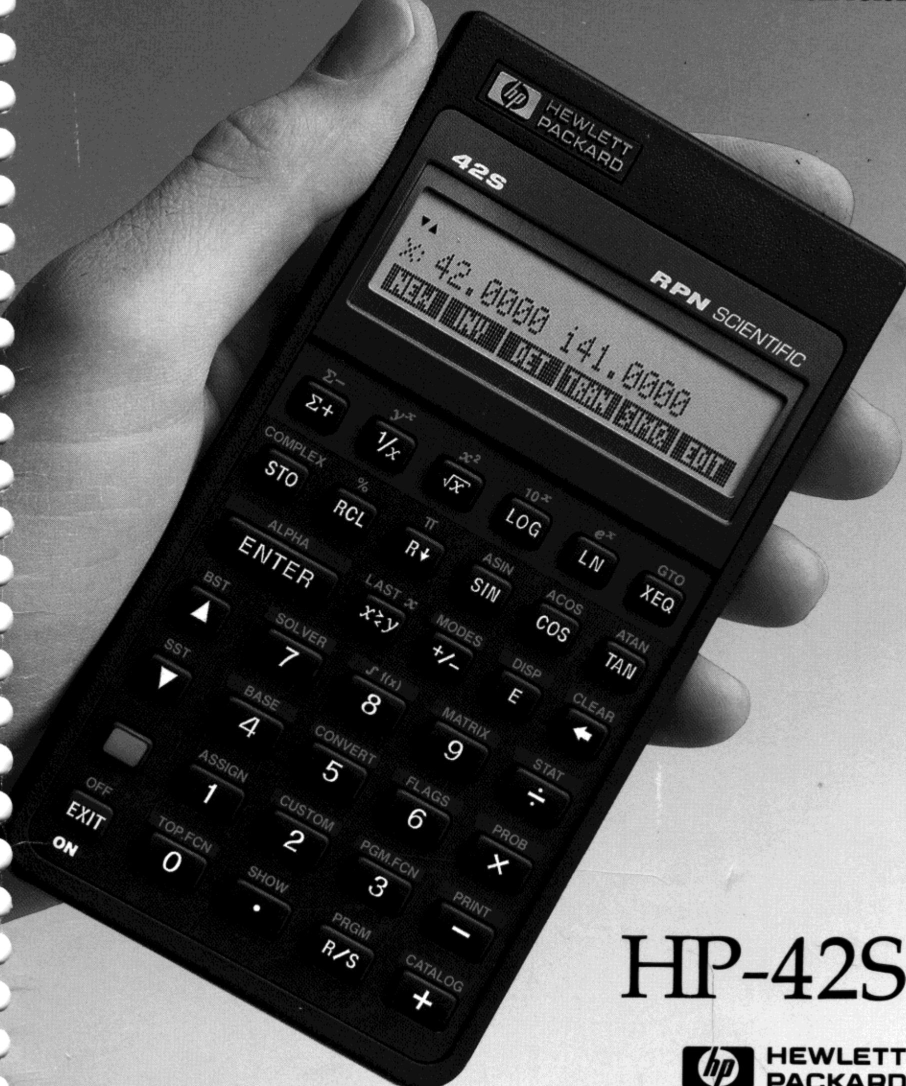
HEWLETT-PACKARD

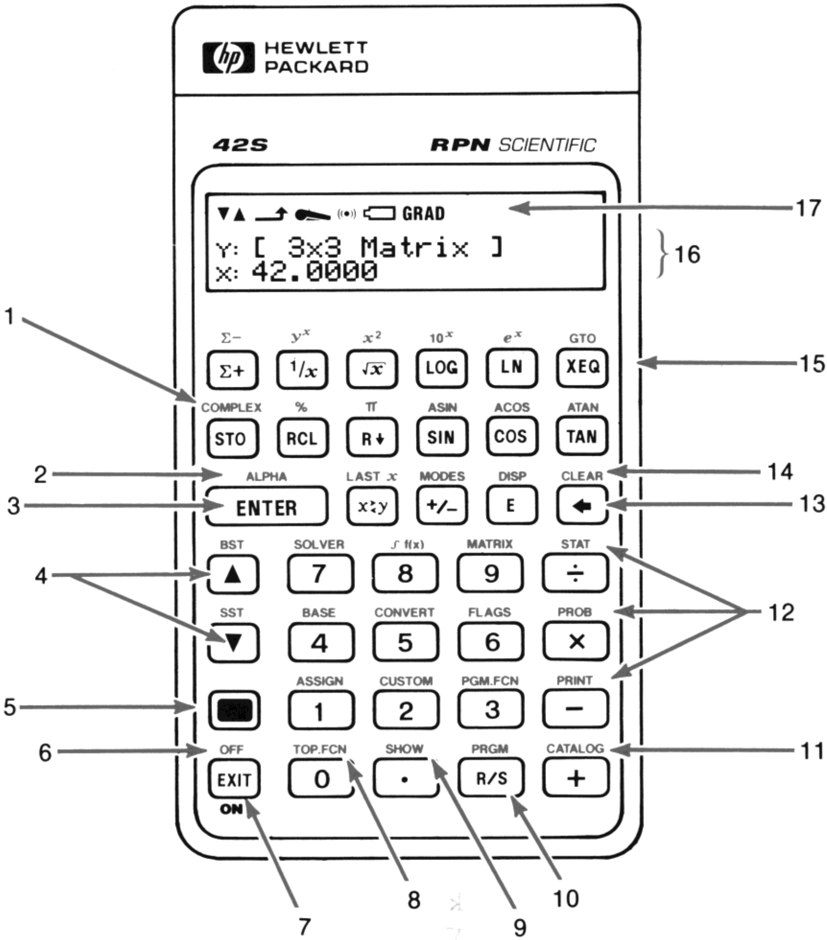
RPN Scientific Calculator

Owner's Manual



HP-42S

HEWLETT PACKARD



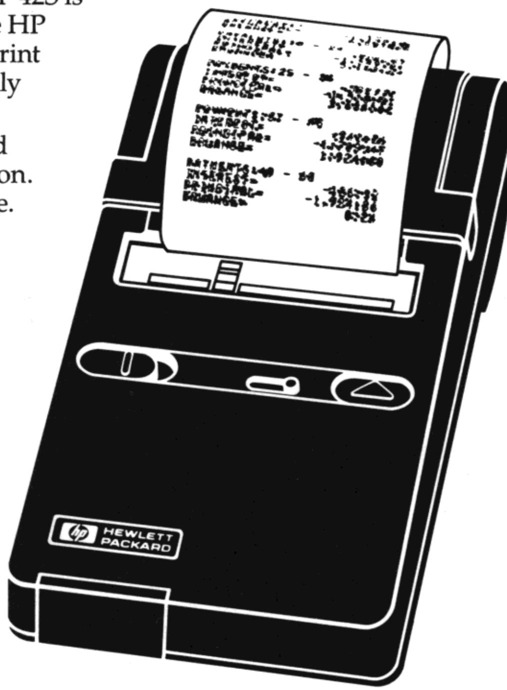
1. Converts to/from complex numbers.
2. Menu for typing characters.
3. Enters a number.
4. Moves up/down through a menu or program.
5. Shift key.
6. Calculator OFF.
7. Exits current menu or mode.
8. Top-row functions.
9. Shows full precision of number.
10. Run/stop program.
11. Catalogs of functions, programs, and variables.
12. Menu-selection keys.
13. Backspace.
14. Functions for clearing.
15. Menu keys (top row).
16. Two-line display.
17. Display annunciators.

HEWLETT-PACKARD

For Your HP-42S: An Invisible Link for Visible Results

An added bonus to using the HP-42S is seeing your work on paper. The HP Infrared Printer (82240A) will print all your steps as you work or only what you tell it to.

The printer is cordless – infrared signals make the print connection. No cords clutter your workspace. Four AA alkaline batteries give the HP Infrared Printer go-anywhere portability. Or, to extend battery life, plug in the optional AC adapter.



Accessories

Printer Adapters

U.S./Canada	82241A
Japan	82241AJ
Europe	82241AB
UK	82241AU
Australia	82241AG

Thermal Printing Paper

Black printing, 6 rolls per box	82175A

Leather Cases

For the HP-42S		*For the HP Infrared Printer*	
Black	92169K	Black	92169G
Brown	92169L	Brown	92169H
Burgundy	92169M	Burgundy	92169J

Application Book for the HP-42S

Programming Examples and Techniques (00042-90020)

- Solving problems in science, engineering and business with these built-in applications:
  - the equation-solving function
  - integration
  - matrices
  - statistics
- Using the equation-solving and integration functions in programs
- Enhancing HP-41 programs for the HP-42S (with examples)
- Building plots and graphics with the HP-42S
- Printing plots and graphics with the HP Infrared Printer

For More Information

In the U.S.A., visit your nearest HP dealer for additional information on calculator accessories or a demonstration of Hewlett-Packard professional calculators. For the location and number of the dealer nearest you, call toll-free 800-752-0900.

For items your local dealer does not carry, and for information about availability and prices of accessories for calculators which are no longer in production, call toll-free 800-538-8787. Please refer to Call Code P280 when ordering. MasterCard, Visa and American Express cards are welcome.

Outside the U.S.A., contact your local HP sales office. It is listed in your telephone directory.

U.S.A.:
Hewlett-Packard Co.
Corvallis Division
1000 NE Circle Blvd.
Corvallis, OR 97330

Canada:
Hewlett-Packard (Canada) Ltd.
6877 Goreway Drive
Mississauga, Ontario
L4V 1M8

Europe, North Africa, Middle East:
Hewlett-Packard S.A.
7, rue du Bois-du Lan
P.O. Box 364
CH-1217 Meyrin 1
Geneva
Switzerland

Other countries:
Hewlett-Packard Intercontinental
3495 Deer Creek Road
Palo Alto, California 94304
U.S.A.

Hewlett-Packard Corporate Offices
3000 Hanover Street
Palo Alto, California 94304
U.S.A.

Note: Product availability subject to change without notice.

HEWLETT PACKARD

Printed in U.S.A. 8/88

HP-42S

Owner's Manual

HEWLETT PACKARD

Edition 1 June 1988
Reorder Number 00042-90001

Notice

For warranty and regulatory information for this calculator, see pages 262 and 265.

This manual and any keystroke programs contained herein are provided **"as is"** and are subject to change without notice. **Hewlett-Packard Company makes no warranty of any kind with regard to this material or the keystroke programs contained herein, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose.** Hewlett-Packard Co. shall not be liable for errors or for incidental or consequential damages in connection with the furnishing, performance, or use of this manual or the keystroke programs contained herein.

Corvallis Division
1000 N.E. Circle Blvd.
Corvallis, OR 97330, U.S.A.

Printing History

Edition 1 June 1988 Mfg. No. 00042-90002

Welcome to the HP-42S

Your HP-42S reflects the superior quality and attention to detail in engineering and manufacturing that have distinguished Hewlett-Packard products for nearly 50 years. Hewlett-Packard stands behind this calculator: we offer accessories, worldwide service, and expertise to support its use (see inside the back cover).

Hewlett-Packard Quality

Our calculators are made to excel, to last, and to be easy to use.

- This calculator is designed to withstand the usual drops, vibrations, pollutants (smog, ozone), temperature extremes, and humidity variations that it may encounter in normal, everyday worklife.
- The calculator and its manual have been designed and tested for ease of use. We selected spiral binding to let the manual stay open to any page, and we added many examples to highlight the varied uses of this calculator.
- Advanced materials and permanent, molded key lettering provide a long keyboard life and a positive feel to the keyboard.
- CMOS (low-power) electronics and the liquid-crystal display allow the HP-42S to retain data while it is off and let the batteries last a long time.
- The microprocessor has been optimized for fast and reliable computations. The calculator uses 15 digits internally, then rounds to 12 digits for precise results.
- Extensive research has created a design that has minimized the adverse effects of static electricity, a potential cause of malfunctions and data loss in calculators.

Features

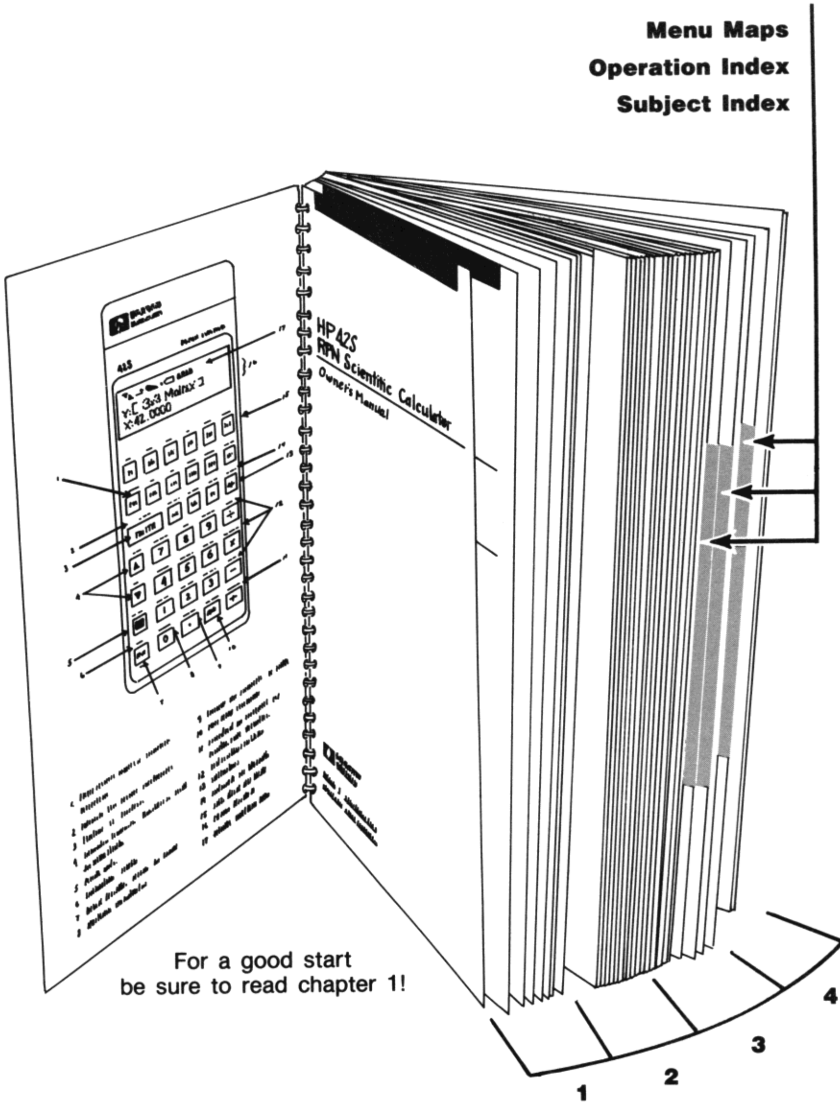
The feature set of this calculator reflects needs and wishes we solicited from customers. The HP-42S features:

- Built-in applications:
  - A solver (root finder) that can solve for any variable in an equation.
  - Numeric integration for calculating definite integrals.
  - Matrix operations, including a Matrix Editor, a solver for simultaneous linear equations, and many other useful matrix functions.
  - Statistical operations, including curve fitting and forecasting.
  - Base conversions, integer arithmetic, and binary manipulation of hexadecimal, decimal, octal, and binary numbers.
- Complex numbers and vector functions.
- Graphic display control functions.
- Menus that can be customized.
- The ability to run programs written for the HP-41C and HP-41CV calculators.
- Over 7,200 bytes of memory for storing programs and data.
- An infrared printer port for printing calculations, programs, data, and graphics using the HP 82240A Infrared Printer.
- Catalogs for reviewing and using items stored in memory.
- An easy-to-use menu system that uses the bottom line of the display to label the top row of keys.
- Reverse Polish Notation (*RPN*) operating logic for the most efficient solutions to complicated problems.
- Keystroke programming with branching, looping, tests, and flags.
- A two-line, 22-character, alphanumeric display with adjustable contrast.

