S]. (Alternatively, we could store and recall *h*, as for *r*, though in this program it would require more total keystrokes to do so.) This illustrates the two modes of data entry in a program:

1. Prior entry. Store (with [STO]) the data in a storage register prior to running the program, and then recall it (with [RCL]) within the program.

2. Direct entry. Enter the data at the necessary point in the program, then start or re-start (with [R/S]) the program. If this is not at the beginning of the program, a programmed stop instruction ([R/S]) is necessary to allow data entry.

Now we'll enter the program into program memory. Do *not* key in the radius and height of each can; these values will vary, and so will be entered *prior* to each program run.

We'll also include [PSE] (or [R/S]) instructions so that the intermediate results for BASE AREA, VOLUME, and SURFACE AREA are automatically displayed when the program is executed.

Keystrokes	Display	
[P/R]	00-	Sets calculator to Program mode.
[f] CLEAR [PRGM]	00-	Clears program memory.
[f] [x^2]	01- 42 11	
[f] [π]	02- 42 16	
[×]	03- 20	
[STO] 4	04- 44 4	
[STO] [+] 1	05-44 40 1	
[R/S]	06- 31	Stops to display BASE AREA and allow entry of h value.
[×]	07- 20	
[f] [PSE]	08- 42 31	Pauses to display VOLUME.
[STO] [+] 2	09-44 40 2	
[RCL] 0	10- 45 0	Recalls r, which will be stored in R_0.
[÷]	11- 10	
2	12- 2	
[×]	13- 20	
[RCL] 4	14- 45 4	
2	15- 2	
[×]	16- 20	
[+]	17- 40	
[STO] [+] 3	18-44 40 3	

Now, to run the program:

Keystrokes	Display	
[P/R]		Sets calculator to Run mode. (Display left from previous calculation.)
[f] CLEAR [REG]	0.0000	Clears registers R_0 through R_9.
2.5 [STO] 0	2.5000	Enters and stores r of first can in R_0.

Keystrokes	Display	
[R/S]	**19.6350**	BASE AREA of first can.
8	**8.**	Enters h of first can.
[R/S]	**157.0796**	VOLUME of first can.
	164.9336	SURFACE AREA of first can.
4 [STO] 0	**4.0000**	Enters and stores r of second can in R_0.
[R/S]	**50.2655**	BASE AREA of second can.
10.5	**10.5**	Enters h of second can.
[R/S]	**527.7876**	VOLUME of second can.
	364.4247	SURFACE AREA of second can.
4.5 [STO] 0	**4.5000**	Enters and stores r of third can in R_0.
[R/S]	**63.6173**	BASE AREA of third can.
4	**4.**	Enters h of third can.
[R/S]	**254.4690**	VOLUME of third can.
	240.3318	SURFACE AREA of third can.
[RCL] 1	**133.5177**	Sum of BASE AREAS.
[RCL] 2	**939.3362**	Sum of VOLUMES.
[RCL] 3	**769.6902**	Sum of SURFACE AREAS.

If the duration of the pause is not long enough to write down the number displayed, you can prolong it by using more than one [PSE] instruction, or you can have the program stop automatically by programming a [R/S] instruction.

Program execution is also automatically halted when the calculator overflows (refer to page 20) or attempts an improper operation that results in an **Error** display. Either of these conditions signifies that the program itself probably contains an error.

To determine at which program line execution has halted (in order to locate the error), press any key to clear the **Error** display, then press [P/R] to set the calculator to Program mode and display that program line.

You may also want to display the current program line (by pressing [P/R]) if your program has halted at one of several [R/S] instructions in your program and you want to determine which one that is. To continue executing the program afterward:

1. Press [P/R] to set the calculator back to Run mode. This also sets the program back to line 00.
2. If you want to resume execution from the program line at which execution halted rather than from line 00, press [GTO] followed by the two-digit program line number desired.
3. Press [R/S] to resume execution.

Stopping Program Execution Manually

Pressing any key while a program is running halts program execution. You may want to do this if the calculated results displayed by a running program appear to be incorrect (indicating that the program itself is incorrect).

To halt program execution during a pause in a running program (that is, when [PSE] is executed), press any key.

After stopping program execution manually, you can determine at which program line execution has halted and/or resume program execution as described above.

Nonprogrammable Functions

When the calculator is in Program mode (**PRGM** annunciator displayed), almost every function on the keyboard can be recorded as an instruction in program memory. The following functions *cannot* be stored as instructions in program memory:

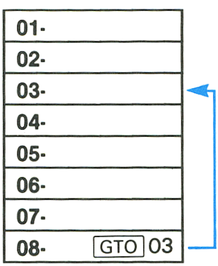
[f] CLEAR [PRGM]	[P/R]	[SST]
[f] CLEAR [PREFIX]	[f] [MEM]	[f] [BST]
[GTO] [.] *nn*	[.] / [ON]	

Branching and Looping

Although the instructions in a program normally are executed in order of their program line numbers, in some situations it is desirable to have program execution transfer or "branch" to a program line that is not the next line in program memory. Branching also makes it possible to automatically execute portions of a program more than once—a process called "looping."

Simple Branching

The GTO (*go to*) instruction is used in a program to transfer execution to any program line. The program line desired is specified by keying its two-digit line number into the program line containing the GTO instruction. When the GTO instruction is executed, program execution branches or "goes to" the program line specified and then continues sequentially as usual.



GTO 03 causes program execution to branch to line 03.

You have already seen a common use of branching: the GTO 00 instruction (that is stored in program memory after the program you key in) transfers execution to program line 00. A GTO instruction can be used to branch forward as well as backward in program memory. Backward branching is typically done to create loops (as described next); forward branching is typically done in conjunction with an $x \leq y$ or $x=0$ instruction for conditional branching (as described afterward).

Looping

If a [GTO] instruction specifies a lower numbered line in program memory, the instructions in the program lines between the specified line and the [GTO] instruction will be executed repeatedly. As can be seen in the illustration above under Simple Branching, once the program begins executing the "loop", it will execute it again and again.

If you want to terminate the execution of a loop, you can include an [$x \leqslant y$] or [$x = 0$] instruction (described below) or an [R/S] instruction within the loop. You can also terminate execution by pressing any key while the loop is being executed.

Example: Your friendly neighborhood Radiobiology Lab wants to predict the diminishing radioactivity of a test amount of ^{131}I, a radioisotope. The following program automatically figures the number of milliCuries of isotope theoretically remaining at four-day intervals of decay. (The half-life of ^{131}I is 8 days.) The initial batch (N_0) of isotope for this example is 100 milliCuries.

The formula for N_t, the amount of radioisotope left after t days, is:

$$N_t = N_0 e^{-kt} \qquad \text{where } k = \frac{\ln 2}{\underbrace{8 \text{ days}}_{\text{half-life of } ^{131}I}} = 0.087 \text{ days}^{-1}$$

We'll store the N_0 value (100 milliCuries) in register R_1 before running the program, and enter the first t value (4 days) just prior to executing the program. The program will automatically increase the value of t by 4 days for each successive N_t calculation (each loop).

Keystrokes	Display	
[P/R]	00-	Sets calculator to Program mode.
[f] CLEAR [PRGM]	00-	Clears program memory.

Keystrokes	Display	
STO 0	01– 44 0	Stores number from display in R_0. This number will be t, the number of days the ^{131}I batch has existed.
RCL 0	02– 45 0	Recalls t. This program line is the one to which program execution will later branch. t will change each time the program is run.
f PSE	03– 42 31	Pauses to display t.
2	04– 2	
f LN	05– 42 12	
8	06– 8	
÷	07– 10	
×	08– 20	kt.
CHS	09– 16	$-kt$.
e^x	10– 12	e^{-kt}.
RCL 1	11– 45 1	Recalls N_0, the initial number of milliCuries, from R_1.
×	12– 20	N_t, the milliCuries of ^{131}I remaining after t days.
f PSE	13– 42 31	Pauses to display N_t.
4	14– 4	
STO + 0	15–44 40 0	Adds 4 days to t.
GTO 02	16– 22 02	Transfers program execution to line 02, so the new t can be recalled to display before beginning new calculations.

