

HEWLETT-PACKARD

**HP-55**

**Owner's  
Handbook**

HEWLETT  PACKARD

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**Owner's Handbook**

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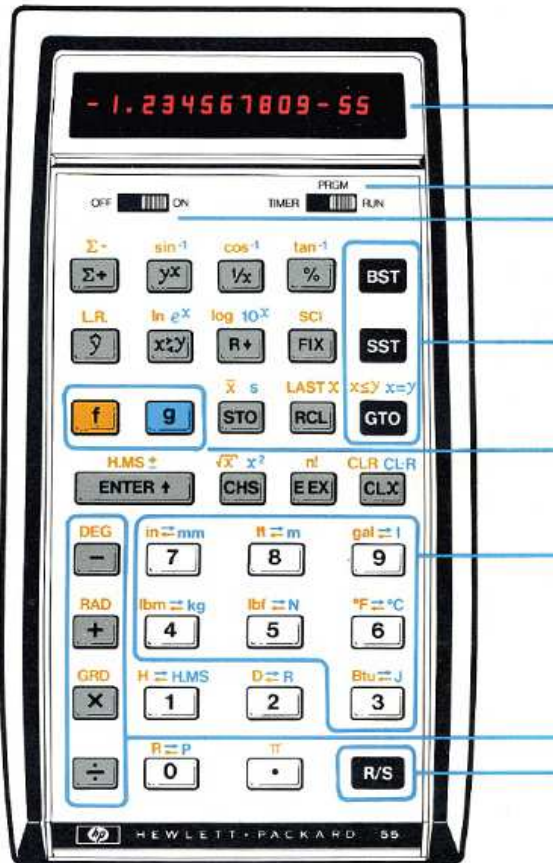


Figure 1. Keyboard Layout

Display

Mode Switch

OFF-ON Switch

Programming Keys: BST SST GTO

Prefix Keys: f 9

Metric Conversions:  $\text{in} \leftrightarrow \text{mm}$   $\text{ft} \leftrightarrow \text{m}$   $\text{gal} \leftrightarrow \text{l}$   
 $\text{lbm} \leftrightarrow \text{kg}$   $\text{lbf} \leftrightarrow \text{N}$   $^{\circ}\text{F} \leftrightarrow ^{\circ}\text{C}$   
 $\text{Btu} \leftrightarrow \text{J}$

Arithmetic Keys:  $\div$   $\times$   $+$   $-$

Timer and Program Control Key: R/S

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## Versatility Is Everything

The HP-55 is an incredibly versatile calculator designed to provide in one compact, attractive package the functions and features you need most. For example, take its precision digital timer. Did you know that most electronic calculators possess many of the ingredients necessary for a digital timer? The HP-55, however, has added a very small quartz crystal to provide an accurate time base. The result is a precision digital timer with a range of 100 hours.

Why not try the timer yourself now? Switch the calculator ON and set the mode switch in the upper right hand corner to **TIMER**. You should see 00.00.00 00 in the display. Then you can start the timer by pressing **R/S** (*run/stop*). While it is running, read the list of features that follows.

1. The HP-55 is programmable to help you create on-the-spot programs for faster, easier, and more accurate solutions to your special problems.
2. The HP-55's keystroke programming is simple and easy to understand and includes both direct and conditional branching.
3. To help you with programming, several editing features allow you to review programs easily as you're writing them.
4. The HP-55 also features more pre-programmed functions than any other scientific pocket calculator in the world.
5. It provides 20 addressable data storage locations to make data manipulation easy regardless of the problem.
6. Like other Hewlett-Packard calculators, the HP-55 offers a four-register operational stack and reverse Polish notation (RPN) to make your problem-solving easier.
7. It also provides statistics for mean, standard deviation, and linear regression calculations.
8. And of course it has transcendental functions, such as sines, cosines, logarithms, etc.; and polar/rectangular coordinate conversions for handling vectors and complex arithmetic.
9. Also, for your convenience, the HP-55 provides a variety of metric/English conversions.

10. The precision digital timer, which you have running, is combined with the ability to store times while the timer is running and later recall them.
11. To increase your calculating power, two books of programs are also available:
- HP-55 Mathematics Programs
  - HP-55 Statistics Programs

These books contain a representative collection of key sequence routines for solving mathematics and statistics problems in the most efficient manner.

Okay, now press **R/S** again to stop the timer. Now let's calculate your reading speed. The list of features is about 230 words long. To calculate your reading speed, set the switch in the upper right hand corner of the calculator to RUN and press:

**f** **H=MMS**  
**f** **1** **6** **0** **x** **2** **3** **0** **x/y** **÷**

The answer is in words per minute. Try it again if you like!

## Getting Started

### Power On

Your HP-55 calculator is shipped fully assembled and is ready to calculate after making a few simple checks. If you have just received your calculator, please be sure that you have all of the standard accessories and that the calculator's battery pack has been charged. (Refer to appendix A.) If the battery pack is already charged or if you plan to run the calculator from the charger, here's how to get started:

- Set the power switch to OFF.
- Set the mode switch to RUN.
- Set the power switch to ON.

You should now see displayed 0.00; if not, please refer to appendix C.

The display flashes whenever an improper operation has been attempted. You can stop the flashes by pressing any key. Improper operations are listed on the inside back cover of this handbook.

### Keyboard




Figure 1, inside the cover foldout, illustrates the keyboard layout. The blue and gold prefix keys are used to increase the number of functions for each key.

### Gold Operations

Press the gold **f** prefix key before an operation written in gold above the key or before a conversion in the direction of the gold arrow.

### Blue Operations

Press the blue **g** prefix key before an operation written in blue above the key or before a conversion in the direction of the blue arrow.

**Note:** Gold and blue functions are shown in this handbook as appearing above a key like this: , , .

## Initial Display

When you first switch the calculator ON with the mode switch set to RUN, the display shows 0.00. This represents the contents of the display, or "X-register."

Basically, numbers are stored and manipulated in the machine in things called "registers." Each number, no matter how simple (i.e., 0, 1, or 5) or how complex (i.e., 3.141592654, -23.28362, or  $2.87148907 \times 10^{23}$ ), occupies one entire register.

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

Name	Register
T (top)	0.00
Z	0.00
Y	0.00
X	0.00

Always displayed

## Keying In and Entering Numbers

Key in numbers from left to right and include the decimal point if it is a part of the number. For example, 314.32 is keyed in by pressing:

**3 1 4 . 3 2**

Why not try it yourself now? If you make a mistake, clear the entire number by pressing **CLX** (clear x); then key in the number correctly. Your stack registers now look like this:

Name	Register
T	0.00
Z	0.00
Y	0.00
X	314.32

In order to key in a second number, you must tell the calculator that you're finished with the first number. For example, if you were to key in 567 right now, the number in the displayed X-register would be 314.32567 and the calculator would still not know if you were through. (It's clever, but it can't read your mind.)

One way to tell the calculator you're through with a number is to press **ENTER**. \* Press **ENTER** to change the contents of the registers

from this:		to this:	
T	0.00	T	0.00
Z	0.00	Z	0.00
Y	0.00	Y	314.32
X	314.32	X	314.32

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

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

from this:		to this:	
T	0.00	T	0.00
Z	0.00	Z	0.00
Y	314.32	Y	314.32
X	314.32	X	543.28

\*A detailed discussion on number termination can be found in appendix B.

**CLX** also prepares the displayed X-register for a new number by replacing any number in the display with zero. Any new number then writes over the zero in X. For example, press **CLX** now to change the stack

from this:		to this:	
T	0.00	T	0.00
Z	0.00	Z	0.00
Y	314.32	Y	314.32
X	543.28	X	0.00

And then key in 689.4 to change the stack

from this:		to this:	
T	0.00	T	0.00
Z	0.00	Z	0.00
Y	314.32	Y	314.32
X	0.00	X	689.4

Notice that numbers in the stack do not move when a new number is keyed in immediately after pressing **ENTER+** or **CLX**.

## Simple Arithmetic

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

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

and then you'd add like this:

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

Numbers are positioned the same way in the HP-55. Here's how it is done (Clear the previous number entry first by pressing **CLX**.)

Press	Display	
34	34.	34 is keyed into X.
<b>ENTER+</b>	34.00	34 is copied into Y.
21	21.	21 writes over the 34 in X.

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

T	0.00
Z	0.00
Y	34.00
X	21.

Press	Display	
<b>+</b>	55.00	The answer.

The simple old-fashioned math notation explains how to use your calculator. Both numbers are always positioned in the stack first and then the operation is executed when the key is pressed. *There are no exceptions to this rule.*

Subtraction, multiplication, and division work the same way. In each case, the data must be in the proper position before the operation can be performed.

To subtract 21 from 34  $\left(\begin{smallmatrix} 34 \\ -21 \end{smallmatrix}\right)$ :

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

To multiply 34 by 21  $\left(\begin{smallmatrix} 34 \\ \times 21 \end{smallmatrix}\right)$ :

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

To divide 34 by 21  $\left(\begin{smallmatrix} 34 \\ \div 21 \end{smallmatrix}\right)$ :

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

## Arithmetic and the Stack

You've already learned how to enter numbers into the calculator and perform calculations with them. In each case you first needed to position the numbers in the stack manually using the **ENTER↵** key. However, the stack also performs many movements automatically. It's these automatic movements that give it tremendous computing efficiency and ease of use. The stack automatically "lifts" every calculated number in the stack when a new number is keyed in because it *knows* when it completes a calculation that any digits you key in are a part of a new number. For example, calculate  $16 + 30 + 11 + 17 = ?$

**Note:** For the sake of simplicity in the following examples, we are going to assume that the stack contains no data from previous examples.

Press	Stack Contents	Comments
	T 0.00	
16	Z 0.00	16 is keyed into the displayed
	Y 0.00	X-register
	X 16.	
ENTER↵	T 0.00	
	Z 0.00	16 is copied into Y.
	Y 16.00	
	X 16.00	
30	T 0.00	
	Z 0.00	30 writes over the 16 in X.
	Y 16.00	
	X 30.	
+	T 0.00	16 and 30 are added together.
	Z 0.00	The answer, 46 is displayed.
	Y 0.00	
	X 46.00	

Press	Stack Contents	Comments
11	T 0.00	11 is keyed into the displayed X-register. The 46 in the stack is automatically raised.
	Z 0.00	
	Y 46.00	
	X 11.	
+	T 0.00	46 and 11 are added together. The answer, 57, is displayed.
	Z 0.00	
	Y 0.00	
	X 57.00	
17	T 0.00	17 is keyed into the X-register. 57 is automatically entered into Y.
	Z 0.00	
	Y 57.00	
	X 17.	
+	T 0.00	57 and 17 are added together for the final answer.
	Z 0.00	
	Y 0.00	
	X 74.00	

After any calculation or number manipulation, the stack automatically lifts when a new number is keyed in. (Refer to Automatic Stack Lift in appendix B.) Because operations are performed when they are pressed, the length of this problem is unlimited until the answers exceed the range of the calculator (up to  $10^{100}$ ).

In addition to the automatic stack lift after a calculation, the stack automatically drops during calculations involving both X- and Y-registers. It happened in the above example, but let's do the problem differently to see this feature more clearly.

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

Press	Stack Contents	Comments
17	T 16.00	17 is written over the 11 in X.
	Z 30.00	
	Y 11.00	
	X 17.	
+	T 16.00	17 and 11 are added together and the rest of the stack drops. 16 is duplicated in T and Z. 30 and 28 are ready to be added.
	Z 16.00	
	Y 30.00	
	X 28.00	
+	T 16.00	30 and 28 are added together and the stack drops again. Now 16 and 58 are ready to be added.
	Z 16.00	
	Y 16.00	
	X 58.00	
+	T 16.00	16 and 58 are added together for the final answer and the stack continues to drop.
	Z 16.00	
	Y 16.00	
	X 74.00	

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

### Left to Right Execution

The automatic stack lift and automatic stack drop let you retain and position intermediate results without reentering the numbers. This is an advantage the stack has over other data handling methods. Almost any problem can be solved by keying in the numbers in left to right order.

\*The stack also drops during  $\times$  and  $\div$  operations, which are discussed later.

Try it with the following expression:

$$(35 + 45) \times (55 + 65)$$

Press	Display	
35	35.	The left-most number is keyed into the X-register.
ENTER	35.00	No operations can be performed so you press ENTER.
45	45.	The next number is keyed into X.
+	80.00	The intermediate result of the addition operation is displayed.
55	55.	The next number is keyed into X.
ENTER	55.00	The multiplication operation cannot be performed yet, so you press ENTER.
65	65.	The next number is keyed into X.
+	120.00	The addition operation is performed next.
$\times$	9600.00	The answer is calculated without repositioning the numbers.

Of course, you don't have to work problems from left to right. Many people start in the middle and key in numbers as they need them. Either way, the more complex the problem, the more you'll appreciate the capabilities of the operational stack. Try these additional examples.