Menu Maps

Operation Index

Subject Index



Part 1: Basic Operation

Part 2: Programming

Part 3: Built-In Applications

Part 4: Appendixes and Reference

Contents

Part 1: Basic Operation

Part 2: Programming

Part 3: Built-In Applications

Part 4: Appendixes and Reference

Part 1

Basic Operation

1

Getting Started

This chapter provides you with a detailed orientation to the HP-42S. You'll learn how to:

- Use menus to access calculator functions.
- Clear information from calculator memory.
- Key in numbers and do arithmetic.
- Change the way numbers are displayed.
- Key in alphanumeric data with the ALPHA menu.
- Use catalogs to review the contents of calculator memory.

Important Preliminaries

Power On and Off; Continuous Memory

To turn on the HP-42S, press [EXIT]. Notice that **ON** is printed below the key.

To turn the calculator off, press ■ [OFF]. That is, press and release the shift key, ■, then press [EXIT] (which has OFF printed above it). Since the calculator has *Continuous Memory*, turning it off does not affect any information you've stored.

After about 10 minutes of inactivity, the calculator turns itself off to conserve battery power. When you turn the calculator on again, you can resume working right where you left off.

Under most conditions, calculator batteries last well over a year. If you see the low-battery symbol () in the display, replace the batteries as soon as possible. Refer to appendix A for details and instructions.

Regular and Shifted Keystrokes

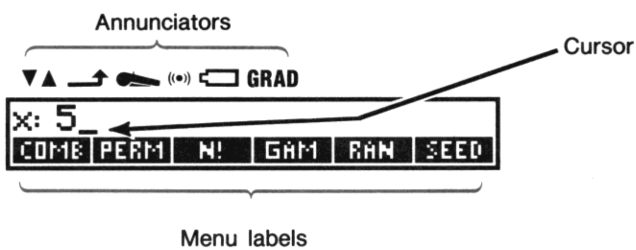
Each key has two functions: one printed on its face, and a *shifted* function printed in color above the key. For example, OFF is the shifted function of the [EXIT] key (written as ■ [OFF]). To execute a shifted function, press ■, then press the key.

Pressing ■ turns on the shift annunciator (), which remains on until you press the next key. To cancel , just press ■ again.

The remains active for as long as you hold down the ■ key. To execute several consecutive shifted functions, hold ■ down and press the appropriate keys.

Annunciators

The calculator uses seven *annunciators* at the top of the display to indicate various conditions.



Annunciator	Meaning
▼▲	The [▼] and [▲] keys are active for moving through a multirow menu (page 23).
↗	Shift (■) is active.
(printer)	The calculator is sending information to the printer (page 100).
((•))	The calculator is busy executing a function or a program.
(battery)	Battery power is low.
RAD	Radians angular mode is set (page 80).
GRAD	Grads angular mode is set (page 80).

Adjusting the Display Contrast

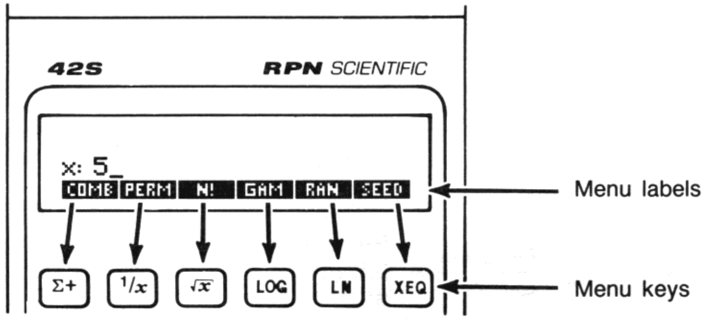
To adjust the contrast of the display for various viewing angles and lighting conditions:

1. Press and hold [EXIT].
2. Press [+] to darken the display, [−] to lighten the display.
3. Release [EXIT].

You can use this sequence at any time without disrupting any other calculator operation.

Using Menus

The top row of keys is very special. In addition to the standard functions printed on the keyboard, these six keys can be redefined by *menu labels* in the display. To execute a function in a menu, press the key directly below the corresponding menu label.



Example: Using a Menu. Use the N! (*factorial*) function in the menu shown above to calculate the factorial of 5 (that is, 5!). Key in 5 and display the PROB (*probability*) menu.

5 ■ [PROB]

```
x: 5.0000
COMB PERM  N!  GAM  RAN SEED
```

To execute the N! function, press the key directly below the menu label ([√x]). This is written as:

N!

```
y: 0.0000
x: 120.0000
```

Thus, 5! = 120.

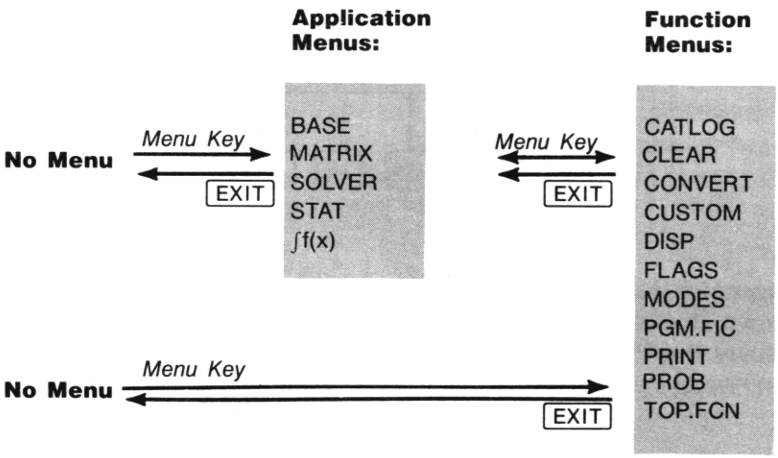
Displaying a Menu

Notice that some of the shifted functions are printed on the keyboard in shaded boxes. These are keys that select menus. When you select a menu with one of these keys, the first row of the menu is immediately displayed.

Application Menus. There are five menu-driven *applications* in the HP-42S. (See the illustration below.) Application menus have top priority among all of the menus. To exit from an application, press [EXIT] or select another application.

Function Menus. The HP-42S has over 350 built-in functions. The most frequently used functions are grouped into *function menus*. In the example above, you used a function menu (■ [PROB]) to execute the N! function.

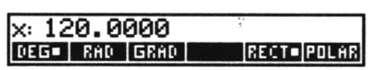
If you select a function menu while in an application, the calculator remembers the application menu and displays it again when you exit the function menu.



Disabling Automatic Exit. Function menus automatically exit as soon as you execute one of the functions in the menu. If you want to use a function menu repeatedly, you can disable automatic exiting by selecting the menu twice. For example, if you press ■ [PROB] ■ [PROB], the PROB menu stays in the display until you press [EXIT] or select another menu.

Menu Labels Marked With "■". There are a variety of modes and settings in the HP-42S. If a menu label contains the ■ character, then that mode or setting is currently selected. For example, display the MODES menu:

■ [MODES]



The menu in this display shows that Degrees (DEG■) and Rectangular (RECT■) modes are selected. (These modes are explained in chapter 5.)

The ALPHA Menu. The ALPHA menu (■ [ALPHA]) is neither an application nor a function menu. It is an extension of the keyboard that allows you to type characters (alphabetic and others) that don't appear on the keyboard. Instructions for using the ALPHA menu are on page 37.

The TOP.FCN Menu. Pressing ■ [TOP.FCN] (*top-row functions*) displays a menu containing the functions (shifted and unshifted) on the six top-row keys:

$\Sigma-$	y^x	x^2	10^x	e^x	GTO
[Σ+]	[1/x]	[$\sqrt{x}$]	[LOG]	[LN]	[XEQ]

Use the TOP.FCN menu when you want to use one of these functions without exiting from the current application menu.

Multirow Menus (▼▲)

Menus with more than six labels are divided into *rows*. If a menu has more than one row, the ▼▲ annunciator appears, indicating that the [▼] and [▲] keys can be used to display the other rows.

For example, the CLEAR menu has two rows. Press ■ [CLEAR] to see the first row:

CLΣ CLP CLV CLST CLA CLX

Press [▼] to display the second row:

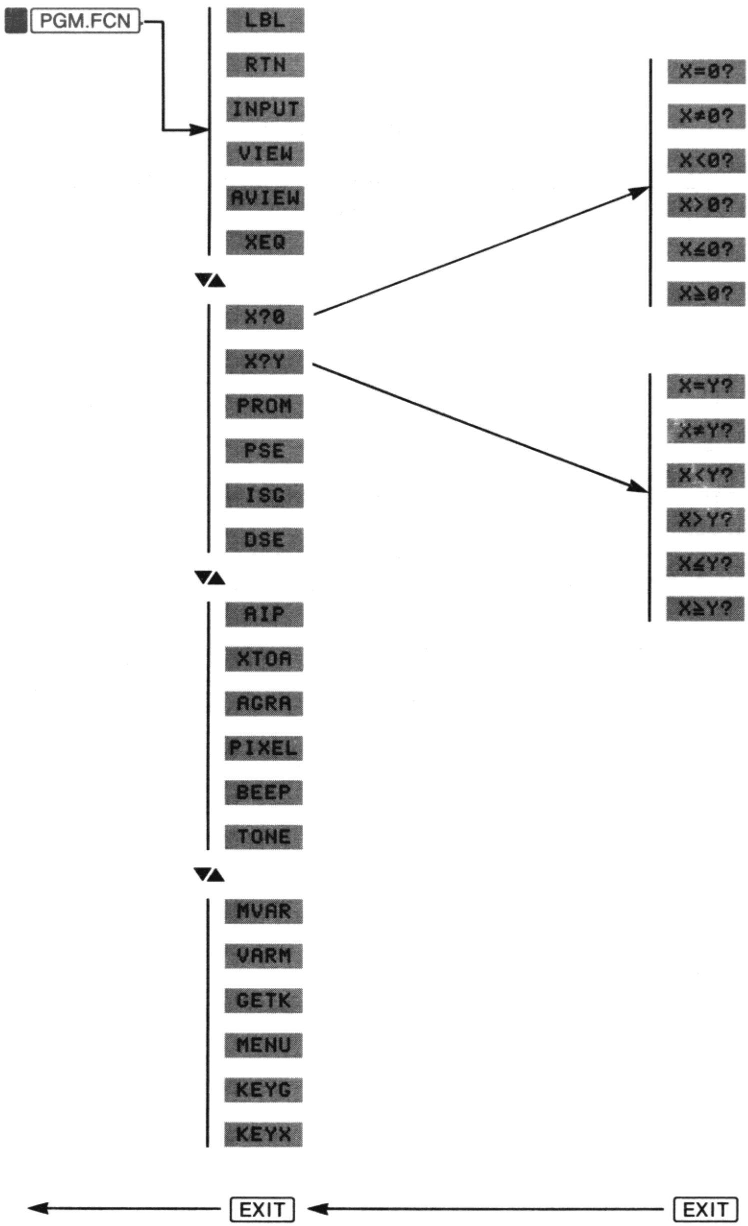
CLRG DEL CLKY CLLCD CLMN CLALL

Because menus are *circular*, pressing [▼] again returns to the first row.

Submenus and [EXIT]

Some menu keys lead to other menus, called *nested* menus or *submenus*. The *menu map* below shows:

- Pressing ■ [PGM.FCN] displays the first of four rows in the PGM.FCN menu.
- Pressing [▼] or [▲] displays the next or previous row (▼▲ is displayed).
- Pressing X?0 or X?Y displays a corresponding submenu.
- Pressing [EXIT] exits the current menu. If it is a submenu, then the previous menu is displayed.


PGM.FCN
LBL
RTN
INPUT
VIEW
AVIEW
XEQ
X?0
X?Y
PROM
PSE
ISG
DSE
AIP
XTOA
AGRA
PIXEL
BEEP
TONE
MVAR
VARM
GETK
MENU
KEYG
KEYX
X=0?
X≠0?
X<0?
X>0?
X≤0?
X≥0?
X=Y?
X≠Y?
X<Y?
X>Y?
X≤Y?
X≥Y?
EXIT
EXIT

Example: Displaying the X?0 Submenu. Display the second row of the PGM.FCN menu.

■ [PGM.FCN]

```
x: 120.0000
LBL  RTN  INPUT  VIEW  AVIEW  XEQ
```

[▼]

```
x: 120.0000
X?0  X?Y  PROM  PSE  ISG  DSE
```

Now display the X?0 submenu.

X?0

```
x: 120.0000
X=0?  X≠0?  X<0?  X>0?  X≤0?  X≥0?
```

When you exit the submenu, the calculator displays the second row of PGM.FCN again.

[EXIT]

```
x: 120.0000
X?0  X?Y  PROM  PSE  ISG  DSE
```

Press [EXIT] again and the PGM.FCN menu disappears.

[EXIT]

```
y: 0.0000
x: 120.0000
```

Clearing the Calculator

There are several ways to clear information from the calculator. You can clear characters, numbers, variables, programs, or even all of calculator memory with a single operation.

Using the [◆] Key

The [◆] key is a backspace and delete key. The calculator's response when you press [◆] depends on what is in the display.