Now we can run the program. It will pause at the beginning and end of each loop to display each t and N_t value. Program execution will continue indefinitely—until we stop it. (You can run the program one step at a time—using SST—if you want to follow the execution of the loop.)

Keystrokes	Display	
[P/R]	0.0000	Sets calculator to Run mode. (Display shown assumes no results remain from previous calculations.)
[f] CLEAR [REG]	0.0000	Clears registers R_0 through R_9.
[f] [FIX] 3	0.000	Sets display format to three decimal places.
100 [STO] 1	100.000	Stores N_0 in R_1.
4	4.	Keys in t.
[R/S]	4.000	$t = 4$ days.
	70.711	N_4 (milliCuries of ^{131}I remaining after 4 days).
	8.000	$t = 8$ days (the half-life of ^{131}I).
	50.000	N_8.
	12.000	$t = 12$ days.
	35.355	N_{12}.
[R/S] (or any key)	35.355	Halts program execution.

Conditional Branching

Often there are situations when it is desirable for a program to be able to branch to different lines in program memory, depending on certain conditions. For example, a program used to calculate sales commissions might need to branch to different program lines depending on the commission rate for the particular sales level. Also, conditional branching can be used to end the execution of a loop such as that in the preceding example. A conditional instruction can shift the program out of a loop either after a specified number of loop executions, or when a certain value within the loop has been reached.

The HP-10C provides two *conditional test* instructions that are used in programs for conditional branching:

- $\boxed{x \leq y}$ tests whether the number in the X-register (represented by the x in the key symbol) is less than or equal to the number in the Y-register (represented by the y in the key symbol).

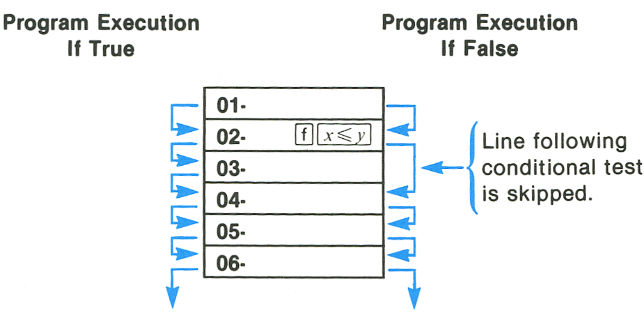
- $\boxed{x = 0}$ tests whether the number in the X-register is equal to zero.

The possible results of executing either of these instructions are:

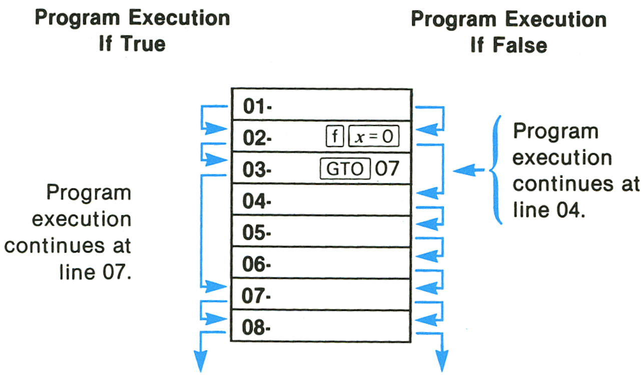
- If the condition tested for is true when the instruction is executed, program execution continues sequentially with the instruction in the next line of program memory.

- If the condition tested for is false when the instruction is executed, program execution skips the instruction in the next line of program memory and continues with the instruction in the following line.

These rules can be summarized as "DO if TRUE."



The program line immediately following that containing the conditional test instruction can contain any instruction; however, the most commonly used instruction there is [GTO]. If a [GTO] instruction follows a conditional test instruction, program execution branches elsewhere in program memory if the condition is true and continues with the next line in program memory if the condition is false.



Example: The radioisotope decay program (page 78) can be made to stop automatically after a specified number of loops by using the [x=0] condition.

Suppose N at $t = 12$ days is the last value you need. You can stop execution automatically at this point by storing the number of loops to be run (3), subtracting 1 from this number each time the loop is run, and instructing the program to stop (with a [GTO] 00 instruction) when this number equals zero.

The revised program would then look like this:

Keystrokes	Display
[P/R]	00-
[f] CLEAR [PRGM]	00-
[STO] 0	01- 44 0

Keystrokes	Display	
3	02– 3	Loop counter. Initializes the total number of loops to be run.
[STO] 2	03– 44 2	Stores loop counter in R_2.*
[RCL] 0	04– 45 0	Original lines.
[f] [PSE]	05– 42 31	
2	06– 2	
[f] [LN]	07– 42 12	
8	08– 8	
[÷]	09– 10	
[×]	10– 20	
[CHS]	11– 16	
[e^x]	12– 12	
[RCL] 1	13– 45 1	
[×]	14– 20	
[f] [PSE]	15– 42 31	
4	16– 4	
[STO] [+] 0	17–44 40 0	
1	18– 1	Loop increment number.
[STO] [−] 2	19–44 30 2	Subtracts 1 from initialized loop counter (line 02) in R_2.
[RCL] 2	20– 45 2	Recalls loop counter to display.
[f] [$x=0$]	21– 42 20	Tests whether number in X-register (loop number) equals zero.
[GTO] 00	22– 22 00	If condition is true, branches to beginning of program and stops.

* These lines can be entered manually *prior* to running the program instead of writing them into the program if you wish to: 1) conserve program lines; or 2) retain the flexibility of periodically changing the number of loops to be executed.

GTO 04	23– 22 04	If condition is false, branches to line 04 to continue program by restarting loop. (Note that the line number specified has been changed.)

To run this revised program, we proceed as follows:

Keystrokes	Display	
P/R		Sets calculator to Run mode.
f CLEAR REG	0.000	
100 STO 1	100.000	Stores N_0 in R_1.
4	4.	Keys in t.
R/S	4.000	t.
	70.711	N_4.
	8.000	
	50.000	N_8.
	12.000	
	35.355	N_{12}.
	0.000	Loop counter equals 0.

Exercise: Write a program that will enable a salesperson to compute a commission at the rates of 10% for sales up through $1,000 and 12.5% for sales over $1,000. The test value (1,000) and the commission rates can be stored for recall or included in the program. Below, they are stored in registers R_0 through R_2 for later recall by the program.

Note: If a program requires that certain numbers be in the X- and Y-registers when instructions such as [x≷y] are executed, it is helpful when writing the program to show the quantities in each register after each instruction is executed, as in the following diagram.

	1	2	3	4	5
Y ➜	**0**	**sale**	**1,000**	**1,000**	**1,000**
X ➜	**sale**	**1,000**	**sale**	**sale**	**sale**
Keys ➜	sale	[RCL] 0	[x≷y]	[x≤y]	[GTO] 07
Line ➜		01	02	03	04

	6	7	8	9
Y ➜	**sale**	**sale**	**sale**	**sale**
X ➜	**12.50**	**12.50**	**10.00**	**commis.**
Keys ➜	[RCL] 2	[GTO] 08	[RCL] 1	[%]
Line ➜	05	06	07	08

We'll key the amount of the sale into the display before running the program so that it will be in the X-register before the [RCL] 0 instruction in program line 01 is executed. This instruction will place the test value (1,000) in the X-register (the display) and move the sale amount into the Y-register. The [x≷y] instruction in program line 02 will exchange the numbers in the X- and Y-registers: that is, it will place the sales figure back into the X-register and place the test value into the Y-register. This is necessary because when either the [RCL] 2 instruction in line 05 or the [RCL] 1 instruction in line 07 is executed, the number in the

X-register is moved into the Y-register; if the [$x \gtrless y$] instruction were not included, the test value (1,000) rather than the sale amount would be in the Y-register when the [%] instruction in line 08 is executed.