**Example:** Calculate  $5 \times [(3 \div 4) + (5 \div 2) + (4 \div 3)] \div (3 \times .213)$ .

Press	Display	
5	5.	
ENTER	5.00	
2	2.	
$\div$	2.50	(5 $\div$ 2)
3	3.	
ENTER	3.00	
4	4.	
$\div$	.75	(3 $\div$ 4)
+	3.25	(5 $\div$ 2) + (3 $\div$ 4)
4	4.	
ENTER	4.00	
3	3.	
$\div$	1.33	(4 $\div$ 3)
+	4.58	(3 $\div$ 4) + (5 $\div$ 2) + (4 $\div$ 3)
3	3.	
ENTER	3.00	
.213	.213	
$\times$	.64	(3 $\times$ .213)
$\div$	7.17	
5	5.	The first number is keyed in.
$\times$	35.86	The answer.

## Constant Arithmetic

**Example:** The population of a certain bacteria culture increases by 15% each day under ideal conditions. If a sample culture of 1000 is allowed to grow, what will the population be at the end of each day for six consecutive days?

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

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

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

## Manipulating Numbers in the Stack

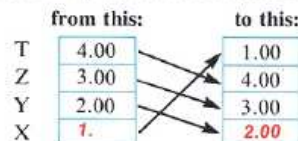
ENTER is not the only key that positions numbers in the stack. The  $\mathbf{R\downarrow}$  and  $\mathbf{\times\downarrow}$  keys reposition numbers in the stack without losing numbers from the T-register.

### Rotating the Stack

The **R↓** (roll down) key lets you review the entire stack contents at any time. To see how this key works, load the stack with the numbers 1 through 4 by pressing:

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

If you then press **R↓**, the stack contents are rotated



Now watch the stack contents that follow as we use **R↓** to bring the other numbers in the stack one-by-one into the displayed X-register.

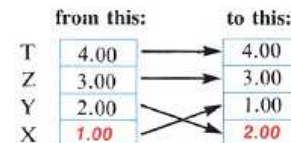
Press	Stack Contents	Comments
	T 4.00 Z 3.00 Y 2.00 X 1.00	
<b>R↓</b>	T 2.00 Z 1.00 Y 4.00 X 3.00	Once again all the numbers are rotated in the stack. 3.00 is now in the X-register.
<b>R↓</b>	T 3.00 Z 2.00 Y 1.00 X 4.00	The numbers are rotated down one place again. 4.00, which was in T, is now in the X-register.
<b>R↓</b>	T 4.00 Z 3.00 Y 2.00 X 1.00	All the numbers are back in the registers they started in. No numbers have been lost.

**R↓** is used primarily to position numbers in the stack. However, whenever you're unsure of the contents of the stack, use **R↓**, as we have done here, to verify the location of your data.

**Note:** The stack is lifted and the number in the T-register is lost when a keyboard entry or **RCL** follows **R↓**.

### Exchanging X and Y

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



Similarly, pressing **xy** again will restore the numbers in the X- and Y-registers to their original places. The **xy** key is used to position numbers in the stack or simply to view the contents of the Y-register.

### Storing and Recalling Numbers

Although the stack automatically holds intermediate results for you, occasionally you will find the need to set aside some number or group of numbers to be used in calculations much later. For this purpose, your HP-55 provides you with 20 storage locations in addition to the stack.

#### STACK REGISTERS DATA STORAGE REGISTERS

T	
Z	
Y	
X	

R <sub>0</sub>		R <sub>0</sub>	
R <sub>1</sub>		R <sub>1</sub>	
R <sub>2</sub>		R <sub>2</sub>	
R <sub>3</sub>		R <sub>3</sub>	
R <sub>4</sub>		R <sub>4</sub>	
R <sub>5</sub>		R <sub>5</sub>	
R <sub>6</sub>		R <sub>6</sub>	
R <sub>7</sub>		R <sub>7</sub>	
R <sub>8</sub>		R <sub>8</sub>	
R <sub>9</sub>		R <sub>9</sub>	

## Storing Numbers

To store a displayed number in storage registers  $R_0$  through  $R_9$ :

1. Press **STO** (store).
2. Press the applicable register number key (**0** thru **9**).

To store a displayed number in storage registers  $R_{0.0}$  through  $R_{9.9}$ :

1. Press **STO**.
2. Press the decimal point key **.**
3. Press the applicable register number key (**0** thru **9**).

The number in the displayed X-register is copied in the storage register, leaving the original in X.

## Recalling Numbers

Numbers may be recalled in much the same way as they are stored. To recall a number from registers  $R_0$  through  $R_9$  to the displayed X-register:

1. Press **RCL** (recall).
2. Press the applicable register number key (**0** thru **9**).

To recall a number from registers  $R_{0.0}$  through  $R_{9.9}$  to the displayed X-register:

1. Press **RCL**.
2. Press the decimal point key **.**
3. Press the applicable register number key (**0** thru **9**).

The number in the storage register is copied into the displayed X-register, leaving the original in the storage register. Whenever a value is recalled to the displayed X-register, the stack automatically behaves as if it were a new number.

**Example:** Suppose you want to calculate the cost of buying an item in various quantities. The unit price of the item is \$132.57 and the quantities you need to calculate cost for are 47, 36 and 29.

**Method:** Store the unit price in storage register 0. Then recall it to multiply each quantity.

Press	Display	
132.57	132.57	
<b>STO</b> <b>0</b>	132.57	132.57 is stored in register $R_0$ .
47	47.	47 lifts the unit price to Y.
<b>×</b>	6230.79	1st total.
<b>RCL</b> <b>0</b>	132.57	Recall the unit price.
36	36.	36 lifts the unit price to Y.
<b>×</b>	4772.52	2nd total.
<b>RCL</b> <b>0</b>	132.57	Recall the unit price.
29	29.	29 lifts the unit price to Y.
<b>×</b>	3844.53	3rd total.

In this case you can easily calculate the total cost because the individual totals are still in the stack.

<b>+</b>	8617.05	3844.53 + 4772.52
<b>+</b>	14847.84	Total cost.

We did all the totaling at the end, but you could just as easily total as you go along, if you wish.

## Storage Register Arithmetic

Arithmetic operations can also be performed using the number in the displayed X-register and a number in storage registers  $R_0$  thru  $R_9$ . In storage register arithmetic, answers are placed in the storage register.

To modify a number in one of the  $R_0$  through  $R_9$  storage registers using a number in the displayed X-register:

1. Press **STO**.
2. Press the desired arithmetic operator (**+**, **-**, **×**, or **÷**).
3. Press the applicable number key (**0** thru **9**).

**Example.** Store 6 in register  $R_3$  and increment it by 5.

Press	Display	
6	6.	
<b>STO</b> <b>3</b>	6.00	Store 6 in register $R_3$ .
5	5.	
<b>STO</b> <b>+</b> <b>3</b>	5.00	Adds 5 to the 6 in register $R_3$ .
<b>RCL</b> <b>3</b>	11.00	Confirms that 11 is stored in register $R_3$ .

Now subtract 4 from the number in register  $R_3$ .

4	4.	
<b>STO</b> <b>-</b> <b>3</b>	4.00	Subtracts 4 from 11 in $R_3$ .
<b>RCL</b> <b>3</b>	7.00	Confirms the answer.

Then multiply register  $R_3$  by 8.

8	8.	
<b>STO</b> <b>×</b> <b>3</b>	8.00	The value in register $R_3$ times 8.00.
<b>RCL</b> <b>3</b>	56.00	Confirms the answer.

Finally, divide register  $R_3$  by 14.

14	14.	
<b>STO</b> <b>÷</b> <b>3</b>	14.00	The value in register $R_3$ divided by 14.00.
<b>RCL</b> <b>3</b>	4.00	Confirms the answer.

You'll find storage register arithmetic very useful for saving steps when writing programs or in calculations requiring several different subtotals.

## Clearing Operations

You have already learned how to clear an unwanted entry to the displayed X-register by pressing **CLX**. This replaces any number in the display with zero. For your convenience there are three additional clearing operations.

### Clearing Storage Registers and the Stack

To clear storage registers  $R_0$  through  $R_9$  and the stack, press **f** **CLR**. To clear storage registers  $R_0$  through  $R_9$  and the stack, press **g** **CLR**.

### Clearing Prefix Keys

Pressing **BS** (back step) in RUN mode will clear a prefix key.\* For example, if you accidentally press **f** or **g** when you didn't want either, simply press **BS** to undo your mistake.

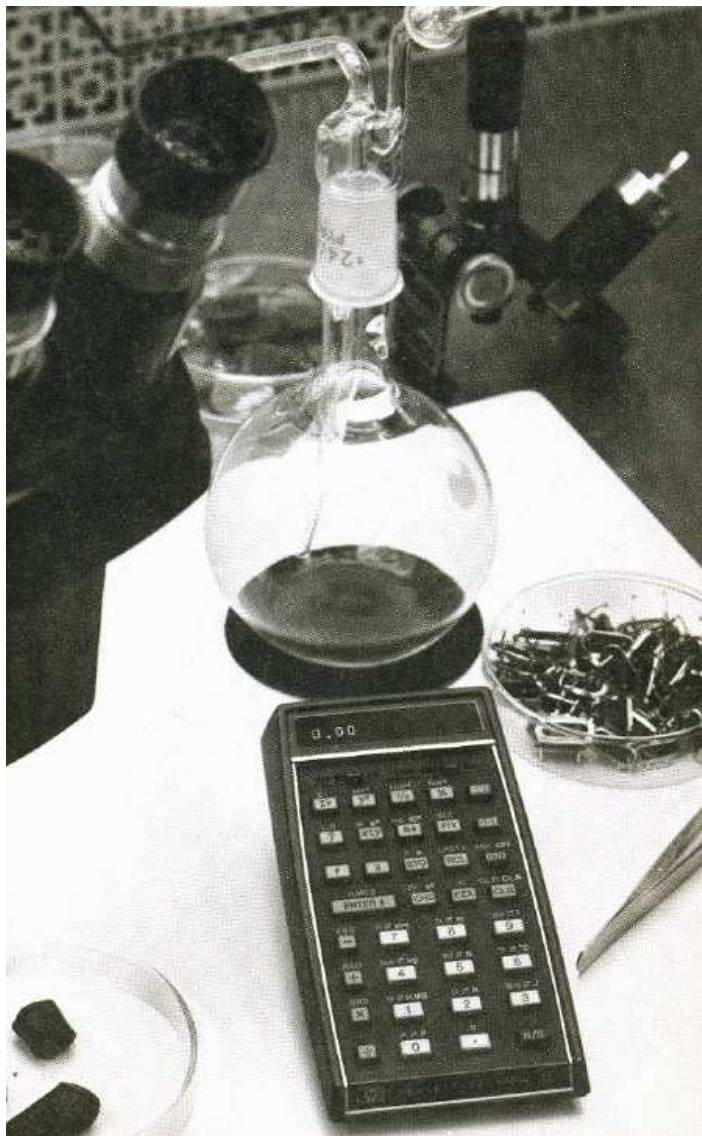
If you pressed **f** when you meant to press **g** or vice versa, the mistake can be corrected merely by pressing the correct prefix key and proceeding from there.

Pressing **BS** also clears these additional keys:

**RCL** **□**, **STO** **□**, **STO**, **RCL**, **FIX**, **SC**, **GTO**

which act as prefix keys for their respective operations.

\*Pressing **BS** also sets the program pointer to the top of memory. This operation is explained thoroughly in section 5.



## Section 2

### Fundamental Operations

You'll find that the basic control operations and elementary functions discussed in this section are useful in a wide variety of applications.

#### The Display Format

Numbers are always maintained internally to 10 significant digits and are stored in scientific notation. For example, 1,268,417 is stored in the calculator like this

1.268417000 06

where 06 represents the exponent of 10 ( $1,268,417 = 1.268417000 \times 10^6$ ).

When the calculator is switched ON, numbers appear rounded to two places to the right of the decimal point for easier reading. For example, 1,000 is displayed as:

1000.00

And .034 is displayed as:

.03

But 100,000,000 is displayed as:

100000000.0

because there is no room in the display for two places to the right of the decimal point.

You can easily change the number of digits shown to the right of the displayed decimal point by pressing **FIX** [0] thru [9], where the digit key is the desired number of places. For example, if you press **FIX** [5], numbers will be displayed rounded to five places to the right of the decimal point. Now key in the number 1.23456789 and look at it using each of these 10 display formats.

<b>FIX</b> [9]	1.234567890	<b>FIX</b> [4]	1.2346
<b>FIX</b> [8]	1.23456789	<b>FIX</b> [3]	1.235
<b>FIX</b> [7]	1.2345679	<b>FIX</b> [2]	1.23
<b>FIX</b> [6]	1.234568	<b>FIX</b> [1]	1.2
<b>FIX</b> [5]	1.23457	<b>FIX</b> [0]	1.

Notice that the display “rounds up” if the first *hidden* digit is 5 or greater.

Scientific notation can also be specified as a display format and is helpful when you are working with very large or small numbers. Simply press **f** **SCI** [0] thru [9], where the digit key once again is the desired number of places to the right of the decimal point. For example, 31557600 in scientific notation with four places to the right of the decimal point (**f** **SCI** [4]) appears in the display like this:

3.1558 07

Once again, the display “rounds up” if the first hidden digit is 5 or greater.