- If a cursor is present (_), [◆] backspaces and deletes the preceding digit or character.
- If a message is displayed, [◆] clears the message.
- If a number (or other data) is displayed *without a cursor,* [◆] clears the entire number to zero.
- If program lines are displayed, [◆] deletes the current program line. (Program-entry mode is explained in chapter 8.)

The CLEAR Menu

The CLEAR menu contains 12 functions for clearing information from the calculator.

■ CLEAR

CLΣ	*Clear statistics.*
CLP	*Clear program.*
CLV	*Clear variable.*
CLST	*Clear stack.*
CLA	*Clear Alpha register.*
CLX	*Clear X-register* to zero.
▼▲	
CLRG	*Clear storage registers.*
DEL	*Delete* program lines.
CLKY	*Clear keys.*
CLLCD	*Clear liquid crystal display.*
CLMN	*Clear MENU.*
CLALL	*Clear all* programs and data.

Clearing All Programs and Data

The CLALL (*clear all*) function clears *all* programs and data from calculator memory but leaves display formats and other settings intact.

1. Press ■ CLEAR ▼ CLALL .
2. Press YES to confirm; or any other key to cancel.

A special key sequence can be used to clear all of memory (including modes and flags). Refer to "Clearing All Memory" in appendix B.

Errors and Messages

Whenever you attempt an operation that the calculator cannot complete, it displays a message that specifies the problem. If you're not sure what you've done wrong, refer to appendix D, "Messages."

You do not have to clear the message to continue working—the message disappears as soon as you press a key. If you want to clear the message without altering anything else, press [◄].

Keying In Numbers

If you make a mistake while keying in a number, press [◄] to backspace and delete the last digit, or press ■[CLEAR] CLX (*clear X-register*) to clear the entire number.

Making Numbers Negative

The [+/-] (*change sign*) key changes the sign of a number.

- To key in a negative number, type the number, then press [+/-].
- To change the sign of a number *already* displayed, just press [+/-].

Exponents of Ten

Numbers with exponents of ten are shown in the display with an E to separate the nonexponent part of the number from the exponent. A number too large or too small for the current display format is automatically displayed in exponential form. For example, the number 123,000,000,000,000 (1.23×10^{14}) is displayed as 1.2300E14.

To key in a number with an exponent:

1. Key in the nonexponent part of the number. If this part is negative, press [+/-].
2. Press [E]. Notice that the cursor follows the E.

3. Key in the exponent. If it is negative, press [+/-]. The largest possible exponent you can key in is ± 499 (with one digit to the left of the decimal point).

For example, to key in Planck's constant, 6.6262×10^{-34}, you would press: 6.6262 [E] 34 [+/-].

For a power of ten without a multiplier, such as 10^{34}, just press [E] 34. The calculator automatically inserts a "1" before the exponent: `1E34_`.

Other Exponent Functions. To specify an exponent of ten *while entering a number,* use [E]. To *calculate* an exponent of ten (the base 10 antilogarithm), use ■ [10^x]. To *calculate* the result of *any* number raised to a power, use ■ [y^x]. Numeric functions (including ■ [10^x] and ■ [y^x]) are covered in chapter 5.

Understanding Digit Entry

As you key in a number, the *cursor* (_) appears in the display. The cursor shows you where the next digit will go and indicates that the number is not completed yet. That is, when a cursor is present, *digit entry is not terminated.*

- If digit entry *is not* terminated, then [◆] backspaces to erase the last digit.
- If digit entry *is* terminated (no cursor), then [◆] clears the entire number (which is equivalent to ■ [CLEAR] CLX).

Simple Arithmetic

All numeric functions follow one simple rule: *when you press a function key, the calculator immediately executes the function.* Therefore, all operands must be present *before* you execute a function.

Arithmetic can be broken down into two types of functions: one-number functions (such as square root) and two-number functions (such as addition).

Note Many of the displays shown in this manual assume that you've worked the preceding example. Unless indicated otherwise, previous results and the contents of your calculator are irrelevant to the current example.

One-Number Functions

One-number functions operate on the the value in the display (x: *value*). To use a one-number function:

1. Key in the number. (*If the number is already displayed, you can skip this step.*)
2. Press the function key. (The function may be on a normal or shifted key or in a menu.)

For example, to calculate 1/32, key in 32 ...

32

```
Y: 120.0000
X: 32_
```

... then press the function key:

[1/x]

```
Y: 120.0000
X: 0.0313
```

The result (to four decimal places) is 0.0313.

Now calculate $\sqrt{1.5129}$.

1.5129 [$\sqrt{x}$]

```
Y: 0.0313
X: 1.2300
```

If a number is already in the display, you don't have to key it in again. Calculate the square of 1.23.

■ [x^2]

```
Y: 0.0313
X: 1.5129
```

Remember, you can make a number negative at any time with the [+/-] key. Notice that only the number in the bottom line changes.

[+/-]

```
Y: 0.0313
X: -1.5129
```

One-number functions also include the logarithmic functions, the trigonometric functions, the parts-of-numbers functions, and the hyperbolic functions; they are covered in chapter 5.

Two-Number Functions

To use a two-number function (such as [+], [−], [×], or [÷]):

1. Key in the first number.
2. Press [ENTER] to separate the first number from the second.
3. Key in the second number. (Do not press [ENTER] again.)
4. Press the function key.

Remember, both numbers must be present before executing the function.

For example:

To Calculate:	Press:	Result:
12 + 3	12 [ENTER] 3 [+]	15.0000
12 − 3	12 [ENTER] 3 [−]	9.0000
12 × 3	12 [ENTER] 3 [×]	36.0000
12 ÷ 3	12 [ENTER] 3 [÷]	4.0000

The order of entry is essential for noncommutative functions (such as [−] and [÷]). If the numbers have been entered in the wrong order, you can still get the correct answer without reentering the numbers. *Swap* the order of the numbers by pressing [x≷y] (*x exchange y*), then perform the intended function. (Refer also to "Exchanging *x* and *y*" in chapter 2.)

Chain Calculations

The speed and simplicity of calculating with the HP-42S is apparent during *chain calculations* (calculations with more than one operation). Even during the longest of calculations, *you still work with only one or two numbers at a time*—the automatic memory stack stores intermediate results until you need them. (The stack is explained in chapter 2.) The process of working through a problem is the same as working it out on paper, but the calculator does the hard part.

Example: A Chain Calculation. Solve (12 + 3) × 7. To work this problem on paper, you would first calculate the intermediate result of (12 + 3). That is, you would start *inside* the parentheses and work outward.

$$\overset{15}{(1\cancel{2 + 3})} \times 7$$

Then you would multiply the intermediate result by 7 to get the final answer.

$$15 \times 7 = 105$$

Solving the problem on the HP-42S uses the same logic. Start inside the parentheses:

12 [ENTER] 3 [+]

```
Y: 4.0000
X: 15.0000
```

This intermediate result is saved automatically—you don't need to press [ENTER]. Simply multiply it by seven.

7 [×]

```
Y: 4.0000
X: 105.0000
```

Example: Another Chain Calculation. Problems that have multiple parentheses can be solved in the same simple manner because intermediate results are automatically remembered. For example, to solve (2 + 3) × (4 + 5) on paper, you would first calculate the values inside parentheses, and then you would multiply them together.

$$\overset{5}{(\cancel{2 + 3})} \times \overset{9}{(\cancel{4 + 5})}$$

Again, working the problem on the HP-42S involves the same logical steps:

2 [ENTER] 3 [+]	Y: 105.0000 X: 5.0000
4 [ENTER] 5 [+]	Y: 5.0000 X: 9.0000

Notice that the two intermediate results in the display are the same ones you calculated on paper. Press [×] to multiply them.

[×]	Y: 105.0000 X: 45.0000

Remember: This method of entering numbers, called Reverse Polish Notation (*RPN*), is unambiguous and therefore does not need parentheses. It has the following advantages:

- You never work with more than two numbers at a time.
- Pressing a function key immediately executes that function so there is no need for an [=] key.
- Intermediate results appear as they are calculated, so you can check each step as you go.
- Intermediate results are automatically stored. They reappear as they are needed for the calculation—the last result stored is the first to come back out.
- You can calculate in the same order as you would with pencil and paper.
- If you make a mistake during a complicated calculation, you don't have to start over. (Correcting mistakes is covered in chapter 2.)
- Calculations with other types of data (such as complex numbers and matrices) follow the same rules.
- Calculations in programs follow the same steps as when you execute them manually.

Exercises: Calculations for Practice

The following calculations exercise the methods you've learned for simple arithmetic. Work each problem in the same order as you would work it on paper. (There may be more than one way to work each problem.) Remember, use [ENTER] only for separating two numbers entered *sequentially*.

Calculate: $(2 + 3) \div 10$
Answer: 0.5000

A Solution: 2 [ENTER] 3 [+] 10 [÷]

Calculate: $2 \div (3 + 10)$
Answer: 0.1538

A Solution: 3 [ENTER] 10 [+] 2 [x≷y] [÷]

Another Solution: 2 [ENTER] 3 [ENTER] 10 [+] [÷]

Calculate: $(14 + 7 + 3 - 2) \div 4$
Answer: 5.5000

A Solution: 14 [ENTER] 7 [+] 3 [+] 2 [−] 4 [÷]

Calculate: $4 \div (14 + (7 \times 3) - 2)$
Answer: 0.1212

A Solution: 7 [ENTER] 3 [×] 14 [+] 2 [−] 4 [x≷y] [÷]

Another Solution: 4 [ENTER] 14 [ENTER] 7 [ENTER] 3 [×] [+] 2 [−] [÷]

Range of Numbers

The HP-42S is capable of representing numbers as large as $9.99999999999 \times 10^{499}$ and as small as 1×10^{-499}. If you attempt to execute a function that returns a result larger than $9.99999999999 \times 10^{499}$, the calculator displays the `Out of Range` error message. The operation you attempted is ignored, and the message disappears when you press the next key.

If you attempt an arithmetic function that returns a number whose magnitude is smaller than 1×10^{-499}, the calculator automatically substitutes the number zero.

Changing the Display Format

Internally, the HP-42S *always* saves numbers with full 12-digit accuracy plus a three-digit exponent of ten.

Even though numbers are stored with full precision, the way they're displayed depends on the current display format. There are two general ways to display numbers:

- Round the number to a specified number of digits. There are three formats that do this: FIX (*fixed-decimal notation*), SCI (*scientific notation*), and ENG (*engineering notation*).
- Show all of the digits in a number (except trailing zeros). This is the ALL format.

In addition to controlling how digits are displayed, you can select the character used as the decimal point—called the *radix*. The radix may be a period (default) or a comma.

Functions for changing the display format are in the DISP (*display*) menu:

■ DISP

FIX	*Fixed-decimal* notation.
SCI	*Scientific* notation.
ENG	*Engineering* notation.
ALL	*All* notation.
RDX.	*Radix period.*
RDX,	*Radix comma.*

Number of Decimal Places

The default display format is FIX 4. (The calculator displays numbers rounded to four places to the right of the decimal.)

To change the number of decimal places:

1. Press ■ [DISP].
2. Press: FIX, SCI, ENG, or ALL.
3. For FIX, SCI, and ENG, specify the number of digits (0 through 11):
   - Key in two digits (such as 02).
   - Or, key in a single digit followed by [ENTER] (such as 2 [ENTER]).

Example: Changing the Display Format. Key in the numbers 2.46×10^7 and 1234567.89, and then change the display format to ENG 2.

2.46 [E] 7 [ENTER] 1234567.89	Y: 24,600,000.0000 X: 1,234,567.89_
■ [DISP] ENG 2 [ENTER]	Y: 24.6E6 X: 1.23E6

Now change to the ALL display format.

■ [DISP] ALL	Y: 24,600,000 X: 1,234,567.89

Now return to the default setting (FIX 4).

■ [DISP] FIX 4 [ENTER]	Y: 24,600,000.0000 X: 1,234,567.8900

Fixed-Decimal Notation (FIX). In FIX notation, the calculator displays numbers rounded to the specified number of decimal places. Exponents of 10 are used only if the number is too large or too small to display using the current display format. (Example: 3.1416.)

Scientific Notation (SCI). In SCI notation, the calculator displays numbers with one digit to the left of the decimal point and the specified number of digits to the right. An exponent of 10 is always shown; even if it is zero. (Example: 6.0220E26.)

Engineering Notation (ENG). In ENG notation, the calculator displays numbers in a format similar to SCI except the exponent of 10 is always a multiple of three. This means that more than one digit may appear to the left of the decimal point. The number of digits you specify indicates how many digits to display after the first digit. (Example: `10.423E-3`.)

All Notation (ALL). In ALL notation, the calculator displays numbers using full precision. That is, all significant digits to the right of the decimal point are shown. (Example: `4.17359249`.)

Selecting the Radix Mark (Comma vs. Period)

To change the radix mark to a comma, press ■ [DISP] RDX, . When the radix is a comma, periods are used to separate digits.

`1.234.567,8900`

To change the decimal point back to a period, press ■ [DISP] RDX. .

`1,234,567.8900`

You can remove the digit separators by clearing flag 29 (page 276).

Showing All 12 Digits

When you press and hold the ■ [SHOW] key, the calculator displays the contents of the X-register using the ALL format—that is, all significant digits are shown. When you release the key, the display returns to the current display format.

1.23456789012 [ENTER]	`Y: 1.2346` `X: 1.2346`
■ [SHOW] *(hold down)*	`1.23456789012`
(release)	`Y: 1.2346` `X: 1.2346`

The ■ [SHOW] key can also be used to show the entire contents of the Alpha register (page 40), a long program line (page 111), or the first element in a matrix (page 207).

Keying In Alphanumeric Data

Alphabetic and other characters are typed into the HP-42S using the ALPHA menu, which contains all the letters in the alphabet (uppercase and lowercase) and many other characters.

One or more characters typed with the ALPHA menu form an *Alpha string.*

Using the ALPHA Menu

To type a string of characters into the Alpha register:

1. Press ■ [ALPHA] to select the ALPHA menu.
2. Press an ALPHA menu key to select a *group* of letters or characters.
3. Press a menu key to type a character. To type a lowercase letter, press ■ before typing the letter.

Repeat steps 2 and 3 for each letter or character. You can also use the following keys to type Alpha characters: ■ [%], ■ [π], [E], [÷], [×], [−], [+], [0], [1], [2], [3], [4], [5], [6], [7], [8], [9], and [·].