Keystrokes	Display		
[P/R]	00-		
[f] CLEAR [PRGM]	00-		
[RCL] 0	01-	45 0	Recalls test value (1,000) into X-register.
[$x \gtrless y$]	02-	34	Places sale amount (which you will key in prior to running the program) into X-register and test value into Y-register.
[f] [$x \leq y$]	03-	42 10	Tests whether number in X-register (sale) is less than or equal to number in Y-register (1,000).
[GTO] 07	04-	22 07	If condition is true, branches to program line 07.
[RCL] 2	05-	45 2	If condition is false, recalls commission rate of 12.5% from R_2.
[GTO] 08	06-	22 08	Branches program to line 08.
[RCL] 1	07-	45 1	Recalls commission rate of 10% from R_1.
[%]	08-	21	Calculates commission.

Now we'll store the required numbers in registers R_0, R_1, and R_2, and then run the program, using [SST] so that we can check that the branching occurs properly. It's good practice with programs containing conditional test instructions to check that the program branches correctly for all possible conditions: in this case, if the sale amounts are less than, equal to, or greater than the test value.

Keystrokes	Display	
[P/R]	0.000	Sets calculator to Run mode. (Display shows result of previous calculations.)
(Initializing)		
[f] CLEAR [REG]	0.000	
[f] [FIX] 2	0.00	Sets display format to two decimal places.
1000 [STO] 0	1,000.00	Stores test value in R_0.
10 [STO] 1	10.00	Stores 10% commission rate in R_1.
12.5 [STO] 2	12.50	Stores 12.5% commission rate in R_2.
(First Data Test)		
500	500.	Keys sale amount less than test value into display (X-register).
[SST]	01– 45 0 1,000.00	Program line 1: [RCL] 0. Test value has been recalled to X-register, moving sale amount to Y-register.
[SST]	02– 34 500.00	Program line 02: [$x \gtrless y$]. Sale amount has been placed in X-register and test value has been placed in Y-register.
[SST]	03– 42 10 500.00	Program line 03: [f] [$x \leq y$].

Keystrokes	Display	
[SST]	04– 22 07 500.00	Condition tested by [$x \leq y$] was true, so program execution continued with line 04: [GTO] 07.
[SST]	07– 45 1 10.00	Program line 07: [RCL] 1. 10% commission rate has been recalled to X-register, moving sale amount to Y-register.
[SST]	08– 21 50.00	Program line 08: [%]. 10% of 500.00 = 50.00
[SST]	09– 22 00 50.00	Program line 09: sets calculator back to line 00. Commission.
(Second Data Test)		
1000	1,000.	Keys sales equal to test value into display (X-register).
[SST]	01– 45 0 1,000.00	Program line 01: [RCL] 0. Test value has been recalled to X-register, moving sale amount to Y-register.
[SST]	02– 34 1,000.00	Program line 02: [$x \gtrless y$]. Sale amount has been placed in X-register and test value has been placed in Y-register.
[SST]	03– 42 10 1,000.00	Program line 03: [f] [$x \leq y$].

Keystrokes	Display	
[SST]	04– 22 07	Condition tested by [$x \leq y$] was true, so program execution continued with line 04: [GTO] 07.
[SST]	07– 45 1 10.00	Program line 07: [RCL] 1. 10% commission rate has been recalled to X-register, moving sale amount to Y-register.
[SST]	08– 21 100.00	Program line 08: [%]. 10% of 1,000.00 = 100.00.
[SST]	09– 22 00	Program line 09: sets calculator back to line 00.
	100.00	Commission.

(Third Data Entry)

1500	1,500.	Keys sales equal to test value into display (X-register).
[SST]	01– 45 0 1,000.00	Program line 01: [RCL] 0. Test value has been recalled to X-register, moving sale amount to Y-register.
[SST]	02– 34 1,500.00	Program line 02: [$x \gtrless y$]. Sale amount has been placed in X-register and test value has been placed in Y-register.
[SST]	03– 42 10	Program line 03: [f] [$x \leq y$].
	1,500.00	

Keystrokes	Display	
[SST]	05– 45 2	Condition tested by [$x \leqslant y$] was false, so program execution skipped the next line and continued at line 05: [RCL] 2.
	12.50	12.5% commission rate has been recalled to X-register, moving sale amount to Y-register.
[SST]	06– 22 08	Program line 06: [GTO] 08.
	12.50	
[SST]	08– 21 187.50	Program line 08: [%]. 12.5% of 1,500.00 = 187.50.
[SST]	09– 22 00	Program line 09: sets calculator back to line 00.
	187.50	Commission.

Section 7

Program Editing

There are various reasons why you might want to modify a program you have stored in program memory, such as to correct a program that turns out to have errors, or to insert new instructions (like [STO], [PSE], or [R/S]).

Using program editing, you can do such modifications without re-keying in an entire program.

Changing an Instruction in a Program Line

To change a single instruction in program memory:

1. In Program mode, use [SST], [BST], or [GTO] [.] to set the calculator to the program line *preceding* the line containing the instruction to be changed.

2. Key in the new instruction.

3. Return to Run mode.

For example, to change an instruction stored in program line 05, press [GTO] [.] 04, then key in the new instruction that is to be stored in program line 05. The instruction previously stored in line 05 will be replaced; it is *not* "bumped" into line 06.

Adding Instructions at the End of a Program

To add one or more instructions at the end of the last program stored in program memory:

1. In Program mode, set the calculator to the last (highest numbered) line keyed into program memory.

2. Key in the new instruction(s).

3. Return to Run mode.

Adding Instructions Within a Program

If instructions are to be added within a program—or at the end of a program which is not the last one in memory—simply keying them in will replace the instructions previously stored in those program lines. The contents of all higher numbered program lines will remain unchanged. Then, the replaced (written-over) instructions need to be added back. This can be done by re-keying in these and all remaining instructions. (Refer to Adding Instructions by Replacement.) Alternatively, new instructions can be added by branching outside the program(s) to add lines. (Refer to Adding Instructions by Branching.)

Adding Instructions by Replacement

1. In Program mode, set the calculator to the last program line to be executed before the added instruction(s).
2. Key in the new instruction(s).
3. Re-key in the original instructions, starting with the first one written over by a new instruction. (Remember to alter [GTO] line numbers as necessary.)

Example: With the sales commission program, test value (in R_0), and commission rates (in R_1 and R_2), from the preceding section still stored in the calculator, let's insert a new instruction. Add a [R/S] instruction before the [%] instruction so that the program will display the commission rate before displaying the amount of commission. Since there is only one instruction ([%]) to be keyed back in, it is simplest to add the [R/S] instruction by replacement, as follows:

Keystrokes	Display		
[P/R]	00–		Sets calculator to Program mode.
[GTO] [.] 07	07–	45 1	Sets calculator to last program line to be executed, which contains the [RCL] 1 instruction.
[R/S]	08–	31	Keys in new instruction.

Keystrokes	Display		
[%]	09–	21	Keys in original instruction which was replaced by new instruction.
[P/R]			Sets calculator back to Run mode. (Display will show results remaining from last calculation.)
500 [R/S]	10.00		Percent commission rate for a $500 sale.
[R/S]	50.00		Commission for a $500 sale.

Adding Instructions by Branching

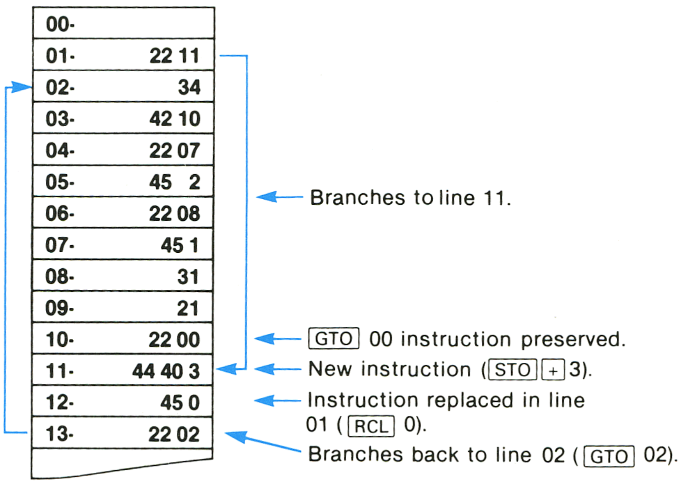
With branching, you can use a [GTO] instruction to move program execution to a new line sequence *after* the current end of your program. A second [GTO] instruction then returns execution to the main body of the program.