If a number is too large or too small for the “FIX” format specified, the calculator automatically displays the number in scientific notation (**f** **SCI** [9]) displaying all 10 significant digits.

For example, press **FIX** [2], and square 500,000.

Press	Display
500000	500000.
<b>ENTER</b> *	500000.00
<b>x</b>	2.500000000 11 $2.5 \times 10^{11}$ in scientific notation.

Now divide 1 by 10000.

Press	Display
1	1.
<b>ENTER</b> *	1.00
10000	10000.
<b>÷</b>	1.000000000-04 $1 \times 10^{-4}$ in scientific notation.

Notice that in both cases, when the calculator switches to scientific notation to display a number, 10 significant digits are displayed. Also, remember that the original display setting is unchanged; numbers within the display format range will still appear in **FIX** [2] format.

**Note 1:** Throughout this handbook, all answers shown assume that the display has been set to **FIX** [2] format unless the particular example specifies otherwise.

**Note 2:** Values having a magnitude greater than  $9.999999999 \times 10^{99}$  are approximated by  $\pm 9.999999999 99$ . Values having a magnitude less than  $10^{-99}$  are approximated by zero.

## Negative Numbers

To key in a negative number, key in the positive value and press **CHS** (change sign).

For example, to key in -12:

Press	Display
12	12.
<b>CHS</b>	-12.

**CHS** changes the sign of the number in the displayed X-register. For example, to change the previous number back to a positive 12:

Press	Display	
<b>CHS</b>	12.	The sign is changed.
<b>ENTER</b> *	12.00	Terminates the number so you can go on to the next example.*

\*A detailed discussion on number termination can be found in appendix B.

## Entering Exponents

Numbers multiplied by a power of 10 can always be keyed in directly using the **EEX** (enter exponent) key. For example, to key in the number of seconds in a year,  $3.1536 \times 10^7$ :

Press	Display
3.1536	3.1536
<b>EEX</b> 7	3.1536 07
<b>ENTER</b>	31536000.00

## Powers of Ten

To key in powers of 10, simply press **EEX** and then the desired exponent. For example, the number of angstroms in a centimeter is 100,000,000 ( $10^8$ ). To key in this number:

Press	Display
<b>EEX</b>	1. 00
8	1. 08
<b>ENTER</b>	100000000.00

## Negative Exponents

To key in negative powers of 10, key in the number, press **EEX** and then **CHS** to change the sign of the exponent. Then key in the power of 10. For example, to key in Planck's constant—roughly  $6.625 \times 10^{-27}$ :

Press	Display
6.625	6.625
<b>EEX</b>	6.625 00
<b>CHS</b>	6.625 -00
27	6.624 -27
<b>ENTER</b>	6.625000000 -27

## Pi

Since the constant  $\pi$  is used in so many applications, it is provided in the calculator for you. To enter this constant to the X-register, simply press **f**  $\pi$ . When the value of  $\pi$  is entered, the stack automatically behaves as if  $\pi$  was a new number.

**Example:** Find the area of a circle with a 3-foot radius.

$$\text{Area} = r^2 \times \pi$$

Press	Display	
3	3.	
<b>ENTER</b>	3.00	
<b>x</b>	9.00	Calculates $3^2$ .
<b>f</b> $\pi$	3.14	Recalls $\pi$ to the X-register and $3^2$ moves to Y.
<b>x</b>	28.27	The answer.

## LAST X

In addition to the four stack registers and the 20 data storage registers, an additional register, the LAST X register, is provided for your convenience. The last displayed number before a calculation is automatically stored here. To recall the last displayed number, simply press **f** **LAST X**.

## To Avoid Reentering Numbers

The LAST X register is useful in calculations where a number occurs more than once.

$$7.32 + 3.65$$

**Example:** Calculate  $\frac{7.32 + 3.65}{3.65}$ .

Press	Display	
7.32	7.32	
<b>ENTER</b>	7.32	
3.65	3.65	
<b>+</b>	10.97	Intermediate answer.
<b>f</b> <b>LAST X</b>	3.65	Recalls 3.65 to X.
<b>÷</b>	3.01	The answer.

### To Correct Input Errors

LAST X is also useful to recover from accidental mistakes, such as pressing the wrong arithmetic key or keying in the wrong number.

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

Press	Display
12	12.
ENTER	12.00
3.157 ÷	3.80
f LAST X	3.16
×	12.00
2.157 ÷	5.56

Oops! You made a mistake.

Retrieves the last entry.

You're back at the beginning.

The right answer.

### Basic Functions

You'll find the basic functions that follow are useful in a wide variety of applications and, in fact, they are combined in numerous ways in the applications presented in the remaining part of this guide.

#### Reciprocal

The  $\frac{1}{x}$  key calculates the reciprocal of the contents of the displayed X-register.

**Example:** Find the reciprocal of .0625.

Press	Display
.0625	.0625
$\frac{1}{x}$	16.00

The answer.

#### Square and Square Root

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

**Example:** Find the square root of 289.

Press	Display
289	289
$\sqrt{x}$	17.00

The answer.

To calculate the square of the value in the displayed X-register, press  $x^2$ .

**Example:** Calculate  $18^2$ .

Press	Display
18	18.
$x^2$	324.00

The answer.

Note that previous to this we squared numbers by pressing ENTER  $\times$ . However, pressing  $x^2$  has the advantage of altering the X-register *without losing the number in the T-register.*

### Percentage

To find the percentage of a number:

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

The pictures below show the operation of the stack when you press %.

	Before	After
Press: %	T 4.00	T 4.00
	Z 3.00	Z 3.00
	Y 150.00	Y 150.00
	X 50.00	X 75.00
		LAST X
		$\frac{(x)(y)}{100}$

**Example:** Find 25% of 78.

Press	Display
78	78.
ENTER	78.00
25	25.
%	19.50

The answer.

The % key does not alter the contents of the Y-register and the stack does not drop. This allows you to add the percentage to or subtract it from the base number in Y.

Press	Display
+	97.50

This is equal to  $19.50 + 78$  which is  $1.25 \times 78$ .

## Summations

Summation calculations use the  $\Sigma+$  (Sigma plus) key to total numbers for use in other calculations. These summations are particularly useful when working with vectors and statistics.

## Accumulating Results

The  $\Sigma+$  key totals both X- and Y-register numbers automatically. The number of entries is displayed and is also stored in data storage register  $R_{.0}$ . The accumulated results are stored in registers  $R_{.1}$  thru  $R_{.5}$ .

Register	Data
$R_{.0}$	n Number of entries.
$R_{.1}$	$\Sigma x$ Summation of x values.
$R_{.2}$	$\Sigma x^2$ Summation of $x^2$ values.
$R_{.3}$	$\Sigma y$ Summation of y values.
$R_{.4}$	$\Sigma y^2$ Summation of $y^2$ values.
$R_{.5}$	$\Sigma xy$ Summation of xy values.

Each time the  $\Sigma+$  key is pressed, these summations are updated and restored in the data storage registers. You can sum x values alone by clearing the Y-register before starting.

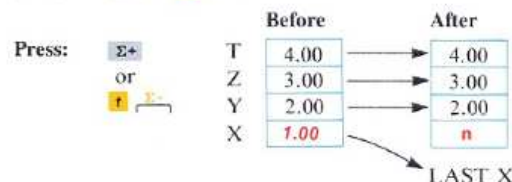
**Note:** Before using the  $\Sigma+$  key these registers should be cleared along with the stack by pressing  $\square$  CLR. Otherwise you will be accumulating new data onto old.

## Deleting Data

If you key in an incorrect value and you have not pressed  $\Sigma+$ , press CLR and key in the correct value. If you have already totaled the value or values by pressing  $\Sigma+$ , reenter the incorrect data into the X- and Y-registers and press  $\square$  LAST X.

**Note:** If one value of an x, y data pair is incorrect, both values must be deleted and reentered.

The pictures below show you the operation of the stack when you press  $\Sigma+$  or  $\square$  LAST X.



The X-register is also prepared for a new data entry (just as if you had pressed CLR or ENTER). This is primarily so that you can recreate your last data point (x and y value) simply by pressing  $\square$  LAST X.

**Example:** Find  $\Sigma x$ ,  $\Sigma x^2$ ,  $\Sigma y$ ,  $\Sigma y^2$ , and  $\Sigma xy$  for the x and y values below.

y	7	5	9
x	5	3	8

Press	Display
$\square$ CLR	0.00
7 ENTER	7.00
5 $\Sigma+$	1.00
5 ENTER	5.00
3 $\Sigma+$	2.00
9 ENTER	9.00
8 $\Sigma+$	3.00

First pair is summed; n=1.

The second pair is summed; n=2.

All the data is summed; n=3.

Press	Display	
<b>RCL</b> $\cdot$ 1	16.00	Sum of x values from register $R_{\cdot 1}$ .
<b>RCL</b> $\cdot$ 2	98.00	Sum of squares of x values from register $R_{\cdot 2}$ .
<b>RCL</b> $\cdot$ 3	21.00	Sum of y values from register $R_{\cdot 3}$ .
<b>RCL</b> $\cdot$ 4	155.00	Sum of squares of y values from register $R_{\cdot 4}$ .
<b>RCL</b> $\cdot$ 5	122.00	Sum of xy values from register $R_{\cdot 5}$ .

### Sums of Products

The summation  $\Sigma xy$  in register  $R_{\cdot 5}$  can also be used to calculate the sums of products.

**Example:** Suppose you sold 12 items at \$1.58 each, 8 items at \$2.67 each, and 16 items at \$ .54 each. The total sale price is:

$$(12 \times 1.58) + (8 \times 2.67) + (16 \times .54)$$

Press	Display	
<b>9</b> <b>CLR</b>	0.00	Clears registers $R_{\cdot 0}$ thru $R_{\cdot 9}$ and the stack.
12 <b>ENTER</b>	12.00	
1.58 <b><math>\Sigma\cdot</math></b>	1.00	$R_{\cdot 5}$ contains the first product.
8 <b>ENTER</b>	8.00	
2.67 <b><math>\Sigma\cdot</math></b>	2.00	$R_{\cdot 5}$ contains the sum of the first two products.
16 <b>ENTER</b>	16.00	
.54 <b><math>\Sigma\cdot</math></b>	3.00	All products have been summed.
<b>RCL</b> $\cdot$ 5	48.96	The answer.

### **RCL** **$\Sigma\cdot$**

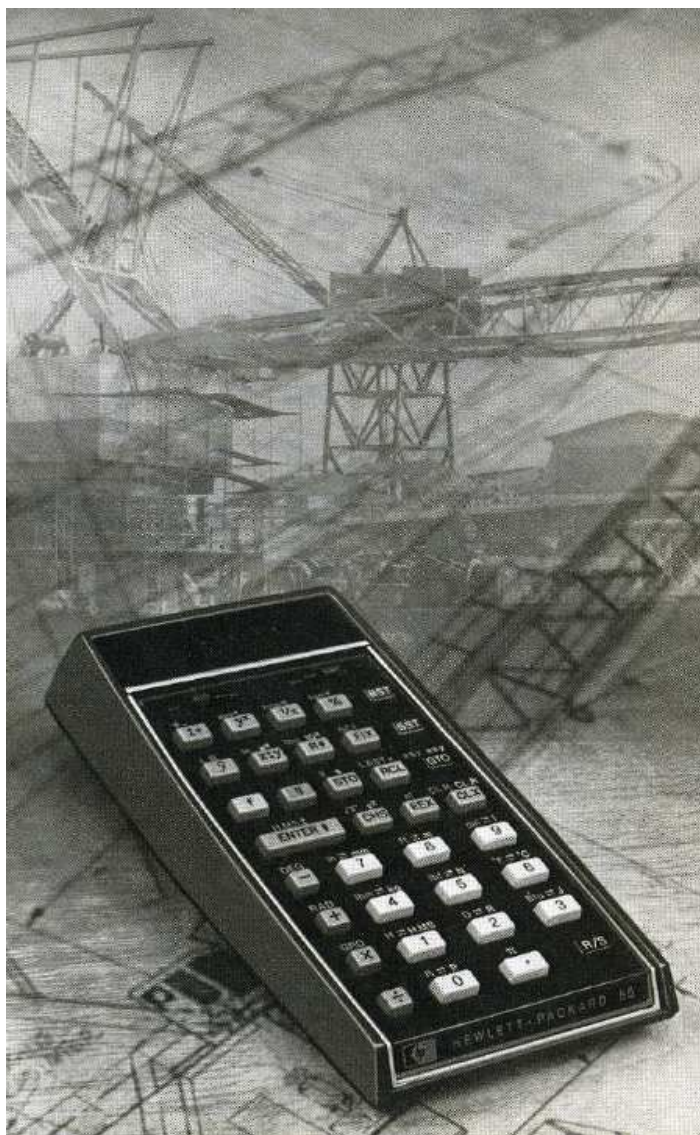
To recall the sum of the x values and the sum of the y values to the X- and Y-registers respectively, press **RCL**  **$\Sigma\cdot$** . The previous value in Y is lost. The previous value in X is stored in the LAST X register. Registers T and Z are unchanged. This feature is useful when summing vectors.