Example. The keystrokes for typing the string `The HP-42S.` are:

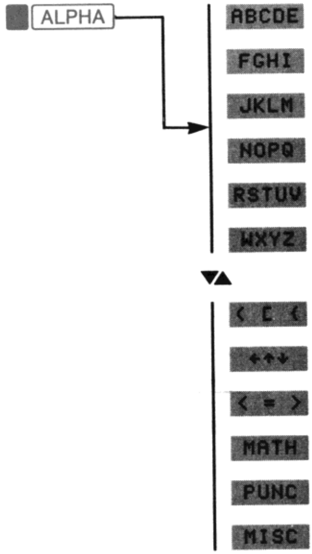
■ [ALPHA] RSTUV T ■ (*hold down*) FGHI H ABCDE E (*release* ■) WXYZ [ ] FGHI H NOPQ P [−] [4] [2] RSTUV S [·]

For simplicity, this manual shows these keystrokes as:

■ [ALPHA] The HP−42S.

ALPHA Typing Tips:

- Any blank menu key in the ALPHA menu can be used to type a space character. A rapid sequence for typing a space is [XEQ] [XEQ] (that is WXYZ [ ] or MISC [ ]).
- To type several lowercase letters, hold down the shift key (■) while typing.



The characters in each of the submenus are shown in the menu maps beginning on page 292.

The Alpha Display and the Alpha Register

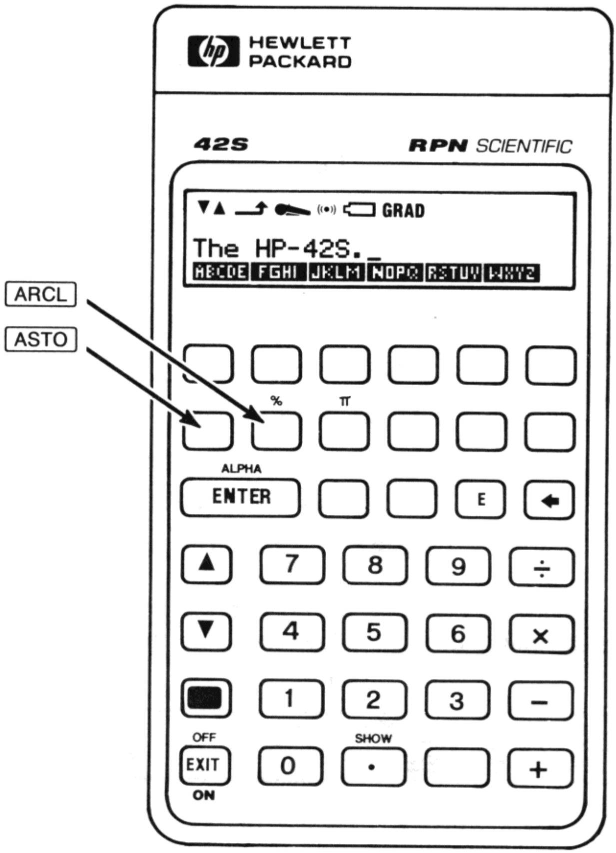
Alpha strings can be typed only when the ALPHA menu is displayed. How strings are used or where they are stored, however, depends on other circumstances. Alpha strings can be:

- Typed directly into the Alpha register.
- Used as a function parameter to specify a variable name or program label (page 73).
- Entered as program instructions (page 130).

Alpha Mode: Entering Characters Into the Alpha Register. In the previous example, the Alpha characters were entered into the *Alpha register*. When you press ■ ALPHA, the calculator displays the ALPHA menu *and* the Alpha register—this is *Alpha mode.*

If there are characters in the Alpha register, they are displayed when you enter Alpha mode. The Alpha register is cleared when you begin typing. To append characters to the current contents of Alpha, press [ENTER] to turn the cursor on before you begin to type.

The following illustration shows the keys that are active in Alpha mode.



Capacity of the Alpha Register. The Alpha register can hold up to 44 characters. The calculator beeps when the Alpha register gets full. The beep warns you that each additional character you type will push the first (left-most) character out of the Alpha register.

If the display overflows, the … character indicates there are some characters you can't see.

To display the entire Alpha register:

- While in Alpha mode, press and hold ■ [SHOW].
- While not in Alpha mode, press ■ [PGM.FCN] AVIEW (*Alpha view*).

Printing the Alpha Register. To print the contents of the Alpha register, press ■ [PRINT] PRA (*print Alpha*). For more information on printing, refer to chapter 7.

Catalogs

Catalogs are used to view the contents of calculator memory. You can also use a catalog to execute functions or programs or recall variables.

■ [CATALOG] →

FCN	*Functions.*
PGM	*Programs.*
REAL	*Real variables.*
CPX	*Complex variables.*
MAT	*Matrix variables.*
MEM	*Memory available.*

To display the amount of available memory, press and hold the MEM key. The calculator displays a message like this:

```
Available Memory:
6836 Bytes
```

The message disappears when you release the key.

An Introduction to Flags

Throughout the rest of this manual there are references to numbered *flags*. A flag has two states, *set* and *clear*. If you are unfamiliar with flags, simply think of them as switches that are either on or off.

The HP-42S has 100 flags (numbered 00–99); most of them have special purposes inside the calculator. To set, clear, and test the status of flags, use the functions in the FLAGS menu:

■ [FLAGS]

SF	*Set flag.*
CF	*Clear flag.*
FS?	*Flag set test.*
FC?	*Flag clear test.*
FS?C	*Flag set test and clear.*
FC?C	*Flag clear test and clear.*

For more information on flags, refer to appendix C.

2

The Automatic Memory Stack

This chapter explains how calculations take place in Hewlett-Packard's automatic memory stack and how it minimizes the number of keystrokes required to do complicated calculations.

More specifically, you will learn:

- What the stack is.
- How the stack automatically remembers results from previous calculations.
- What is meant by *stack lift* and *stack drop*.
- How to view and manipulate the contents of the stack.
- How to save keystrokes and correct mistakes with ■ [LASTx].

You do not need to read and understand this chapter to use the HP-42S. However, you'll find that understanding this material will greatly enhance your use of the calculator. In programs, efficient use of the stack saves memory by reducing the number of program steps needed to solve a problem.

What the Stack Is

Automatic storage of intermediate results is the reason the HP-42S easily processes complex calculations, and does so without parentheses. The key to automatic storage is the *automatic, RPN memory stack.**

* HP's operating logic is based on a mathematical logic known as "Polish Notation," developed by the Polish logician Jan Łukasiewicz (1878—1956). While conventional algebraic notation places the operators *between* the relevant numbers or variables, Łukasiewicz's notation places them *before* the numbers or variables. For optimal efficiency of the stack, we have modified that notation to specify the operators *after* the numbers. Hence the term *Reverse Polish Notation*, or *RPN*.

The stack consists of four storage locations, called *registers*, which are "stacked" on top of each other. It is a work area for calculations. These registers—labeled X, Y, Z, and T—store and manipulate four current numbers. The "oldest" number is the one in the T-register (*top*).

T	0.0000
Z	0.0000
Y	0.0000
X	0.0000

The most "recent" number is in the X-register and is usually displayed.

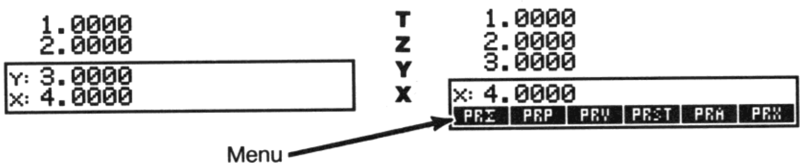
You might have noticed that several functions' names include an x or y. These letters refer to the values in the X- and Y-registers. For example, ■ [y^x] raises the number in the Y-register to the power of the number in the X-register.

To clear all four of the stack registers to zero, press ■ [CLEAR] **CLST** .

Note Each stack register can hold any type of data (a real number, Alpha string, complex number, or matrix). Examples in this chapter use real numbers; however, the stack works the same regardless of the type of data it contains.

The Stack and the Display

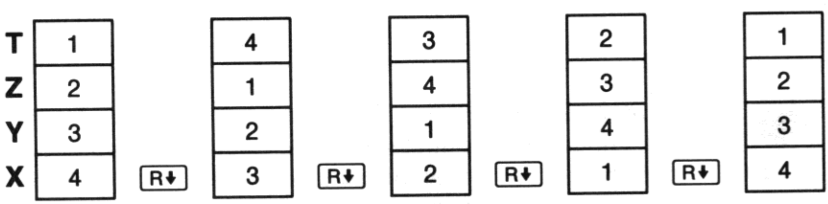
Since the HP-42S has a two-line display, it is capable of displaying two numbers (x and y) or one number (x) and a menu.



Reviewing the Stack ([R↓])

The [R↓] (*roll down*) key lets you review the entire contents of the stack by "rolling" the contents downward, one register at a time.

Suppose the stack is filled with 1, 2, 3, 4 (press 1 [ENTER] 2 [ENTER] 3 [ENTER] 4). Pressing [R↓] four times rolls the numbers all the way around and back to where they started:



Notice that the *contents* of the registers are shifted—the registers themselves maintain their positions.

Exchanging x and *y* ([x⇄y])

Another key for manipulating the contents of the stack is [x⇄y] (*x exchange y*). It swaps the contents of the X- and Y-registers without affecting the rest of the stack. The [x⇄y] function is generally used to swap the order of numbers for a calculation.

To calculate 9 ÷ (13 + 8) you might press 13 [ENTER] 8 [+] 9 [x≷y] [÷]. The [x≷y] function swaps the two numbers so they are in the correct order for division.

Arithmetic—How the Stack Does It

The contents of the stack move up automatically as new numbers enter the X-register (*lifting the stack*). The contents of the stack automatically move down when a function replaces two numbers (x and y) with a single result in the X-register (*dropping the stack*).

Suppose the stack is still filled with the numbers 1, 2, 3, and 4. See how the contents of the stack lift and drop while calculating

$$3 + 4 - 9.$$

T	1		1		1		1
Z	2		1		2		1
Y	3		2		7		2
X	4	[+]	7	[9]	9	[−]	−2
		1.		**2.**		**3.**	

1. The stack "drops" its contents. (The top register replicates its contents.)

2. The stack "lifts" its contents. (The top contents are "lost".)

3. The stack drops.

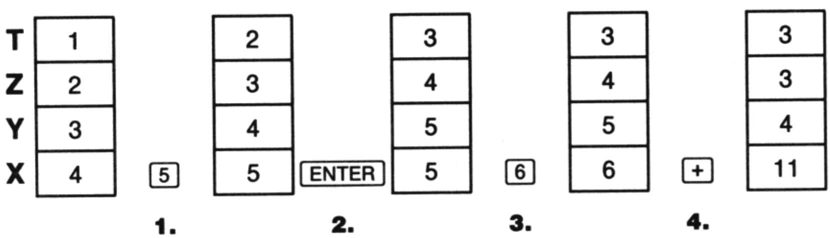
- Notice that when the stack lifts, numbers are pushed off the top of the stack (out of the T-register) and are lost. Therefore, the stack memory is limited to four numbers.
- Because of the automatic movement in the stack, you do not need to clear the display before starting a new calculation. "Old" results are just pushed up the stack.

■ Generally, keying in a number causes the stack to lift. However, there are four functions that specifically *disable stack lift*. They are ENTER, CLX *, Σ+, and ■ Σ−. That is, a number keyed in immediately after one of these functions *replaces* the number in the X-register rather than pushing it up.

How ENTER Works

In chapter 1 you learned that ENTER separates two numbers keyed in one after the other. In terms of the stack, how does it do this? Suppose the stack is again filled with 1, 2, 3, and 4. Now enter and add two new numbers:

5 + 6



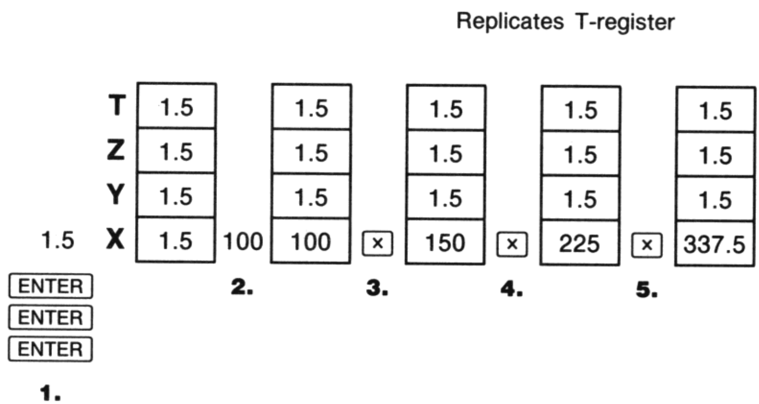
1. Lifts the stack.
2. Lifts the stack and replicates the X-register.
3. Does *not* lift the stack.
4. Drops the stack and replicates the T-register.

ENTER copies the contents of the X-register into the Y-register and *disables stack lift* so that the second number you enter *writes over* the copy of the first number in the X-register. The effect is simply to separate two numbers entered sequentially.

* Remember, the ◆ key sometimes functions as CLX. Refer to "Using the ◆ Key" on page 25.

Filling the Stack With a Constant. Whenever the stack drops, the number in the T-register is duplicated in the Z-register. Therefore, you can completely fill the stack with a constant number and use that number repeatedly in calculations. Every time the stack drops, the constant is duplicated at the top of the stack.

Example: Constant, Cumulative Growth. Given a bacterial culture with a growth rate of 50% per day, how large would a population of 100 be at the end of 3 days?



1. Fills the stack with the growth rate.
2. Keys in the initial population.
3. Calculates the population after 1 day.
4. Calculates the population after 2 days.
5. Calculates the population after 3 days.

Other Uses of the ENTER Key. The primary purpose of the ENTER key is to separate two numbers entered sequentially for a calculation. ENTER can also be used to:

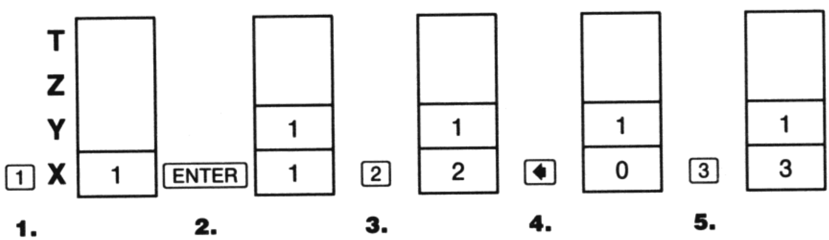
- Turn the cursor on or off in Alpha mode.
- Select the ALPHA menu when a function is prompting for a parameter.
- Complete an instruction after keying in a parameter.