The new line sequence must begin at the *second* line after the end of the original program in order to preserve the automatically recorded [GTO] 00 instruction (which tells the calculator to stop and return to the beginning of the program when the program is done).

1. In Program mode, set the calculator to the last program line to be executed before the added instruction(s).
2. Key in a [GTO] instruction that specifies the *second* line after the last line of your program(s).
3. Set the calculator to the last line of your program(s) and key in a [GTO] 00 instruction.
4. Key in the instruction(s) being added.
5. Key in the instruction that was replaced by the [GTO] instruction keyed in at step 2.
6. Key in a [GTO] instruction to return to the first line (in the original program) to be executed after the new instruction(s).

Example: Suppose you now wanted to have the program in the preceding example sum the sale amounts for all the times the program is run. Let's use storage register arithmetic in register R_3 to do this. This means we need to add the instruction [STO] [+] 3 before the current program line 01. Since the addition of this one line by simple replacement would require that lines 01 through 10 be re-keyed in, it is quicker to add the instructions by branching (since branching only requires four extra lines—not counting the new instructions, which are identical in each case).

The following illustration shows how branching occurs in the edited program.



Keystrokes	Display	
[P/R]	00–	Sets calculator to Program mode.
[GTO] [.] 00	00–	Last program line to be executed before added instruction. In *this* case, this step is not necessary since we were at line 00 already.

Keystrokes	Display	
[GTO] 11	01– 22 11	Programs a branch to line 11, the second line after the last line of the program.
[GTO] [.] 09	09– 21	Sets calculator to the last line of the program so that the [GTO] 00 instruction keyed in next will be stored in the first line following the program.
[GTO] 00	10– 22 00	Ensures that the [GTO] 00 instruction follows the program.
[STO] [+] 3	11–44 40 3	Keys in instruction being added.
[RCL] 0	12– 45 0	Keys in instruction replaced in line 01 by [GTO] 11 instruction.
[GTO] 02	13– 22 02	Branches back to first line to be executed after added instruction.
[P/R]		Sets calculator back to Run mode.
0 [STO] 3	0.00	Clears register R_3.
1000 [R/S]	10.00	Commission rate for a \$1,000 sale.
[R/S]	100.00	Commission for a \$1,000 sale.
1500 [R/S]	12.50	Commission rate for a \$1,500 sale.
[R/S]	187.50	Commission for a \$1,500 sale.
[RCL] 3	2,500.00	Total sales.

Section 8

Multiple Programs

You can store multiple programs in program memory, provided that you separate them by instructions that will halt program execution after each program is run and return to the beginning of the program. You can run programs after the first one stored in program memory by setting the calculator to the first line of the program before pressing [R/S].

Storing Another Program

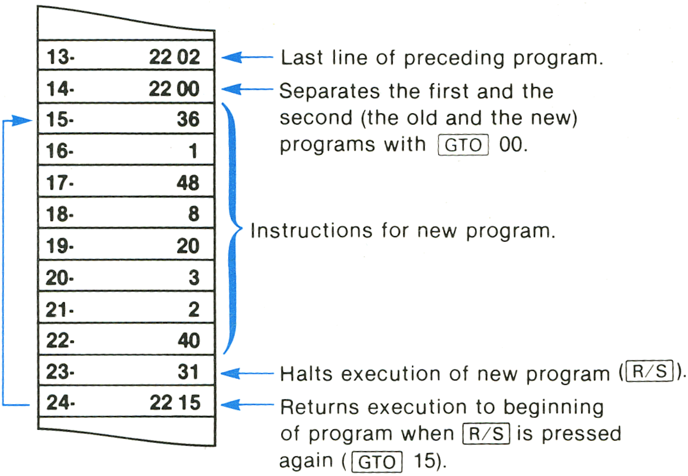
To store a program after another program is already stored in program memory:

1. In Program mode, go to the last line of the last program. Do *not* clear program memory.
2. If there is *only one* program already in program memory, add a [GTO] 00 instruction so that program execution returns to line 00 after this first program is run.
3. Key the program into program memory. (Be sure that any [GTO] instructions specify the correct line numbers.)
4. Press [R/S]. This will halt program execution at the end of the program.
5. If the new program does not end with a loop, key in a [GTO] instruction to the first line of the new program. This transfers program execution back to the beginning of the program if [R/S] is pressed to rerun the program.

Example: Assuming that program memory still contains the last program from the preceding section (which consisted of 13 program lines), store after that program the temperature conversion program from section 5 (page 61). Since this will be the second program stored in program memory, we'll insert a [GTO] 00 instruction to separate it from the first program (step 2 above). This program does not end with a loop, so we'll do steps 4 and 5, too.

Keystrokes	Display		
[P/R]	00–		Sets calculator to Program mode.
[GTO] [.] 13	13–	22 02	Sets calculator to last line keyed into program memory.
[GTO] 00	14–	22 00	Ensures that second program is separated from first by [GTO] 00.
[ENTER]	15–	36	Keys in program.
1	16–	1	
[.]	17–	48	
8	18–	8	
[×]	19–	20	
3	20–	3	
2	21–	2	
[+]	22–	40	
[R/S]	23–	31	Halts program execution.
[GTO] 15	24–	22 15	Branches to beginning of program.
[P/R]			Sets calculator back to Run mode. (Display shows previous results.)

The following illustration shows how the second program looks in program memory:



Running Another Program

To run a program that does not begin with program line 01:

1. In Run mode, set the calculator to the first line of the program desired.
2. Press [R/S].

Example: Run the temperature conversion program, now stored in the calculator beginning at program line 15, for a 35.7°C water bath.

Keystrokes	Display	
[GTO] 15		Sets calculator to first line of program to be executed. (Run mode.)
35.7 [R/S]	**96.26**	Temperature of water in degrees Fahrenheit.

Appendix A

Stack Lift and LAST X

Your HP-10C calculator has been designed to operate in a natural manner. As you have seen as you worked through this handbook, you are seldom required to think about the operation of the automatic memory stack—you merely work through calculations in the same way you would with a pencil and paper, performing one operation at a time.

There may be occasions, however—especially as you program the HP-10C—when you wish to know the effect of a particular operation upon the stack. The following explanation should help you.

Digit Entry Termination

Most operations on the calculator, whether executed as instructions in a program or pressed from the keyboard, terminate digit entry. This means that the calculator knows that any of these operations are part of a new number. The [CHS], [·], and [EEX] operations do *not* terminate digit entry.

Stack Lift

There are three types of operations on the calculator, depending upon how they affect the stack lift. These are stack-*disabling* operations, stack-*enabling* operations, and *neutral* operations.

Disabling Operations

There are four stack-*disabling* operations on the calculator. These operations disable the stack lift, so that a number keyed in *after* one of these operations writes over the current number in the displayed X-register and the stack does not lift. These special disabling operations are:

[ENTER]   [CLx]   [Σ+]   [Σ-]

Enabling Operations

Most of the operations on the keyboard, including one- and two-number mathematical functions like [x^2] and [×], are stack-*enabling* operations. This means that a number keyed in *after* one of these operations will lift the stack (because the stack has been "enabled" to lift).

T →			
Z →			
Y →		4.0000	4.0000
X →	4.	4.0000	3.
Keys →	4	[ENTER]	3
		Stack disabled.	No stack lift.

T →			
Z →			
Y →	53.1301	53.1301	53.1301
X →	5.0000	0.0000	7.
Keys →	[f] [→P]	[CLx]	7
	Stack enabled.	Stack disabled.	No stack lift.

Neutral Operations

Some operations, like [FIX], are neutral; that is, they do not alter the previous status of the stack lift. Thus, if you disable the stack lift by pressing [ENTER], then press [f] [FIX] n and key in a new number, that number will write over the number in the X-register and the stack will not lift. Similarly, if you have previously enabled the stack lift by executing, say, [x^2] then execute a [FIX] instruction followed by a digit entry sequence, the stack will lift.