**Note:** Press **STO**  **$\Sigma\cdot$**  to accumulate the first data pair following **RCL**  **$\Sigma\cdot$** . Then continue accumulations using the  **$\Sigma\cdot$**  key as you did before.

Practical applications in statistics and vector arithmetic using the  **$\Sigma\cdot$**  key can be found on pages 57 and 52 respectively.

### Choosing Data Registers

During  **$\Sigma\cdot$**  calculations, registers  $R_{\cdot 0}$  through  $R_{\cdot 5}$  should not be used for data storage as errors in accumulations will result. Registers  $R_{\cdot 6}$  through  $R_{\cdot 9}$  and  $R_{\cdot 6}$  through  $R_{\cdot 9}$ , however, are still available.



## Section 3

# Keyboard Calculations

The functions and operations discussed in this section complete the description of the calculator's capabilities in RUN mode. Undoubtedly you'll find many more applications for these functions than we are able to present here.

## Logarithms

Logarithms are particularly useful to the scientist and engineer. For example, sound level is measured on a logarithmic scale (in decibels). Another example is the Richter scale, used by seismologists to measure the magnitude of earthquakes, which operates on a logarithmic basis so there is a 10-fold increase in magnitude from one unit to the next. And there are many other relationships that are logarithmic.

## Natural Logarithms

The HP-55 calculates the natural logarithm (base e) of the value in X by pressing  $\ln$ . To raise e (2.718281828) to the power of the value displayed, press  $e^x$ . This is the natural antilog of the value in X. After either of these operations the stack automatically lifts the result prior to accepting a new data entry.

**Example:** Suppose you wish to use an ordinary barometer as an altimeter. After measuring the sea level pressure (30 inches of mercury) you climb until the barometer indicates 9.4 inches of mercury. How high are you?

**Method:** Although the exact relationship of pressure and altitude is a function of many factors, a reasonable approximation is given by:

$$\begin{aligned} \text{Altitude (feet)} &= 25000 \ln \frac{30}{\text{pressure}} \\ &= 25000 \ln \frac{30}{9.4} \end{aligned}$$

Press	Display	
25000	25000.	
ENTER	25000.00	
30	30.	
ENTER	30.00	
9.4	9.4	
$\div$	3.19	$30 \div 9.4$
$\ln$	1.16	$\ln 3.19$
$\times$	29012.19	The answer.

We suspect you are on Mt. Everest!

### Common Logarithms

The HP-55 calculates the common logarithm (base 10) of the value in X when  $\log$  is pressed. To calculate  $10^x$ , the common antilog of the value in X, press  $10^x$ . Again, the stack automatically lifts the result prior to accepting a new data entry.

**Example:** The 1906 San Francisco earthquake, with a magnitude of 8.25 on the Richter scale, is estimated to have been about 105 times greater than the Nicaragua quake of 1972. What would be the magnitude of the latter on the Richter scale?

**Method:** Magnitude =  $8.25 - \log 105$ .

Press	Display	
8.25	8.25	
ENTER	8.25	
105	105.	
$\log$	2.02	$\log 105$
$-$	6.23	The answer.

### Exponentials

The  $y^x$  key raises the base number in the Y-register to the power in the displayed X-register using the formula  $y^x = e^{x \ln y}$ .

**Example 1:** Calculate  $7^{15}$ .

Press	Display	
7	7.00	
15 $y^x$	4.747561529 12	The answer.

**Example 2:** Calculate  $12^5$ .

Press	Display	
12	12.	
ENTER	12.00	
5	5.	
$y^x$	248832.00	The answer.

**Example 3:** Calculate  $5^{2.45}$ .

Press	Display	
5	5.	
ENTER	5.00	
2.45	2.45	
$y^x$	51.58	The answer.

The  $y^x$  function does not work for:

1.  $y < 0$
2.  $y = 0$  and  $x \leq 0$

### Roots.

The  $y^x$  key in conjunction with the  $\sqrt{x}$  key enables you to take roots of a number, since  $\sqrt[n]{y} = y^{\frac{1}{n}}$ .

**Example:** Calculate  $\sqrt[4]{789} = 789^{\frac{1}{4}}$

Press	Display	
789	789.	
ENTER	789.00	
4	4.	
$\sqrt{x}$	.25	The reciprocal of 4.
$y^x$	5.30	The answer.

## Factorial

The keys  $\text{f}$   $\text{m}$  permit you to handle permutations and combinations with ease. To calculate the factorial of an integer in the displayed X-register, press  $\text{f}$   $\text{m}$ .

**Example:** Calculate the number of ways six people can line up for a photograph.

**Method:**  $P_6^6 = 6! = 6 \times 5 \times 4 \times 3 \times 2 \times 1$ .

Press	Display
6	6.
$\text{f}$ $\text{m}$	720.00

The answer.

The calculator overflows for factorials greater than 69.

## Angular Functions

Your HP-55 calculator provides you with 6 trigonometric functions. In addition, you have your choice of angular modes, various angle conversions, and angle addition and subtraction in degrees, minutes, seconds, and hundredths of a second.

### Angular Modes

The HP-55 calculates trigonometric functions using angles expressed in degrees, radians, or grads (360 degrees =  $2\pi$  radians = 400 grads). When the calculator is switched ON, it automatically is set in degrees mode. To set radians mode, press  $\text{f}$   $\text{RAD}$ . To set grads mode, press  $\text{f}$   $\text{GRD}$ . To switch back again to degrees mode, press  $\text{f}$   $\text{DEG}$ .

**Note:** An angle in degrees is not automatically converted to radians when you press  $\text{f}$   $\text{RAD}$ . Neither is an angle in radians converted to grads when you press  $\text{f}$   $\text{GRD}$ . Only the mode is changed.

In order to convert an angle from degrees to radians and back, see Angular Mode Conversion on page 47.

## Trigonometric Functions

The HP-55 calculates six trigonometric functions:

sin	$\sin^{-1}$
cos	$\cos^{-1}$
tan	$\tan^{-1}$

To calculate a sine, cosine, or tangent:

1. Key in the angle.
2. Press  $\text{f}$ .
3. Press  $\text{sin}$  or  $\text{cos}$  or  $\text{tan}$ .

To calculate arc sine, arc cosine or arc tangent:

1. Key in the value.
2. Press  $\text{g}$ .
3. Press  $\text{sin}^{-1}$  or  $\text{cos}^{-1}$  or  $\text{tan}^{-1}$ .

Try the following examples to help familiarize yourself with the basic procedures. In each case the angular mode is set as part of the example, although this is not necessary if you are already in the correct mode when you work the problem.

**Example 1:** Find the cosine of  $35^\circ$ .

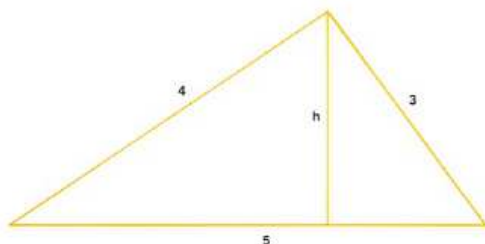
Press	Display	
$\text{f}$ $\text{DEG}$	0.00	Degrees mode is set.
35	35.	
$\text{f}$ $\text{cos}$	.82	The answer.

**Example 2:** Find the arc sine of .964 in grads.

Press	Display	
$\text{f}$ $\text{GRD}$	0.00	Grads mode is set.
.964	.964	
$\text{g}$ $\text{sin}^{-1}$	82.87	The answer in grads.

**Example 3:** In the triangle below, find the altitude (h).

**Method:**  $h = 3 \times \sin[\tan^{-1}(4/3)]$



Press	Display	
$\text{f DEG}$	0.00	Set degrees mode.
4 ENTER	4.00	
3 $\div$	1.33	4/3.
$\text{g tan}^{-1}$	53.13	$\tan^{-1} 1.33$ .
$\text{f sin}$	.80	$\sin 53.13$ .
3 $\times$	2.40	The answer.

### Angle Conversion

$\text{g} \text{HMS}$  is the key sequence used to convert times in decimal hours (H) to times in hours, minutes, seconds, and hundredths of a second (H.MS). However it can also be used to convert angles in decimal degrees to angles in degrees, minutes, seconds and hundredths of a second regardless of the angular mode. Simply key in an angle in decimal degrees (i.e., 30.5, 43.625, etc.) and press  $\text{g} \text{HMS}$ . The converted angle is in the following form:



Similarly, angles expressed in degrees, minutes, seconds and hundredths of a second can be converted to their decimal equivalents. Simply key in the angle in the above format and press  $\text{f H}$ .

**Example.** Convert  $38^\circ 8' 56.7''$  to its decimal equivalent.

Press	Display	
38.08567	38.08567	Key in the angle.
$\text{f H}$	38.15	Answer in decimal degrees.

**Example.** Convert 42.57 degrees to degrees, minutes, and seconds.

Press	Display	
42.57	42.57	Key in the angle.
$\text{FIX } 6$	42.570000	Reset display for easier readout.
$\text{g HMS}$	42.341200	$42^\circ 34' 12.00''$

### Angular Mode Conversion

To convert an angle in degrees to radians, press  $\text{g} \text{R}$ . To convert an angle in radians to degrees, press  $\text{f D}$ . (Set to  $\text{FIX } 2$  display format.)

**Example:** Convert  $27.55^\circ$  to radians.

Press	Display
27.55	27.55
$\text{g R}$	.48

**Example:** Convert 4 radians to degrees.

Press	Display
4	4.
$\text{f D}$	229.18

To convert angles from degrees to grads, divide the decimal degree angle by .9. To convert angles from grads to degrees, multiply the angle by .9.

**Example:** Convert 46.7 degrees to grads.

Press	Display
46.7	46.7
ENTER	46.70
.9 $\div$	51.89

**Example:** Convert 95 grads to radians.

Press	Display	
95	95.	
ENTER	95.00	
.9 $\times$	85.50	Convert angle to degrees first.
$\frac{\pi}{180}$	1.49	Convert angle to radians.

### Angle Arithmetic in Degrees, Minutes, and Seconds

Press  $\frac{\pi}{180}$  (hours, minutes, seconds, plus) to add angles (or times) in degrees, minutes, seconds and hundredths of a second in the X- and Y-registers regardless of the angular mode. The angles must be entered in the form . . . d.mmsshh . . . , as explained under Angle conversion, p. 46. Change the display format by pressing **FIX** **6** to see the answer in the . . . d.mmsshh . . . form.

**Example:** Find the sum of 45° 10' 50.76" and 44° 49' 10.95".

Press	Display	
<b>FIX</b> <b>6</b>	0.000000	Change display format.
45.105076	45.105076	
ENTER	45.105076	
44.491095	44.491095	
$\frac{\pi}{180}$	90.000171	Answer is 90° 00' 01.71".

Press  $\frac{\pi}{180}$  (hours, minutes, seconds, minus) to subtract the angle in the X-register from the angle in the Y-register in degrees, minutes, seconds, and hundredths of a second. The angles again must be in the form . . . d.mmsshh . . . .

**Example:** Calculate 97° 47' 17.4" - 23° 14' 57.65".

Press	Display	
<b>FIX</b> <b>6</b>	0.0000	Change display setting.
97.47174	97.47174	
ENTER	97.471740	
23.145765	23.145765	
$\frac{\pi}{180}$	74.321975	The answer is 74° 32' 19.75".

As in any other arithmetic problem, the stack automatically drops after the calculation. The X-register value is stored in the LAST X register. The Y-register value is lost. Reset the display by pressing **FIX** **2** before continuing.

### Conversions

Your HP-55 calculator allows you to convert from polar coordinates to rectangular coordinates and vice versa. It also enables you to convert to or from several English and metric units.

Press  $\frac{\pi}{180}$  before a conversion in the direction of the gold arrow. Press  $\frac{\pi}{180}$  before a conversion in the direction of the blue arrow.

### Coordinate Conversion

Two functions are provided for rectangular/polar coordinate conversion. To convert from rectangular coordinates to polar coordinates:

1. Key in the y value
2. **ENTER** it into the Y-register.
3. Key in the x value.
4. Press  $\frac{\pi}{180}$  to convert in the direction of the blue arrow.

The magnitude r value appears in the displayed X-register. The angle  $\theta$  value is in the Y-register in the prevailing angular mode. To see the  $\theta$  value, press  $\frac{\pi}{180}$ . The calculator uses the following equations for this conversion:

$$\theta = \tan^{-1} \frac{y}{x} \quad r = \sqrt{x^2 + y^2}$$

To convert from polar coordinates to rectangular coordinates:

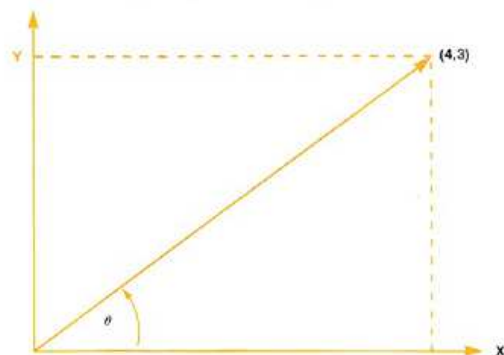
1. Key in the value for  $\theta$  in the prevailing angular mode.
2. **ENTER** it into the Y-register.
3. Key in the value for  $r$ .
4. Press **f** **→R←** to convert in the direction of the gold arrow.