How CLX Works

To prevent an unwanted zero from being added to the stack, the CLX function (and [←] when it clears the X-register) disables stack lift. That is, CLX puts a zero in the X-register, but the next number entered writes over the zero.

This feature lets you correct mistakes without interfering with the current calculation. Since stack lift does not occur, the contents of the Y-, Z-, and T-registers are left unchanged.

For example, suppose you wanted to enter 1 and 3 but mistakenly entered 1 and 2. This is what you would do:



1. Lifts the stack.
2. Lifts the stack and replicates the X-register.
3. Overwrites the X-register.
4. Clears *x* by overwriting it with zero.
5. Overwrites *x* (replaces the zero.)

The LAST X Register

The LAST X register is a companion to the stack—it holds the contents of the X-register used in the most recent numeric function. Pressing ■ [LASTx] recalls this value into the X-register. This ability to retrieve the "last *x*" has two main uses: correcting mistakes and reusing a number in a calculation.

Using ■ [LASTx] To Correct Mistakes

Wrong One-Number Function. If you execute the wrong one-number function, use ■ [LASTx] to retrieve the number so you can execute the correct function.

If you are in the middle of a chain calculation when you make the mistake, clear the X-register ([◆]) before executing ■ [LASTx]. This clears the incorrect result and disables stack lift so that intermediate results in the stack are not lost.

Example. Suppose that you had just calculated $4.7839^3 \times (3.879 \times 10^5)$ and wanted to find its square root ([$\sqrt{x}$]) but pressed [LOG] by mistake. You don't have to start over! To find the correct result, just press [◆] ■ [LASTx] [$\sqrt{x}$]. ([◆] is needed only if you want to prevent the incorrect result from being lifted into the Y-register.)

Mistakes With Two-Number Functions. If you make a mistake with a two-number function, you can correct it by using ■ [LASTx] and the *inverse* of the two-number function.

For mistakes with the *wrong function* or *wrong second number:*

1. Press ■ [LASTx] to recover the second number (the one in the X-register just before the operation).
2. Execute the inverse operation. (For example, [−] is the inverse of [+] and [÷] is the inverse of [×].) This returns the number that was originally first. The second number is still in the LAST X register.
3. Execute the correct calculation:
   - If you had used the *wrong function,* press ■ [LASTx] again to restore the original stack contents. Now execute the correct function.
   - If you had used the *wrong second number,* key in the correct one and then execute the function.

For mistakes with the *wrong first number:*

1. Key in the correct first number.
2. Press ■ [LASTx].
3. Execute the function again.

If the contents of the other stack registers are important, clear the X-register *first* to prevent the incorrect result from being lifted into the stack.

Example. Suppose you made an error while calculating

$$16 \times 19 = 304.$$

There are three kinds of mistakes you could have made:

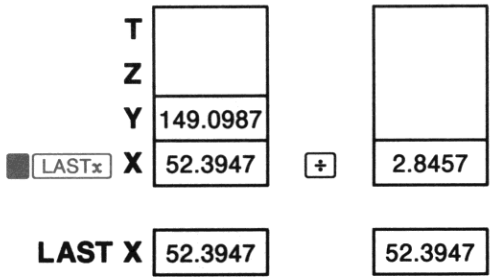
Wrong Calculation	Mistake	Correction
16 [ENTER] 19 [−]	Wrong function.	■ [LASTx] [+] ■ [LASTx] [×]
16 [ENTER] 18 [×]	Wrong second number.	■ [LASTx] [÷] 19 [×]
15 [ENTER] 19 [×]	Wrong first number.	16 ■ [LASTx] [×]

Using ■ [LASTx] To Reuse Numbers

Recovering and reusing a number can be useful in short calculations that use the same number more than once. Since ■ [LASTx] recovers the last value that was used in a calculation, you can reuse the same number. Often, pressing ■ [LASTx] is quicker than keying the number in again.

Example. Calculate (96.704 + 52.3947) ÷ 52.3947. Remember to enter 52.3947 second so it can be reused.

Keys	Register		Keys		Keys	
	T					
	Z					
	Y	96.704		96.704		
96.704 [ENTER]	X	96.704	52.3947	52.3947	[+]	149.0987
	LAST X					52.3947



96.704 [ENTER]	Y: 96.7040 X: 96.7040
52.3947 [+]	Y: 0.0000 X: 149.0987
■ [LASTx]	Y: 149.0987 X: 52.3947
[÷]	Y: 0.0000 X: 2.8457

Example. Two close stellar neighbors of Earth are Rigel Centaurus (4.3 light-years away) and Sirius (8.7 light-years away). Use *c*, the speed of light (9.5×10^{15} meters per year), to convert the distances from the Earth to these stars into meters.

Enter the distance to Rigel Centaurus and multiply by the speed of light.

4.3 [ENTER] 9.5 [E] 15 [×]	Y: 2.8457 X: 4.0850E16

The distance to Rigel Centaurus is 4.085×10^{16} meters.

Now, enter the distance to Sirius and recall the speed of light from the LAST X register.

8.7 ■ [LASTx]

```
Y: 8.7000
X: 9.5000E 15
```

Multiply to get the distance.

[×]

```
Y: 4.0850E 16
X: 8.2650E 16
```

The distance to Sirius is 8.265×10^{16} meters.

Chain Calculations

The automatic lifting and dropping of the stack's contents let you retain intermediate results without storing or reentering them, and without using parentheses.

Order of Calculation

In chapter 1 we recommended solving chain calculations by working from the innermost parentheses outward. You may choose to work problems in a left-to-right order. (However, since the stack can only hold four numbers at a time, some expressions may be too long to calculate from left to right.)

For example, in chapter 1 you calculated:

$$4 \div [14 + (7 \times 3) - 2]$$

by starting with the innermost parentheses (7×3) and working outward—just as you would with pencil and paper. The keystrokes were:

7 [ENTER] 3 [×] 14 [+] 2 [−] 4 [x≷y] [÷].

Working the problem from left-to-right, the solution would be:

4 [ENTER] 14 [ENTER] 7 [ENTER] 3 [×] [+] 2 [−] [÷],

which takes one additional keystroke. Notice that the first intermediate result is still the innermost parentheses: (7 × 3). The advantage of working a problem from left-to-right is that you don't have to use [x≷y] to reposition operands for noncommutative functions ([−] and [÷]).

The first method (starting with the innermost parentheses) is often preferred because:

- It takes fewer keystrokes.
- It requires fewer registers in the stack.

In summary, the stack gives you the flexibility to work problems in an order that best fits *your* needs.

Exercises: More RPN Calculations

Here are some additional problems that you can work for more practice using RPN. As demonstrated above, there's more than one way to solve most problems. Therefore, the solutions shown below are not necessarily unique.

Calculate: (14 + 12) × (18 − 12) ÷ (9 − 7)
Answer: 78.0000

A Solution: 14 [ENTER] 12 [+] 18 [ENTER] 12 [−] [×] 9 [ENTER] 7 [−] [÷]

Another Solution: 14 [ENTER] 12 [+] 18 ■ [LASTx] [−] [×] 9 [ENTER] 7 [−] [÷]

Calculate: 23^2 − (13 × 9) + 1/7
Answer: 412.1429

A Solution: 23 ■ [x^2] 13 [ENTER] 9 [×] [−] 7 [1/x] [+]

Another Solution: 23 [ENTER] [×] 13 [ENTER] 9 [×] [−] 7 [1/x] [+]

Calculate: $\sqrt{(5.4 \times 0.8) \div (12.5 - 0.7^3)}$
Answer: 0.5961

A Solution: 5.4 [ENTER] .8 [×] .7 [ENTER] 3 [■] [y^x] 12.5 [$x \gtrless y$] [−] [÷] [$\sqrt{x}$]

Another Solution: 5.4 [ENTER] .8 [×] 12.5 [ENTER] .7 [ENTER] 3 [■] [y^x] [−] [÷] [$\sqrt{x}$]

Calculate: $\sqrt{\dfrac{8.33 \times (4 - 5.2) \div [(8.33 - 7.46) \times 0.32]}{4.3 \times (3.15 - 2.75) - (1.71 \times 2.01)}}$

Answer: 4.5728

A Solution: 4 [ENTER] 5.2 [−] 8.33 [×] [■] [LASTx] 7.46 [−] .32 [×] [÷] 3.15 [ENTER] 2.75 [−] 4.3 [×] 1.71 [ENTER] 2.01 [×] [−] [÷] [$\sqrt{x}$]

3

Variables and Storage Registers

In the previous chapter, you learned how the calculator's stack provides temporary storage during calculations. For more permanent data storage, you can use variables and storage registers. In this chapter you will learn how to use [STO] (*store*) and [RCL] (*recall*) to:

- Copy data between the stack and variables or storage registers.
- Perform arithmetic with variables and registers.
- Directly access each of the stack registers.

In addition, you'll see how the [ASTO] (*Alpha store*) and [ARCL] (*Alpha recall*) functions are used to copy data between the Alpha register and variables or registers.

Storing and Recalling Data

The X-register is used in all store and recall operations. [STO] copies data *from* the X-register into a variable or register. [RCL] recalls data *into* the X-register from a variable or register.

When you press [STO] or [RCL], the calculator displays a prompt (`STO __` or `RCL __`) and a menu of variable names. To complete the instruction, you must supply one of the following parameters to indicate what you want to store or recall:

- A variable name.
- A storage register number.
- A stack register.

Variables

Variables are *named* storage locations. Each variable can hold any type of data, from a single number to a large, two-dimensional matrix of complex numbers. The number of variables stored in the calculator is limited only by the amount of memory available.

To store data into a variable:

1. Press [STO].
2. Select the variable from the catalog (automatically displayed), or type the variable name using the ALPHA menu:

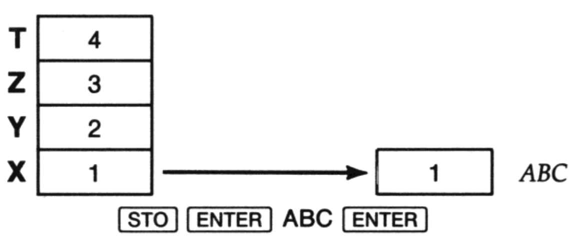
   - *Using the variable catalog:* If the variable name you want already exists, press the corresponding menu key. Data previously stored in the variable is overwritten with the new data.
   - *Using the ALPHA menu:*

     a. Press [ENTER] or ■ [ALPHA] to select the ALPHA menu.

     b. Type the variable name (one to seven characters).*

     c. Press [ENTER] or ■ [ALPHA] to complete the name.

For example, to store a copy of the X-register into a variable named *ABC*, press [STO] [ENTER] ABC [ENTER]. If *ABC* already exists, press [STO] ABC.

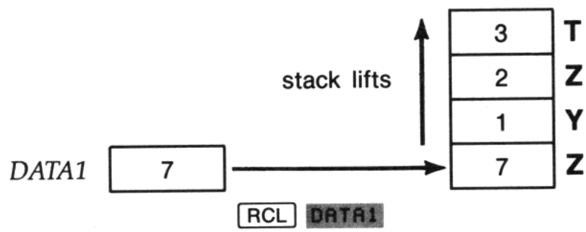


To recall data from a variable:

1. Press [RCL].
2. Select the variable from the catalog, or type the variable name using the ALPHA menu. (Refer to step 2 above.)

* Instructions for using the ALPHA menu are on page 37.

For example, to recall a copy of the data in the variable *DATA1*, press [RCL] DATA1 (assuming *DATA1* already exists).



Storage Registers

Storage registers are numbered storage locations that each hold a single number. Initially, the HP-42S has 25 storage registers (designated R_{00}–R_{24}), each containing a zero. You can change the number of storage registers with the SIZE function (page 64).

To store data into a storage register:

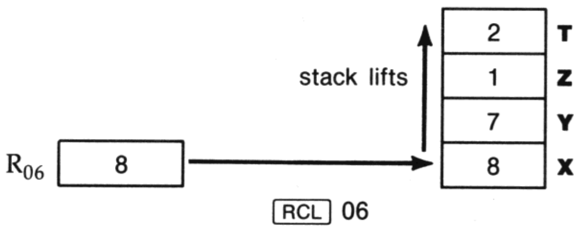
1. Press [STO].
2. Key in the register number: two digits *or* a single digit followed by [ENTER]. Data previously stored in the register is overwritten with the new data.

For example, to store a copy of the number in the X-register into R_{02}, press [STO] 02 *or* [STO] 2 [ENTER].

To recall data from a storage register:

1. Press [RCL].
2. Key in the register number: two digits *or* a single digit followed by [ENTER].

For example, to recall a copy of the number in R_{06}, press [RCL] 06 *or* [RCL] 6 [ENTER].



Storing and Recalling Stack Registers

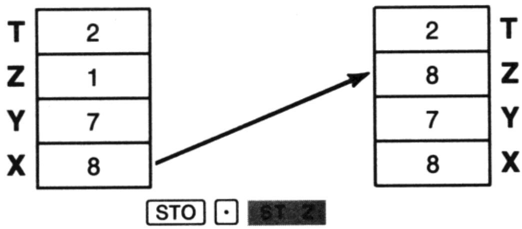
You can store and recall data directly to registers in the stack using *stack addressing*.

To store data directly into a stack register:

1. Press [STO].
2. Press [·] to display the stack menu.
3. Press *one* of the following menu keys:
   - ST L to copy the data into the LAST X register.
   - ST X to copy the data into the X-register.*
   - ST Y to copy the data into the Y-register.
   - ST Z to copy the data into the Z-register.
   - ST T to copy the data into the T-register.

* Although [STO] [·] ST X is a valid instruction, storing a copy of the X-register into itself is of little value.

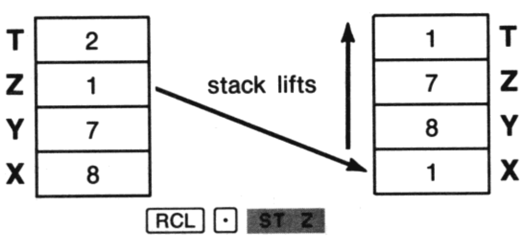
For example, to copy the data in the X-register into the Z-register, press [STO] [·] ST Z.



To recall data directly from a stack register:

1. Press [RCL].
2. Press [·] to display the stack menu.
3. Press *one* of the following menu keys:
   - ST L to copy data from the LAST X register (equivalent to executing ■ [LASTx].)
   - ST X to copy data from the X-register. (This is similar to executing [ENTER] except that stack lift is enabled.)
   - ST Y to copy data from the Y-register
   - ST Z to copy data from the Z-register.
   - ST T to copy data from the T-register (equivalent to executing the R↑ function).