The following operations are neutral on the HP-10C:

[FIX]	[GRAD]	[MEM]	[PSE]
[SCI]	[GTO] *nn*	CLEAR [PREFIX]	[P/R]
[ENG]	[GTO] [·] *nn*	CLEAR [PRGM]	[$x=0$]
[DEG]	[BST]	[CHS]*	[$x \leqslant y$]
[RAD]	[SST]	[R/S]	[ON]

LAST X

The following operations save x in the LAST X register:

[−]	[Σ+]	[LN]	[TAN]
[+]	[Σ−]	[e^x]	[TAN^{-1}]
[×]	[%]	[LOG]	[$\sqrt{x}$]
[÷]	[$\hat{y}$,r]	[10^x]	[x^2]
[➔H.MS]	[$\hat{x}$,r]	[SIN]	[$1/x$]
[➔H]	[n!]	[SIN^{-1}]	[y^x]
[➔DEG]	[FRAC]	[COS]	[➔R]
[➔RAD]	[INT]	[COS^{-1}]	[➔P]

* [CHS] is neutral during entry of a number from the keyboard, as in 123 [CHS] to enter −123, or 123 [EEX] 6 [CHS] to enter 123×10^{-6}. But otherwise, [CHS] enables the stack, as you would expect.

Appendix B

Error Conditions

If you attempt a calculation containing an improper operation—say, division by zero—the display will show **Error** and a number. To clear an error message, press any key.

The following operations will display **Error** plus a number:

Error 0: Improper Mathematical Operation

Illegal argument to math routine:

[÷], where $x = 0$

[y^x], where $y = 0$ and $x \leqslant 0$, or $y < 0$ and x is noninteger.

[$\sqrt{x}$], where $x < 0$.

[$1/x$], where $x = 0$.

[LOG], where $x \leqslant 0$.

[LN], where $x \leqslant 0$.

[SIN^{-1}], where $|x|$ is > 1.

[COS^{-1}], where $|x|$ is > 1.

[STO] [÷], where $x = 0$.

[n!], where x is noninteger, or $x < 0$.

Error 1: Storage Register Overflow

Storage register overflow (except [$\Sigma+$], [$\Sigma-$]). Magnitude of number in storage register would be larger than $9.999999999 \times 10^{99}$.

Error 2: Improper Statistical Operation

[$\bar{x}$]	$n = 0$
[s]	$n \leqslant 1$
[$\hat{y}$,r]	$n \leqslant 1$
[$\hat{x}$,r]	$n \leqslant 1$
[L.R.]	$n \leqslant 1$

Note: **Error 2** is also displayed if division by zero or the square root of a negative number would be required during computation with any of the following formulas:

$$s_x = \sqrt{\frac{M}{n(n-1)}} \qquad s_y = \sqrt{\frac{N}{n(n-1)}} \qquad r = \frac{P}{\sqrt{M \cdot N}}$$

$$A = \frac{P}{M} \qquad B = \frac{M\Sigma y - P\Sigma x}{n \cdot M}$$

(A and B are the values returned by the operation L.R., where $y = Ax + B$.)

$$\hat{y} = \frac{M\Sigma y + P(n \cdot x - \Sigma x)}{n \cdot M} \qquad \hat{x} = \frac{P\Sigma x + M(n \cdot y - \Sigma y)}{n \cdot P}$$

where:

$$M = n\Sigma x^2 - (\Sigma x)^2$$
$$N = n\Sigma y^2 - (\Sigma y)^2$$
$$P = n\Sigma xy - \Sigma x\ \Sigma y$$

Error 3: Statistical Register(s) Unavailable

Registers R_0 through R_5 unavailable for statistical computations because currently converted to program memory.

Error 4: Improper Line Number

Line number called for is currently unoccupied, or nonexistent (>79), or you have attempted to load more than 79 lines of program memory.

Error 5: Improper Register Number

Storage register named is currently converted to program memory, or is a nonexistent storage register.

Error 9: Service

Self-test discovered circuitry problem, or wrong key pressed during key test. Refer to appendix C.

Pr Error

Continuous Memory interrupted and reset because of power failure.

Appendix C

Battery, Warranty, and Service Information

Batteries

The HP-10C is powered by three batteries. In "typical" use, the HP-10C has been designed to operate 6 months or more on a set of alkaline batteries. The batteries supplied with the calculator are alkaline, but silver-oxide batteries (which should last twice as long) can also be used.

A set of three fresh alkaline batteries will provide at least 80 hours of *continuous* program running (the most power-consuming kind of calculator use*). A set of three fresh silver-oxide batteries will provide at least 180 hours of *continuous* program running. If the calculator is being used to perform operations other than running programs, it uses much less power. When only the display is on—that is, if you are not pressing keys or running programs—very little power is consumed.

If the calculator remains turned off, a set of fresh batteries will preserve the contents of Continuous Memory for as long as the batteries would last outside of the calculator—at least 1½ years for alkaline batteries or at least 2 years for silver-oxide batteries.

The actual lifetime of the batteries depends on how often you use the calculator, whether you use it more for running programs or more for manual calculations, and which functions you use.*

The batteries supplied with the calculator, as well as the batteries listed below for replacement, are *not* rechargeable.

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* Power consumption in the HP-10C depends on the mode of calculator use: off (with Continuous Memory preserved); idle (with only the display on); or "operating" (running a program, performing a calculation, or having a key pressed). While the calculator is turned on, typical calculator use is a mixture of idle time and "operating" time. Therefore, the actual lifetime of the batteries depends on how much time the calculator spends in each of the three modes.

WARNING

Do not attempt to recharge the batteries; do not store batteries near a source of high heat; do not dispose of batteries in fire. Doing so may cause the batteries to leak or explode.

The following batteries are recommended for replacement in your HP-10C (not all batteries are available in all countries):

Alkaline	Silver-Oxide
Eveready A76*	Eveready 357*
UCAR A76	UCAR 357
RAY-O-VAC RW82	RAY-O-VAC RS76 or RW42
National or Panasonic LR44	Duracell MS76
Varta 4276	Duracell 10L14
	Varta 541

Low-Power Indication

An asterisk (*) flashing in the lower left corner of the display when the calculator is on signifies that the available battery power is running low.

With alkaline batteries installed:

- The calculator can be used for at least 2 hours of continuous program running after the asterisk first appears.†
- If the calculator remains turned off, the contents of its Continuous Memory will be preserved for at least 1 month after the asterisk first appears.

With silver-oxide batteries installed:

- The calculator can be used for at least 15 minutes of continuous program running after the asterisk first appears.†
- If the calculator remains turned off, the contents of its

* Not available in the United Kingdom or Republic of Ireland.

† Note that this time is the minimum available for *continuous program running*—that is, while continuously "operating" (as described in the footnote on the previous page). If you are using the calculator for manual calculations—a mixture of the idle and "operating" modes—the calculator can be used for a much longer time after the asterisk first appears.

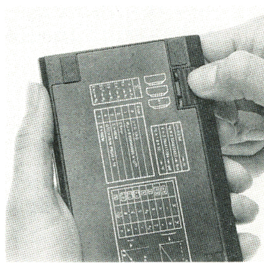
Continuous Memory will be preserved for at least 1 week after the asterisk first appears.

Installing New Batteries

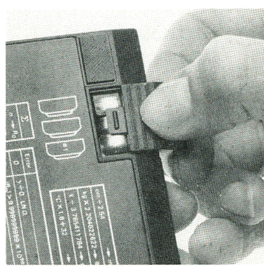
The contents of the calculator's Continuous Memory are preserved for a short time while the batteries are out of the calculator (provided that you turn off the calculator before removing the batteries). This allows you ample time to replace the batteries without losing data or programs. If the batteries are left out of the calculator for an extended period, the contents of Continuous Memory may be lost.