The  $x$  value appears in the displayed X-register. The  $y$  value is in the Y-register. To see the  $y$  value, press **x↔y**. The calculation uses the following equations for this conversion:

$$x = r \cos \theta$$

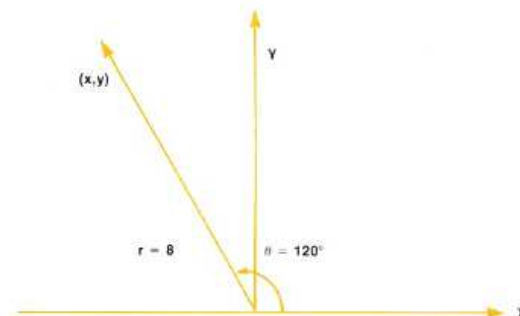
$$y = r \sin \theta$$

**Example 1.** Convert rectangular coordinates (4,3) to polar form with the angle expressed in degrees.



Press	Display	
<b>f</b> <b>DEG</b>	0.00	Set degrees mode.
3 <b>ENTER</b>	3.00	The y coordinate is entered.
4	4.	The x coordinate is keyed in.
<b>g</b> <b>→P←</b>	5.00	Magnitude.
<b>x↔y</b>	36.87	Angle in degrees.

**Example 2.** Convert polar coordinates (8, 120°) to rectangular coordinates.

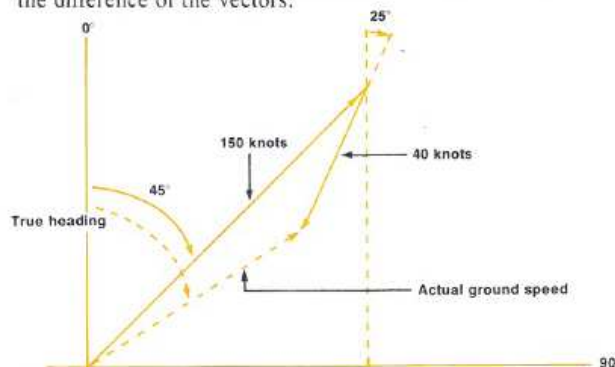


Press	Display	
120	120	
<b>ENTER</b>	120.00	
8	8.	
<b>f</b> <b>→R←</b>	-4.00	x coordinate.
<b>x↔y</b>	6.93	y coordinate.

By combining the polar/rectangular conversion functions with the accumulation function, **Σ+**, vectors can be added or subtracted. The resultant vectors, in rectangular coordinates are stored in registers  $R_{11}$  and  $R_{13}$ .

**Example:** An aircraft has a true air speed of 150 knots and an estimated heading of  $45^\circ$ . There is a head wind of 40 knots at  $25^\circ$ . What is the actual ground speed and true heading?

**Method:** The true heading and actual ground speed are equal to the difference of the vectors:



Press	Display	
$\text{C}\text{L}\text{R}$	0.00	Clears registers $R_{0.0}$ thru $R_{9.9}$ .
$\text{D}\text{E}\text{G}$	0.00	Set degrees mode.
45 $\text{ENTER}$	45.00	$\theta$ for the 1st vector is entered.
150	150.	$r$ for the 1st vector is keyed in.
$\text{R}\rightarrow$	106.07	Converted to rectangular.
$\Sigma+$	1.00	Accumulated in $R_{1.1}$ and $R_{3.3}$ .
25 $\text{ENTER}$	25.00	$\theta$ of 2nd vector is entered.
40	40.	$r$ of 2nd vector is keyed in.
$\text{R}\rightarrow$	36.25	Converted to rectangular.
$\text{R}\leftarrow$	0.00	Subtracted from 1st vector.
$\text{RCL } \Sigma+$	69.81	Recalls both $R_{1.1}$ and $R_{3.3}$ .
$\text{R}\leftarrow$	113.24	Actual ground speed.
$\text{X}\text{Y}$	51.94	True heading.*

\*Remember for later statistics calculations, you must press  $\text{STO } \Sigma+$  (or turn the calculator OFF and then ON again) to accumulate the first data pair since  $\text{RCL } \Sigma+$  was used in this example.

## English/Metric Conversion

The English/metric conversions are located above the digit keys [3] thru [9]. Using these functions, you can convert a displayed  $x$  value into its metric equivalent and back again. Each conversion is color-coded to the  $\text{f}$  and  $\text{g}$  keys.

To convert from English to metric:

1. Key in the value in English units.
2. Press  $\text{g}$  (because you want to convert from left to right as shown by the blue arrows).
3. Press the appropriate digit key [3] thru [9].

To convert from metric to English:

1. Key in the value in metric units.
2. Press  $\text{f}$  (in order to convert from right to left as shown by the gold arrows).
3. Press the appropriate digit key [3] thru [9].

The following examples will help you understand each conversion.

**Example 1.** What is the joule rating of a 5,000 Btu air-conditioner?

Press	Display	
5000	5000.	English value is keyed into X.
$\text{g}$	5275279.27	Metric equivalent.

**Example 2.** If an object has a mass of 40 kilograms, what is the equivalent mass in pounds?

Press	Display	
40	40.	Metric value keyed into X.
$\text{f}$	88.18	English equivalent.


**Example 3.** If the force of a vector is 100 Newtons, what is the force in pounds?

Press	Display	
100	100.	Metric value keyed into X.
$\text{f}$	22.48	English equivalent.


**Example 4.** Convert 12 inches to millimeters.

Press	Display	
12	12.	English value is keyed into X.
	304.80	Metric equivalent.


**Example 5.** What is the Celsius (centigrade) temperature if the thermometer reads 68° Fahrenheit?

Press	Display	
68	68.	English value is keyed into X.
	20.00	Metric equivalent.

**Example 6.** Convert 107 meters to feet.



Press	Display	
107	107.	Metric value is keyed into X.
	351.05	English equivalent.

**Example 7.** How many U.S. gallons is 5 liters?


Press	Display	
5	5.	Metric value is keyed into X.
	1.32	English equivalent.

The conversions for the squares or cubes of several of the units provided can also be calculated easily by performing the conversion two or three times.

**Example 8.** How many square meters is a 9000 square foot office building?

Press	Display	
9000	9000.	
	2743.20	
	836.13	Square meters.




**Example 9.** How many cubic millimeters are there in 5 cubic inches?

Press	Display	
5	5.	
	127.00	
	3225.80	
	81935.32	Cubic millimeters.

## Statistics

With values in registers R<sub>0</sub> thru R<sub>5</sub>, you can use your HP-55 to calculate the mean and standard deviation of both the x and y values. You can also calculate the coefficients of the linear equation  $y = A + Bx$  using the least squares method and then calculate  $\hat{y}$  for as many values of x as you like.


## Mean

With the data totaled in registers R<sub>0</sub>, R<sub>1</sub> and R<sub>3</sub>, calculate  $\bar{x}$  and  $\bar{y}$  by pressing  . The mean of x is displayed. The mean of y is in the Y-register. Press  to see  $\bar{y}$ .

Your HP-55 calculates both  $\bar{x}$  and  $\bar{y}$  using the formulas:

$$\bar{x} = \frac{1}{n} \sum_{i=1}^n x_i$$

$$\bar{y} = \frac{1}{n} \sum_{i=1}^n y_i$$

The data must be totaled using the  key or the needed summations can be stored directly in registers R<sub>0</sub> (n), R<sub>1</sub> (Σx), and R<sub>3</sub> (Σy).

**Note:** For all statistical calculations, the data need be accumulated only once. The accumulations are kept intact in registers R<sub>0</sub> through R<sub>5</sub> until those registers are cleared. If Σx<sup>2</sup> or Σy<sup>2</sup>, in registers R<sub>2</sub> and R<sub>4</sub> respectively, are greater than 9.99999999 × 10<sup>99</sup> wrong answers will result because these numbers will be approximated by 9.99999999 99.

The illustrations below represent what happens in the stack when you press **f**  $\frac{\square}{\square}$ :

Press: **f**  $\frac{\square}{\square}$

	Before		After
T	1.00	→	1.00
Z	2.00	→	2.00
Y	3.00	→ lost	$\bar{y}$
X	4.00	→	$\bar{x}$
			LAST X

### Standard Deviation

With the data totaled in registers  $R_{.0}$  thru  $R_{.4}$ , calculate  $s_x$  and  $s_y$  by pressing **g**  $\frac{\square}{\square}$ . The standard deviation of  $x$  is displayed. The standard deviation of  $y$  is in the Y-register. Press **xzy** to see  $s_y$ .

The standard deviation of both  $x$  and  $y$  values is calculated using the formulas:

$$s_x = \sqrt{\frac{\sum x^2 - \frac{(\sum x)^2}{n}}{n - 1}}$$

$$s_y = \sqrt{\frac{\sum y^2 - \frac{(\sum y)^2}{n}}{n - 1}}$$

The data can be totaled using the **Σ+** key or the needed summations can be stored directly in registers  $R_{.0}$  ( $n$ ),  $R_{.1}$  ( $\sum x$ ),  $R_{.2}$  ( $\sum x^2$ ),  $R_{.3}$  ( $\sum y$ ), and  $R_{.4}$  ( $\sum y^2$ ).

The illustrations below represent what happens in the stack when you press **g**  $\frac{\square}{\square}$ :

Press: **g**  $\frac{\square}{\square}$

	Before		After
T	1.00	→	1.00
Z	2.00	→	2.00
Y	3.00	→ lost	$s_y$
X	4.00	→	$s_x$
			LAST X

**Example:** In a recent survey to determine the average age and net worth (in millions of dollars) of 10 of the wealthiest people in the U.S., the following data was obtained (sampled). Calculate the average age and value and the standard deviation for each.

Age	Value	Age	Value	Age	Value
62	1200	84	1000	47	1250
58	1500	68	1750	60	1300
62	1450	59	1350	71	1100
73	1950				

Press	Display	
<b>g</b> $\frac{\square}{\square}$	0.00	Clears $R_{.0}$ thru $R_{.9}$ and the stack.
62 <b>ENTER+</b> 1200 <b>Σ+</b>	1.00	Number of data pairs ( $n$ ).
58 <b>ENTER+</b> 1500 <b>Σ+</b>	2.00	
62 <b>ENTER+</b> 1450 <b>Σ+</b>	3.00	
73 <b>ENTER+</b> 1950 <b>Σ+</b>	4.00	
84 <b>ENTER+</b> 1000 <b>Σ+</b>	5.00	
68 <b>ENTER+</b> 1750 <b>Σ+</b>	6.00	
59 <b>ENTER+</b> 1350 <b>Σ+</b>	7.00	
47 <b>ENTER+</b> 1250 <b>Σ+</b>	8.00	
60 <b>ENTER+</b> 1300 <b>Σ+</b>	9.00	
71 <b>ENTER+</b> 1100 <b>Σ+</b>	10.00	
<b>f</b> $\frac{\square}{\square}$	1385.00	Average value.
<b>xzy</b>	64.40	Average age.
<b>g</b> $\frac{\square}{\square}$	290.64	$s_x$ .
<b>xzy</b>	10.10	$s_y$ .

If the 10 people were the 10 *wealthiest people*, the data would have to be considered a population instead of a sample. The relationship between the sample standard deviation ( $s$ ) and the population standard deviation ( $s'$ ) is given in the following equation:

$$s' = \sqrt{\frac{n-1}{n}} \times s$$

Since  $n$  is automatically stored in register  $R_{10}$  when the data is accumulated, it is a simple matter to convert the sample standard deviations, which have already been calculated, to population standard deviations.

If the accumulations are still intact from the previous example in registers  $R_{10}$  thru  $R_{15}$ , you can calculate the population standard deviation this way.

Press	Display	
$\sigma$	290.64	Calculate $s_x$ and $s_y$ .
RCL $\div$ 0	10.00	Recall $n$ .
1 $=$	9.00	Calculate $n-1$ .
RCL $\div$ 0 $\div$	.90	Divide $n-1$ by $n$ .
$\sigma$ $\times$	275.73	$s'_x$ is calculated.
$\times$ Y	10.10	Bring $s_y$ to the X-register.
$\sigma$ LAST Y	.95	Recall conversion factor.
$\times$	9.58	$s'_y$ is calculated.