For example, to recall the data in the Z-register into the X-register, press [RCL] [·] ST Z.



Data Types

The HP-42S uses four data types. You can identify a type of data by the way it is displayed:

- *Real numbers* are displayed using the current display format. Some real numbers are displayed with exponents of 10.

  Examples: `1,024.0000`
  `3.1600E4`

- *Complex numbers* are displayed in two parts, separated with `i` or `∡` (depending on the current coordinate mode). If a complex number is too long to be displayed in the current display mode, it is automatically displayed in ENG 2 format.

  Examples: `12.1314 i15.1617` (Rectangular mode)
  `55.0300 ∡90.0000` (Polar mode)

- *Alpha strings* (in the stack) are displayed with surrounding quotation marks. The quotation marks are not part of the string.

  Examples: `"String"`
  `"JIM"`

- *Matrices* are displayed with brackets (`[` and `]`). The dimensions of the matrix are shown (*rows* × *columns*) and complex matrices are indicated with `Cpx`.

  Examples: `[ 3×2 Matrix ]`
  `[ 5×7 Cpx Matrix]`

Where Data Can Be Stored. You can store any type of data into a stack register (X, Y, Z, T, or LAST X) or variable. However, individual storage registers may only contain a single number. That is, you cannot store a matrix into a storage register. Further, you cannot store a complex number into a storage register unless the entire set of registers is converted to complex (page 98).

An Alpha string (up to six characters) can be stored into a variable, stack register, or storage register. Each element in a real matrix may also contain an Alpha string. (Alpha strings are not allowed in complex matrices.)

Arithmetic With [STO] and [RCL]

By combining [STO] and [RCL] with the basic arithmetic operators ([+], [−], [×], and [÷]) you can do arithmetic using stored values without first recalling them to the stack.

- Arithmetic with the [STO] function changes only the contents of the variable or register; the stack is not affected.

  For example, you could triple the value in the variable *ABC* by pressing 3 [STO] [×] ABC.

- Arithmetic with the [RCL] function calculates the result in the X-register. The contents of the variable or register and the other stack registers are not affected.

  For example, you could subtract the number in R_{12} from the number in the X-register by pressing [RCL] [−] 12.

Instruction	Result	Location of Result
[STO][+] *destination*	*destination* + *x*	*destination*
[STO][−] *destination*	*destination* − *x*	*destination*
[STO][×] *destination*	*destination* × *x*	*destination*
[STO][÷] *destination*	*destination* ÷ *x*	*destination*
[RCL][+] *source*	*x* + *source*	X-register
[RCL][−] *source*	*x* − *source*	X-register
[RCL][×] *source*	*x* × *source*	X-register
[RCL][÷] *source*	*x* ÷ *source*	X-register

Note that the *destination* and *source* may be any stack register, storage register, or variable. *x* denotes the contents of the X-register.

Recall Arithmetic and LAST X. [RCL] arithmetic saves the *x*-value in the LAST X register just as one-number functions do. Note how a normal recall instruction followed by arithmetic compares to recall arithmetic:

■ 100 [RCL] 03 [÷] recalls the contents of R_{03} and then divides that value into 100. The divisor, R_{03}, is saved in the LAST X register. Since the stack lifts when you execute [RCL], the value in the T-register is lost.

■ 100 [RCL][÷] 03 calculates the same result. However, the contents of LAST X are different. The numerator, 100, is saved in LAST X because it was the last x-value used in a calculation. The source, R_{03}, is never recalled to the stack. Since the stack does not lift, the value in the T-register is not lost.

Managing Variables

Clearing Variables

To clear a variable from memory:

1. Press ■[CLEAR] CLV.
2. Select the variable from the catalog, or type the variable name using the ALPHA menu.

Using the Variable Catalogs

When you create a variable, the HP-42S adds that variable's name to the appropriate catalog. You can think of each catalog as a file holding variables of the same data type. To display a catalog, press ■[CATALOG] and then:

- REAL for variables containing real numbers or Alpha strings.
- CPX for variables containing complex numbers.
- MAT for variables containing matrices.

To recall a variable from a catalog, select the catalog, and then press the corresponding menu key.

Printing Variables

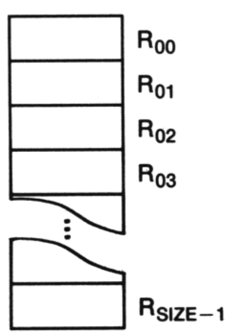
To print the contents of a single variable:

1. Press ■ [PRINT] PRV .
2. Select the variable from the catalog, or type the variable name using the ALPHA menu.

To print a complete list of variable names: Press ■ [PRINT] [▼] PRUSR (*print user*). The PRUSR function prints all variable names and global program labels. The variable names are printed first, so if you're not interested in the program labels, press [R/S] to stop the listing.

Managing Storage Registers

The storage registers are maintained in the HP-42S as a matrix named *REGS*. Each element in the matrix is a single storage register that, as you've already seen, can be stored to or recalled from with [STO] and [RCL]. Because *REGS* is a variable, you can manipulate the entire set of storage registers as a single matrix. (Refer to chapter 14 for more information on matrix operations.)



Changing the Number of Storage Registers (SIZE)

The SIZE function changes the number of storage registers available. The default size is 25 registers (R_{00}–R_{24}). The maximum number of storage registers is limited by the amount of available memory. However, the [STO] and [RCL] functions can only *directly* access registers R_{00} through R_{99}. To store and recall data in registers numbered above 99, you must use *indirect addressing* (page 74).

To change the SIZE:

1. Press ■[MODES] [▼] SIZE.
2. Key in the number of registers. Use one, two, or three digits followed by [ENTER] or key in all four digits.

For example, to set the SIZE to 10 registers, press: ■[MODES] [▼] SIZE 10 [ENTER].

You can also change the number of storage registers by redimensioning the *REGS* matrix. Refer to "Redimensioning a Matrix" in chapter 14.

Clearing Storage Registers

To clear all of the storage registers to zero, press ■[CLEAR] [▼] CLRG.

To clear a single storage register to zero, store zero in it. For example, to clear R_{10}, press 0 [STO] 10.

Printing Storage Registers

To print all of the storage registers, press ■[PRINT] PRV REGS. You can stop the listing at any time by pressing [R/S]. Note that the registers are printed as a matrix—element 1:1 corresponds to R_{00}.

For more information, refer to chapter 7, "Printing."

Storing and Recalling Alpha Data

When the calculator is in Alpha mode, the [STO] and [RCL] keys are redefined as [ASTO] (*Alpha store*) and [ARCL] (*Alpha recall*). These Alpha functions are used to copy data to and from the Alpha register in the same way [STO] and [RCL] are used to move data to and from the X-register.

There are several other functions for working with Alpha data. Refer to "Working With Alpha Data" in chapter 9.

Storing Alpha Data (ASTO)

The ASTO function copies the six left-most characters in the Alpha register into a variable or register. Variables containing Alpha strings are located in the real-variable catalog (■ [CATALOG] REAL).

Example: Storing Alpha Data. Type a string of characters into the Alpha register and store the string (the first six characters) into R_{03}.

Turn Alpha mode on. (If you worked the last example in chapter 1, the string `The HP-42S.` may still be in the Alpha register. It disappears as soon as you start typing a new string.)

■ [ALPHA]

```
The HP-42S.
ABCDE FGHI JKLM NOPQ RSTUV WXYZ
```

Type in the string `RESULT=`. (The keystrokes are RSTUV R ABCDE E RSTUV S RSTUV U JKLM L RSTUV T [▼] < = > = .)

RESULT=

```
RESULT=_
( [ { ←↑↓ < = > MATH PUNC MISC
```

Now, store the string into R_{03}. (Remember, to execute the ASTO function, press [STO] when Alpha mode is on.)

[ASTO] 03

```
RESULT=
( [ { ←↑↓ < = > MATH PUNC MISC
```

Exit Alpha mode and recall R_{03} into the X-register.

[EXIT] [RCL] 03

```
Y: 0.0000
X: "RESULT"
```

This is what an Alpha string looks like when it is in the stack. The = character is not included because strings stored in variables and registers are limited to six characters.

Recalling Alpha Data (ARCL)

The ARCL function copies data in a variable or register into the Alpha register. If the Alpha register already contains a string, the recalled data is appended to it.

If you recall a number into the Alpha register, the ARCL function converts it into Alpha characters using the current display format.

Example: Recalling Data to the Alpha Register. Calculate 5^3 and append the result to the Alpha register (which should contain RESULT= from the previous example). Remember, to execute the ARCL function, press [RCL] when Alpha mode is on.

5 [ENTER] 3 ■ [y^x] ■ [ALPHA]

```
RESULT=
ABCDE FGHI JKLM NOPQ RSTUV WXYZ
```

[ARCL] [.] ST X

```
RESULT=125.0000_
ABCDE FGHI JKLM NOPQ RSTUV WXYZ
```

Display the contents of the Alpha register using the AVIEW function.

■ [PGM.FCN] AVIEW

```
RESULT=125.0000
X: 125.0000
```

The viewed information can be cleared from the display like any other message.

[◆]

```
Y: "RESULT"
X: 125.0000
```

4

Executing Functions

The HP-42S has over 350 built-in functions—far too many to fit them all on the keyboard. Because of this, there are several ways to execute functions. You've already learned how to execute functions that appear on the keyboard and in menus. In this chapter you will learn three additional ways to execute functions:

- *Using the function catalog.* Press ■ [CATALOG] FCN to display a menu containing all of the calculator's functions. The functions are arranged in alphabetical order with special characters at the end.
- *Using the CUSTOM menu.* You can create a menu containing the functions, programs, and variables you use most often.
- *Using the* [XEQ] *(execute) key.* You can execute any calculator function by pressing [XEQ] and then typing the function name using the ALPHA menu.

You will also learn how to:

- Specify a parameter when a function prompts for additional information.
- *Preview* an instruction by holding down a key.

Using the Function Catalog

To execute a function using the function catalog:

1. Press ■ [CATALOG] FCN . (If you are planning on executing more than one function, you can prevent automatic exiting by selecting the CATALOG menu twice: ■ [CATALOG] ■ [CATALOG] FCN .)

2. Find the function you want to execute:
   - Use the [▲] and [▼] keys to move up and down through the menu. If you hold either of these keys down, they repeat so you can scroll quickly through the menu.
   - To return to the top of the catalog, press [EXIT] FCN .
3. To execute a function, press the corresponding menu key.

Example: Using the Function Catalog. Use the ASINH (*hyperbolic arc sine*) function to determine the hyperbolic arc sine of 15.

15	Y: 0.0000 X: 15_
■ [CATALOG] FCN	X: 15.0000 ABS ACOS ACOSH ADV AGRA AIP

Use the [▼] key to search the catalog until you find ASINH.

[▼] [▼]	X: 15.0000 ARCL AROT ASHF ASIN ASINH ASGN
ASINH	Y: 0.0000 X: 3.4023

The hyperbolic arc sine of 15 is 3.4023 (to four decimal places).

Using the CUSTOM Menu

The CUSTOM menu contains 18 blank menu labels. Each label can be redefined by assigning the name of a function, program, or variable. Therefore, you can tailor your own menu to include functions, programs, and variables you use most often.

Making CUSTOM Menu Key Assignments

To make a key assignment:

1. Press ■ [ASSIGN].

2. Use a catalog or the ALPHA menu to specify the function, program, or variable you want to assign:

- *Using a catalog:*

  a. Press FCN, PGM, REAL, CPX, or MAT.

  b. Press the menu key corresponding to the item you want to assign.

- *Using the ALPHA menu:*

  a. Press [ENTER] or ■ [ALPHA] to select the ALPHA menu.

  b. Type the name of the function, program, or variable.

  c. Press [ENTER] or ■ [ALPHA] to complete the name.

3. Press the menu key for the label to be assigned. There are 18 menu labels in the CUSTOM menu (numbered 01 through 18). Press [▼] to display the second row (labels 07 through 12). Press [▼] again to display the third row (labels 13 through 18). If you press a key for a label that already has an assignment, the new assignment replaces the previous one.

Example: Using the CUSTOM Menu. Assign the ACOSH (*hyperbolic arc cosine*) function to the first key in the CUSTOM menu and calculate the arc hyperbolic cosine of 27.

■ [ASSIGN] FCN

```
ASSIGN "_
ABS  ACOS ACOSH ADV  AGRA  AIP
```

The ACOSH function is in the first row of the function catalog.

ACOSH

```
ASSIGN "ACOSH" TO _
```

Now press the first key in the CUSTOM menu ([Σ+]).

[Σ+]

```
x: 3.4023
ACOSH
```

The assignment is ready to use.

27 ACOSH

```
x: 3.9886
ACOSH
```

Thus, the arc hyperbolic cosine of 27 is 3.9886 (to four decimal places).

Unlike other function menus, CUSTOM does not automatically exit after each use. Press [EXIT].

Clearing CUSTOM Menu Key Assignments

To clear a single key assignment:

1. Press ■[ASSIGN].
2. Press [ENTER] [ENTER] or ■[ALPHA] ■[ALPHA]. This terminates the prompt for a name.
3. Press the CUSTOM menu key for the label whose assignment you want to clear.

To clear all key assignments:

1. Press ■[CLEAR] [▼] to select the second row of the CLEAR menu.
2. Press CLKY .

Using the [XEQ] Key

To execute a function with [XEQ]:

1. Press [XEQ].
2. Press [ENTER] or ■[ALPHA] to select the ALPHA menu.
3. Type the name of the function.
4. Press [ENTER] or ■[ALPHA] to complete the entry.

For example, you can execute the BEEP function by pressing [XEQ] [ENTER] BEEP [ENTER].*

* If you are not sure how to type BEEP, refer to the instructions for using the ALPHA menu on page 37.

Specifying Parameters

Many functions require a parameter to specify exactly what the function is to do. For example, the ARCL function interprets a numeric parameter as a register number and an Alpha parameter as a variable name. Refer to the table below.

Function name

`ARCL 14`   `ARCL "ABC"`

Numeric parameter
(register number)

Alpha parameter
(variable name)

Functions That Require One Parameter

Functions	Numeric Parameter	Alpha Parameter
ARCL, ASTO, DSE, INPUT, ISG, RCL, STO, VIEW, X<>	Register number.*	Variable name.
ΣREG	Register number.*	-
CLV, DIM, EDITN, INDEX, INTEG, MVAR, PRV, SOLVE	-	Variable name.
CF, FC?, FC?C, FS?, FS?C, SF	Flag number.	-
ENG, FIX, SCI	Number of digits.	-
GTO, LBL†	Numeric program label.	Alpha program label.
XEQ	Numeric program label.	Function name or Alpha program label.
CLP,† PGMINT, PGMSLV, PRP†	-	Alpha program label.