To install new batteries, use the following procedure:

1. Be sure that the calculator is off.



2. Holding the calculator as shown, press outward on the battery compartment door until it opens slightly.

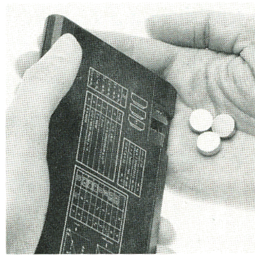


3. Grasp the outer edge of the battery compartment door, then tilt it up and out of the calculator.

CAUTION

In the next two steps, be careful not to press any keys while batteries are out of the calculator. If you do so, the contents of Continuous Memory may be lost and keyboard control may be lost (that is, no response to keystrokes).

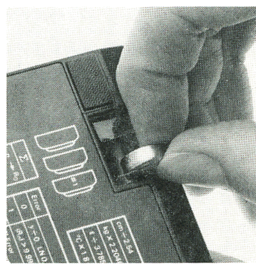
4. Turn the calculator over and gently shake, allowing the batteries to fall into the palm of your hand.



CAUTION

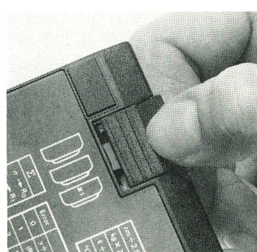
In the next step, replace *all three* batteries with fresh ones. If you leave an old battery inside, it may leak. Furthermore, be careful not to insert the batteries backwards. If you do so, the contents of Continuous Memory may be lost.

5. Holding open the two plastic flags shielding the battery compartment, insert three new batteries. The batteries should be positioned with their flat sides (the sides marked +) facing *toward* the nearby rubber foot, as shown in the illustration on the calculator case.



6. Insert the tab of the battery compartment door into the slot in the calculator case.

7. Lower the battery compartment door until it is flush with the case, then push the door inward until it is tightly shut.



8. Turn the calculator on. If for any reason Continuous Memory has been reset (that is, if its contents have been lost), the display will show **Pr Error**. Pressing any key will clear this message from the display.

Verifying Proper Operation (Self-Tests)

If it appears that the calculator will not turn on or otherwise is not operating properly, review the following steps.

For a calculator that does *not* respond to keystrokes:

1. Press the [y^x] and [ON] keys simultaneously, then release them. This will alter the contents of the X-register, so clear the X-register afterward.
2. If the calculator still does not respond to keystrokes, remove and reinsert the batteries. Make sure the batteries are properly positioned in the compartment.
3. If the calculator still does not respond to keystrokes, leave the batteries in the compartment and short both battery terminals together. (Fold back the plastic flaps to expose the terminals, which are the metal strips on either side of the battery compartment.) *Only momentary contact is required.* After you do this, the contents of the Continuous Memory will be lost, and you may need to press the [ON] key more than once to turn the calculator back on.
4. If the calculator still does not turn on, install fresh batteries. If there is still no response, the calculator requires service.

For a calculator that *does* respond to keystrokes:

1. With the calculator off, hold down the [ON] key and press [×].
2. Release the [ON] key, then release the [×] key. This initiates a complete test of the calculator's electronic circuitry. If everything is working correctly, within about 15 seconds (during which the word **running** flashes) the display should show **-8,8,8,8,8,8,8,8,8,8,** and all of the status indicators (except the * low-power indicator) should turn on.* If the display shows **Error 9**, goes blank, or otherwise does not show the proper result, the calculator requires service.†

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* The status indicators turned on at the end of this test include some that normally are not displayed on the HP-10C.

† If the calculator displays **Error 9** as a result of the [ON]/[×] test or the [ON]/[+] test but you wish to continue using your calculator, you should reset Continuous Memory as described on page 21.

Note: Tests of the calculator's electronics are also performed if the [+] key or the [÷] key is held down when [ON] is released. †* These tests are included in the calculator to be used in verifying that it is operating properly during manufacture and service.

If you had suspected that the calculator was not working properly but the proper display was obtained in step 2, it is likely that you made an error in operating the calculator.We suggest you reread the section in this handbook applicable to your calculation. If you still experience difficulty, write or telephone Hewlett-Packard at an address or phone number listed under Service (page 111).

Limited One-Year Warranty

What We Will Do

The HP-10C is warranted by Hewlett-Packard against defects in materials and workmanship for one year from the date of original purchase. If you sell your unit or give it as a gift, the warranty is automatically transferred to the new owner and remains in effect for the original one-year period. During the warranty period, we will repair or, at our option, replace at no charge a product that proves to be defective, provided you return the product, shipping prepaid, to a Hewlett-Packard service center.

What Is Not Covered

This warranty does not apply if the product has been damaged by accident or misuse or as the result of service or modification by other than an authorized Hewlett-Packard service center.

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*The [ON]/[+] combination initiates a test that is similar to that described above, but continues indefinitely. The test can be terminated by pressing any key, which will halt the test within 15 seconds. The [ON]/[÷] combination initiates a test of the keyboard and the display. When the [ON] key is released, certain segments in the display will be lit. To run the test, the keys are pressed in order from left to right along each row, from the top row to the bottom row. As each key is pressed, different segments in the display are lit. If the calculator is operating properly *and all keys are pressed in the proper order*, the calculator will display **10** after the last key is pressed. (The [ENTER] key should be pressed both with the third-row keys and with the fourth-row keys.) If the calculator is not working properly, *or if a key is pressed out of order*, the calculator will display **Error 9**. *Note that if this error display results from an incorrect key being pressed, this does not indicate that your calculator requires service.* This test can be terminated by pressing any key out of order (which will, of course, result in the **Error 9** display). Both the **Error 9** display and the **10** display can be cleared by pressing any key.

No other express warranty is given. The repair or replacement of a product is your exclusive remedy. **ANY OTHER IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS IS LIMITED TO THE ONE-YEAR DURATION OF THIS WRITTEN WARRANTY.** Some states, provinces, or countries do not allow limitations on how long an implied warranty lasts, so the above limitation may not apply to you. **IN NO EVENT SHALL HEWLETT-PACKARD COMPANY BE LIABLE FOR CONSEQUENTIAL DAMAGES.** Some states, provinces, or countries do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

This warranty gives you specific legal rights, and you may also have other rights which vary from state to state, province to province, or country to country.

Warranty for Consumer Transactions in the United Kingdom

This warranty shall not apply to consumer transactions and shall not affect the statutory rights of a consumer. In relation to such transactions, the rights and obligations of Seller and Buyer shall be determined by statute.

Obligation to Make Changes

Products are sold on the basis of specifications applicable at the time of manufacture. Hewlett-Packard shall have no obligation to modify or update products once sold.

Warranty Information

If you have any questions concerning this warranty, please contact an authorized Hewlett-Packard dealer or a Hewlett-Packard sales and service office. Should you be unable to contact them, please contact:

- In the United States:

Hewlett-Packard
Corvallis Division
1000 N.E. Circle Blvd.
Corvallis, OR 97330
Telephone: (503) 758-1010
Toll-Free Number: (800) 547-3400 (except in Oregon, Hawaii, and Alaska)

- In Europe:

Hewlett-Packard S.A.
7, rue du Bois-du-Lan
P.O. Box
CH-1217 Meyrin 2
Geneva
Switzerland

Telephone: (022) 83 81 11

Note: Do *not* send calculators to this address for repair.

- In other countries:

Hewlett-Packard Intercontinental
3495 Deer Creek Rd.
Palo Alto, California 94304
U.S.A.
Telephone: (415) 857-1501

Note: Do *not* send calculators to this address for repair.

Service

Hewlett-Packard maintains service centers in most major countries throughout the world. You may have your unit repaired at a Hewlett-Packard service center any time it needs service, whether the unit is under warranty or not. There is a charge for repairs after the one-year warranty period.

Hewlett-Packard calculator products normally are repaired and reshipped within five (5) working days of receipt at any service center. This is an average time and could possibly vary depending upon the time of year and work load at the service center. The total time you are without your unit will depend largely on the shipping time.