## Linear Regression

After a group of data points have been totaled in registers  $R_{10}$  thru  $R_{15}$ , you can calculate the coefficients of the linear equation  $y = A + Bx$  using the least squares method by pressing  $\sigma$   $\sigma$ . Naturally, at least two data points must be in the machine before a least squares line can be fitted to them. The  $y$  intercept of the least squares line of the data ( $A$ ) is calculated using the equation:

$$A = \frac{\sum y \sum x^2 - \sum x \sum xy}{n \sum x^2 - (\sum x)^2}$$

The slope of the least squares line of the data ( $B$ ) is calculated using the equation:

$$B = \frac{n \sum xy - \sum x \sum y}{n \sum x^2 - (\sum x)^2}$$

The illustrations below represent what happens in the stack when you press  $\sigma$   $\sigma$ :

	Before	After
Press: $\sigma$ $\sigma$	T 1.00	1.00
	Z 3.00	3.00
	Y 4.00	B
	X 5.00	A
		LAST X

**Example:** A quality control engineer notes a relationship between the amount of chemical added to a batch, and the final concentration of the chemical in the final product. The following data represents the weight in grams added ( $X$ ) and the weight in the final product ( $Y$ ).

y	3	1	5	5	7	8	8.5
x	2	1	6	3	7	6	9

Press	Display	
$\sigma$ $\sigma$	0.00	Clears registers $R_{10}$ thru $R_{15}$ and the stack.
3 ENTER	3.00	
2 $\Sigma+$	1.00	Number of data pairs.
1 ENTER $\Sigma+$	2.00	
5 ENTER	5.00	
6 $\Sigma+$	3.00	
5 ENTER	5.00	
3 $\Sigma+$	4.00	
7 ENTER $\Sigma+$	5.00	
8 ENTER	8.00	
6 $\Sigma+$	6.00	
8.5 ENTER	8.50	
9 $\Sigma+$	7.00	
$\sigma$ $\sigma$	1.22	The $y$ intercept ( $A$ ).
$\times$ Y	.85	The slope of the line.

That is,  $y = 1.22 + .85x$ .

**Linear Estimate**

With the data totaled in registers R<sub>0</sub> thru R<sub>5</sub>, a predicted  $\hat{y}$  can be calculated by keying in an  $x$  value and pressing  $\square$ . This will help you to plot the least squares line.

Press	Display	
0	0.	Key in an $x$ value.
$\square$	1.22	The $y$ intercept again.
5	5.	Key in another $x$ value.
$\square$	5.48	The predicted value for $y$ .

You can calculate predicted  $y$  values for as many  $x$  values as you choose. The line passing through all of these points is the least squares linear regression of the data.

**Coefficient of Determination**

To establish how well the data fits the linear regression, you may want to calculate the coefficient of determination ( $r^2$ ). The coefficient of determination is a value between 0 and 1. At  $r = 0$ , you have no fit. At  $r^2 = 1$ , you have a perfect fit. The traditional equation for  $r^2$  is:

$$r^2 = \frac{[\sum(x - \bar{x})(y - \bar{y})]^2}{[\sum(x - \bar{x})^2][\sum(y - \bar{y})^2]}$$

On your HP-55, however, the most efficient way to calculate  $r^2$  is to use this equivalent equation:

$$r^2 = \left[ \frac{n\sum xy - \sum x \sum y}{n(n-1) s_x s_y} \right]^2$$

**Example:** Calculate  $r^2$  for the previously calculated linear regression.

Press	Display
$\square$ $\square$	1.22
ENTER	1.22
0 $\square$	2.91
$\div$	.93
$\div$	.91
0 $\square$	.83

Since  $r^2 = .83$ , you can assume you have a relatively good fit.



## Section 4

### Using the Timer

With the mode switch set to **TIMER**, your HP-55 can be used as a timer with a range from 0 to 100 hours. The basic operation is simple, as you saw in the introduction. Press **CLX** to clear the timer and **R/S** (*run/stop*) to start and stop it. When running, the X-register increments every .01 seconds with .01% accuracy (about  $\pm 1.5$  seconds in 8 hours). But there are other operations involving the timer.

## Starting the Timer

The timer can be started anywhere within the 0 to 100 hour range. Starting times, however, are keyed into the X-register in RUN mode. The times must be keyed in using the following format:



For example, 43 hours, 17 minutes, 9 seconds and 92 hundredths of a second is keyed in like this:

43.170992

Then, when you switch to **TIMER** mode, the display changes to:

43.17.09 92

If the initial time is an invalid number, the display will show 00.00 00 when you switch to **TIMER** mode. Invalid starting times are negative numbers or any times with more than 99 hours in the hours field, or more than 59 minutes in the minutes field, or more than 59.9999 seconds in the seconds field.

**Note:** When you switch to TIMER mode, all places beyond the sixth decimal place are truncated.

With a starting time keyed in, simply press **R/S** to start the timer, as you did in the introduction.

## Stopping the Timer

The timer is stopped by pressing **R/S** again. If you switch to RUN mode, times are again changed in format to HH.MMSShh. The display automatically changes to **FIX 6** for easier reading.

If you set the mode switch to either RUN or PRGM mode with the timer running, the timer will continue to run. If you then press **R/S**, the timer will stop and the calculator will change to the mode selected. The timer can always be reset to 0.00.00 00 by pressing **CLX** whether the timer is running or not.

## Changing the Display

The **EEEX** key in TIMER mode is used to switch the hundredths digits OFF and ON, whether the timer is running or not. Press **EEEX** once to switch the display of the hundredths digits OFF if you are not interested in watching them flash. Press **EEEX** again to relight these two digit places. The timer calculates times in hundredths regardless of the display setting.

**Note:** Whenever you switch to TIMER mode, these two digit places are lit regardless of the previous setting using the **EEEX** key.

## Taking Splits

You can also store intermediate time readings in registers  $R_0$  thru  $R_9$ . These “splits” are stored by pressing any of the digit keys (**0** thru **9**) while the timer is running. The time reading at that instant is stored in the corresponding register. In TIMER mode, these splits can be recalled merely by pressing the same digit key with the timer stopped. In RUN mode, these times are recalled conventionally by pressing first **RCL** and then the corresponding digit key.

Now let's try an example.

**Example:** Test your eye coordination by trying to take splits precisely at 1 second intervals for 10 consecutive seconds. Then see how well you did. (Switch to TIMER mode for this problem.)

Press	Display	
<b>CLX</b>	00.00.00 00	Zero starting time.
<b>R/S</b>		Display is incrementing.
<b>1</b>	00.00.01 00	
<b>2</b>	00.00.02 00	
<b>3</b>	00.00.03 00	
<b>4</b>	00.00.04 00	Display continues to increment as you press these keys.
<b>5</b>	00.00.05 00	
<b>6</b>	00.00.06 00	
<b>7</b>	00.00.07 00	
<b>8</b>	00.00.08 00	
<b>9</b>	00.00.09 00	
<b>0</b>	00.00.10 00	Finally, stop the timer.
<b>R/S</b>		

Now recall each split to the X-register by pressing the digit keys in succession to see how well you did.

## Adding and Subtracting Times

Often it is convenient to be able to add or subtract times in RUN mode in . . . H.MMSShh . . . format. On your HP-55 you can add two times (or angles) in the X- and Y-registers by pressing

**f** **HMS** **+**.

To subtract a time in the X-register from a time in the Y-register in . . . H.MMSShh . . . format, press **f** **HMS** **-**.

**Example:** If you still have times stored in registers  $R_0$  thru  $R_9$ , find out exactly how well you did by calculating the mean and standard deviation of the **differences** of the stored values. (Switch to RUN mode for this problem.)

Press	Display	
	0.000000	
RCL 0 RCL 9		
$\Sigma +$	1.000000	1st difference is totaled (n=1).
RCL 9 RCL 8		
$\Sigma +$	2.000000	2nd difference is totaled (n=2).
RCL 8 RCL 7		
$\Sigma +$	3.000000	3rd difference is totaled (n=3).
RCL 7 RCL 6		
$\Sigma +$	4.000000	4th difference is totaled (n=4).
RCL 6 RCL 5		
$\Sigma +$	5.000000	5th difference is totaled (n=5).
RCL 5 RCL 4		
$\Sigma +$	6.000000	6th difference is totaled (n=6).
RCL 4 RCL 3		
$\Sigma +$	7.000000	7th difference is totaled (n=7).
RCL 3 RCL 2		
$\Sigma +$	8.000000	8th difference is totaled (n=8).
RCL 2 RCL 1		
$\Sigma +$	9.000000	9th difference is totaled (n=9).
	.000100	If you were consistent.
EEX 4 $\times$	1.000000	Multiply by $10^4$ for easier reading.
	.000000	If you were perfect.
EEX 4 $\times$	.000000	Again, multiply by $10^4$ for easier reading.

## Converting Times

On your HP-55 you can also convert times (or angles) expressed in HH.MMSShh format to decimal hours and back again. Press to convert times in HH.MMSShh format to decimal hours (in the direction of the gold arrow).

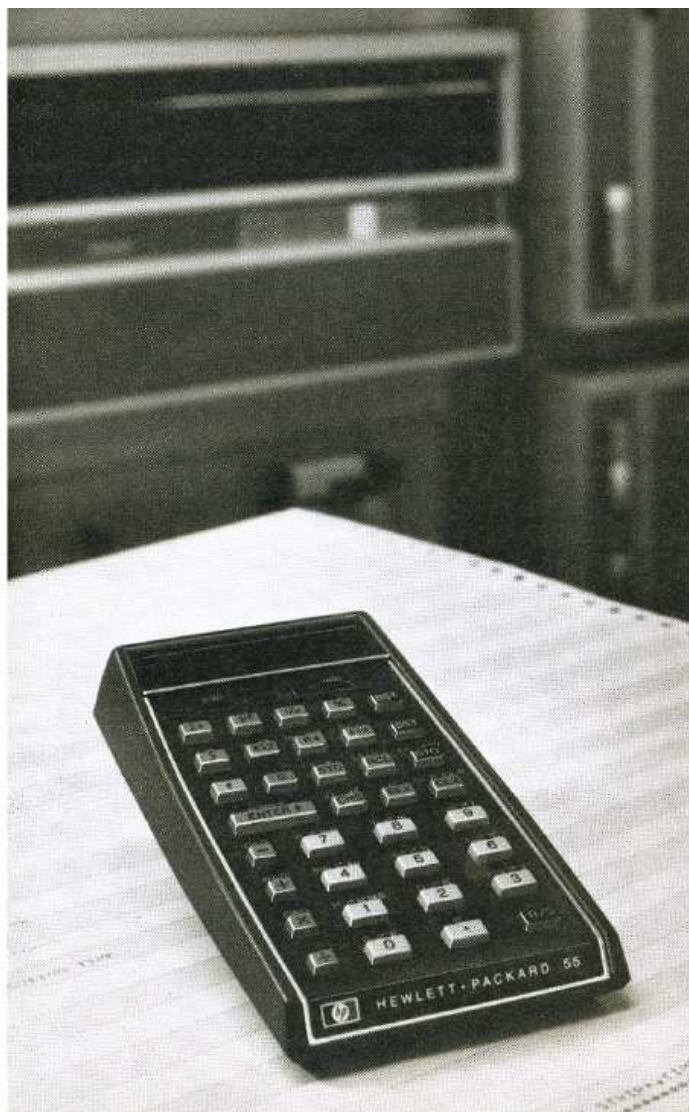
To convert times in decimal hours to HH.MMSShh format (in the direction of the blue arrow), press .

**Example:** Convert 5 hours, 16 minutes, and 27 seconds to decimal hours.

Press	Display
FIX 2	0.00
5.1627	5.1627
	5.27

**Example:** Convert 4.5 hours to hours, minutes, and seconds.

Press	Display
FIX 6	0.000000
4.5	4.5
	4.300000
FIX 2	4.30



## Section 5

# Programming

This section is about programming, where the extra power of your HP-55 is demonstrated. As you know, in RUN mode pressing any key produces an immediate result. However, every operation in RUN mode can be generated in two ways: from the keyboard or from program memory. You set the mode switch of the calculator to PRGM to store operations in program memory for later execution.

**Note:** If you reset the mode switch when the calculator is in the middle of a calculation or a running program, the calculator may **blank out**. To regain control, you must switch the calculator OFF and then ON.

## What Is a Program?

A program is nothing more than a sequence of keystrokes stored in the calculator and executed automatically with the press of a button—one keystroke replacing many. In the previous sections of this handbook, whenever an example was done, *you*, the operator, were programmed. You were asked to press keys in a given sequence to obtain a particular result. In most cases, if the sequence was not followed exactly, the result was not correct. Similarly, in a program, the calculator is given a sequence of keystrokes. The calculator “remembers” the keystroke sequence and can execute it automatically any number of times, and much faster than you could yourself!

What key sequence do you give the calculator? The bulk of every program you write will be the same keys you would press manually in RUN mode to solve your problem. In fact, from the entire keyboard there are only two keys that cannot be given to the calculator for later execution:

**BS** ( *back-step* )

**SST** ( *single-step* )

These two keys are the only active keys in PRGM mode. All other keys pressed in PRGM mode are stored in program memory to be executed later.

The only keys that work differently from the keyboard than they do when executed automatically in a program are:

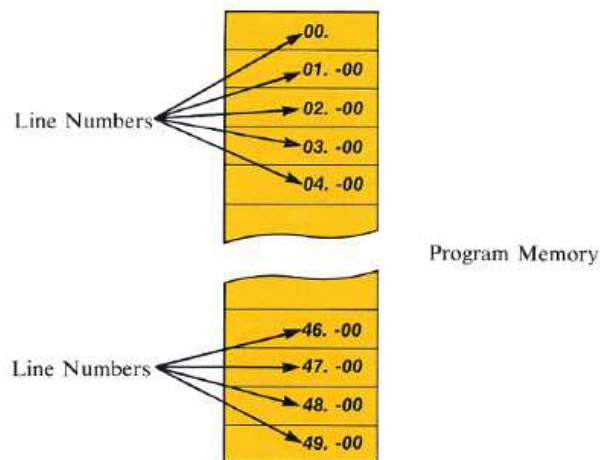
**GTO** (go-to)

**R/S** (run-stop)

These keys control program execution and should be studied carefully. All other keys work exactly the same in a program as they do from the keyboard.