* Functions that accept register numbers also accept stack registers as parameters. Refer to "Specifying Stack Registers as Parameters" below.

† Indirect addressing cannot be used with this function.

Functions That Require One Parameter (Continued)

Functions	Numeric Parameter	Alpha Parameter
DEL,† LIST†	Number of program lines.	-
SIZE†	Number of storage registers.	-
TONE	Tone number.	-

* Functions that accept register numbers also accept stack registers as parameters. Refer to "Specifying Stack Registers as Parameters" below.

† Indirect addressing cannot be used with this function.

Functions That Require Two Parameters

Functions	First Parameter	Second Parameter
ASSIGN	Function name, Alpha program label, or variable name.†	Key number (01 through 18).†
KEYG, KEYX	Key number (1 through 9).†	Program label (local or global).

† Cannot be specified using indirect addressing.

Numeric Parameters

Functions that accept numeric parameters display a cursor for each digit expected. For example, the FIX function prompts you with `FIX __`, which takes two digits.

To complete an instruction with a numeric parameter:

- Key a digit for each position marked by a cursor. Include leading zeros if there are any.
- *Or,* key in fewer digits and complete the function by pressing [ENTER].

For example, you can set the SIZE to 9 storage registers by pressing ■ [MODES] [▼] SIZE followed by 9 [ENTER] *or* 0009.

Alpha Parameters

If the function accepts Alpha parameters, you can select the ALPHA menu by pressing [ENTER] or ■[ALPHA]. After typing the parameter, press [ENTER] or ■[ALPHA] to complete the instruction. Digits typed while the ALPHA menu is displayed are treated as Alpha characters.

Many functions that take Alpha parameters automatically display an appropriate catalog menu. If the parameter you need already exists, select it by pressing the corresponding menu key.

For example, when you execute [STO] the calculator displays a catalog of all variables currently stored in the calculator. If there are more than six entries in the catalog, the ▼▲ annunciator indicates that you can use [▼] and [▲] to display the additional rows of the catalog menu.

Specifying Stack Registers as Parameters

Any function that uses a numbered storage register can also access any of the stack registers (X, Y, Z, T, and LAST X).

To specify a stack register as a parameter:

1. Execute the function. (For example, press [STO].)
2. Press [·].
3. Specify which register you want to address:
   - ST L for the LAST X register.
   - ST X for the X-register.
   - ST Y for the Y-register.
   - ST Z for the Z-register.
   - ST T for the T-register.

Refer to page 59 for examples using stack parameters.

Indirect Addressing—Parameters Stored Elsewhere

Parameters for many functions can be specified using *indirect addressing*. That is, rather than entering the parameter itself as part of the instruction, you supply the variable, storage register, or stack register that contains the actual parameter.

Indirect addressing is particularly useful in programs when the parameter for a function is calculated.

To specify a parameter using indirect addressing:

1. Execute the function.
2. Press [·]. If the calculator displays `IND __` after the function name, skip to step 4.
3. Press `IND`.
4. Specify where the actual parameter is located:
   - *In a variable.* Press a menu key to select the variable (the real-variable catalog is automatically displayed if there are any real variables) or type the name of the variable using the ALPHA menu.
   - *In a storage register.* Key in the register number (two digits or a single digit followed by [ENTER]).
   - *In a stack register.* Press [·] followed by `ST L`, `ST X`, `ST Y`, `ST Z`, or `ST T`.

Note Alpha parameters specified indirectly are limited to six characters because Alpha strings stored in variables and registers are limited to six characters.

Example: Indirect Addressing Using a Variable. Store 3 into *ABC*. Then store $\sqrt{7}$ in R_{03} using indirect addressing.

Keys	Display
3 [STO] [ENTER] ABC [ENTER]	Y: 3.9886 X: 3.0000
7 [$\sqrt{x}$]	Y: 3.0000 X: 2.6458

[STO] [.] IND ABC

```
Y: 3.0000
X: 2.6458
```

To see that the instruction was successful, recall the contents of R_{03}.

[RCL] 03

```
Y: 2.6458
X: 2.6458
```

Exercises: Specifying Parameters

Task: Set the display format to two decimal places.

Keystrokes: ■ [DISP] FIX 02

Task: Set the display format to engineering notation using the number of digits specified in the X-register.

Keystrokes: ■ [DISP] ENG [.] [.] ST X

Task: Store a copy of the X-register into the variable or storage register specified in the Y-register.

Keystrokes: [STO] [.] IND [.] ST Y

Task: Copy the first six characters of the Alpha register into the X-register. (In Alpha mode, the [STO] key executes the ASTO function.)

Keystrokes: ■ [ALPHA] [ASTO] [.] ST X

Task: Append a copy of the data in the T-register to the contents of the Alpha register. (In Alpha mode, the [RCL] key executes the ARCL function.)

Keystrokes: ■ [ALPHA] [ARCL] [.] ST T

Task: Test the flag specified by the number in the variable *F* (assuming *F* already exists).

Keystrokes: ■ [FLAGS] FS? [.] F

Function Preview and NULL

When you hold down a key that executes a function, the name of the function is displayed. This is a *preview* of the function.

If you hold the key down for about a second, the word `NULL` replaces the function name in the display and the function is not executed. If you release the key before `NULL` is displayed, the instruction is executed.

For example, press and hold the [TAN] key.

[TAN] *(hold down)*

```
TAN
x: 2.6458
```

```
NULL
x: 2.6458
```

The `NULL` message remains in the display until you release the key and the TAN function is not executed.

(release)

```
Y: 2.6458
x: 2.6458
```

You can preview instructions that include parameters by holding down the last key in the sequence that executes the instruction.

15 [STO] 02 (*hold down the* [2] *key*)

```
STO 02
x: 15.0000
```

```
NULL
x: 15.0000
```

(release)

```
Y: 2.6458
x: 15.0000
```

Since the instruction was aborted, the data in R_{02} was not overwritten.

5

Numeric Functions

Most of the functions built into the HP-42S are for numeric calculations. This chapter describes numeric functions for:

- General mathematics.
- Percent and percent change.
- Trigonometric calculations and conversions.
- Altering parts of numbers.
- Probability.
- Hyperbolics.

Many of the functions presented in this chapter do not appear on the HP-42S keyboard. The preceding chapter, "Executing Functions," describes how to execute functions that are not on the keyboard or in a menu.

Remember, there are two types of numeric functions:

- *One-number* functions, which replace the number in the X-register with a result (page 29).
- *Two-number* functions, which replace the numbers in the X- and Y-registers with a result and drop the stack (page 30).

General Mathematical Functions

The following table summarizes the general mathematical functions on the HP-42S keyboard. The Alpha name for each function is displayed when you hold down the key or when the function is entered into a program.

One-Number Functions

To Calculate	Press	Alpha Name
Negative of x.	[+/-]	+/−
Reciprocal of x.	[1/x]	1/X
Square root of x.	[$\sqrt{x}$]	SQRT
Square of x.	■ [x^2]	X↑2
Common logarithm of x.	[LOG]	LOG
Common exponential of x.	■ [10^x]	10↑X
Natural logarithm of x.	[LN]	LN
Natural exponential of x.	■ [e^x]	E↑X

Two-Number Functions

To Calculate	Press	Alpha Name
Sum of x and y ($x + y$).	[+]	+
Difference of x and y ($y - x$).	[−]	−
Product of x and y ($x \times y$).	[×]	×
Quotient of x and y ($y \div x$).	[÷]	÷
y to the x (y^x).	[y^x]	Y↑X

Example: Calculating a Cube Root. Calculate $\sqrt[3]{14}$. Since this can be expressed as an exponent ($14^{1/3}$), use the ■ [y^x] function.

Keys	Display
14 [ENTER] 3	Y: 14.0000 X: 3_
[1/x]	Y: 14.0000 X: 0.3333
■ [y^x]	Y: 0.0000 X: 2.4101

The cube root of 14 is 2.4101 (to four decimal places).

Percentages

The percentage functions are special two-number functions because, unlike other two-number functions, the stack does not drop when the result is returned to the X-register.

Simple Percent

The percent function (■[%]) calculates x% of y. For example, to calculate 12% of 300:

300 [ENTER] 12 ■[%]

```
Y: 300.0000
X: 36.0000
```

Since the original value is preserved in the Y-register, you can easily calculate another percentage of the same number. Clear the X-register and calculate 25% of 300.

[◆] 25 ■[%]

```
Y: 300.0000
X: 75.0000
```

The preservation of the y-value is also useful if you want to add it to the calculated percentage.

[+]

```
Y: 2.4101
X: 375.0000
```

This result is 300 plus 25% of 300 (or 125% of 300).

Percent Change

The %CH (*percent change*) function calculates the percentage of change from y to x.

Example: Calculating a Percent Change. The cost of blouses at Sonja's Boutique recently rose from $24.99 to $26.99. What was the percentage increase?

24.99 [ENTER] 26.99

```
Y: 24.9900
X: 26.99_
```

■ CATALOG FCN ▲ %CH

```
Y: 24.9900
X: 8.0032
```

The price increased slightly more than 8%.

Trigonometry

Setting Trigonometric Modes

The first row of the MODES menu (■ MODES) shows two sets of modes:

- The *angular mode* tells the HP-42S what unit of measure to assume for numbers used with trigonometric functions.

  360 degrees = 2π radians = 400 grads

- The *coordinate mode* indicates how complex numbers are displayed—rectangular or polar notation. Refer to chapter 6 for a complete description of complex numbers.

To change a mode, press the corresponding menu key.

■ MODES →

DEG	*Degrees* (no annunciator).*
RAD	*Radians* (**RAD** annunciator).
GRAD	*Grads* (**GRAD** annunciator).
RECT	*Rectangular.**
POLAR	*Polar.*

Trigonometric Functions

To calculate the sine, cosine, or tangent of an angle, use the trigonometric functions on the keyboard. For example, to calculate the sine of 30°, press 30 SIN.

* Default setting.

To calculate an angle, use the inverse trigonometric functions on the keyboard. For example, to calculate the angle that produces a sine of 0.866, press .866 ■ [ASIN] (*arc sine*).

The trigonometric functions (including the inverse functions) observe the current angular mode for all calculations.

Example: Using the COS Function. Show that the cosine of $(5/7)\pi$ radians and the cosine of 128.57° are the same (to four decimal places). Start by setting Radians mode (**RAD** turns on).

■ [MODES] **RAD**

```
Y: 24.9900
X: 8.0032
```

Calculate $(5/7)\pi$.

5 [ENTER] 7 [÷] ■ [π] [×]

```
Y: 8.0032
X: 2.2440
```

Calculate the cosine of $(5/7)\pi$.

[COS]

```
Y: 8.0032
X: -0.6235
```

Now, switch to Degrees mode (**RAD** turns off).

■ [MODES] **DEG**

```
Y: 8.0032
X: -0.6235
```

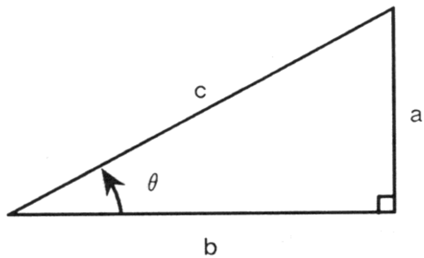
Calculate the cosine of 128.57°.

128.57 [COS]

```
Y: -0.6235
X: -0.6235
```

When you're done, both results are in the display for you to compare.

Example: Calculating an Angle. The angle θ in the following triangle can be determined by using the *arc* (inverse) trigonometric functions.



θ = arc sine $(^a/_c)$ = arc cosine $(^b/_c)$ = arc tangent $(^a/_b)$

Suppose $a = 4$ and $c = 8$. What is θ?

4 [ENTER] 8 [÷]

```
Y: -0.6235
X: 0.5000
```

■ [ASIN]

```
Y: -0.6235
X: 30.0000
```

The angle θ is 30°.

The Conversion Functions

The first row of the CONVERT menu (■ [CONVERT]) contains six functions for converting trigonometric units or coordinates.

■ [CONVERT]

→DEG	*Radians to degrees.*
→RAD	*Degrees to radians.*
→HR	*Hours-minutes-seconds to hours.*
→HMS	*Hours to hours-minutes-seconds.*
→REC	*Polar to rectangular.*
→POL	*Rectangular to polar.*

Converting Between Degrees and Radians

The →DEG (*to degrees*) function converts a real number in the X-register from radians into decimal degrees. Conversely, the →RAD (*to radians*) function converts a real number in the X-register from decimal degrees into radians. (The current angular mode is ignored by these two functions.)

For example, convert 0.5 radians to degrees.

.5 ■ CONVERT →DEG

```
Y: 30.0000
X: 28.6479
```

Convert 30° to radians.

30 ■ CONVERT →RAD

```
Y: 28.6479
X: 0.5236
```

Using the Hours-Minutes-Seconds Format

The HP-42S has four functions for working with numbers expressed in hours-minutes-seconds format. You may use this format for time values (*H.MMSSss*) or angles expressed in degrees (*D.MMSSss*). For example, the following numbers could represent the time 15:25:18.98 or the angle 15°25′18.98″:

15.251898

Hours or degrees · Minutes · Seconds (18.98)

15.4219

Hours or degrees in decimal format (rounded to four decimal places)

Converting Between Formats. Values for time (in hours) or angles (in degrees) can be converted between decimal-fraction form and hours-minutes-seconds form using the one-number functions →HR (*to decimal hours*) and →HMS (*to hours-minutes-seconds*).

For example, convert 1.25 hours to hours-minutes-seconds format.

1.25 ■ CONVERT →HMS

```
Y: 0.5236
X: 1.1500
```

Executing →HR would change 1.1500 (that is, 1:15:00 or 1°15′00″) back to 1.2500.

Arithmetic With Minutes and Seconds. To add and subtract time (or angle) values in hours-minutes-seconds form, use the HMS+ (*hours-minutes-seconds, add*) and HMS− (*hours-minutes-seconds, subtract*) functions.

For example, if a meeting started at 9:47 a.m. and adjourned at 1:02 p.m., how long was the meeting? Enter the two times in hours-minutes-seconds format. (Enter 1:02 p.m. as 13:02.)

13.02 [ENTER] 9.47

```
Y: 13.0200
X: 9.47_
```

Execute HMS− using the function catalog.