Obtaining Repair Service in the United States

The Hewlett-Packard United States Service Center for handheld and portable calculator products is located in Corvallis, Oregon:

Hewlett-Packard Company
Corvallis Division Service Department
P.O. Box 999/1000 N.E. Circle Blvd.
Corvallis, Oregon 97330, U.S.A.
Telephone: (503) 757-2000

Obtaining Repair Service in Europe

Service centers are maintained at the following locations. For countries not listed, contact the dealer where you purchased your calculator.

AUSTRIA
HEWLETT-PACKARD GmbH
Kleinrechner-Service
Wagramerstr.-Lieblgasse
A 1220 VIENNA
Telephone: (222) 23 65 11

BELGIUM
HEWLETT-PACKARD BELGIUM SA/NV
Boulevard de la Woluwe 100
Woluwelaan
B 1200 BRUSSELS
Telephone: (2) 762 32 00

DENMARK
HEWLETT-PACKARD A/S
Datavej 52
DK 3460 BIRKEROD (Copenhagen)
Telephone: (02) 81 66 40

EASTERN EUROPE
Refer to the address listed under Austria

FINLAND
HEWLETT-PACKARD OY
Revontulentie 7
SF 02100 ESPOO 10 (Helsinki)
Telephone: (90) 455 02 11

FRANCE
HEWLETT-PACKARD FRANCE
S.A.V. Calculateurs de Poche
Division Informatique Personnelle
F 91947 Les Ulis Cedex
Telephone: (6) 907 78 25

GERMANY
HEWLETT-PACKARD GmbH
Kleinrechner-Service
Vertriebszentrale
Berner Strasse 117
Postfach 560 140
D 6000 FRANKFURT 56
Telephone: (611) 50041

ITALY
HEWLETT-PACKARD ITALIANA S.P.A.
Casella postale 3645 (Milano)
Via G. Di Vittorio, 9
I 20063 CERNUSCO SUL NAVIGLIO (Milan)
Telephone: (2) 90 36 91

NETHERLANDS
HEWLETT-PACKARD NEDERLAND B.V.
Van Heuven Goedhartlaan 121
NL 1181 KK AMSTELVEEN (Amsterdam)
P.O. Box 667
Telephone: (020) 472021

NORWAY
HEWLETT-PACKARD NORGE A/S
P.O. Box 34
Oesterndalen 18
N 1345 OESTERAAS (Oslo)
Telephone: (2) 17 11 80

SPAIN
HEWLETT-PACKARD ESPANOLA S.A.
Calle Jerez 3
E MADRID 16
Telephone: (1) 458 2600

SWEDEN
HEWLETT-PACKARD SVERIGE AB
Enighetsvagen 3
Box 205 02
S 161 BROMMA 20 (Stockholm)
Telephone: (8) 730 05 50

SWITZERLAND
HEWLETT-PACKARD (SCHWEIZ) AG
Kleinrechner-Service
Allmend 2
CH 8967 WIDEN
Telephone: (057) 50111

UNITED KINGDOM
HEWLETT-PACKARD Ltd
King Street Lane
Winnersh, Wokingham
GB BERKSHIRE RG11 5AR
Telephone: (734) 784774

International Service Information

Not all Hewlett-Packard service centers offer service for all models of HP calculator products. However, if you bought your product from an authorized Hewlett-Packard dealer, you can be sure that service is available in the country where you bought it.

If you happen to be outside of the country where you bought your unit, you can contact the local Hewlett-Packard service center to see if service is available for it. If service is unavailable, please ship the unit to the address listed above under Obtaining Repair Service in the United States. A list of service centers for other countries can be obtained by writing to that address.

All shipping, reimportation arrangements, and customs costs are your responsibility.

Service Repair Charge

There is a standard repair charge for out-of-warranty repairs. The repair charges include all labor and materials. In the United States, the full charge is subject to the customer's local sales tax. In European countries, the full charge is subject to Value Added Tax (VAT) and similar taxes wherever applicable. All such taxes will appear as separate items on invoiced amounts.

Calculator products damaged by accident or misuse are not covered by the fixed repair charges. In these situations, repair charges will be individually determined based on time and material.

Service Warranty

Any out-of-warranty repairs are warranted against defects in materials and workmanship for a period of 90 days from date of service.

Shipping Instructions

Should your unit require service, return it with the following items:

- A completed Service Card, including a description of the problem.
- A sales receipt or other documentary proof of purchase date if the one-year warranty has not expired.

The product, the Service Card, a brief description of the problem, and (if required) the proof of purchase date should be packaged in the original shipping case or other adequate protective packaging to prevent in-transit damage. Such damage is not covered by the one-year limited warranty; Hewlett-Packard suggests that you insure the shipment to the service center. The packaged unit should be shipped to the nearest Hewlett-Packard designated collection point or service center. Contact your dealer for assistance. (If you are not in the country where you originally purchased the unit, refer to International Service Information, above.)

Whether the unit is under warranty or not, it is your responsibility to pay shipping charges for delivery to the Hewlett-Packard service center.

After warranty repairs are completed, the service center returns the unit with postage prepaid. On out-of-warranty repairs in the United States and some other countries, the unit is returned C.O.D. (covering shipping costs and the service charge).

Further Information

Service contracts are not available. Calculator product circuitry and design are proprietary to Hewlett-Packard, and service manuals are not available to customers.

Should other problems or questions arise regarding repairs, please call your nearest Hewlett-Packard service center.

Programming and Applications Assistance

Should you need technical assistance concerning programming, applications, etc., call Hewlett-Packard Customer Support at (503) 757-2000. This is not a toll-free number, and we regret that we cannot accept collect calls. As an alternative, you may write to:

Hewlett-Packard
Corvallis Division Customer Support
1000 N.E. Circle Blvd.
Corvallis, OR 97330

Dealer and Product Information

For dealer locations, product information, and prices, please call (800) 547-3400. In Oregon, Alaska, or Hawaii, call (503) 758-1010.

Temperature Specifications

- Operating: 0° to 55° C (32° to 131° F)
- Storage: −40° to 65° C (−40° to 149° F)

Federal Communications Commission Radio Frequency Interference Statement

The HP-10C generates and uses radio frequency energy and if not installed and used properly, that is, in strict accordance with the manufacturer's instructions, may cause interference to radio and television reception. It has been type tested and found to comply with the limits for a Class B computing device in accordance with the specifications in Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference in a residential installation. However, there is no guarantee that interference will not occur in a particular installation. If your HP-10C does cause interference to radio or television reception, which can be determined by turning the calculator off and on, you are encouraged to try to correct the interference by one or more of the following measures:

- Reorient the receiving antenna.
- Relocate the calculator with respect to the receiver.
- Move the calculator away from the receiver.

If necessary, you should consult your dealer or an experienced radio/television technician for additional suggestions. You may find the following booklet prepared by the Federal Communications Commission helpful: *How to Identify and Resolve Radio-TV Interference Problems*. This booklet is available from the U.S. Government Printing Office, Washington, D.C. 20402, Stock No. 004-000-00345-4.

Function Key Index

[ON] Turns the calculator's display on and off.

Conversions

[➔R] Converts polar magnitude *r* and angle *θ* in X- and Y-registers respectively to rectangular *x*- and *y*-coordinates **(Page 42)**.

[➔P] Converts *x*-, *y*-rectangular coordinates placed in X- and Y-registers respectively to polar magnitude *r* and angle *θ* **(Page 42)**.

[➔H.MS] Converts decimal hours (or degrees) to hours, minutes, seconds (or degrees, minutes, seconds) **(Page 39)**.

[➔H] Converts hours, minutes, seconds (or degrees, minutes, seconds) to decimal hours (or degrees) **(Page 39)**.

[➔RAD] Converts degrees to radians **(Page 40)**.

[➔DEG] Converts radians to degrees **(Page 40)**.

Digit Entry

[ENTER] Enters a copy of a number in display (X-register) into Y-register; used to separate multiple number entries **(Page 17)**.

[CHS] Changes sign of number or exponent of 10 in display (X-register) **(Page 15)**.

[EEX] Enter exponent; next digits keyed in are exponents of 10 **(Page 15)**.