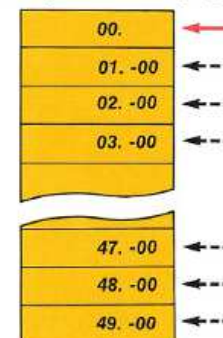
## Program Memory

Before writing a program let's examine program memory. The program memory for the HP-55 consists of 50 lines numbered 00 through 49 as shown below.



Line 00 contains an automatic stop instruction. Every line from 01 to 49 can contain one of your program instructions (keystrokes).

When a program is run, the calculator executes each line sequentially downward by means of a program "pointer."



The calculator executes the instruction at which the program pointer is pointing. The pointer then increments one step downward\* and points to a new instruction. After executing line 49, the pointer automatically returns to line 00 and program execution stops.

## Writing a Program

Now let's write a simple program to calculate the volume of a sphere given the radius. We'll use the formula:  $\text{Volume} = \frac{4}{3} \times \pi \times r^3$ . The keystrokes you would press to solve the problem manually are listed below:

Keys	Comments
<b>ENTER</b>	
<b>3</b>	Calculate $r^3$ .
<b>y<sup>x</sup></b>	
<b>π</b>	Multiply $r^3$ by $\pi$ .
<b>×</b>	
<b>4</b>	Multiply by $4/3$ .
<b>÷</b>	
<b>3</b>	

\*In case of a simple branch, it jumps to the line specified. (Refer to Simple Branching, page 78.)

To turn this key sequence into a program that can be executed automatically, we need to:

1. Set the program pointer.
2. Key in the list of keys.
3. End the program.

### Setting the Program Pointer

Your HP-55 programs do not need starting statements. However, the program pointer must be positioned at the line at which you want the program to begin. Most programs will start at line 00. You can set the program pointer to line 00 by pressing **GTO** **0** **0** (read "go to zero zero") in RUN mode. Similarly, you can set the program pointer to any line in a program in RUN mode by pressing **GTO** and then keying in the desired line number.

**Note:** Always use two digits for designating line numbers following the **GTO** key. For instance, to set the program pointer to line 6 you must press **GTO** **0** **6**.

Invalid addresses are numbers outside the range 00 thru 49. When an invalid address is used in RUN mode, the program pointer does not move and the display is also invalid. In PRGM mode, the **GTO** is omitted and the subsequent key is stored in program memory.

Another way to set the program pointer to line 00 is to press the same key that clears prefix keys: **BST**. This is for your convenience so that you can perform this particular pointer operation in RUN mode by pressing one key instead of three.

### Keying In a Program

To key in a program, switch to PRGM mode. You should see 00 in the display. Now key in the listed keys. They are not executed but instead stored in program memory for later execution. The first key is **ENTER**. When you key it in, the display changes to:

01. 41

The number 01 designates the first line of the program. The number 41 designates the key stored in that line. How can you tell what key it is? Simply count down four rows and find the first key. You should arrive at the **ENTER** key. The codes are simply the number of rows down and the number of keys across.



The digit keys are the exception. Their codes are 00 thru 09 depending on the key. The second key is **3** and the display changes to:

02. 03

This represents the second line of the program which is the digit key **3**. The list of keys for finding the volume of a sphere and their corresponding displays are shown below:

Press	Display
<b>ENTER</b>	01. 41
<b>3</b>	02. 03
<b>y<sup>x</sup></b>	03. 12
<b>f</b>	04. 31
<b>□</b>	05. 83
<b>x</b>	06. 71
<b>4</b>	07. 04
<b>x</b>	08. 71
<b>3</b>	09. 03
<b>÷</b>	10. 81

If there had been a previous program in memory, it would not make any difference. Each key overwrites one line in memory. You never have to clear program memory before keying in a new program.

### Ending a Program

Key in **R/S** (*run/stop*) as the final line (line 11) of your program. When executed in a program, the **R/S** key halts program execution.

Another way to halt program execution is to end your program with **GTO** **0** **0**. This instruction returns the program pointer to line 00, just as it does when pressed in RUN mode. Whenever the calculator executes line 00, it automatically stops. Whenever a program stops, the pointer is set at the last instruction executed (or the last instruction the calculator attempted to execute in the case of an improper operation). Later, you'll learn how to instruct the calculator to go to other lines in your program using similar instructions.

### Running the Program

All programs are executed in RUN mode. To run the sphere volume program, switch to RUN mode, press **BS** to reset the program pointer, key the radius into the X-register, and press **R/S**.

**Example:** Calculate the volume of a sphere with  $r = 10$ . With  $r = 25$ .

Press	Display	
<b>BS</b>	0.00	Reset the program pointer.
10	10.	Radius of the first sphere.
<b>R/S</b>	4188.79	Volume of the first sphere.
<b>BS</b>	4188.79	Reset the program pointer.
25	25.	Radius of the second sphere.
<b>R/S</b>	65449.85	Volume of the second sphere.

**R/S** starts program execution from whatever line the calculator is stopped at with two important exceptions:

1. If the program pointer is at line 00, which cannot contain an instruction, **R/S** starts the program at line 01.
2. If the program pointer is at a **R/S** in a program, it resumes program execution at the line following the **R/S**.

**Note:** **R/S** terminates numbers in the X-register and also clears prefix keys.

### Single Step and Back Step

Before going any further, let's review what we have. Reset the program pointer to line 00, switch to PRGM mode, and press **SST** (*single step*) once. You should see a display like this:

01. 41

Press **SST** again and the display changes to:

02. 03

Now press **BS** (*back step*). You can see what has happened. You are back at line 01. Press **BS** again and you're at line 00. Additional **BS**'s do nothing.

**BS** and **SS** are used to review programs in memory one line at a time. Of course, because these two keys are active in PRGM mode, neither is programmable.

Now use **SS** to review your program. Once you have stepped through it to the end, you can use the **BS** key to reposition the program pointer at line 00 line-by-line, or you can simply switch to RUN mode and press **BS** once.

## Changing or Correcting a Program

Changing or correcting your program is easy with your HP-55 calculator. To show you this, let's change the program you just wrote. Instead of ending it with **R/S**, we'll use **GTO** 0 0. That way, the program pointer will return to line 00 after each running of the program.

The fundamental rule for correcting a program is this: In order to correct a line, you must position the program pointer so that the line *preceding* it is displayed (line 10 in this example).

Keys	Display
<b>ENTER</b>	01. 41
<b>3</b>	02. 03
<b>yx</b>	03. 12
<b>f</b>	04. 31
<b>π</b>	05. 83
<b>x</b>	06. 71
<b>4</b>	07. 04
<b>x</b>	08. 71
<b>3</b>	09. 03
<b>÷</b>	10. 81
<b>R/S</b>	11. 84

Displayed Line  
Line to be Changed

There are two ways to position the program pointer:

1. If you do not know the line number to be changed or if it occurs early in the program, press **BS** until you reach it. Then press **BS** to correctly position the pointer.
2. If you do know the line number, switch to RUN mode and press **GTO** [previous line number]. Valid line numbers are two digit entries from 00 thru 49. Then switch back to PRGM mode.

In this case, switch to RUN mode and press **GTO** 1 0. Then switch back to PRGM mode. Now key in **GTO** 0 0. As a program step, **GTO** and the two digit keys following it are merged to take only one line of program memory. When you press **GTO** in PRGM mode, a dash appears in the middle of the keycode field like this:

11. -

Then when you key in a valid line number, the display changes to show it. In this case, the display should look like this:

11. -00

This new step writes over the old one.

**Note:** In PRGM mode if the **GTO** is followed by an invalid key (i.e., **5**, **R**, etc.), the **GTO** is omitted and the keycode for the subsequent key is stored in program memory and displayed.

Now let's see what effect this change has on program operation. Switch to RUN mode and try the following example.

**Example:** Use the modified program to calculate the volume of a sphere with  $r = 15$ , with  $r = 30$ .

Press	Display	
<b>BS</b>	0.00	Reset the program pointer.
15	15.	Radius of the first sphere.
<b>R/S</b>	14137.17	Volume of the first sphere.
30	30.	Radius of the second sphere.
<b>R/S</b>	113097.34	Volume of the second sphere.

Notice that you do not have to reset the program pointer to line 00 manually before starting a new sphere volume calculation. The program does it for you. This is the advantage of using **GTO** **0** **0** instead of **R/S** to end your programs.

When the calculator is switched ON, program memory is filled with **GTO** **0** **0** instructions. So you do not actually need to end your first program with this instruction; it is already there. If the second program you write is longer than the first, you can again omit the **GTO** **0** **0** instruction—and so on for subsequent programs. If you are unsure in a particular case about whether the instruction is there, you can check using the **SST** key or, to play safe, you can key in **GTO** **0** **0** anyway.

## Branching

You have seen how **GTO** is used in RUN mode to position the program pointer for editing, and in PRGM mode to end your programs. In both cases, the program pointer is rerouted or “branched” to a new line number. The “branch” can be made unconditionally or dependent on the outcome of a comparison of data values in the X- and Y-registers.

## Simple Branching

In a program, **GTO** [line number] branches program execution to the line specified. Program execution continues at the new line with the exception of line 00; at line 00 program execution always halts. The line number must be a valid two digit entry from 00 thru 49. The modified program for calculating sphere volume incorporated a simple branch to line 00. Now let’s write a program that uses a simple branch in another way.

**Writing a Program Using a Simple Branch.** This program calculates a running average of a group of numbers. The simple branch at the end of the program is used to branch around an initializing routine at the beginning. To key in the program, press **BSI** in RUN mode, then set the mode switch to PRGM and key in the following list of keys:

Press	Display
<b>9</b>	01. 32
<b>Cl-R</b>	02. 44
<b>R/S</b>	03. 84
<b>Σ+</b>	04. 11
<b>1</b>	05. 31
<b>1</b>	06. 33
<b>GTO</b> <b>0</b> <b>3</b>	07. -03

In order to run the program, first switch back to RUN mode and press **BSI** again to set the program counter to line 00. Now try the following example.

**Example:** Calculate the average of the following group of numbers.

11, 6, 17, 32, 9

Press	Display	
<b>R/S</b>	0.00	First clear registers R <sub>0</sub> thru R <sub>9</sub> and the stack.
<b>5</b> <b>R/S</b>	5.00	
<b>11</b> <b>R/S</b>	8.00	The average of 5 and 11.
<b>6</b> <b>R/S</b>	7.33	The average of 5, 11, and 6.
<b>17</b> <b>R/S</b>	9.75	The average of 5, 11, 6, and 17.
<b>32</b> <b>R/S</b>	14.20	The average of 5, 11, 6, 17, and 32.
<b>9</b> <b>R/S</b>	13.33	The final average.

Each time a number is keyed in and **R/S** is pressed, the new average is calculated and the program pointer returns to line 03 for a new number.

## Conditional Branching

Often during calculations you need to look at an intermediate answer in order to determine what calculation to perform next. This decision-making capability can also be programmed on your HP-55. The calculator can test for two separate conditions and then branch program execution accordingly.

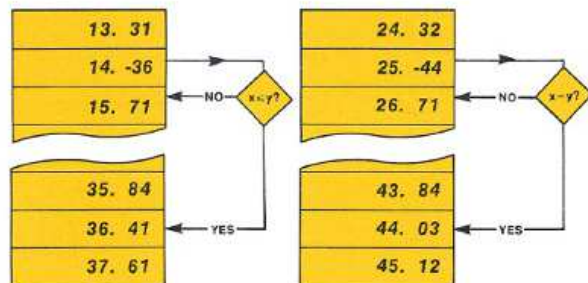
**f**  $\overline{x \leq y}$  [line number] tests the condition: Is the value in X less than or equal to the value in Y? ( $x \leq y$ )

**e**  $\overline{x = y}$  [line number] tests the condition: Is the value in X equal to the value in Y? ( $x = y$ )

**Note:** The comparison tests are made on the 10 digit numbers and exponents actually stored in the registers, not on the displayed values.

In each case, the alternate function of GTO ( $\overline{x \leq y}$ ,  $\overline{x = y}$ ) and the two digit keys following it are combined to take only one line of memory. The prefix keys are not included in the same line.

If the answer is **YES**, the program branches to the line specified. If the answer is **NO**, program execution continues sequentially.



As you can see above in the section of program on the left, the test is made in line 14 to see if the value in the X-register is less than or equal to the value in the Y-register. If the answer is **YES**, the program pointer branches to line 36 and the calculator executes the **ENTER** instruction stored in that line. If it is **NO**, the program pointer continues to line 15 and the calculator executes a **x** instruction instead.

In the section of program on the right, the test is made in line 25 to see if the value in the X-register is equal to the value in the Y-register. If the answer is **YES**, the program pointer branches to line 44 and the calculator enters the **[3]** key. If the answer is **NO**, the program pointer continues sequentially to line 26 and the calculator executes the **x** instruction stored in that line.