■ [CATALOG] FCN

Use [▼] and [▲] to find the HMS− function. (Remember, these keys repeat if you hold them down.) When you find the function, execute it by pressing the corresponding menu key.

HMS-

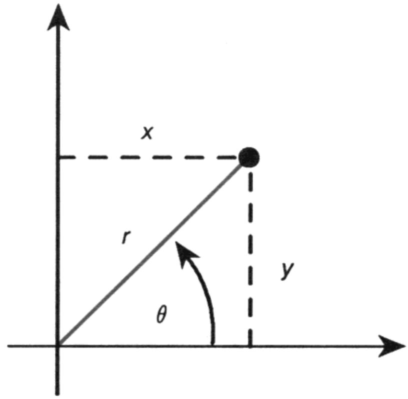
```
Y: 1.1500
X: 3.1500
```

The meeting lasted 3 hours and 15 minutes.

To multiply or divide using an hours-minutes-seconds value, first convert the number to decimal hours (■ [CONVERT] →HR), then perform the arithmetic. If you need the result expressed in hours-minutes-seconds format, convert it back (■ [CONVERT] →HMS).

Coordinate Conversions (Polar, Rectangular)

The coordinate conversion functions are →REC (*to rectangular*) and →POL (*to polar*). The rectangular coordinates (x,y) and the polar coordinates (r,θ) are measured as shown in the illustration below. The angle θ is measured in the units set by the current angular mode. (The current coordinate mode is ignored by these two functions.)



Before converting a set of coordinates, be sure the angular mode is set to the proper units for θ (page 80).

To convert rectangular to polar coordinates:

1. Key in the y-coordinate and press [ENTER].
2. Key in the x-coordinate.
3. Press ■ [CONVERT] →POL. The polar coordinates (r and θ) replace x and y in the X- and Y-registers.

To convert polar to rectangular coordinates:

1. Key in θ and press [ENTER].
2. Key in the radius, r.
3. Press ■ [CONVERT] →REC. The rectangular coordinates (x and y) replace r and θ in the X- and Y-registers.

Altering Parts of Numbers

The second row of the CONVERT menu contains the following functions:

■ [CONVERT] [▼] →

IP	*Integer part.*
FP	*Fractional part.*
RND	*Round.*
ABS	*Absolute value.*
SIGN	*Sign.*
MOD	*Modulo.*

Integer Part (IP). The IP function removes the fractional part of a real number. For example, the integer part of 14.2300 is 14.0000.

Fractional Part (FP). The FP function removes the integer part of a real number. For example, the fractional part of 14.2300 is 0.2300.

Rounding Numbers (RND). The RND function rounds a real number to the number of digits specified by the current display format. For example, to round a dollar value to the nearest penny, set the display format to FIX 2 and then execute RND (■ [DISP] FIX 02 ■ [CONVERT] [▼] RND).

Absolute Value (ABS). The ABS function replaces the number in the X-register with its absolute value. If the X-register contains a complex number, ABS returns *r* (the radius).

The Sign of a Number (SIGN). The SIGN function tests a real number in the X-register and returns:

- 1 if x is a number greater than or equal to zero.
- -1 if x is a number less than zero.
- 0 if x is not a number.

If the X-register contains a complex number, SIGN returns the two-dimensional *unit vector* (which is also a complex number).

Modulo (MOD). The MOD function calculates the remainder of $y \div x$ (where x and y are real numbers).

Probability

The PROB (*probability*) menu contains the following functions:

■ PROB →

COMB	*Combinations.*
PERM	*Permutations.*
N!	*Factorial.*
GAM	*Gamma.*
RAN	*Random number* ($0 \leqslant x < 1$).
SEED	*Seed.*

The Probability Functions

Combinations. The COMB (*combinations*) function calculates the number of possible *sets* of y different items taken in quantities of x items at a time. No item occurs more than once in a set, and different orders of the same x items are *not* counted separately. The formula is

$$C_{y,x} = \frac{y!}{x!(y - x)!}.$$

Permutations. The PERM (*permutations*) function calculates the number of possible different *arrangements* of y different items taken in quantities of x items at a time. No item occurs more than once in an arrangement, and different orders of the same x items *are* counted separately. The formula is

$$P_{y,x} = \frac{y!}{(y - x)!}.$$

Factorials. The N! (*factorial*) function calculates the factorial of the real number (integers only) in the X-register. For example, calculate 5!.

5 [PROB] N!

```
Y: 3.1500
X: 120.0000
```

Gamma. The GAMMA function calculates $\Gamma(x)$. Key in x and then press [PROB] GAM.

Generating a Random Number

To generate a random number: Press [PROB] RAN. The RAN function returns a number in the range $0 \leqslant x < 1$.*

The calculator uses a *seed* to generate random numbers. Each random number generated becomes the seed for the next random number. Therefore, a sequence of random numbers can be repeated by starting with the same seed.

To store a new seed:

1. Key in any real number.
2. Press [PROB] SEED.

Whenever Continuous Memory is reset, the seed is reset to zero. When the seed is equal to zero, the calculator generates a seed internally.

* The random number generator in the HP-42S actually returns a number that is part of a uniformly distributed pseudorandom number sequence. This sequence passes the spectral test (D. Knuth, *Seminumerical Algorithms*, vol. 2, London: Addison Wesley, 1981).

Hyperbolic Functions

To use a hyperbolic function, key in x, then execute the function.

To Calculate:	Execute:
Hyperbolic sine of x.	SINH
Hyperbolic cosine of x.	COSH
Hyperbolic tangent of x.	TANH
Hyperbolic arc sine of x.	ASINH
Hyperbolic arc cosine of x.	ACOSH
Hyperbolic arc tangent of x.	ATANH

6

Complex Numbers

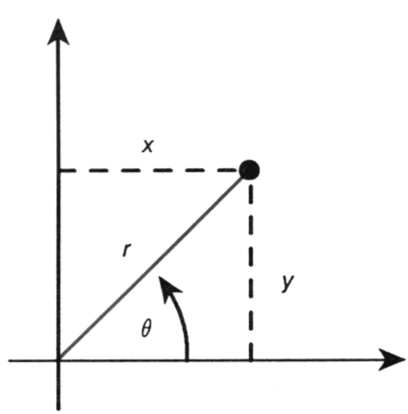
As mentioned in chapter 3, complex numbers are one of the four types of data used by the HP-42S. In this chapter you will learn:

- How to enter complex numbers.
- How complex numbers are stored and displayed.
- How to do arithmetic with complex numbers.
- How to convert the storage registers to hold complex numbers.

Entering Complex Numbers

There are two common notations for writing a complex number z:

- *Rectangular* form: $z = x + iy$.
- *Polar* form: $z = r \measuredangle \theta$.



The following relationships exist and define how the two forms are related.

$$x = r \cos \theta$$

$$y = r \sin \theta$$

$$r = \sqrt{x^2 + y^2}$$

$$i = \sqrt{-1}$$

There are two parts to a complex number: x and y, or r and θ. Each part may be any real number. The angle θ is expressed using the current angular mode (Degrees, Radians, or Grads).

To key in a complex number:

1. If necessary, set the correct coordinate and angular modes (using the MODES menu).
2. Key in the left-hand part (x or r); press [ENTER].
3. Key in the the right-hand part (y or θ).
4. Press ■[COMPLEX] to convert the two real numbers in the X- and Y-registers to a complex number in the X-register. Each part is displayed using the current display format.

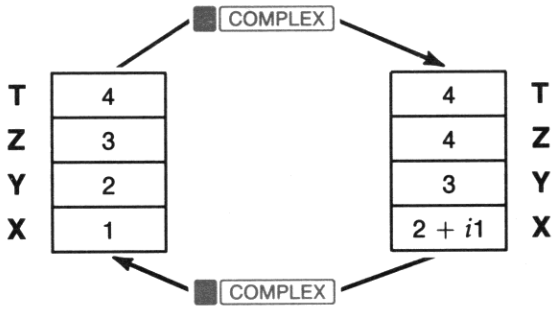
For example, to key in the complex number $2 + i1$, press 2 [ENTER] 1 ■[COMPLEX].

The coordinate mode (Rectangular or Polar) determines how the calculator interprets and displays complex numbers (as $x + iy$ or $r \measuredangle \theta$).

How ■[COMPLEX] Works:

- If the X- and Y-registers contain real numbers, executing ■[COMPLEX] combines them to form a complex number.

- If the X-register contains a complex number, executing ■ COMPLEX separates the number into two real numbers. The left-hand part goes into the Y-register and the right-hand part stays in the X-register.

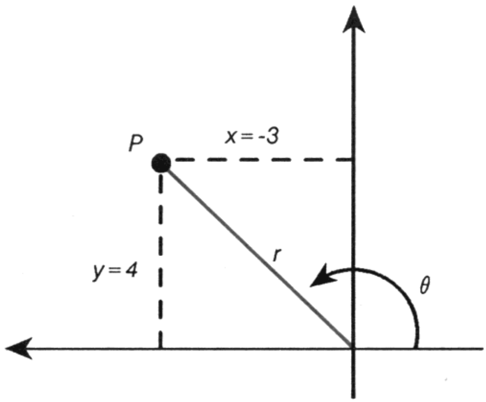


How Complex Numbers Are Displayed

Internally, the calculator always stores complex numbers in rectangular form. This has the following effects when Polar mode is used:

- The angle θ is always *normalized.* That is, the angle portion of a complex number is never larger than $\pm 180°$ ($\pm\pi$ radians).
- If a complex number is keyed in with a negative radius, the radius is made positive. The angle θ is increased by 180° (π radians) and then normalized.
- If a complex number is keyed in with a radius of zero, the angle portion of the number is also reduced to zero.

If either part of a complex number is too large or too small to display using the current display format, both parts are displayed using engineering notation (ENG 2). To view both parts of a complex number using full precision, press and hold ■ SHOW.



The following four complex numbers are equivalent representations of the point P shown above.

Coordinate Mode:	Angular Mode:	Display:
Rectangular	Any	-3.0000 i4.0000
Polar	Degrees	5.0000 ∡126.8699
Polar	Radians	5.0000 ∡2.2143
Polar	Grads	5.0000 ∡140.9666

Arithmetic With Complex Numbers

Most of the arithmetic functions in the previous chapter work with complex numbers as well as real numbers. For example, calculate the following expression:

$$(5 + i3) + (7 - i9).$$

Ensure the calculator is in Rectangular mode.

■ MODES RECT

```
Y: 0.0000
X: 0.0000
```

Enter the two numbers.

5 [ENTER] 3 ■[COMPLEX]
7 [ENTER] 9 [+/-] ■[COMPLEX]

```
Y: 5.0000 i3.0000
X: 7.0000 -i9.0000
```

And add them.

[+]

```
Y: 0.0000
X: 12.0000 -i6.0000
```

Complex Results Produced by Real-Number Functions. Some real-number functions can produce a complex number as a result. For example, calculating the square root of a negative number produces the appropriate complex number.

Multiply the result from the calculation above by $\sqrt{-25}$.*

25 [+/-] [$\sqrt{x}$]

```
Y: 12.0000 -i6.0000
X: 0.0000 i5.0000
```

[×]

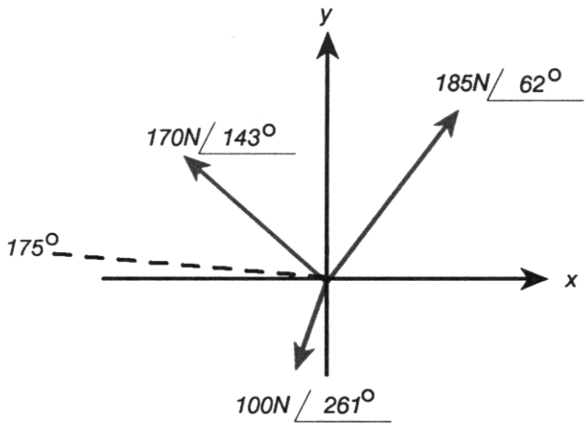
```
Y: 0.0000
X: 30.0000 i60.0000
```

Vector Operations Using Complex Numbers

A complex number can represent a vector in a two-dimensional plane. Using the vector functions in the second row of the MATRIX menu (page 220), you can perform vector operations with complex numbers.

Example: Dot Product of Complex Numbers. The figure below represents three two-dimensional force vectors. Use complex numbers and add the three vectors. Then use the DOT (*dot product*) function to find the component of the resulting vector along the 175° line.

* The calculator's ability to produce complex results with real-number functions can be disabled by pressing ■[MODES] [▼] RRES (*real results only*). To enable complex results (after they have been disabled with RRES), press ■[MODES] [▼] CRES (*complex-result enable*).



Select Degrees and Polar modes.

■ [MODES] DEG ■ [MODES] POLAR

```
Y: 0.0000
X: 67.0820 ∠63.4349
```

Add the three vectors.

185 [ENTER] 62 ■ [COMPLEX]

```
Y: 67.0820 ∠63.4349
X: 185.0000 ∠62.0000
```

170 [ENTER] 143 ■ [COMPLEX]

```
Y: 185.0000 ∠62.0000
X: 170.0000 ∠143.0000
```

[+]

```
Y: 67.0820 ∠63.4349
X: 270.1198 ∠100.4332
```

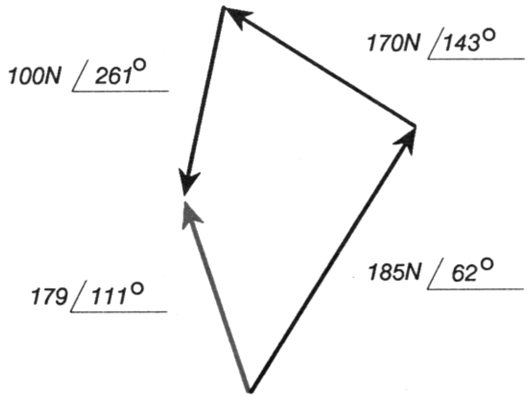
100 [ENTER] 261 ■ [COMPLEX]

```
Y: 270.1198 ∠100.4332
X: 100.0000 ∠-99.0000
```

[+]

```
Y: 67.0820 ∠63.4349
X: 178.9372 ∠111.1489
```

Thus, the resulting sum is a force of approximately 179 Newtons at 111°.



Now calculate the 175° component of this result.

1 [ENTER] 175 ■[COMPLEX]

```
Y: 178.9372 ∡111.1489
X: 1.0000 ∡175.0000
```

■[MATRIX] [▼] DOT

```
X: 78.8586
 DOT  CROSS UVEC  DIM  INDEX EDITN
```

Thus, the resulting sum has a component of approximately 79 Newtons in the direction of 175°.

[EXIT]