[0] through [9] Digit keys.

[·] Decimal point.

Display Control

[FIX] *n* Selects fixed point display mode **(Page 54)**.

[SCI] *n* Selects scientific notation display mode **(Page 55)**.

[ENG] *n* Selects engineering notation display mode **(Page 57)**.

Mantissa. Pressing [f] CLEAR [PREFIX] displays all 10 digits of the number in the X-register as long as the [PREFIX] key is held down **(Page 57)**. It also clears any partial key sequences (refer to Clearing Prefixes, **Page 15**).

Logarithmic and Exponential

[LN] Computes natural logarithm of number in display (X-register) **(Page 40)**.

[e^x] Natural antilogarithm. Raises *e* to power of number in display (X-register) **(Page 40)**.

[LOG] Computes common logarithm (base 10) of number in display (X-register) **(Page 40)**.

[10^x] Common antilogarithm. Raises 10 to power of number in display (X-register) **(Page 40)**.

[y^x] Raises number in Y-register to power of number in display (X-register) (enter *y*, then *x*) **(Page 41)**.

Mathematics

[−] [+] [×] [÷] Arithmetic operators **(Page 37)**.

[$\sqrt{x}$] Computes square root of number in display (X-register) **(Page 37)**.

[x^2] Computes square of number in display (X-register) **(Page 37)**.

[n!] Calculates *n* factorial (*n*!) **(Page 37)**.

[1/*x*] Computes reciprocal of number in display (X-register) **(Page 37)**.

[π] Places value of π (3.141592654) in display (X-register) **(Page 36)**.

[%] Percent. Computes *x*% of value in the Y-register **(Page 41)**.

Number Alteration

[INT] Leaves only integer portion of number in display (X-register) by truncating fractional portion **(Page 36)**.

[FRAC] Leaves only fractional portion of number in display (X-register) by truncating integer portion **(Page 36)**.

Prefix Keys

[f] Pressed before a function key, selects gold function printed above that key **(Page 14)**.

CLEAR [PREFIX] Cancels the [f] prefix keystroke and partially entered instructions such as [f] [SCI]. Also displays 10-digit mantissa of number in display (X-register) **(Pages 15 and 57)**.

For other prefix keys, refer to listings under Display Control, Storage, and [GTO] (in Programming Key Index).

Stack Manipulation

[$x \gtrless y$] Exchanges contents of X- and Y-stack registers **(Page 24)**.

[R↓] Rolls down contents of stack **(Page 24)**.

[CL*x*] Clears contents of display (X-register) to zero **(Page 16)**.

Statistics

[Σ+] Accumulates statistics of numbers from X- and Y-registers in storage registers R_0 through R_5 **(Page 43)**.

[Σ−] Subtracts statistics of numbers in X- and Y-registers from storage registers R_0 through R_5 for correcting [Σ+] accumulations **(Page 46)**.

[$\bar{x}$] Computes mean (average) of *x*- and *y*-values accumulated by [Σ+] **(Page 47)**.

[s] Computes sample standard deviations of x- and y-values accumulated by [Σ+] **(Page 48)**.

[$\hat{y}$,r] [$\hat{x}$,r] Linear estimate and correlation coefficient. Computes estimated value of y ($\hat{y}$) for a given value of x, or estimated value of x ($\hat{x}$) for a given value of y, by least squares method and places result in display (X-register). Computes the correlation coefficient (r) of the linear estimate data by measuring how closely the data pairs would, if plotted on a graph, represent a straight line, and places result in Y-register **(Page 51)**.

[L.R.] Linear regression. Computes y-intercept (B) and slope (A) for linear function $y = Ax + B$ that best approximates x- and y-values accumulated using [Σ+]. The value of the y-intercept is placed in the X-register; the value of the slope is placed in the Y-register **(Page 50)**.

Storage

[STO] Store. Followed by register address (0 through 9), stores displayed number in the storage register specified. Also used to perform storage register arithmetic **(Page 32)**.

[RCL] Recall. Followed by address (0 through 9), recalls number from storage register specified into the display (X-register) **(Page 33)**.

CLEAR [REG] Clears contents of the stack and all storage registers to zero **(Page 33)**.

[LSTx] Recalls number displayed before the current operation back into the display (X-register) **(Page 24)**.

Trigonometry

[DEG] Sets decimal degree mode for trigonometric functions—indicated by absence of **GRAD** or **RAD** annunciator **(Page 38)**.

[RAD] Sets Radians mode for trigonometric functions—indicated by **RAD** annunciator **(Page 38)**.

[GRD] Sets Grads mode for trigonometric functions—indicated by **GRAD** annunciator **(Page 38)**.

[SIN^{-1}] [COS^{-1}] [TAN^{-1}] Compute sine, cosine, or tangent, respectively, of number in display **(Page 38)**.

Programming Key Index

P/R Program/Run mode. Sets the calculator to Program mode—**PRGM** annunciator on—or Run mode—**PRGM** annunciator cleared. Automatically sets program to line 00 when returning to Run mode **(Page 60)**.

MEM Displays current status of program memory/storage register allocation (number of allocated program lines and number of available data storage registers) **(Page 67)**.

GTO *nn* Go to. Used with 00 through 79. In Run mode: causes calculator to search downward in program memory for designated line number and halt. In Program mode: becomes an instruction within the program **(Page 70)**.

GTO . *nn* Go to line number. Positions calculator to the existing line number specified by *nn* **(Page 70)**.

BST Back step. Moves calculator back one line in program memory. Displays line number and contents of previous program line **(Page 65)**.

SST Single step. In Program mode: moves calculator forward one or more lines in program memory. In Run mode: displays line number and contents of next program line, and executes the step **(Page 65)**.

CLEAR PRGM In Program mode, clears all instructions from program memory and resets calculator to line 00. In Run mode, only resets calculator to line 00 **(Page 60)**.

PSE Pause. Halts program execution for about 1 second to display contents of X-register, then resumes execution **(Page 72)**.

R/S Run/Stop. Begins program execution from current line number in program memory. Stops execution if program is running **(Page 62)**.

$x \leq y$ $x = 0$ Conditionals. Tests value in X-register against value in Y-register or zero as indicated. If true, calculator executes instruction in next line of program memory. If false, calculator skips one line in program memory before resuming execution **(Page 81)**.

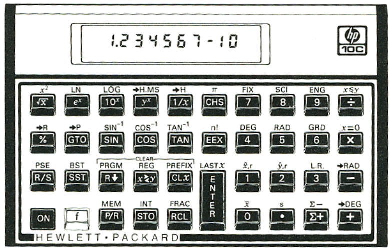
Subject Index

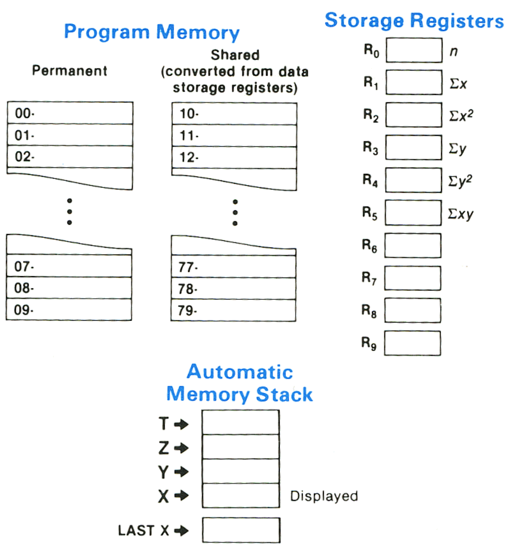
Page numbers in **bold** type indicate primary references; page numbers in regular type indicate secondary references.

T-U-W

X-Y-Z

The HP-10C Keyboard and Continuous Memory





The basic program memory and storage register allocation is nine lines of programming and 10 data storage registers. The calculator automatically converts one data storage register into seven lines of program memory, one register at a time, as you need them. Conversion begins with R_9 and ends with R_0, giving you a maximum of 79 program lines. R_0 through R_5 are also used as statistics registers.

HEWLETT PACKARD

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