**Writing a Program with a Conditional Branch.** The following program calculates the arc sine of an input value x (x must be within the limits of -1 and +1). If the resulting angle in decimal degrees is negative or zero, it adds 360 degrees to it. To key in the program, press **BSI** in RUN mode, then set the mode switch to PRGM and key in the following list of keys:

Press	Display
<b>e</b>	01. 32
$\overline{\sin^{-1}}$	02. 12
<b>[0]</b>	03. 00
<b>x<math>\rightarrow</math>y</b>	04. 22
<b>f</b>	05. 31
$\overline{x \leq y}$ <b>[0]</b> <b>[8]</b>	06. -08
<b>GTO</b> <b>[0]</b> <b>[0]</b>	07. -00
<b>[3]</b>	08. 03
<b>[6]</b>	09. 06
<b>[0]</b>	10. 00
<b>+</b>	11. 61
<b>GTO</b> <b>[0]</b> <b>[0]</b>	12. -00

To run the program, switch to RUN mode, press **BSI** again, and try the following example.

**Example:** Calculate the arc sine of .5 and  $-.5$  in degrees.

Press	Display
<b>1</b> <b>DEG</b>	0.00
<b>.5</b> <b>R/S</b>	30.00
<b>.5</b> <b>CHS</b>	-.5
<b>R/S</b>	330.00

The conditional branch is used to compare the angle to zero. If it is less than or equal to zero, program execution branches to line 08 and 360 is added to the angle. If it is greater than zero, program execution branches to line 00 and stops.

## Debugging your Programs

Even the most experienced programmer finds "bugs" in his programs. These bugs range from mistakes in the original equations to mistakes in keying in the program. Wherever they occur, they need to be corrected and the HP-55 is designed to make this error-checking process as easy as possible.

### Program Stops

Many times a "bug" in a program will stop program execution. To help you identify why the calculator stopped in the middle of your program, all possible program stops are described below.

**Executing a **R/S**.** The execution of a **R/S** in a program halts program execution at the **R/S**.

**Executing Line 00.** Whenever line 00 is executed in a program, program execution halts at line 00.

**Pressing Any Key.** Pressing any key (even accidentally) halts program execution. If a program has been stopped by pressing a key, be careful not to restart program execution in the middle of a digit entry key sequence within the program or between a prefix key and the corresponding operation. Use **BS** or **SST** to reposition the program pointer in either of these cases.

**Overflow and Underflow.** Program execution halts when any register overflows (numbers with a magnitude greater than  $9.99999999 \times 10^{99}$ ). If the overflow appears in the X-register, it is easy to determine the operation that caused the overflow by switching to PRGM mode and identifying the code in the display. Occasionally, however, the overflow will occur in one of the data storage registers and occasionally in the Y-register. If your program seems to have stopped arbitrarily and you are sure that you did not press any keys, check these other registers.

If an underflow occurs in a register (numbers with a magnitude less than  $10^{-99}$ ), zero is substituted for the number; a running program continues execution normally in this case.

**Flashing Display Stops.** Errors that cause a flashing display, if executed in a program, also stop the program. Stop the flashing by pressing any key. You can then identify the reason for the stop by switching momentarily to PRGM mode to see the keycode of the improper operation. A list of these operations can be found on the inside back cover of this handbook.

### Single-Step Execution

One easy way to discover mistakes in your programs is to slow down program execution using the **SST** key in RUN mode. In RUN mode, the **SST** key executes your program one step at a time. If only a portion of your program seems to have bugs, move the program pointer to a nearby line number using the **GTO** key and press **SST** from there.

### Common Mistakes

The mistakes you are most likely to make with your HP-55 are listed here for your convenience.

1. Forgetting that prefix keys are not combined with conditional branch instructions when writing your program.
2. Omitting a prefix key or using the wrong prefix key for a calculation.
3. Losing the T-register contents because the stack has lifted a terminated number.
4. Performing a trigonometric function in wrong angular mode.

5. Trying to perform a calculation involving both the X-and Y-registers with the numbers in the opposite registers because **x/y** was not pressed.
6. Failing to key in both digits following a branch instruction.
7. Positioning the program pointer at the wrong line in memory before an editing operation.

## General Information

### Accessories

Please check to see that all the standard accessories listed below have been included with your HP-55.

#### Standard Accessories

Your HP-55 comes complete with one each of the following standard accessories:

Battery Pack  
 Battery Charger (115/230 Vac)  
 Travel Safety Case  
 Zipper Case  
*HP-55 Owner's Handbook*  
*HP-55 Quick Reference Guide*  
 Programming Worksheet Pad

#### Optional Accessories

Other accessories, including software application packs, are specified on the Accessory Order Form in the Important Information Envelope. Optional accessories include:

Optional Accessory	Model/Part No.
Reserve Power Pack	82004A
Security Cradle	82007A
Field Case	82006A
Extra Programming Worksheet Pads	9320-2940
HP-55 Mathematics Programs	00055-66001
HP-55 Statistics Programs	00055-66002

### Battery Operation

A rechargeable battery pack is provided with your calculator. Be sure to fully charge the battery pack before portable use of your calculator. A fully charged battery pack provides approximately 3 hours of continuous operation. By turning the power OFF when the calculator is not in use, the HP-55's battery pack should easily last throughout a normal working day. You can extend battery operation time by reducing the number of digits in the display. If the wait between entries is extensive, press **□** between calculations. Then press **CLX** prior to starting a new calculation.

**Note:** If you use your HP-55 extensively in field work or during travel, you may want to order the HP 82004A Reserve Power Pack, consisting of a battery charging attachment and spare battery pack. This enables you to charge one pack while using the other.

## Recharging and AC Line Operation

To avoid any transient voltage from the charger, the HP-55 should be turned OFF before plugging it in. It can be turned ON again after the charger is plugged into the power outlet and used during the charging cycle.

A discharged battery will be fully charged after being connected to the charger for a period of 14 hours; overnight charging is recommended.

If desired, the HP-55 can be operated continuously from the ac line. The battery pack is in no danger of becoming overcharged.

The procedure for using the battery charger is as follows:

1. Make sure the line-voltage select switch on the battery charger is set to the proper voltage. The two line voltage ranges are 86 to 127 volts (for U.S.) and 172 to 254 volts.

### CAUTION

Your HP-55 may be damaged if it is connected to the charger when the charger is not set for the correct line voltage.

2. Turn the HP-55 power switch to OFF.
3. Insert the battery charger plug into the rear connector of the HP-55 and insert the power plug into a live power outlet.

### CAUTION

Your HP-55 battery pack may be damaged if the re-charger is not pushed all the way into the calculator.

4. Set the mode switch to RUN.
5. Set the power switch to ON. You should see a display of 0.00.
6. Set the power switch to OFF if you do not want to use the calculator while it is charging.

7. At the end of the charging period, you may continue to use your HP-55 with ac power or proceed to the next step for battery-only operation.

### CAUTION

The use of a charger other than the HP 82002A Battery Charger (or the equivalent charger for operation outside the U.S.) may result in damage to your calculator.

8. With the power switch set to OFF, disconnect the battery charger from both the power receptacle and the HP-55.

## Battery Pack Replacement

To replace your battery pack use the following procedure:

1. Set the power switch to OFF and disconnect the battery charger.
2. Slide the two battery-door latches toward the side of the calculator.



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

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





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

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



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



## Appendix B

### Additional Operating Information

#### Automatic Stack Lift

In order to remember when a number is lifted in the stack following a new number entry and when it is not, we would like to present a concept which, previous to this, has only been implied: number termination.

The operations on your calculator can generally be divided into two classes: the number building operations and number terminating operations. The number building operations are:


0 thru 9  
.  
CHS  
EEX

These keys are used to key in numbers.

*Every other operation is a number terminating operation.* Whenever you build a number, you must somehow tell the calculator that you are through keying in the number—that the number is terminated. For example, if you key in the number 123, the calculator does not know if the number is terminated. If you now key in the number 456, you would have the number 123456. And if you then press **CHS**, you would have the number -123456. However, if 123 had been terminated, it would have been lifted in the stack automatically and you would have two numbers 123 in the Y-register, and -456 in the X-register.

This feature enables us to make a simple rule for the automatic stack lift:

**If the number is terminated, the stack lifts it upon the entry of a new number.**

There are only four number terminating operations which are exceptions to this rule, **CLX**, **ENTER+**, **Σ+** and **f** .

**CLX** replaces the number in the displayed X-register with zero and prepares the X-register for a new number. The new number then writes over the zero in X without affecting the other registers.

**ENTER** also prepares the X-register for a new number by terminating the old number and copying it into the Y-register. A new number then writes over the number in the X-register without lifting the stack.

**Σ+** and also **Σ-** prepare the X-register for a new number. They return the number of data points entered (n) to the displayed X-register but this number is overwritten by the next number keyed in.

## Calculating Range

The HP-55 performs all calculations by using a 10-digit number and a power of 10. This abbreviated form of expressing number using powers of 10 is called scientific notation; i.e.,  $23712.45 = 2.371245 \times 10^4$  in scientific notation. Numbers are always represented internally to 10 digits regardless of how many digits are displayed.

## Underflow

If a result develops that is too small in magnitude to be carried in a register ( $< 10^{-99}$ ), the register is set to zero; a running program would continue execution.

## Overflow

If a computation develops a magnitude that exceeds the capacity of a register ( $> 9.9999999999$ ), the register is set to all 9's (with appropriate sign), the largest magnitude expressible in a register; a running program halts execution on overflow.

## Temperature Range

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

# Calculator Troubleshooting

## CAUTION

Calculator can be damaged by **strong static charge**.

## Blank Display

If the display blanks out, turn the HP-55 **OFF**, set the mode switch to **RUN**, and turn the HP-55 back **ON**. If 0.00 does not appear in the display, check the following:

1. Examine the battery pack to see if it is discharged and whether it is making proper contact with the calculator.
2. If the display is still blank, try operating the HP-55 from the ac line.
3. With the battery charger connected to the HP-55, make sure the charger is plugged into a live ac outlet.
4. If the display is still blank, the HP-55 is defective. (Refer to warranty information that follows.)

## Multiple Decimal Point Display

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

1. Operate from ac power
2. Charge the battery pack
3. Insert a fully charged battery pack

## Blurring Display

During execution of a stored program, the display continuously changes and is purposely illegible to indicate that the program is running. When the program stops, the display is steady.

## Flashing Display

The display flashes when any of several improper operations are attempted. Pressing any key stops the flashing without performing the key function. The complete list of improper operations can be found on the inside back cover of this handbook.

## Battery Failure

If the battery won't hold a charge, it may be defective. If the warranty is in effect, return to Hewlett-Packard according to the shipping instructions that follow. If the battery pack is out of warranty, use the Accessory Order Form provided with your HP-55 to order a replacement.

## Warranty

The HP-55 is warranted against defects in materials and workmanship for one (1) year from date of delivery to the original purchaser. During the warranty period, Hewlett-Packard will repair or, at its option, replace components that prove to be defective, when the calculator is returned, shipped prepaid, to a Hewlett-Packard Customer Service Facility. (Refer to Shipping Instructions.)

This warranty does not apply if the calculator has been damaged by accident or through misuse or as a result of service or modification by any person other than at an authorized Hewlett-Packard Customer Service Facility.

No other warranty is expressed or implied. Hewlett-Packard is not liable for consequential damages.

Beyond the one-year warranty period, your HP-55 will be repaired for a moderate charge. Return the HP-55 along with the battery pack, recharger and travel case. (Refer to Shipping Instructions.) If only the battery pack is defective, simply order a replacement on the Accessory Order Form provided.

## Shipping Instructions

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

1. Your HP-55 with battery pack, recharger and travel case.
2. A completed Service Card.

If a battery pack is defective and within warranty, return:

1. Only the defective battery pack.
2. A completed Service Card.

**Note:** The serial number of your calculator may be found by removing the battery pack.

Send items to be returned to the address nearest you shown on the Service Card, after packaging them safely. Should other problems or questions arise regarding service, please call the applicable service telephone number on the Service Card, or, if inside the U.S., call **Advanced Products Division, Customer Service Department**, at (408) 996-0100.

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3. Pressing  $f \ln$  with  $x \leq 0$ .
4. Pressing  $f \log$  with  $x \leq 0$ .
5. Pressing  $y^x$  with either:  $y < 0$ , or:  $y = 0$  and  $x \leq 0$ .
6. Pressing  $f n!$  with  $x$  a non-integer value or  $x < 0$ .
7. Pressing  $g \sin^{-1}$  with  $|x| > 1$ .
8. Pressing  $g \cos^{-1}$  with  $|x| > 1$ .
9. Pressing  $f e^x$  with  $x < 0$ .
10. Pressing  $f \frac{x}{n}$  with  $n \leq 0$ .
11. Pressing  $g \frac{1}{n}$  with  $n \leq 1$ .
12. Pressing  $f \frac{1}{n}$  or  $\frac{1}{n}$  with  $n \sum x^2 - (\sum x)^2 = 0$ .
13. Pressing  $f \frac{1}{n}$  or  $\frac{1}{n}$  with  $n \leq 0$ .



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